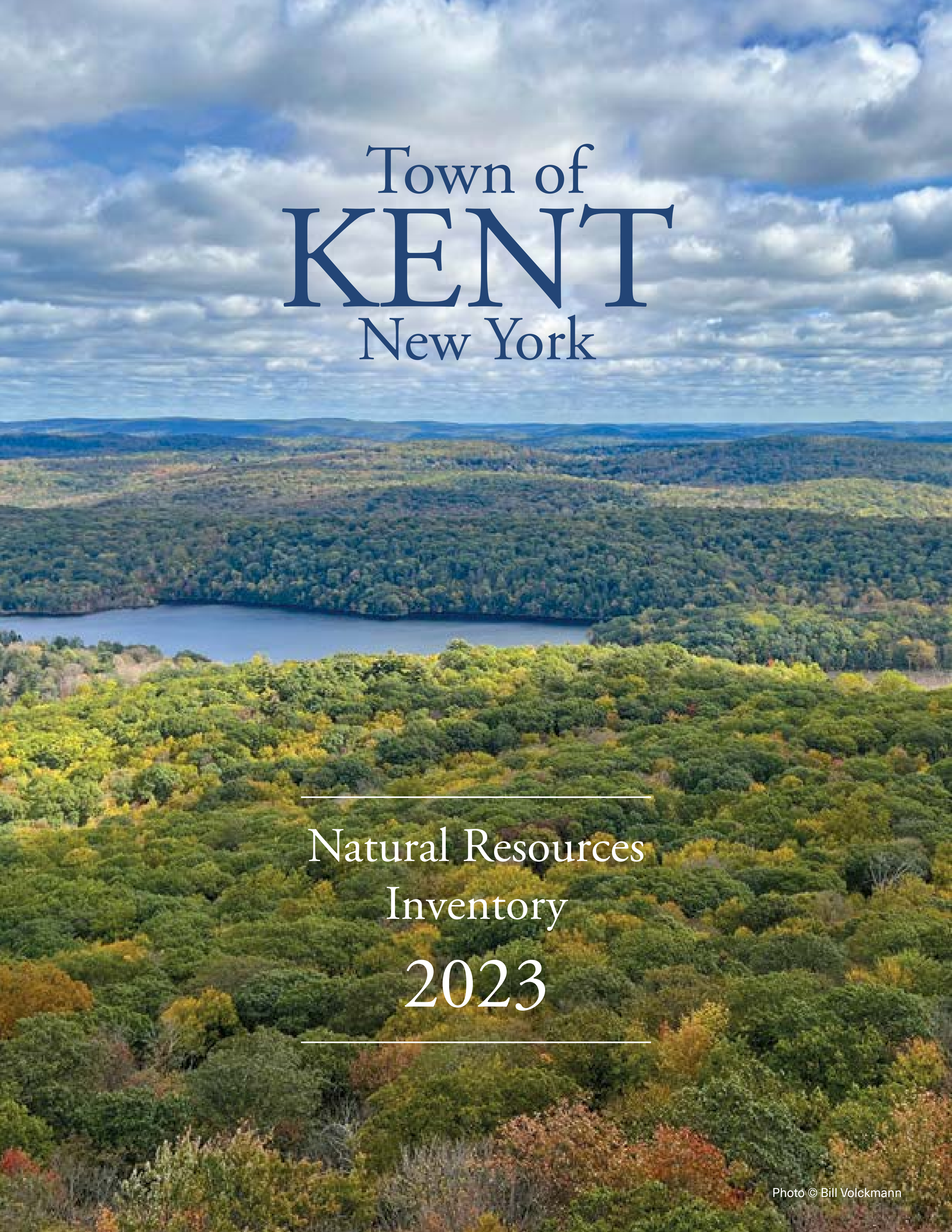

Town of KENT New York

Natural Resources Inventory 2023

Photo © Bill Volckmann

Town of
KENT
New York

NATURAL RESOURCES INVENTORY

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TABLE OF CONTENTS

TABLES

FIGURES

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-- Gretchen Stevens, Chris Graham, and the NRI Steering Committee

SUMMARY

Little Buck Pond. Photo © Dod Charoudi.

This *Natural Resources Inventory* (*NRI*) for the Town of Kent describes and illustrates many aspects of the Kent landscape — topography, bedrock, soils, groundwater, surface water, habitats, plants and animals, farmland, and more — and the significance of those resources to local ecosystems and the people of Kent.

Kent has changed much since the departure of the last glacier ca. 18,000 years ago. The barren land — scraped clean of vegetation and topsoil by the massive ice sheet — was slowly populated by plants and animals, including humans who arrived in the Hudson Valley in the early millennia of the post-glacial period. For thousands of years since then, the local natural resources provided for most of the day-to-day needs — for food, clothing, shelter, and tools — of the Indigenous people. For much of that time the land was substantially forested, and remained so by the time Europeans started arriving in the Hudson Valley in the early 1600s. Over the next two centuries, the forest was cut for timber and fuel, and cleared for agriculture, and many streams were dammed to provide water power to saw mills, grist mills, fulling mills, tanneries, and other local resource-based industry. By the mid-1800s, much of the forest was gone and Kent's hills and valleys had become hayfields, pastures, and cropfields. By the late 1800s some of the region's keystone species — American beaver, eastern wolf, eastern cougar, white-tailed deer — had been trapped and hunted to regional extirpation.

A combination of factors led to the decline of agriculture and industry in the late 1800s and early 1900s. Since then, forests have retaken the land, and today the livelihoods of most Kent residents are earned elsewhere — no longer depending on hunting, trapping, farming, logging, mining, milling, or other uses of local natural resources. Nonetheless, the people of Kent still depend on forests to provide clean air and clean and abundant drinking water, to moderate local air temperatures, to support wildlife, and to store large amounts of carbon. The lakes of Kent are scenic centerpieces for residential development, and the beauty of Kent's landscape is prized by everyone.

This *NRI* was created to inform the people of Kent about the natural resources of the town, and to identify aspects of the town that deserve special attention in planning and decision-making about our uses of the land. For example, the unconsolidated aquifers that underlie several areas of the town hold abundant and easily accessible groundwater for residential wells, but may be especially vulnerable to contamination from our land use activities. Kent has many large and small streams, and several have the clean, coolwater conditions and unsilted stream bottoms required by trout and many other sensitive aquatic organisms. These conditions will persist only if we can protect the streams from sediment- and salt-laden runoff, warming, and other forms of pollution. The NRI describes the great value of forests for wildlife, water resources, carbon storage, climate moderation, and many other services provided to the ecosystem and to the human community. Large, unfragmented forests are especially important for the area-sensitive wildlife that do poorly in small habitat areas, and tend to disappear from suburbanizing landscapes.

Kent has many of the habitat types that are common in the region — hardwood and coniferous forests, shrublands, upland and wet meadows, marshes, hardwood swamps — as well as some that are less common, such as oak-heath barrens, ledge and talus habitats, highbush blueberry bog thickets, and a “poor fen.” The NRI includes a long list of rare plant and animal species that are known to occur in Kent. Understanding the kinds of habitats where rare species occur can help us recognize and protect those places before the rarities are lost. Ongoing biodiversity surveys by Bill Buck and Beth Herr are greatly increasing our knowledge of the biological resources of the town.

Kent’s forests have been fragmented by many roads, but large forests still remain, some exceeding 1000 acres, and are part of a regionally significant forest “linkage zone” connecting even larger forests of the region. Some of Kent’s forest areas rank in the 90th percentile and higher compared to other Hudson Valley forests, using measures of size, fragmentation, habitat connectivity, habitat values, and carbon sequestration values, according to an analysis conducted by the New York Natural Heritage Program. Maintaining the town’s high-quality forests intact will ensure that local ecosystems and the people of Kent can continue to benefit from the important ecosystem services they provide.

Although map data from the Federal Emergency Management Agency show 100-year flood zones only along Stump Pond Stream, Horse Pound Brook, Peekskill Hollow Creek and around the edges of several lakes and reservoirs, many of the smaller streams also have significant floodplains that deserve prominent consideration in planning for or permitting new development. Prohibiting the building of new structures in floodplains is an obvious precaution these days when large floods are becoming more frequent, more extensive, and more damaging. Allowing streams to expand unobstructed across their floodplains as needed during large runoff events attenuates downstream flooding and also helps to support the stream ecosystem.

Agriculture once dominated the economic and cultural life of the town, but is now restricted to a few active farms at scattered locations. Still, Kent has significant areas of good farmland soils. Future market forces, local economies, natural events, and local needs are hard to predict, but the town may wish to preserve the capability to produce food locally. If so, adopting measures to protect the best farmland soils from non-farm development would be a necessary step.

Scenic beauty is the natural resource that may be most appreciated in the daily lives of the people of Kent. The lakes and reservoirs, the forested hills, the vistas from high places, and the more intimate views of rocky streams, mossy ledges, and old stone walls comprise the visual signature of the town and provide an immediate connection to the land for residents and visitors. Furthermore, the public roads and the large areas of parks, NYCDEP lands, and other public-use areas in Kent make the beauty of the landscape accessible to everyone. There are no regulatory protections for scenic areas in Kent that are not on formally protected land. A project to survey and map the most scenic locations could provide the basis for future legislation and site design standards aimed at protecting the places of greatest importance.

Among Kent's great natural assets are the large areas of land in state, county and town parks, state-owned Multiple Use Areas, and New York City-owned lands that offer abundant opportunities for outdoor public recreation. The sites are variously open for hiking, biking, snowshoeing, hunting, fishing, rustic camping, swimming, and other activities for Kent residents and visitors alike.

Prominent threats to natural resources of concern in Kent include:

- fragmentation of forests and other habitat areas;
- contamination of streams, lakes, and groundwater from
  - de-icing salts applied to roads and driveways,
  - petroleum hydrocarbons and other pollutants in runoff from roads, driveways, and parking lots,
  - fertilizers and pesticides in runoff from lawns, and
  - failing septic systems;
- nighttime lighting which disrupts the behavior of many kinds of wildlife and kills many insects;
- non-native insect pests, diseases, and pathogens which are assisted by the changing climate;
- non-native invasive plants which disrupt native communities of plants and animals;
- human-subsidized predators which disrupt natural communities around human-settled areas;
- the over-abundant deer population which is transforming our forest communities; and
- climate change, which presents ongoing challenges to water resources, ecosystems, and human health.

Kent is fortunate that approximately 44 percent of the town has some kind of formal protected status, including fee-owned parcels of federal, state, county, and town governments and Putnam County Land Trust, as well as conservation easements held by the New York City Department of Environmental Protection. In addition to lands with formal protected status, however, all the other privately-held lands in Kent can also be managed to promote clean and abundant surface water and groundwater, native biodiversity, and climate resilience.

The *NRI* includes lists of general conservation measures for water resources, biodiversity, farmland, and scenic and recreation resources, with many ideas applicable to parcels of any size in public or private ownership — for example, by landowners who are thinking about managing their own lands, by developers who are considering the location or design of a new development project, and by town agencies who are reviewing new projects, revising the Comprehensive Plan, or considering new legislation for resource protection.

Dramatic worldwide declines in biodiversity and the many adverse effects of climate change have magnified the urgency of environmental protections. Taking care of the land is the responsibility of everyone who lives here, but town government can help by educating landowners, strengthening protections for natural resources, and fostering a culture of sound stewardship.

After studying the natural resources of Kent, their condition, their importance to the town, and the existing regulatory protections at the local, state, and federal levels, the *NRI* Steering Committee has developed a list of Recommendations for Conservation Action that can be carried out by town agencies and by individual landowners. The recommendations include, for example, ideas for strengthening the Kent local code, improving environmental review procedures, identifying important scenic areas, and proactively preparing for large floods, droughts and other disruptions brought on by the changing climate. The recommendations are aimed at ensuring that Kent's high-quality natural resources are able to persist and serve the ecosystems and people of Kent long into the future.

INTRODUCTION

Pastel sky above West Branch Reservoir. Photo © Alexander Milligan.

This *Natural Resources Inventory* (*NRI*) is a reference document with information about physical and biological resources, their significance to local ecosystems and the people of Kent, and recommendations for sustainable uses and conservation. The *NRI* is intended for use by town agencies, landowners, developers, conservation NGOs, and everyone else who is interested in the natural features of the town.

The 2008 Kent *Comprehensive Plan* called for the development of a Natural Resources Inventory to be used for land use planning and decision-making. In 2021, the town was awarded a grant for this project from the Hudson River Estuary Program of the New York State Department of Environmental Conservation with funds from the NYS Environmental Protection Fund. The Kent Conservation Advisory Committee (CAC) convened the *NRI* Steering Committee which included members of the Town Board, the Planning Board, the CAC, the town's environmental consultant, the town historian, and other town residents with natural resource expertise. The town hired Hudsonia Ltd. to compile information and prepare the *NRI* document, and the project was carried out in 2022-2023.

The natural resource information in the *NRI* is compiled from many sources—federal, state, and county agencies, Town of Kent documents, books on Kent history, peer-reviewed scientific literature, published and unpublished reports and field notes from scientists, naturalists, and other local observers of the natural world. Great contributions to the document are the data gathered during ongoing biodiversity studies by retired biologist Bill Buck and retired naturalist Beth Herr, and the many photographs of plants, animals, habitats, and landscapes taken by Kent residents.

Basic descriptions of bedrock and surficial geology, soils, watersheds, groundwater, and surface water are followed by descriptions of the distribution, character, and condition of resources—including mineral, water, and biological resources, farmland, scenic areas, and public areas for outdoor recreation. A brief history of human uses of Kent's natural resources helps to explain how the natural setting has shaped the past and present-day economy, culture, and development of the town, and how those uses have affected the landscape today. A discussion of threats to the town's natural resources includes adverse effects of local uses of the land and water, and the multiple threats imposed by the changing climate. Finally, a discussion of existing protections for natural resources is followed by recommendations for additional measures—both voluntary and regulatory—that can help to ensure that high-quality natural resources persist long into the future, and continue to support Kent's ecosystems and people.

BACKGROUND

Kent is a rural town of 43.33 square miles in Putnam County in the Hudson Valley of southeastern New York. The population as of the 2020 US Census was 12,900, at a density of 298 persons per square mile. (For comparison, the neighboring Town of Carmel had a density of 930 persons per square mile, and the nearby town of Philipstown had 191 persons per square mile.) The main population center in Kent is the hamlet of Lake Carmel which surrounds the lake of that name in the southeastern part of town (Figure 1). Residences are also clustered around several other lakes (e.g., Barrett Pond, China Pond, Sagamore Lake, Seven Hills Lake) and in a few outlying neighborhoods, and are also distributed along the rural roads. As there is little industry, few retail businesses, and few institutional employers in Kent, most of the working residents are employed elsewhere.

Although the town has an agricultural past, today the hilly, rocky terrain is largely forested. The extraordinary number of lakes and large areas of high-quality forests are features that set Kent apart from many other Hudson Valley towns.

Nearly all of Kent is in the watersheds of New York City drinking water reservoirs, and ca. 6,338 acres in Kent are owned and managed by the New York City Department of Environmental Protection (NYCDEP) for protecting the water quality of those reservoirs. The NYCDEP also holds conservation easements on 1043 additional acres of privately-held land in Kent. Other large and small land areas are in state parks, state forests, state "multiple use areas," a county park, and town parks. Together the land owned and managed by public agencies for conservation and recreation totals 12,132 acres, representing approximately 44 percent of the town.

Trout-lily is one of the "spring ephemeral" wildflowers that blooms early before the forest canopy has leafed out. Photo © Beth Herr.

1. Town of Kent, NY

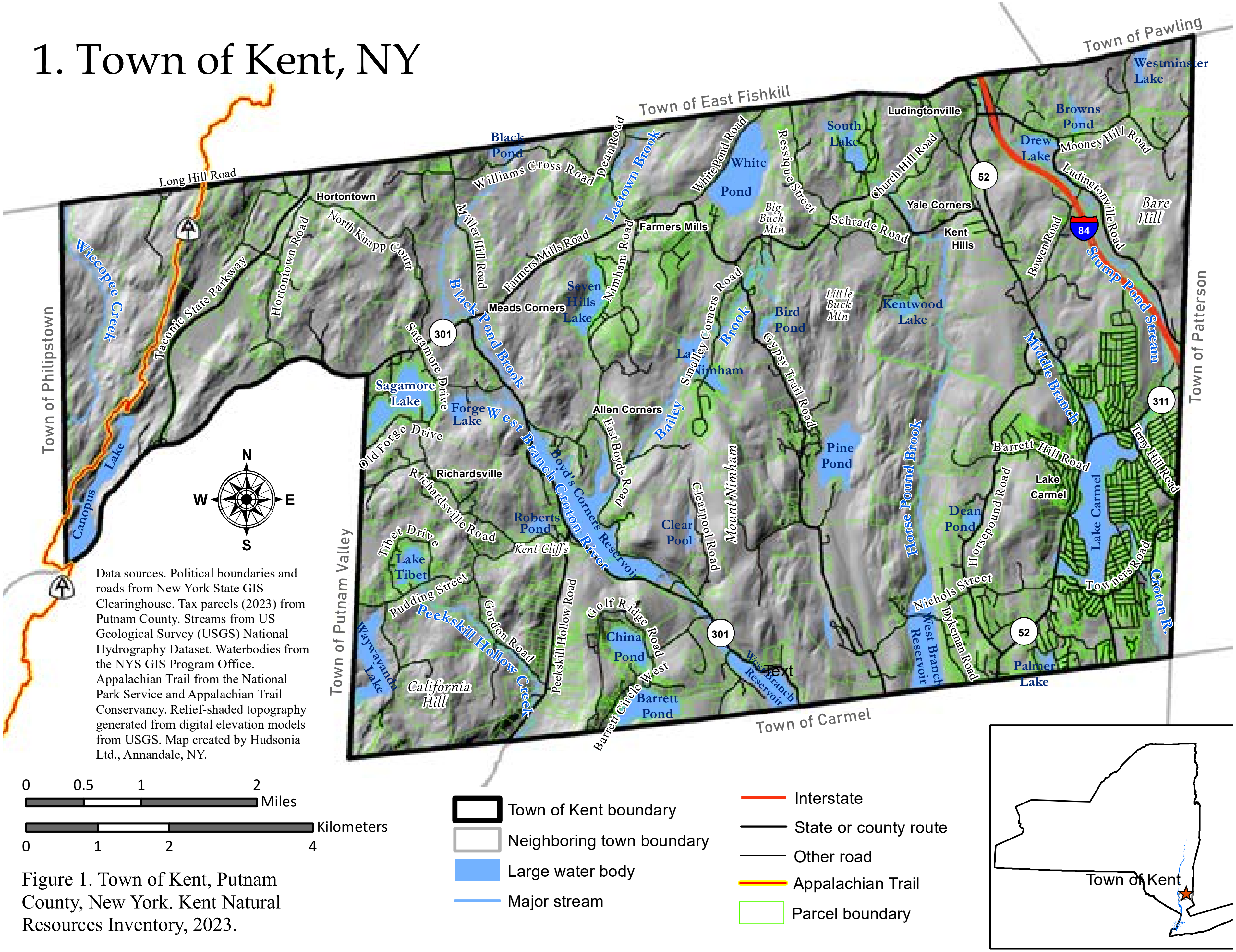


Figure 1. Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

PHYSICAL SETTING

Topography

Kent is a town of hills and ridges, valleys, lakes and streams. The highest elevations in Kent are 1273 feet above sea level (asl) at the summit of Mount Nimham, and 1238 feet asl near the Appalachian Trail in the western panhandle (Figure 2). Other high summits are California Hill and the hills to the north, and the unnamed hills just west of the Lake Carmel hamlet. Prominent valleys are Canopus Hollow, Peekskill Hollow, Whang Hollow, and the Horse Pound Brook corridor.

The lowest elevations in Kent are 426 feet asl in the West Branch Croton Reservoir and 454 feet where Peekskill Hollow Creek crosses the southern Kent boundary.

The terrain is rugged and rocky. More than half the town is on slopes of 15 percent and steeper, and large areas are much steeper (25+ percent) (Figure 3). Exposed bedrock and talus slopes are common throughout, and especially in the steepest areas. (Talus is the loose rock that often accumulates on slopes below exposed ledges.)

Geology

Bedrock

The Town of Kent lies entirely within the Hudson Highlands, a region of hills in the Appalachian Mountain range. The Hudson Highlands is part of the "Reading Prong" geological province of the Appalachian Mountains, extending from Connecticut to Pennsylvania and linking the Green Mountain province in the north to the Blue Ridge in the south.

The Highlands bedrock of metamorphosed sedimentary and igneous rocks is estimated to be more than one billion years old. The mountains and hills of the Highlands were formed during the Grenville Orogeny, a collision of tectonic plates approximately 1.1 to 1.3 billion years ago that also formed the Adirondacks and the Green Mountains.[1] The jagged heights of the Highlands have since been worn down by weathering and erosion, and by the several glaciations occurring here.

Garnet-bearing gneiss. Photo © Silvia Hartmann.

General Rock Types

- **metamorphic rock** Rock that has been transformed in texture and composition by heat, pressure, or chemically active solutions.
- **igneous rock** Rock formed from solidification of molten material deep in the Earth or from volcanic processes.
- **sedimentary rock** Rock formed by layered deposition of mineral and organic material.
- **carbonate rock** Sedimentary rock composed of carbonate minerals, chiefly calcium carbonate ($CaCO_3$) or calcium magnesium carbonate ($CaMg[CO_3]_2$).

Figure 4 gives a very generalized overview of the bedrock geology of Kent. Most of the town is underlain by gneiss in various permutations. Gneiss is a metamorphic rock formed from igneous and sedimentary rocks, with visually distinctive bands and lenses of varying mineral composition. Predominant in Kent are "biotite granitic gneiss" and "biotite-quartz-plagioclase gneiss" which are rich in mica, quartz, and feldspar. Areas of amphibolite—with prism-like or needle-like crystals—occur along the Taconic Parkway, at California Hill, east of Mount Nimham, and in several other small areas. Garnet-bearing gneiss occurs at the western end of the Kent panhandle, and may be seen in rock outcrops along the Appalachian Trail.

Rocks and Minerals

amphibolite	A coarse-grained metamorphic rock composed mainly of green, brown, or black crystalline (amphibole) minerals and plagioclase feldspar.
argillite	A fine-grained compact rock derived from mudstone or shale.
biotite	A large group of black mica minerals (sheet silicates) that are commonly found in igneous and metamorphic rocks.
feldspar	A large group of rock-forming silicate minerals found in igneous, metamorphic, and sedimentary rocks.
gneiss	A foliated (layered) metamorphic rock formed from igneous or sedimentary rocks and distinguished by bands and lenses of varying mineral composition.
granite	A light-colored igneous rock composed mainly of quartz and feldspar; it may be red, pink, gray, or white with dark mineral grains.
graywacke	An impure gray sandstone.
limestone	A fine-grained sedimentary rock composed of calcium carbonate.
metagraywacke	A partially metamorphosed graywacke.
phyllite	A fine-grained metamorphic rock intermediate in grade between slate and schist.
plagioclase	A group of feldspar minerals with chemical compositions spanning between sodium feldspar and calcium feldspar.
quartz	A mineral composed of silicon and oxygen. The most abundant mineral in the Earth's crust, highly resistant to chemical and mechanical weathering, and the primary constituent of beach, river, and desert sand.
quartzite	A hard and durable medium-grained metamorphic rock derived from sandstone.
sandstone	A sedimentary rock composed of sand-size grains of cemented mineral and rock particles
schist	A medium-grained, layered metamorphic rock derived from shale.
serpentine	A greenish, translucent, lustrous metamorphic rock containing a group of minerals including magnesium, nickel, aluminum, zinc, or manganese, along with silicon or iron in various combinations.
shale	A fine-grained thinly layered sedimentary rock derived from silt and clay.
slate	A fine-grained metamorphic rock derived from shale.

Surficial Material

The most recent glaciation—the Wisconsin stage of the Laurentide ice sheet—started advancing south from Labrador around 75,000 years ago and reached its maximum southern extent at Long Island approximately 25,000-21,000 years ago.[2]

The massive ice sheet, one mile thick in some places, scoured and sculpted as it moved over the land—scraping, transporting, and depositing boulders, rocks, and organic material. As the climate warmed and the ice front melted, mineral material and organic debris settled in place, and was also carried by rushing meltwater in streams and sheet flow over the land. The heavier materials—sands and gravels—were deposited near the ice margin as "outwash," along stream corridors, and in mounds called "kames." The main occurrence of glacial outwash in Kent, according to the NYS State Geological Survey (NYGS), is along the West Branch Croton River and the West Branch Reservoir. Just three kames were noted by the NYGS, in areas just east of the Taconic State Parkway, west of Lake Tibet, and east of Gipsy Trail Road (Figure 5).

Surficial Materials

(Loose material over bedrock.)

glacial till Mixtures of unsorted mineral materials of various textures (fine to cobble-size), deposited by melting glacial ice.

glacial outwash Coarse mineral materials (sands and gravels) deposited by glacial meltwater streams.

glacial lacustrine deposits: Fine silts, clays, and sands that settled in glacial lakes and ponds.

alluvium Clay, silt, sand, or gravel, sorted by texture and weight, and deposited by running water in the glacial or post-glacial period to the present.

Some of the lighter materials—clays, silts, and fine sands—were carried farther from the melting glacier and distributed more widely as "glacial till." Glacial till—unsorted mineral material—is the predominant surficial material in Kent and in the region as a whole (Figure 5). "Alluvium" is the mixed material—silt, sand, clay, gravel, and organic matter—deposited along stream floodplains and deltas. Alluvium components are typically sorted by texture and weight, with the coarser, heavier materials deposited where the stream velocity was high, and the finer, lighter materials deposited where the velocity was slower.

The chemistry, structure, and texture of the bedrock and the surficial mineral materials have a large influence on the soils and habitats that develop at any location, the character of the groundwater and surface water, and the communities of plants and animals that establish and persist.

Soils

By about 18,000 years ago the last glacier had mostly receded from Kent.[3] The surficial deposits—the alluvium along streams and the glacial outwash and till left by the receding glacier—are the mineral and structural basis for most of our soils which formed over the ensuing thousands of years as plants, animals, water, weather, and organic processes transformed this thin layer of material at the Earth's surface.

Soil types differ from each other depending on their parent material (the mineral or organic material that they formed in), depth above bedrock, texture, and chemistry, and their wetness or dryness. All of these characteristics help to determine the kinds of biological communities that become established. For example, the shallow, droughty mineral soils of rocky barrens support plants such as pitch pine, scrub oak, and blueberries; the wettish soils of a wet meadow support plants such as fox sedge, soft rush, purple loosestrife, and eastern willow-herb; and the deep organic soils of an acidic bog support *Sphagnum* mosses, leatherleaf, and maleberry.

Soils

"Soils" are organic or unconsolidated mineral materials that have been acted on by weathering and biological processes.

Soil types are distinguished and classified according to depth, texture, color, chemistry, and wetness or dryness. Soil characteristics are much influenced by the "parent" materials of origin (e.g., the bedrock, surficial deposits, or organic material), and by topography, climate, hydrology, vegetation, and time.

The oldest, wettest wetlands have developed deep layers of peat.

Wetland soils ("hydric soils") include those classified as "very poorly drained" or "poorly drained" and some instances of those classified as "somewhat poorly drained." (These classifications are found in the county soil survey[4] and on the Natural Resources Conservation Service [NRCS] website.) Wetland soils are those that remain saturated in their upper layers long enough during the growing season to develop anaerobic conditions and, hence, to support wetland-adapted ("hydrophytic") vegetation. Some wetland soils are saturated or inundated year-round, some are saturated for several months, and some are saturated for only a few days or weeks in the spring. Kent's wetland soils are variously developed in mineral or organic material. The oldest, wettest wetlands—such as the large wetland east of the Taconic State Parkway and the wetland complex along Black Pond Brook—have developed very deep layers of peat (partially decayed organic material), but younger wetlands and those that typically dry out for significant periods during the growing season may have little or no peat accumulation.

The county soil survey[5] provides maps of Putnam County soils and describes many of their characteristics and their suitability for human uses such as lawns, septic leachfields, structural support for roads or buildings, and agriculture. Soil maps and descriptions for any Putnam County location can also be viewed online at the Web Soil Survey of the Natural Resources Conservation Service (NRCS). The Web Soil Survey also has updated names for Putnam County soil types.

The predominant upland soils in Kent are somewhat to very acidic soils in the Charlton-Chatfield and Chatfield-Hollis-Rock outcrop complexes. These are hilly-terrain soils formed in glacial till that range from very deep to shallow, and well drained to somewhat excessively drained. ("Drainage" categories indicate wetness or dryness: well-drained soils are dry and poorly-drained soils are wet.) Wetland soils vary from deep organic soils such as Palms muck and Carlisle muck, to mineral soils such as Leicester loam or Raynham silt loam or the Fluvaquents-Udifluvents along floodplains and in basins. The wetland soil types are described in the county soil survey as ranging from acidic to alkaline, but tend toward the acidic in Kent because of the acidity of the underlying bedrock. See a discussion of the best farmland soils in the **Farmland Resources** section, below.

The soil types depicted on the county soil map have been identified by soil scientists through remote sensing and field observations, and then mapped on the basis of the landscape setting and other factors. Although much field work was conducted for the survey, many of the mapped soil units have not been visited by a soil scientist. Furthermore, each map unit (polygon) is named for the predominant soil type, but may also contain smaller areas of other soil types. For these reasons the soil maps are not suitable for detailed site-specific land use planning, but they nonetheless provide a wealth of information on the general character of the soils at any location.

Soils are a critical resource for plants and animals, and have immeasurable value to the human community. They are responsible for the presence of most of our vegetation, for most kinds of agriculture, for the purification of water, and for immense amounts of carbon storage. Soils are the foundations of our forests, meadows, and wetlands, as well as our farmland, lawns, gardens, and golf courses. The diversity of plants, animals, and ecological communities at any particular location depends in large part on the structure, chemistry, and biology of the local soils.

Soils are the largest reservoir of carbon in most ecosystems.

Soils are the largest reservoir of carbon in most ecosystems.[6] Carbon is stored both in the soil organic matter—composed of live and decomposing organisms—and in the soil mineral material. Where soils remain substantially undisturbed, the carbon can remain sequestered for thousands of years. But disturbance such as soil erosion, drying, removal of vegetation, plowing, or excavation can lead to rapid releases of carbon to the atmosphere, contributing to the greenhouse gases responsible for global warming. Conventional cultivation results in large (up to 50 percent) losses of soil carbon to the atmosphere.[7] Carbon storage as well as soil fertility tend to be increased by use of perennial crops and tillage systems that rely on cover crops, nitrogen fixation, incorporating organic matter into the soils, and no-till or minimum tillage practices.[8,9]

Uncompacted soils that are high in organic matter and have diverse and abundant microbiota are the most effective for water retention, carbon storage, and herbaceous crop production. Soils with other characteristics—shallow soils, low-fertility soils, wetland soils, or those with uncommon mineral or chemical composition—can have great value for native biological diversity. The habitat implications of some of these soil characteristics are discussed in the **Biological Resources** section.

The NRCS has identified the soils best suited to agriculture, and classified them as Prime Farmland Soils and Farmland Soils of Statewide Importance. See the **Farmland Resources** section (below) for further discussion of these soils.

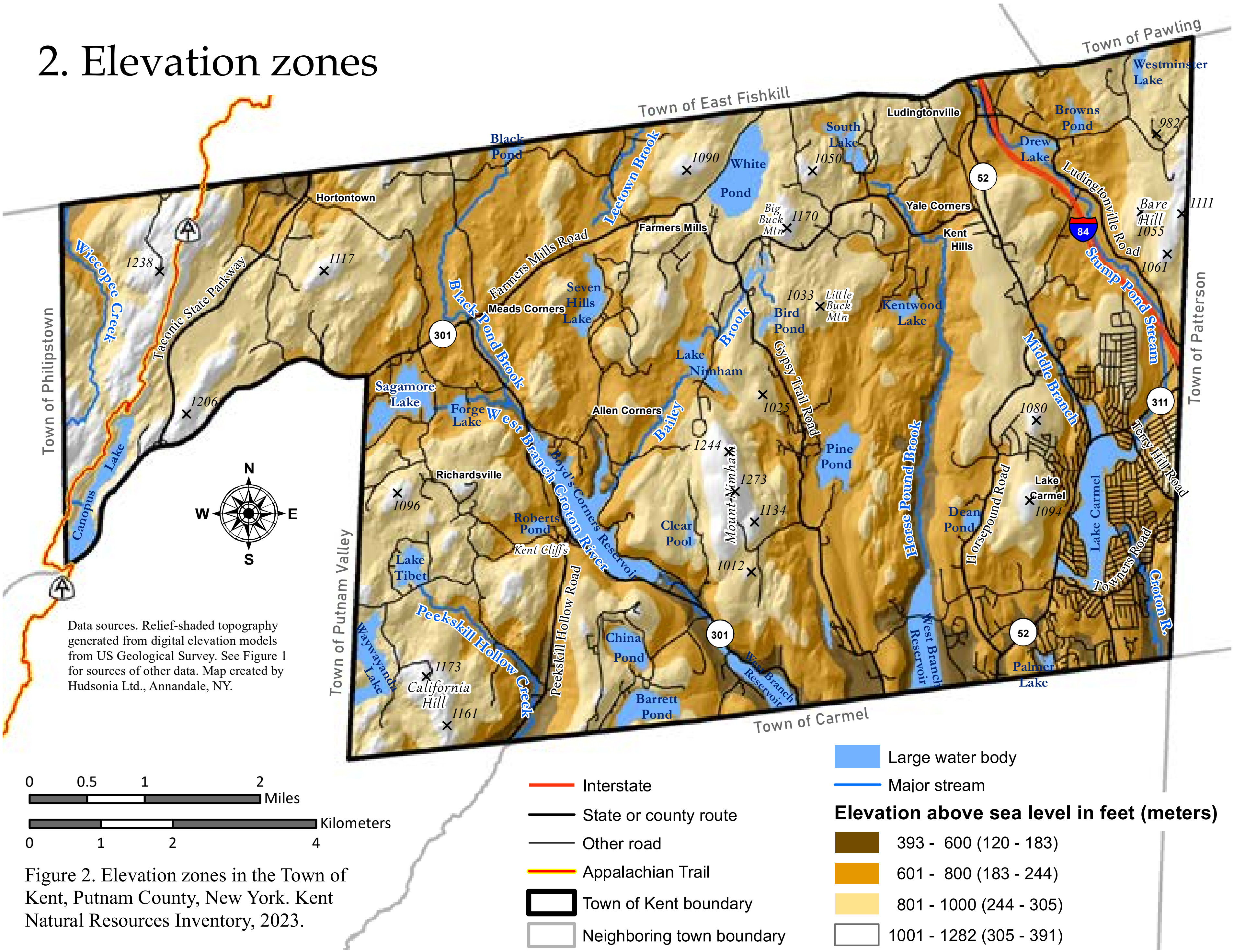
Watersheds

A "watershed" is the entire land area that drains to a particular feature, such as a stream, pond, or wetland. Within each major watershed are sub-basins—the watersheds of smaller streams—each containing networks of perennial and/or intermittent streams that drain the land and provide essential water sources for habitats, wildlife, and humans.

The entire Town of Kent is in the watershed of the Hudson River, and drains to the Hudson through seven major sub-basins (Figure 6). About 80 percent of the town is in the West Branch and Middle Branch Croton River sub-basins which feed several reservoirs in the New York City drinking water system. The other four sub-basins feed streams that drain directly to the Hudson River. Whortlekill and Wiccopee creeks drain much of the high-elevation rocky terrain of the panhandle, and flow north to join Fishkill Creek in Dutchess County. Peekskill Hollow Creek rises in Lake Tibet and, after leaving Kent, runs approximately 14 miles southwest before reaching the Hudson in Peekskill. Annsville Creek rises in Canopus Lake and runs south-southwest for 12 miles until joining Peekskill Hollow Creek near its mouth at the Hudson River.

Within each major sub-basin, a large network of perennial, intermittent, and ephemeral streams drains the land, contributes to ponds, lakes, and wetlands, and provides essential water sources for other habitats and wildlife. The water quality, water volumes, and habitat quality of each stream or waterbody depends not only on the conditions in the immediate adjacent area, but also on the conditions in the entire land area draining to the stream or pond. Careful management of land uses, maintaining extensive undeveloped land around headwater streams, and protecting the land around lakes and ponds and along the corridors of small and large streams will contribute significantly to protecting water resources throughout the town. Replacement of the natural soil cover and vegetation with pavement, buildings, and other impervious materials alters surface water flow patterns, exacerbates flooding, and reduces the recharge of groundwater unless special efforts are made to mitigate those effects.

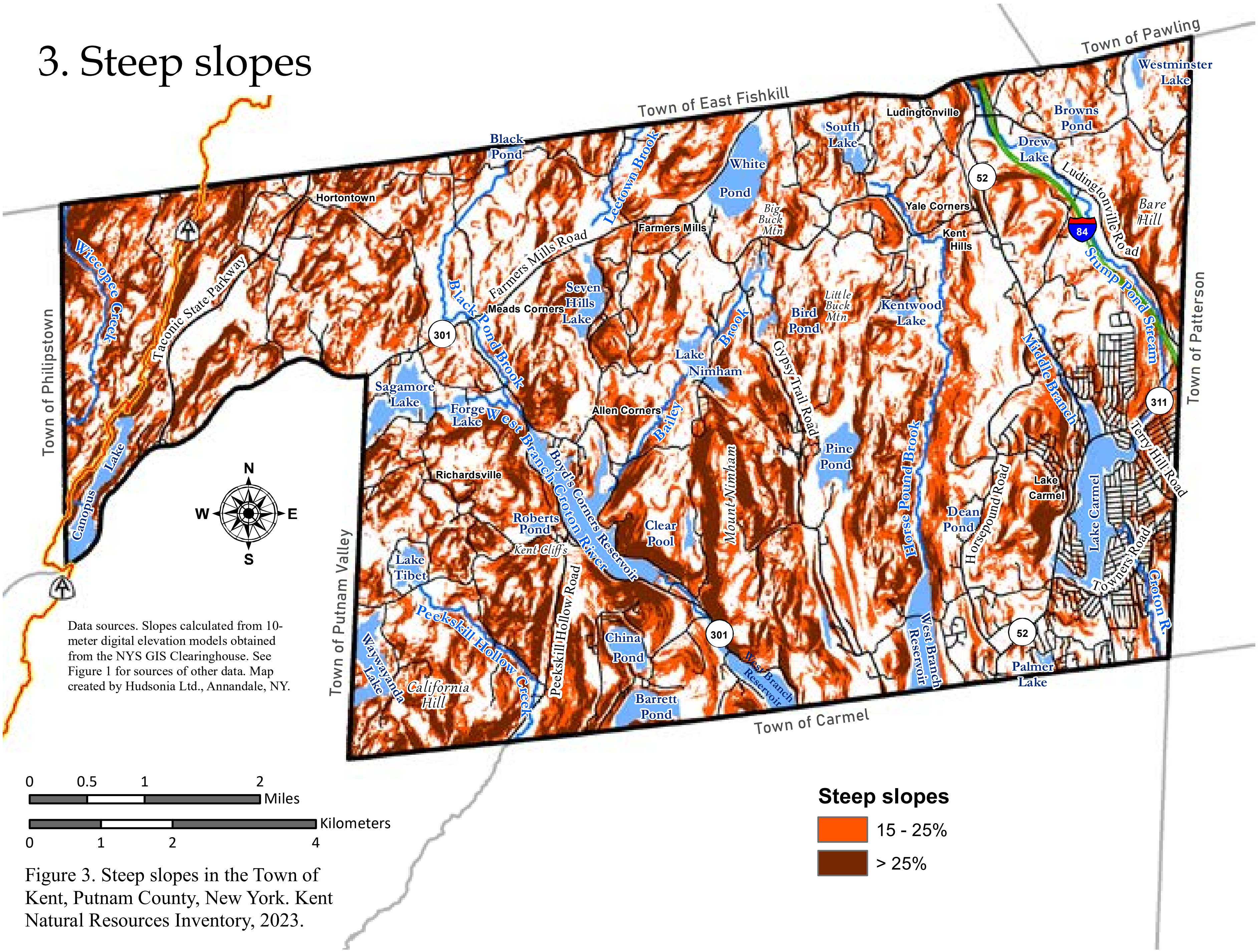
2. Elevation zones



Data sources. Relief-shaded topography generated from digital elevation models from US Geological Survey. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 2. Elevation zones in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

3. Steep slopes



Data sources. Slopes calculated from 10-meter digital elevation models obtained from the NYS GIS Clearinghouse. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 3. Steep slopes in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

4. Bedrock geology

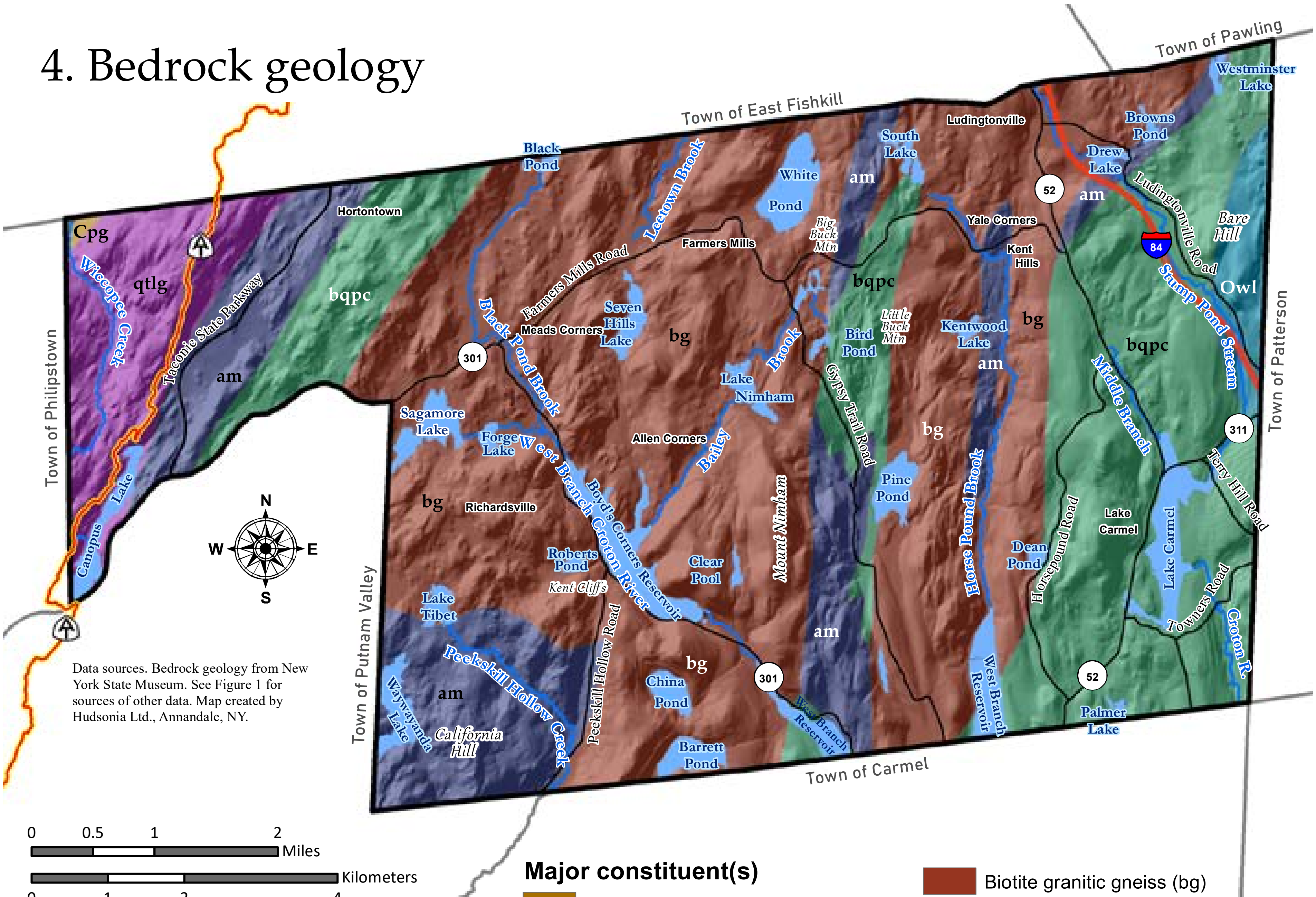


Figure 4. Generalized bedrock geology of the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

5. Surficial geology

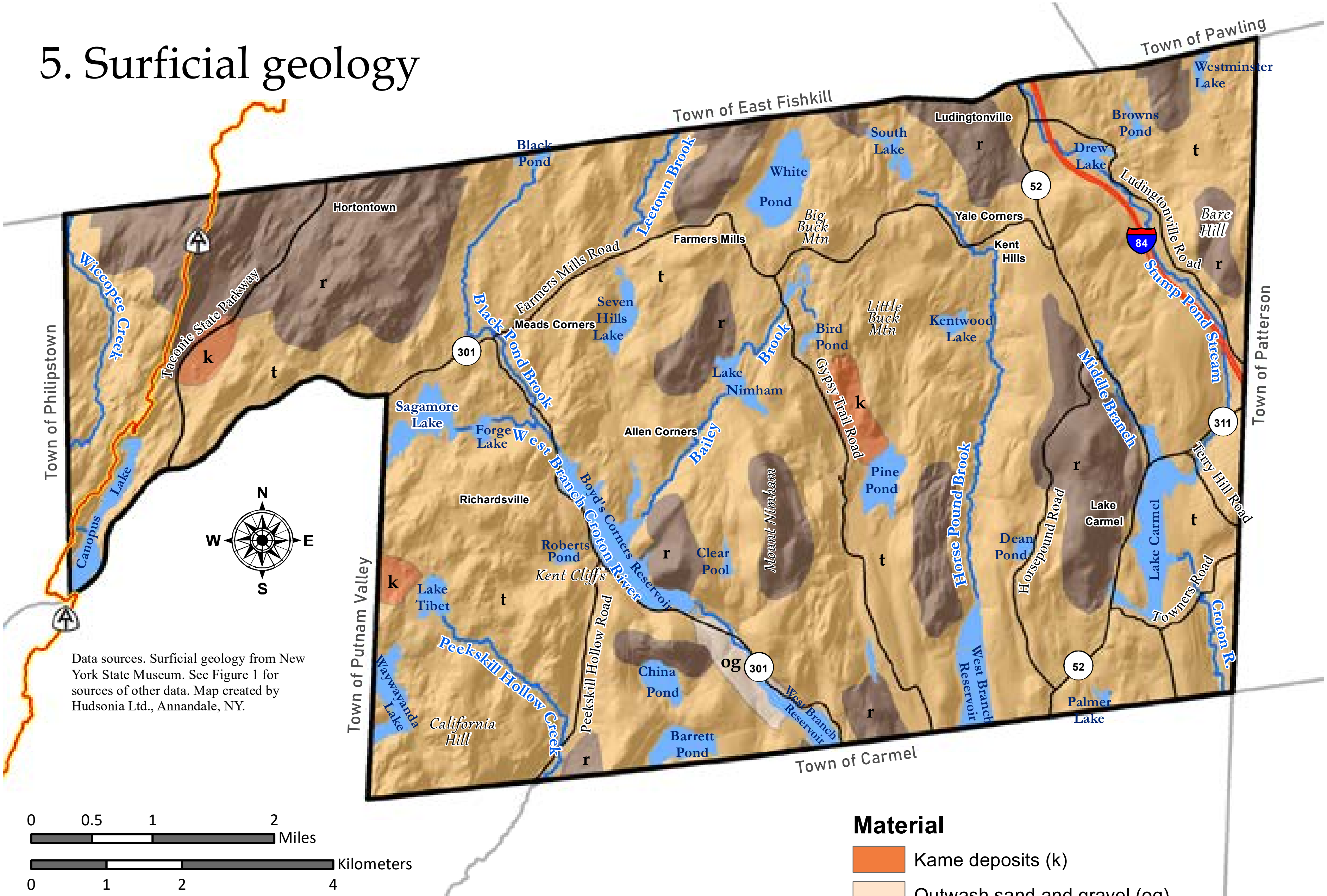
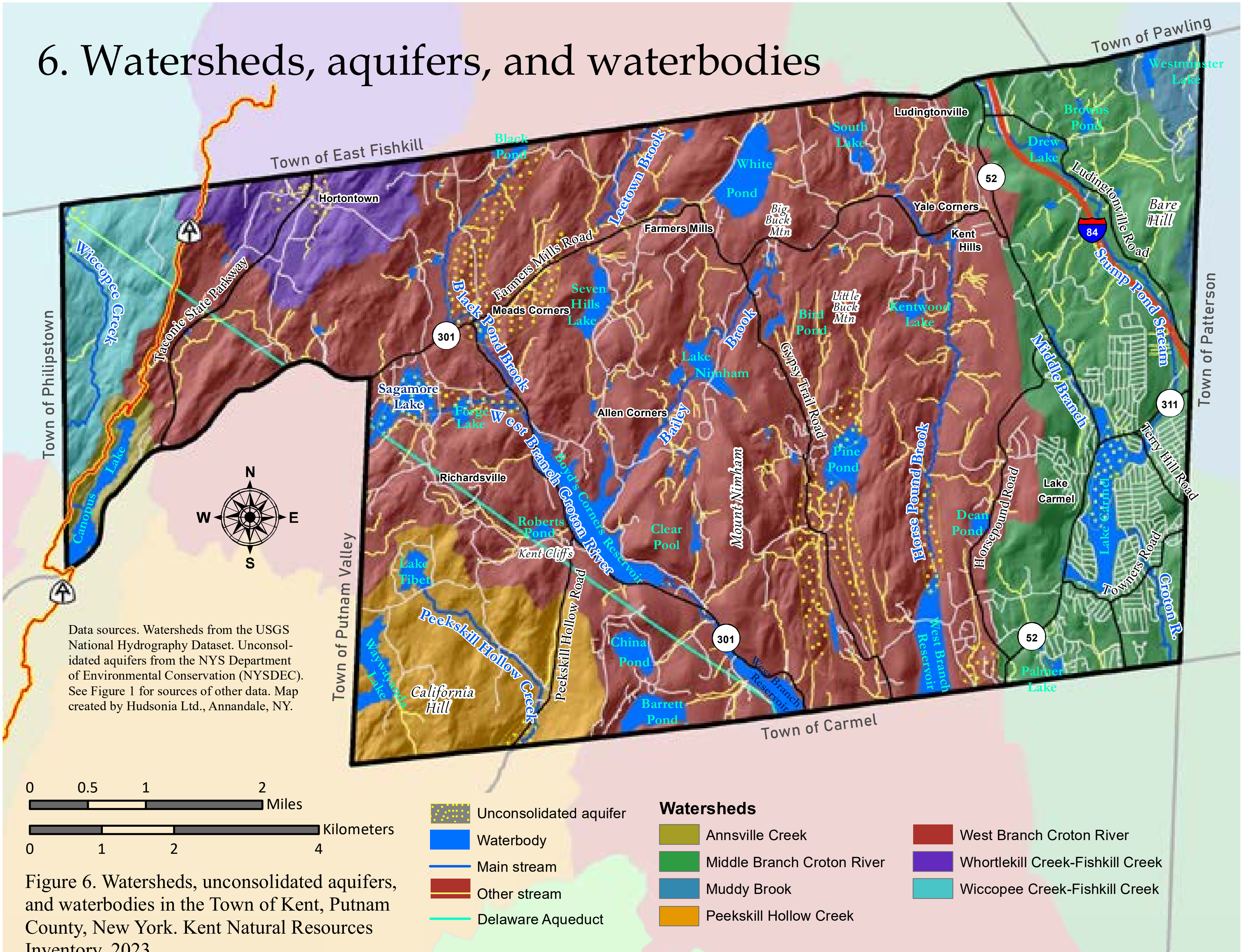


Figure 5. Surficial geology of the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

6. Watersheds, aquifers, and waterbodies



Data sources. Watersheds from the USGS National Hydrography Dataset. Unconsolidated aquifers from the NYS Department of Environmental Conservation (NYSDEC). See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 6. Watersheds, unconsolidated aquifers, and waterbodies in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

NATURAL RESOURCES

China Lake. Photo © David Silver.

The natural resources of Kent include the rocks and soils, groundwater, surface water, and habitats that constitute the visual and ecological landscape. They are fundamental to the ecosystems that support our plants and wildlife, as well as clean air, abundant and clean water, food, and countless other ecological services that have supported the human community for centuries. Some of these resources are briefly described below.

Mineral Resources

Both as the foundation of the natural landscapes of Kent, and as extractable resources, the rocks and unconsolidated materials have helped to shape the patterns of human settlement and land uses. Mineral prospectors may have been active in Kent before the first European settlers began arriving in the mid-1700s.[10] Small-scale mining for arsenic, iron, copper, sulfur, gneiss, sand, and gravel has occurred in Kent in the past (Table 1) but there are no active commercial mines here today and the town code severely limits excavation and mining. Figure 7 shows locations of historical mines noted in New York State records. It is likely that farmers and other landowners conducted—and may still conduct—additional small-scale mining for sand and gravel for onsite uses.

Arsenic is a naturally-occurring element that is widely distributed in rocks, soil, and natural waters. It occurs as an impurity in metal ores and is often a component in sulfur-bearing minerals. It is mined for use in pesticides, wood preservatives, and metal alloys. The arsenic-rich rock on Nimham Mountain is a seam of arsenopyrite in the amphibolite granitic gneiss of the area. The rock has a dark gray to coal black appearance.

In 2017, soil sampling by the Environmental Protection Agency at the Nimham Mountain/Pine Pond mine site (also called the Silver Mine and the Nimham Mountain Mines) in the Nimham Mountain Multiple Use Area (MUA) found arsenic levels as high as 1,600 times the Environmental Protection Agency (EPA) screening level at and downhill from the mine entrance, and elevated but much lower arsenic levels on several nearby properties. Mine tailings (waste rock and soil) contaminated with arsenic had been discarded in areas surrounding the mine. The EPA also found high levels of chromium. The area has been designated a state and federal Superfund site. Remediation will be a long-term effort. The state remediation efforts are focused on state land; the EPA is focused on nearby private properties.

The contamination affects trails on the eastern flank of the mountain in the MUA. NYSDEC has filled in the vertical mine shafts, and installed a fence around the contaminated area to keep people from trying to enter the pits. NYSDEC has also posted signs with information about safety precautions for visitors; has covered some of the trails on the lower mountain with item #4 aggregate to cover any potential contamination on those trails; and has rerouted parts of one trail around and away from the old mine pits. A fact sheet is available on the NYSDEC website.[11]

The situation has also affected how the planned Highlands Trail will cross Putnam County and the Town of Kent. The original plan was to have the trail run up and over Nimham Mountain with the historic fire lookout tower as a key point of interest. Now an alternative route is being planned to avoid the arsenic-contaminated areas.

The EPA has offered to purchase affected private properties in the vicinity and assist homeowners with relocation. Vacated houses will be destroyed.[12] In the meantime the agency has installed barriers to prevent exposure to contaminated soils in high-use areas, removed or replaced contaminated soil around residences, taken steps to reduce arsenic inside residences, and provided safety advice and equipment to homeowners.[13]

Uses of Arsenic

During the 1600s through the 1800s, arsenic compounds were used as medicines to treat, for example, syphilis, psoriasis, and cancer, and they are still used to treat cancers today.[14,15,16] In the mid-1700s to 1800s soluble arsenic compounds were used in small doses as stimulants for people and for sport animals such as race horses or for working dogs.[17,18,19] Arsenic has been used in various formulations as a green pigment in sweets, in embalming fluids, in ceramic glazes, and in optical glass. [20,21,22]

After World War I, the United States built a stockpile (since disposed of) of an organic arsenic compound to be used as a chemical weapon—a blister agent and a lung irritant. During the Vietnam War, the United States used another organic arsenic compound, Agent Blue, as a defoliant to expose North Vietnamese soldiers and destroy their rice crops.[23,24]

The toxicity of arsenic to insects, bacteria, and fungi led to its use as a wood preservative.[25]The process of treating wood with chromated copper arsenate (also known as CCA or Tanalith®) was invented in the 1930s and, for decades, this was the most extensive industrial use of arsenic. Recognition of the toxicity of arsenic led to a ban of CCA in consumer products in the European Union in 2004, but chromated arsenicals are still allowed under “restricted use” for this purpose in the US. [26,27,28]

Formulations of arsenic have also been used in agricultural insecticides. Although many of those uses were phased out by 2013, arsenic compounds are still used in insecticides and fungicides. Arsenic is also used in the US as a feed additive for poultry and swine to increase weight gain, improve feed efficiency, and prevent disease.[29]

Today, the primary uses of arsenic are in alloys of lead—for example, in car batteries and ammunition—and as a semiconductor.[30,31]

Because of its antimicrobial, antiviral, antiparasitic, and anticancer properties, arsenic has been proposed as a possible alternative to traditional antibiotics, especially in the face of increasing antibiotic resistance and the emergence of new deadly pathogens.[32]

Table 1. Historical mines in the Town of Kent

Data are from The Diggings and New York State Mines and Wells (https://thediggings.com/ and https://gisservices.dec.ny.gov/gis/maw/).

Name	Years[1]	Mined Material	Area	Host Material
Putnam County Arsenic Mine	1888; 1906-07	arsenic, iron, copper, sulfur from chalcopyrite and pyrite		gneiss
Brown's Quarry[2]		arsenic, serpentine		
Nimham Arsenic Mine (aka Pine Pond Mine, Silver Mine)	Mid-1800s - 1918	arsenic		
Hobby Pyritiferous Ore Opening Mine	1882 (last)	iron, sulfur		gneiss
Ludingtonville Pyrite Project		iron, sulfur from pyrite		gneiss
Kent Materials Route 52 Quarry	2014-2019	gneiss	12.9 acres	
Ray MacDougall		glacial till		
Edgard B. Polhemus	1901	sand and gravel	6 acres	glacial outwash
Robert Barrett	1982-1986	sand and gravel	2 acres	glacial outwash

[1] Years of operation, if known.
[2] Arsenic was discovered at Brown's Quarry but may never have been mined.

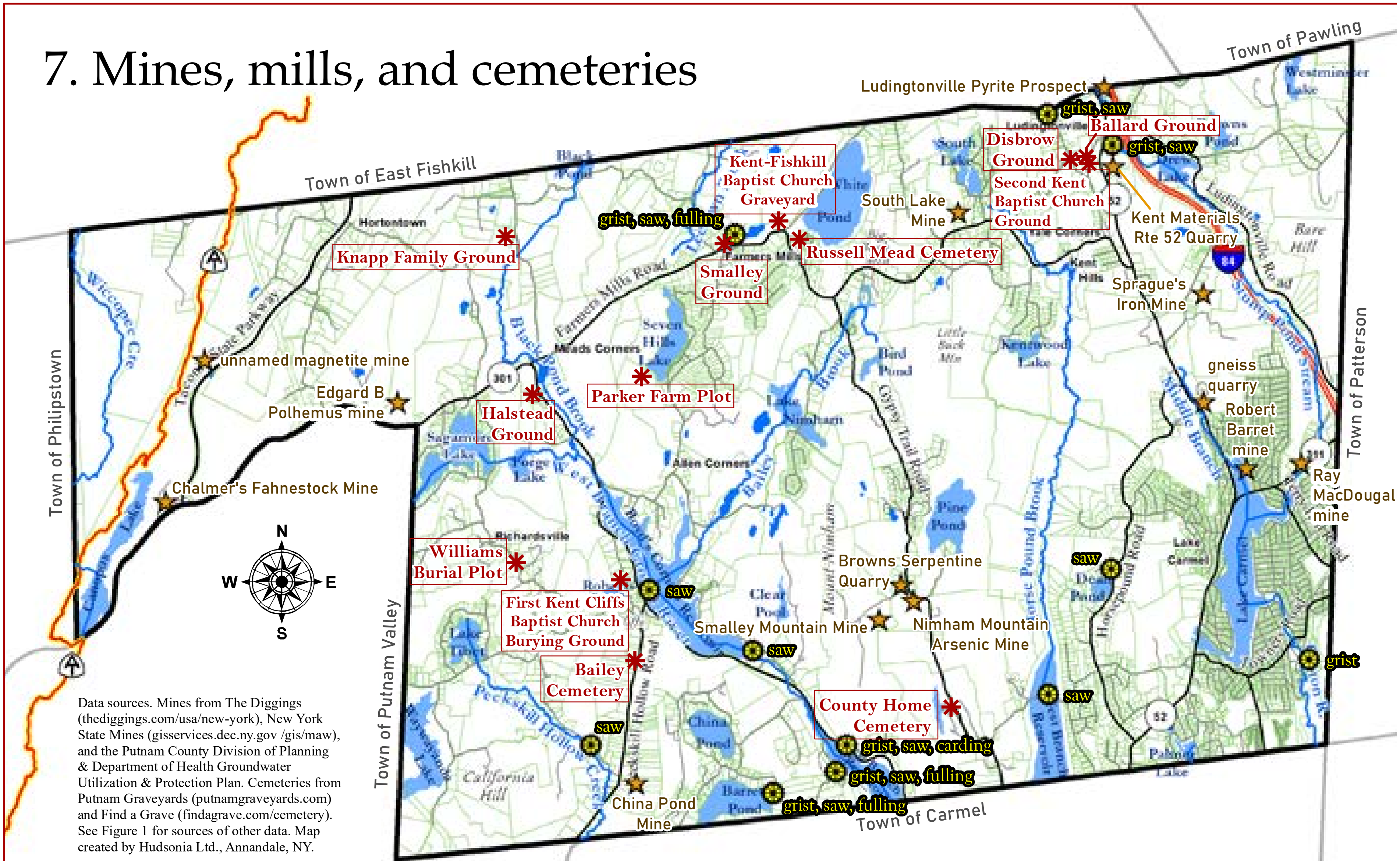
Naturally-occurring sulfur is abundant and widespread in sulfide ore minerals such as pyrite (iron sulfide). Sulfur is used in fertilizers, medicines, insecticides, fungicides, dyes, explosives, and vulcanization. Today the main industrial sources of sulfur are petroleum and natural gas (not found in Kent).

Various forms of gneiss constitute much of Kent's bedrock. Gneiss and other hard rocks are used as building stone and are crushed for "aggregate," which is in high demand for use in construction.

Sands and gravels were deposited here during the melting of glaciers in the last Ice Age approximately 18,000 years ago.[33] Large deposits of sand and gravel occur in only one area in Kent, along the West Branch Croton River (Figure 5). Kame deposits along the Taconic Parkway, west of Lake Tibet, and north of Pine Pond may also have extractable sand and gravel. These materials are widely used in construction industries.

Of course, the mineral resource that is used universally by people is soil, which supports our lawns, gardens, meadows, wetlands, and forests, and the wildlife and ecosystem processes that allow us to live in this landscape. Having taken thousands of years to develop, soils that are lost to erosion, removed, or polluted or damaged in other ways cannot be easily replaced.

7. Mines, mills, and cemeteries



Data sources. Mines from The Diggings (thediggings.com/usa/new-york), New York State Mines (gisservices.dec.ny.gov /gis/maw), and the Putnam County Division of Planning & Department of Health Groundwater Utilization & Protection Plan. Cemeteries from Putnam Graveyards (putnamgraveyards.com) and Find a Grave (findagrave.com/cemetery). See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

0 0.5 1 2 Miles

0 1 2 4 Kilometers

Parcel boundary

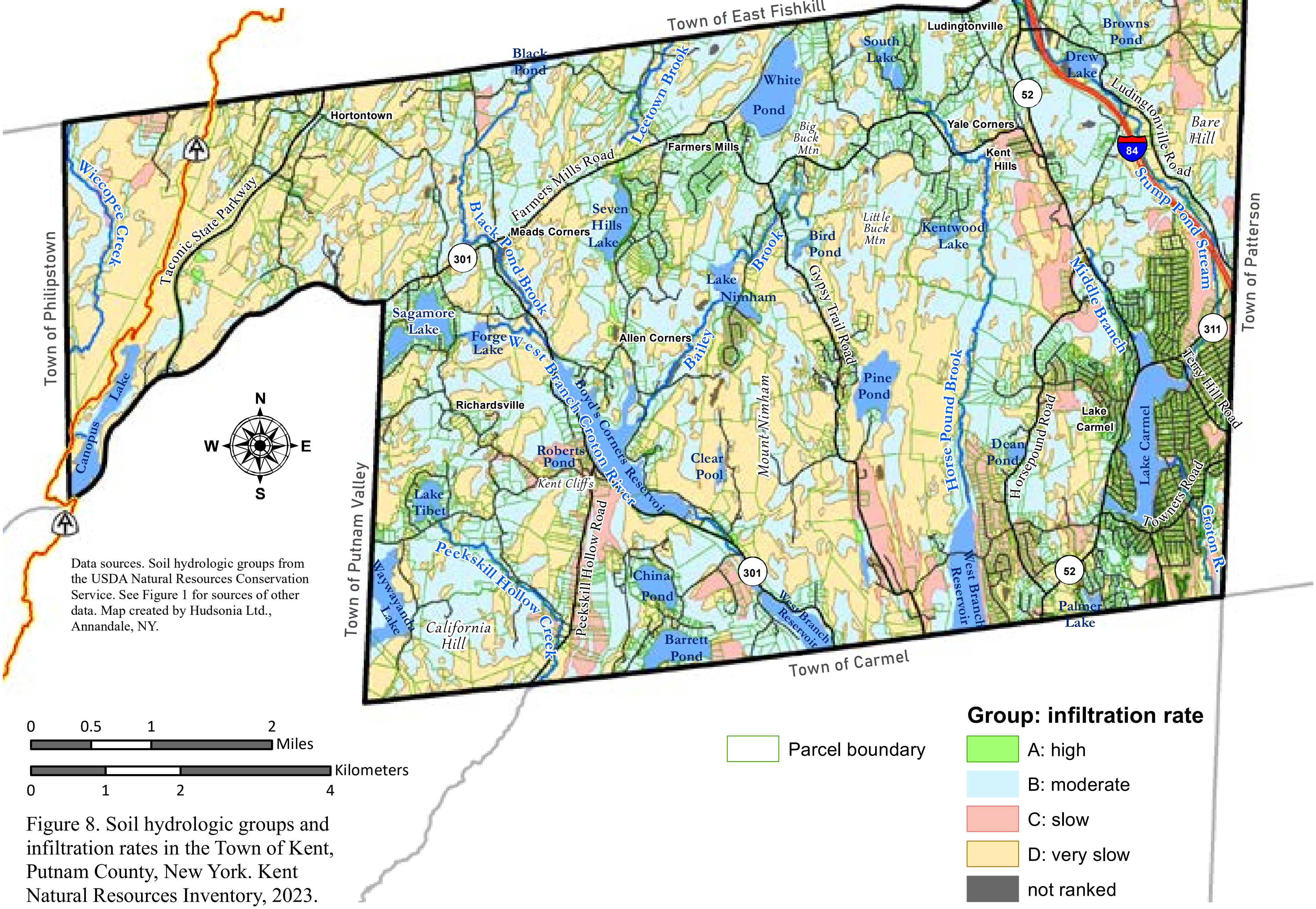
Historic cemetery

Historic mill

Historic mine or ore occurrence

Figure 7. Mines, mills, and cemeteries in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

8. Hydrologic soil groups



Data sources. Soil hydrologic groups from the USDA Natural Resources Conservation Service. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 8. Soil hydrologic groups and infiltration rates in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

Soils are the mineral resource used by everyone.

Among the many other services provided to us by soils are the dispersal, filtering, and processing of waste from septic systems. Certain soil types are more effective than others at absorbing and processing waste. The "hydrologic soils group" (HSG) classification is used to estimate the rates of runoff from precipitation, and is based on the rate of water infiltration to the soils when the soils are not protected by vegetation and are thoroughly wet and receive precipitation from long-duration storms—thus, a worst-case scenario for rapid runoff.[34] There are four HSGs assigned by the NRCS and denoted by letter codes A through D, with Group A having the highest infiltration rate and Group D the slowest.

The Town of Kent uses the HSG classes to help determine the minimum lot sizes for residential lots. Larger minimum lots sizes are required in areas with a greater percentage of soils with slow infiltration rates, to ensure that there will be sufficient infiltration capacity for septic leachate on each lot. Soils with high infiltration rates can accommodate a higher density of residences with septic systems than those with slower rates (§77-34.2). Figure 8 shows the Hydrologic Soil Groups throughout the town.

Hooded merganser. Photo © John Kenny.

Water Resources

We use the term "water resources" to refer both to surface water— i.e., springs, streams, lakes, ponds, and wetlands—and to groundwater, the water that resides beneath the soil surface. The quantity and quality of surface and groundwater available to humans and natural habitats depend on the conditions in the land areas that drain to those resources.

Groundwater

Groundwater is the water held beneath the ground surface in spaces between sediment particles and in rock fissures and seams. Groundwater is fed and replenished by rainwater and snowmelt that seeps through soils and other surficial material and through rock pores and fissures. It can be depleted by over-extraction or by inadequate recharge from the surface, and can be degraded by contaminated seepage.

Groundwater feeds springs, ponds, streams, and wetlands, and is the source of base flow for perennial streams. Those surface water resources in turn support fish and wildlife and human recreation, and are important components of many of the town's scenic landscapes.

Groundwater wells supply most of the water used by residents, farms, and businesses in Kent. Most residences rely on individual drinking-water wells, but two public water districts serve households in their vicinities: The three District 1 wells are on Marian Road and Horsepound Road and served about 360 people through 90 connections in 2021. The two District 2 wells, at the bottom of Leeside Drive, served about 276 people through 69 connections. Those public wells and most of the private wells in Kent are drilled in bedrock.

Each year the water districts submit water quality reports to the county Department of Health with results from regular testing for contaminants. In 2022, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) were detected in the District 1 samples, and PFOS was detected in the

Dean Pond in winter. Photo © Beth Herr.

District 2 samples. These are long-lasting chemicals in the PFAS family (per- and polyfluoroalkyl substances) that were widely used in fabric and leather coatings, household cleaning products, paints, firefighting foams, stain-resistant carpeting, and other products. Although US manufacturers have phased out many of their uses, they are still authorized for use in cookware, food packaging, and food processing equipment. PFAS chemicals remain widespread in the environment, are slow to break down, and can accumulate in the bodies of wildlife and people. They are known to be endocrine disrupters, and have been linked to cancers, liver and thyroid problems, reproductive problems, low birthweight of newborns, and other health effects.[35]

The levels in District 1 were 17.1 parts per thousand (ppt) for PFOA and 11.6 ppt for PFOS. The level for District 2 was 10.3 for PFOS. These exceed the maximum contaminant level (MCL) of 10 ppt set by the State of New York. A notice from the county to householders stated that these levels are below those associated with significant health effects, and that the district managers were working with the county to address the contamination problem.

Groundwater held in sand and gravel deposits is often plentiful but is especially vulnerable to contamination from land uses on the ground surface.

An "unconsolidated aquifer" is a place where groundwater is stored in saturated sand and gravel deposits. Unconsolidated aquifers represent large and easily accessible water sources for shallow wells. The land areas overlying the aquifers are important for recharging groundwater through the coarse, permeable sand and gravel material, but that material is also an efficient conduit for contaminants introduced by above-ground human activities. For all those reasons, protection of the aquifer areas from inappropriate uses is especially important. Figure 6 shows the general locations of unconsolidated aquifers identified by NYSDEC in Kent. The main areas are along Black Pond Brook, in the Sagamore Lake/

Forge Lake corridor, north and south of Pine Pond, and along Horse Pound Brook.

The *Putnam County Groundwater Protection and Utilization Plan*[36] shows a map of unconsolidated aquifers (Figure 5 in that Plan) that appears to reflect the outwash and kame deposits mapped by the New York Geological Survey, identical to those shown in Figure 5 of this *NRI*. While there is some overlap between the aquifer data shown in this *NRI* and in the county groundwater plan, there are large areas of difference. Both maps are based on fairly coarse data. A Kent-specific groundwater survey, based on well data and more detailed geological data, would provide a better picture of the unconsolidated aquifers than either.

A "spring" is a place where groundwater discharges to the ground surface at a single location under gravitational or hydrostatic pressure. Springs occur in a variety of settings throughout the town, emerging unseen into wetlands, streams, and waterbodies, and more visibly into upland habitats. Springs that originate from deep underground emerge at a fairly constant temperature, usually in the range of 45–55°F year-round. Springs that feed streams help to maintain cool water temperatures in summer—an important characteristics for many aquatic organisms—and a warmer environment in winter compared to the surrounding landscape. A "seep" is a place where groundwater emerges diffusely at the ground surface. The habitat values of springs and seeps are discussed in the **Biological Resources** section below. In addition to their ecological importance, springs have been important drinking water sources for humans and livestock. Some have been modified with constructed or excavated basins and spring houses. The quality and quantity of the emerging water can be much affected by land uses in the areas feeding the groundwater sources.

Streams

A "perennial stream" flows continuously in a year of normal precipitation. An "intermittent stream" ordinarily dries up at some time in a normal year. An extreme drought can cause some perennial streams to dry up too, however, and a year of especially heavy precipitation can cause some intermittent streams to run year-round. An "ephemeral stream" flows only in direct response to precipitation or snowmelt, and then dries up quickly within a few hours or a few days.

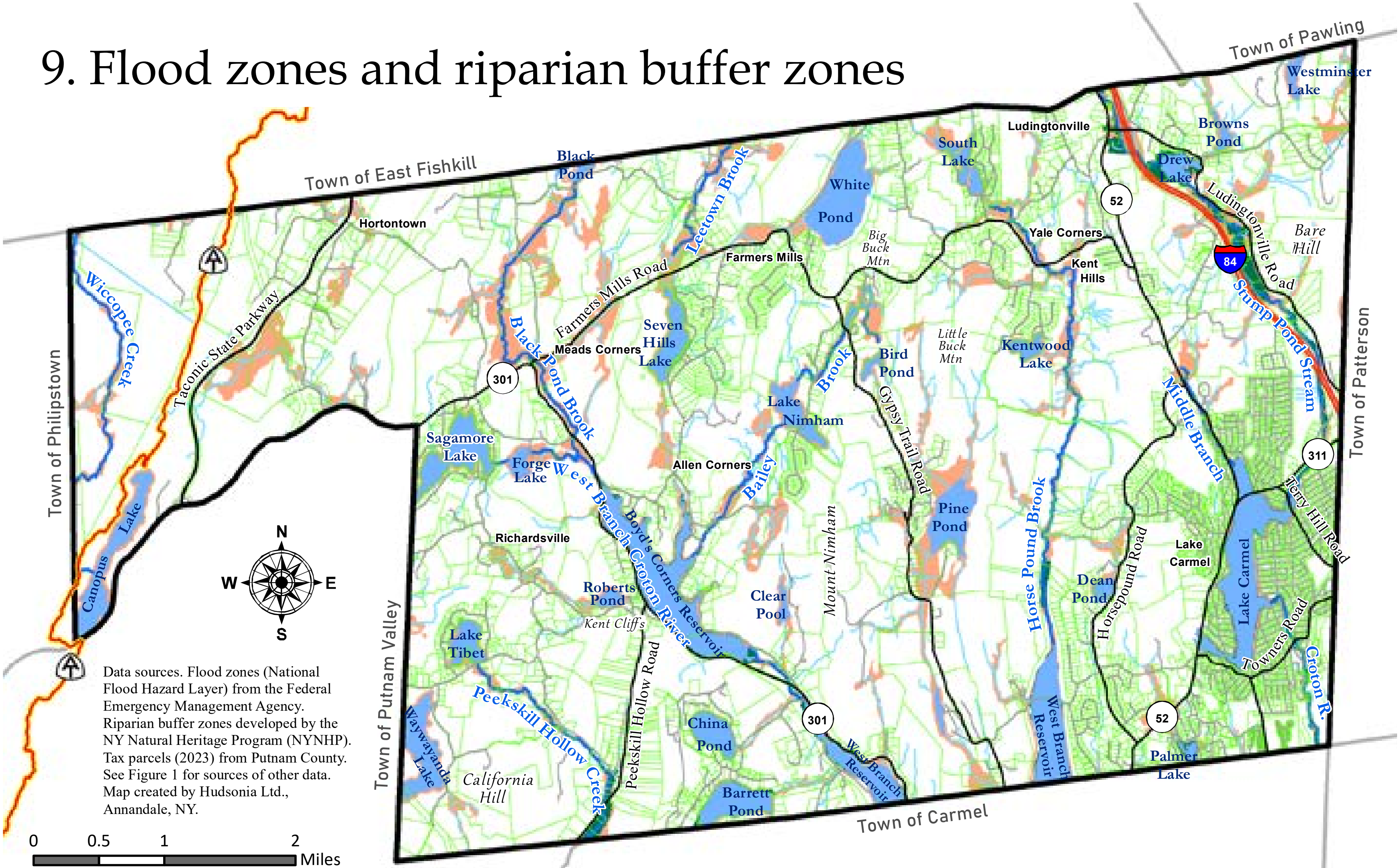
Figure 9 shows most of the perennial streams in Kent, and a few of the smaller streams that run only intermittently throughout the year. The major streams in Kent are the West Branch Croton River, Middle Branch Croton River, Peekskill Hollow Brook, Horse Pound Brook, and Stump Pond Stream.

Intermittent streams can sometimes be detected from contour lines on a topographic map, or identified on an aerial photograph, but often are found only from on-the-ground observations.

Ephemeral streams and most intermittent streams are not shown on Figure 9 or on other public maps; the data are unavailable. Intermittent streams provide valuable instream habitat for aquatic and semi-aquatic organisms, and are used by many kinds of terrestrial wildlife. They also supply essential water, organisms, and organic materials to the larger streams, lakes, and ponds that they feed. The presence of these smaller streams can sometimes be predicted from contour lines on a topographic map, or identified on an aerial photograph, but often they are found only from on-the-ground observations. Users of this *NRI* should be alert to the potential presence of small streams that do not appear in the map figures in the *NRI* or in other publicly available maps.

The water quality, flow volumes, and flow patterns of a stream, as well as the types and quality of instream habitats, depend to a large extent on characteristics of the stream's watershed—the entire land area that drains to the stream. The depths and textures of the soils in the watershed, the depth

9. Flood zones and riparian buffer zones



Data sources. Flood zones (National Flood Hazard Layer) from the Federal Emergency Management Agency. Riparian buffer zones developed by the NY Natural Heritage Program (NYNHP). Tax parcels (2023) from Putnam County. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

0 0.5 1 2 Miles

0 1 2 4 Kilometers

- FEMA 100-year flood zone
- Riparian buffer zone
- Major stream
- Other stream
- Parcel boundary

Figure 9. FEMA flood zones and riparian buffer zones in the Town of Kent, Putnam County, New York. Flood zones are shown only where they extend beyond the mapped boundaries of a stream or waterbody. Riparian buffer zones encompass the 50-year flood zone and adjacent wetlands. Kent Natural Resources Inventory, 2023.

Small streams are the life-blood of Kent's larger streams and lakes, providing water, organisms, and organic material. Photo © Ed Spaeth.

and quality of organic duff at the soil surface, the kinds of vegetation, the extent of impervious surfaces (e.g., roads, driveways, parking lots, roofs), the management of stormwater, and the amount of ditching and other surface water channelization throughout the watershed all influence the volumes and patterns of surface runoff during precipitation and snowmelt events, the degree of water infiltration to the soils, and the amount and quality of water reaching streams, wetlands, ponds, and groundwater reserves throughout the year.

A "floodplain" is the area bordering a stream, lake, or pond that is subject to flooding. Some streamside and lakeside areas flood annually or more frequently, and some flood only in the largest storms or snowmelt events. Floodplains at some locations in Kent are just a few feet wide and elsewhere are hundreds of feet wide, depending on the local topography and the stream flow volumes.

Floodplains serve critical roles in stream ecology and flow dynamics. A well-vegetated floodplain stores water, absorbs excess runoff, and serves as a groundwater recharge area. It helps to stabilize the streambank, reduce stream channel erosion, moderate stream water temperatures, and trap and remove sediments and other pollutants from runoff and floodwaters. Characteristics of the topography, soils, and vegetation at any particular location govern the effectiveness of the streamside and floodplain habitats for providing these services.

A well-vegetated floodplain helps to stabilize the streambank, reduce stream channel erosion, moderate stream water temperatures, and trap and remove sediments and other pollutants from runoff and floodwaters.

An intact floodplain also provides important habitat for terrestrial plants and animals, and contributes woody debris and other organic detritus to the habitat structure and food base for stream organisms.[37] Intact riparian areas tend to have high species diversity. Many animal species depend on riparian areas in some way for their survival,[38,39] and many rare plants such as cattail sedge, Davis's sedge, and goldenseal occur on streambanks and floodplains in the region. Forested and shrubby stream corridors tend to be the most effective at providing the stream protection and habitat services mentioned above.

The Federal Emergency Management Agency (FEMA) maps the areas expected to flood at statistical intervals based on historical flood records. The "100-year flood zone" is the area believed to have a 1 percent chance of flooding in any given year. For property owners this means, for example, that during the span of a 30-year mortgage, a house in the 100-year flood zone has a 26 percent chance of being flooded at least once in that mortgage period.[40] The "500-year flood zone" is the area believed to have a 0.2 percent chance of flooding in any given year. Figure 9 shows the 100-year flood zones mapped

Ox-eye daisies on the Nichols Street causeway, West Branch Croton Reservoir. Photo © Beth Herr.

by FEMA. FEMA delineates flood zones only on the larger streams, even though small streams can also have significant floodplains.

The "riparian corridor" can be loosely defined as the zone along a stream that includes the stream channel, stream banks, floodplain, and adjacent areas, but it can be delineated differently depending on the purpose of the delineation. Floodplains and riparian corridors support many different kinds of habitats, including wetland and non-wetland forests, shrublands, meadows, and ledges.

The New York Natural Heritage Program (NYNHP) has delineated "riparian buffer zones" which encompass the estimated 50-year flood zone based on US Geological Survey stream gage data and topography, and adjacent wetlands.[41] (The 50-year flood zones were developed through modeling and have not been field-verified.) The mapped buffer zones overlap partially with the FEMA 100-yr and 500-yr flood zones, and extend beyond the FEMA zones at some locations. The riparian buffer zones have been delineated along many small streams that are not included in the FEMA flood zone mapping. Figure 9 shows the NYNHP riparian buffer zones. These illustrate the areas most likely to be affected in large flood events, and can inform land use and stream protection efforts.

Lakes and Ponds

Kent has at least 28 named lakes (Table 2, Figure 1) — an extraordinary number for a town this size. Most were created or expanded by damming a stream. Some were dammed long ago to create mill ponds for water-powered industries. Many were created later on to expand the water supply for New York City, and many were created more recently as a recreational or residential amenity.

Lake Carmel was created in the 1920s by damming the Middle Branch Croton River so that the lake would be an attractive focus for a residential community. Today the Lake Carmel vicinity is the most densely developed part of town. Intensive residential development has also occurred around the shores of other lakes such as Lake Tibet, Barrett Pond, Palmer Lake, Sagamore Lake, and the east sides of South Lake and Seven Hills Lake.

Cranberry Swamp was dammed to create Lake Waywayanda in the California Hill State Forest. The tree stumps from the former swamp are still visible and much of the "lake" is still well-vegetated. The plant community observed by Buck and Herr indicates a "bog lake" habitat.

The only named lake that appears to be a natural, undammed water body is Dean Pond, but it may have had a dam in the past to supply water power to a former saw mill.

The Dam Safety Section of NYSDEC inspects the integrity of dams throughout the state, and reports on the dam condition and the hazard potential should the dam fail. Most of Kent's dams have not been assessed or rated in this program, but Table 3 shows the results for those that have. The three South Lake dams and the Lake Carmel dam were found to be in "poor" condition and the Sagamore Lake and West Branch Croton Reservoir dam were found to be "satisfactory."

Cranberry Swamp (Lake Waywayanda). Photo © Beth Herr.

Table 2. The lakes of Kent and when they appeared on public maps.

Name	Present by 1867[1]	Present by 1931[2]	Present by 1960[3]	Present by 1980+[4]
Barrett Pond	√	√	√	√
Bird Pond	--	√	√	√
Black Pond	--	--	--	√
Boyd's Corners Reservoir	√	√	√	√
Brown's Pond	√	√	√	√
Canopus Lake	--	--	√	√
Lake Carmel	--	√	√	√
China Pond	√	√	√	√
Clear Pool	--	--	√	√
Lake Dutchess	--	--	√	√
Dean Pond	√	√	√	√
Drew Lake (Stump Pond)	√	√	√	√
Forge Lake (east of Sagamore Lake)	--	--	--	(2011)
Forge Pond (west of White Pond)	√	--	--	--
Gem Lake	--	--	√	√
Kentwood Lake	--	--	--	√
Lake Nimham	--	--	√	√
Palmer Lake	--	--	√	√
Pine Pond	√	√	√	√
Roberts Pond	--	√	√	√
Sagamore Lake	--	--	√	√
Seven Hills Lake	--	--	--	√
South Lake	--	--	√	√
Lake Tibet	--	--	√	√
Waywayanda Lake	--	--	--	(2011)
West Branch Croton River Reservoir	--	√	√	√
Westminster Lake	--	--	√	√
White Pond	√	√	√	√

[1] *A check mark (√) indicates that the lake appears on the 1867 Beers map.*
[2] *A check mark (√) indicates that the lake appears on the 1931 Putnam County map, updated from a J.H.H. Muirhead map.*
[3] *A check mark (√) indicates that the lake appears on the 1957 or 1960 USGS 7.5 minute topographic map.*
[4] *A check mark (√) indicates that the lake appears on the 1980 USGS 7.5 minute topographic map. Forge Lake and Waywayanda Lake appeared as wetlands on previous maps, and first appeared as lakes on the 2013 USGS map, which was based on 2011 aerial photo imagery.*

Table 3. Safety assessment of Kent dams as of 2021.

Data are from National Inventory of Dams.[42]

Waterbody	Dam Condition[1]	Hazard Potential Classification[2]	Owner Type	Maximum Storage (acre-feet)[3]	Dam Height (feet)
Lake Carmel	poor	high	local government	2,790	25
Sagamore Lake	satisfactory	significant	private	1076	22
South Lake, lower	poor	significant	local government	(ng)	(ng)
South Lake, middle	poor	significant	local government	(ng)	(ng)
South Lake, upper	poor	significant	local government	(ng)	(ng)
West Branch Croton Reservoir	satisfactory	high	local government	42,300	85

1 Dam Condition
Satisfactory: No existing or potential dam safety deficiencies are recognized.
Poor: A dam safety deficiency is recognized for normal operating conditions which may realistically occur. Remedial action is necessary.
2 Hazard Potential Classification
High: Failure or mis-operation will probably cause loss of human life.
Significant: failure or mis-operation will probably cause no loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.
3 "ng" = not given in the National Inventory of Dams data.

Wetlands

A "wetland" is a vegetated area where the soils are saturated for prolonged periods during the growing season. Some wetlands have standing water most of the time; many have standing water that comes and goes during a year of normal precipitation; and some have standing water only rarely, such as after a rainstorm. Wetlands may be forested, shrub-dominated, or open, but all have plant species with special adaptations to the wet conditions. Wetlands in Kent include swamps, marshes, wet meadows, and intermittent woodland pools—habitats that are generically described in the **Biological Resources** section below. Some wetlands are associated with streams, lakes, or ponds, but many are isolated with no surface water connection to those waterbodies.

Wetlands have been damaged and destroyed by human activities for centuries, but some now receive certain protections due to recognition of their important ecological functions and the services they provide to the human community. Wetlands can store large volumes of water from rainstorms and snowmelt, and release it slowly to rivers, streams, and groundwater, thus slowing downstream and downgradient flood volumes. One acre of wetland can typically store approximately 1–1.5 million gallons of water.[43] Wetlands are able to trap sediments and remove some pollutants from runoff before they enter a stream or lake. Wetlands help to stabilize the banks and shorelines of streams and lakes, and also provide essential habitat for plants and wildlife, including many species of conservation concern. The biological significance of wetlands is discussed in the **Biological Resources** section below.

Many of Kent's wetlands do not appear on public maps, and must be discovered by remote sensing or on-the-ground observations.

Figure 10 shows the wetlands mapped by the US Fish and Wildlife Service in the National Wetland Inventory and by the NYS Department of Environmental Conservation. It also shows the hydric and alluvial soils, as mapped by the NRCS, which are defined as wetland in the Kent zoning ordinance. But many of Kent's wetlands are not shown at all in Figure 10 and must be found by other means. The federal, state, and local wetland regulatory programs are described in the **Existing Protections** section below.

Water Uses and Quality

NYSDEC has classified many of the perennial streams and other waterbodies in the state according to the "best uses" that each waterbody should support. Those classifications form the basis for New York State Protection of Waters regulations. Freshwater waterbodies are classified by the letters A, B, C, or D. The letter classifications and the best uses for each class are described in NYS regulation 6 NYCRR Part 701. For each class, the designated best uses are summarized as follows:

- Class A, AA - water supply, primary and secondary contact recreation and fishing
- Class B - primary and secondary contact recreation and fishing
- Class C - fishing, suitable for fish propagation and survival
- Class D - fishing

Waterbodies classified as A, B, or C may also be assigned a standard of "(T)" indicating they are trout waters, or "(TS)" indicating they are trout spawning waters.

Note that the waterbody classification does not necessarily indicate good or bad water quality—it only signifies the "best uses" that should be supported. NYSDEC recognizes that some waterbodies have an existing quality that is better than the assigned classification and uses an anti-degradation policy to protect and maintain high-quality streams.

Figure 11 shows the use classifications assigned by NYSDEC for Kent streams. Not all waterbodies appear on the classification map. Those that do not appear on the map and have flow all year (perennial flow) have the classification of the waterbody into which they flow. Waterbodies that do not appear on the map and have seasonal or intermittent flow have a classification of "D." NYSDEC has the final authority to determine if a waterbody has perennial or intermittent flow.

NYSDEC also establishes water quality standards to protect the uses associated with these classifications (6 NYCRR Part 703). The standards can be numerical or narrative. For example, dissolved oxygen has a numerical standard of no less than 7.0 mg/l in trout spawning waters. Turbidity has a narrative water quality standard which states there should be "no increase that will cause a substantial visible contrast to natural conditions." Information on surface water and groundwater quality standards can be found on the NYSDEC website. If waterbodies are not supporting the standards for their best uses, they may be listed on the Priority Waterbody List as "impaired" (explained below) and are slated for watershed restoration plans.

10. Wetlands

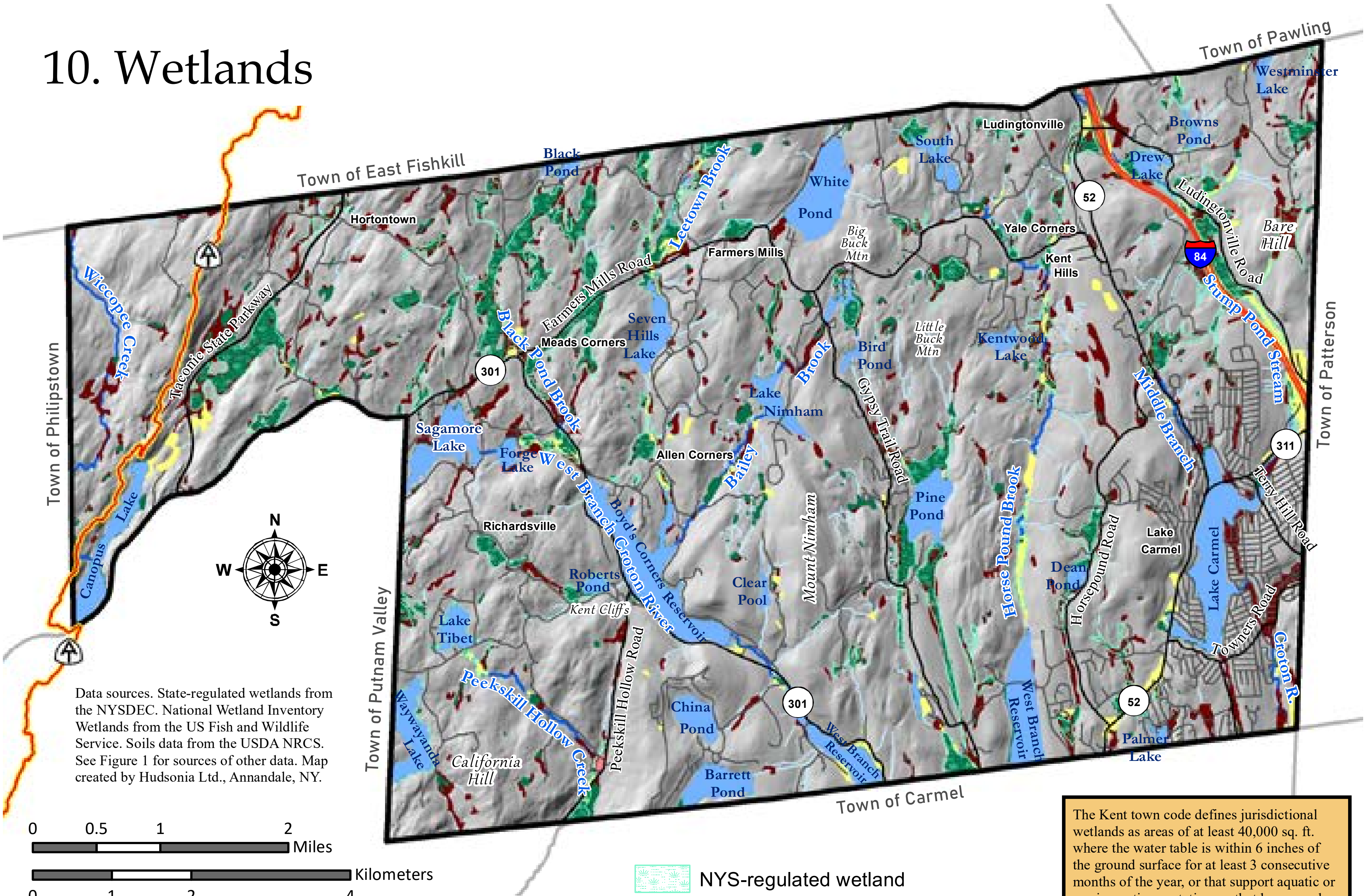
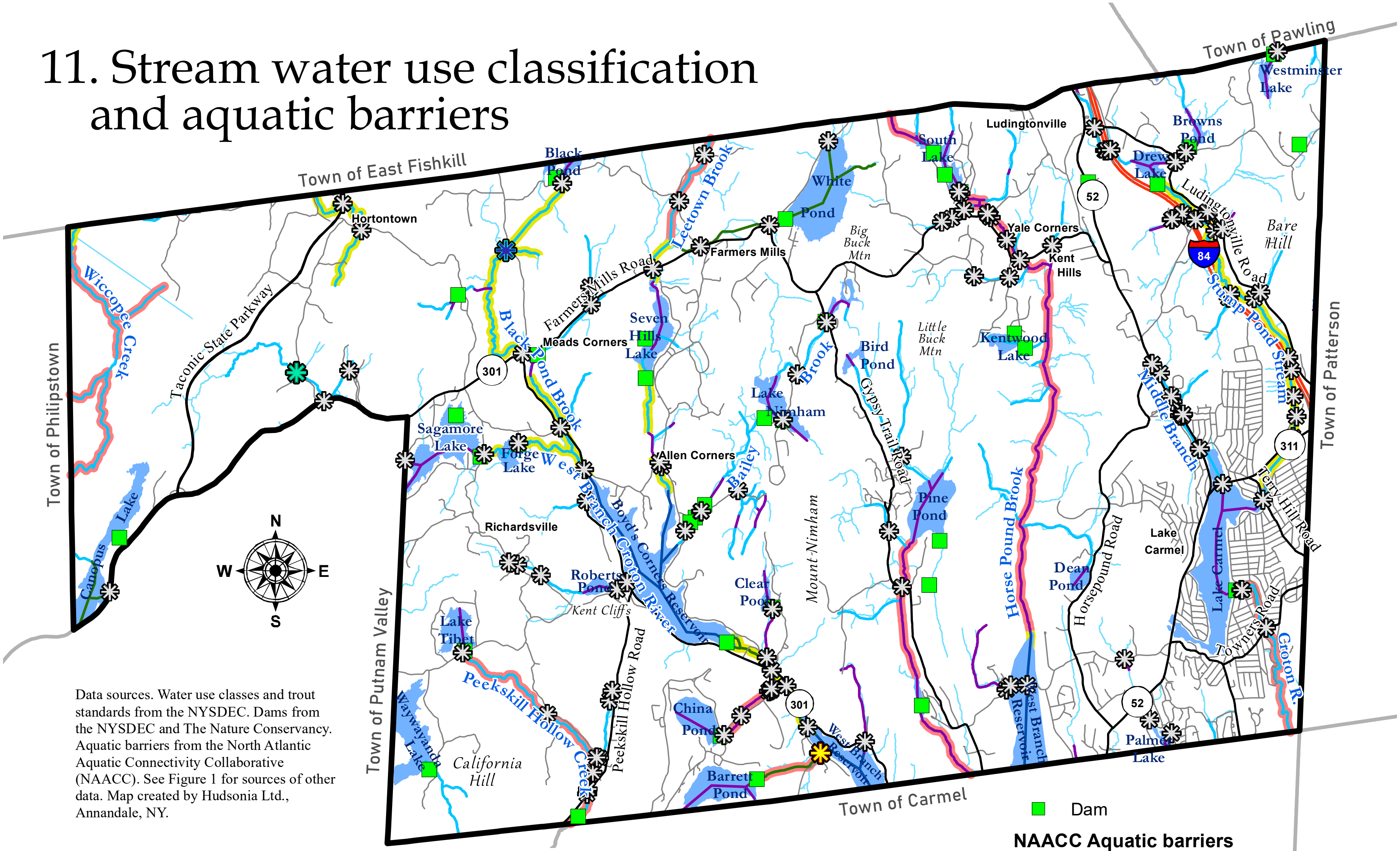


Figure 10. Wetlands on the New York State (NYS) and federal (NWI) wetland maps and other potential wetland areas based on soil drainage, in the Town of Kent, Putnam County, New York. Potential wetland soils are shown only where they occur outside the mapped NYS and NWI wetlands. Kent Natural Resources Inventory, 2023.

- NYS-regulated wetland
- NWI wetland
- Alluvial soil
- Poorly or very poorly drained soil
- Somewhat poorly drained soil

The Kent town code defines jurisdictional wetlands as areas of at least 40,000 sq. ft. where the water table is within 6 inches of the ground surface for at least 3 consecutive months of the year, or that support aquatic or semi-aquatic vegetation, or that have poorly drained, very poorly drained, alluvial, or floodplain soils (full description is at Ch 39A-4). Many wetlands that meet the local, state, or federal wetland jurisdictional definitions are not shown on this map. The presence and extent of jurisdictional wetlands must be determined by on-the-ground observations at any site.

11. Stream water use classification and aquatic barriers



Data sources. Water use classes and trout standards from the NYSDEC. Dams from the NYSDEC and The Nature Conservancy. Aquatic barriers from the North Atlantic Aquatic Connectivity Collaborative (NAACC). See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

0 0.5 1 2 Miles

0 1 2 4 Kilometers

NYSDEC water use classes

- AA Drinking (if disinfected), bathing, fishing
- A Drinking (if filtered & disinfected), bathing, fishing
- B Bathing, fishing
- C Fishing (fish reproduction & survival)
- Unclassified stream

Dam

NAACC Aquatic barriers

- Insignificant barrier
- Minor barrier
- Moderate barrier
- Barrier not evaluated

NYSDEC trout standards

- Trout stream
- Trout-spawning stream

Figure 11. NYSDEC stream water use classification and trout standards, plus aquatic barriers, in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

Priority Waterbodies List

An ongoing NYSDEC Waterbody Inventory program monitors water quality and trends throughout the state, and identifies the impaired streams, lakes, and ponds most in need of improvement. Streams are assessed for aquatic invertebrates, water and sediment chemistry, and sediment toxicity, and are classified into six categories:

- **Impaired waterbodies:** Well-documented water quality problems that result in precluded or impaired uses.
- **Waterbodies with minor impacts:** Less-severe water quality problems; uses are considered fully supported.
- **Threatened waterbodies:** No apparent water quality problems or use restrictions, but may be threatened by land use or changes in the watershed.
- **Waterbodies with impacts needing verification:** Believed to have water quality problems, but documentation is insufficient.
- **Waterbodies with no known impacts:** No use restrictions, although minor impacts may be present.
- **Unassessed waterbodies:** Insufficient water quality information.

The water quality data are evaluated to assess the ability of each waterbody to support specific water uses (e.g., drinking water supply, swimming, aquatic life, or secondary recreation). Figure 12 shows the sampled and unsampled streams and waterbodies, and the impairment classifications that resulted, and Table 4 summarizes the findings. Only six of Kent's lakes have been assessed in the program: Boyd's Corner Reservoir, Lake Carmel, Palmer Lake, Sagamore Lake, Lake Tibet, and the west lobe of the West Branch Croton River Reservoir. Sagamore Lake was found to have "no known impact;" Lake Tibet was found to have "minor impacts;" and the other four were found to be "impaired." The data sheets for those waterbodies that were deemed to have some level of impairment are in Appendix B.

Table 4. Summary of Kent water quality sampling results in the NYSDEC Priority Waterbodies program.

A fact sheet for each waterbody is in Appendix B.

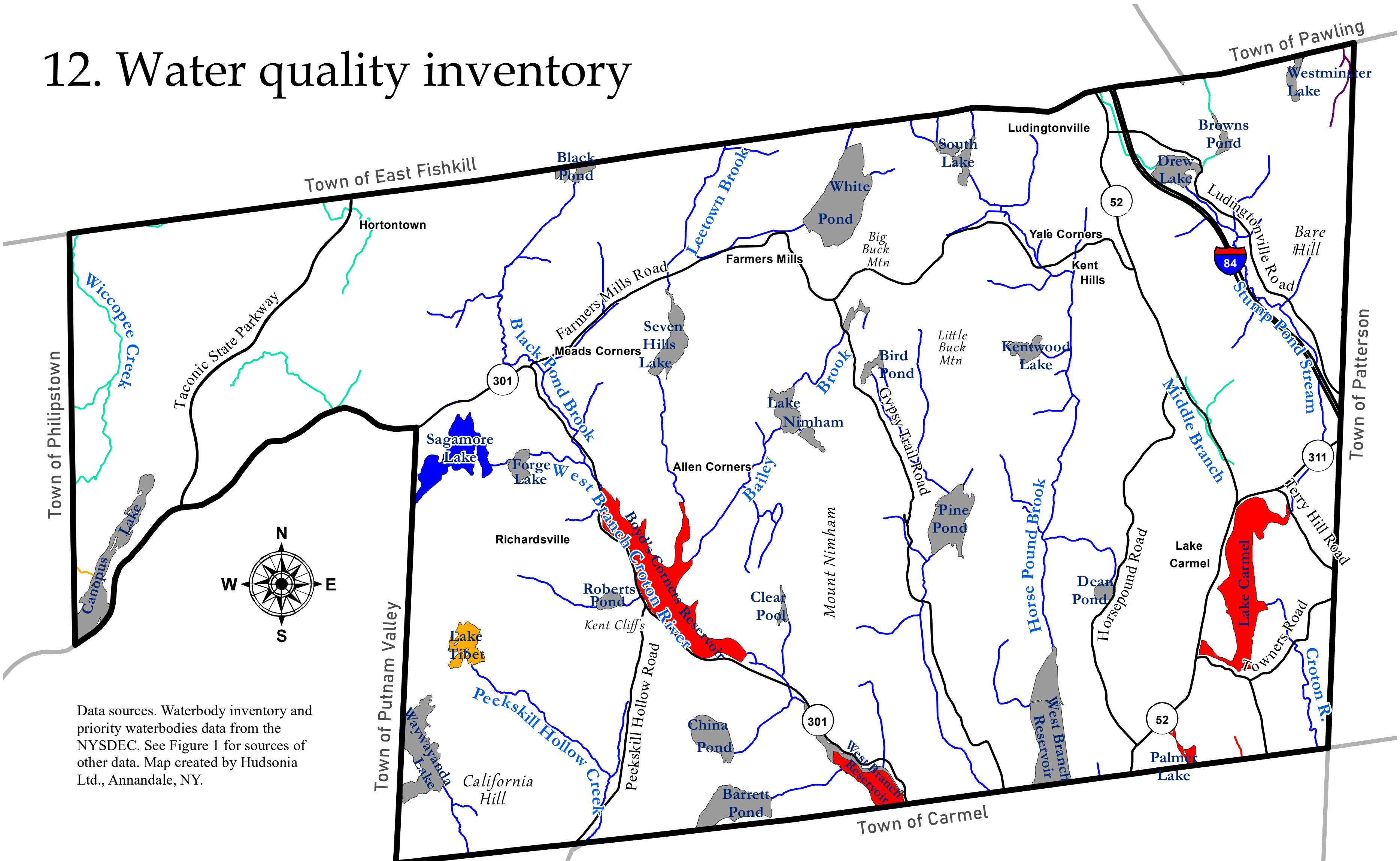
Waterbody (and Segment)	Use Impairment	Type of Impairment
Barrett Pond	fishing	nitrite pollution
Boyd's Corners Reservoir	fishing	mercury, phosphorus pollution
Lake Carmel	fishing (unconfirmed)	phosphorus pollution, low dissolved oxygen, algae, and aquatic weeds
Lake Tibet	swimming, boating	algal/weed growth
Palmer Lake	fishing (unconfirmed)	low dissolved oxygen, phosphorus
West Branch Croton River Reservoir	fishing	mercury, phosphorus

High levels of phosphorus compounds in Lake Carmel have led to over-abundant aquatic weeds, low dissolved oxygen, and an impaired fish community. Photo © Beth Herr.

Primary sources of pollution in Kent's lakes are failing septic systems and fertilized lawns.

The main water quality problems in the Kent waterbodies assessed in the Waterbody Inventory/Priority Waterbodies program were excess mercury, nitrite, and phosphorus, and low dissolved oxygen. The mercury is from atmospheric deposition, mostly originating from combustion of coal from distant power plants and industrial sites. Mercury (usually in the form of methylmercury) is a powerful neurotoxin that can accumulate in fish to levels of concern for the health of the fish and fish-eating wildlife, and for the health of humans who consume the fish. Mercury contamination of fish is the primary reason that NYSDEC issues fish consumption advisories. The other problems detected in Kent waterbodies probably stem mainly from failing septic systems and fertilized lawns. Septic system leachate and fertilizers are typical sources of excess nitrites, nitrates, and phosphorus compounds in surface waters. High levels of those nutrients tend to stimulate the growth of algae and aquatic plants, often leading to the "green scum" (composed of watermeals, duckweeds, algae, and/or cyanobacteria) and rampant growth of aquatic weeds. When those algae and plants die, the decomposing bacteria consume large amounts of dissolved oxygen, depleting the oxygen available for fish and other aquatic organisms. Dissolved oxygen is a critical resource for fish, mollusks, crustaceans, and aquatic insects, so reduced concentrations has far-reaching consequences for the ecology of lakes and streams.

12. Water quality inventory



0 0.5 1 2 Miles

0 1 2 4 Kilometers

Streams
- Impaired segment
- Minor impacts
- Needs verification
- Unassessed
- No known impact

Waterbodies
- Impaired segment
- Minor impacts
- Needs verification
- Unassessed
- No known impact

Figure 12. Water quality inventory of waterbodies and streams in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

13. Predicted EPT richness

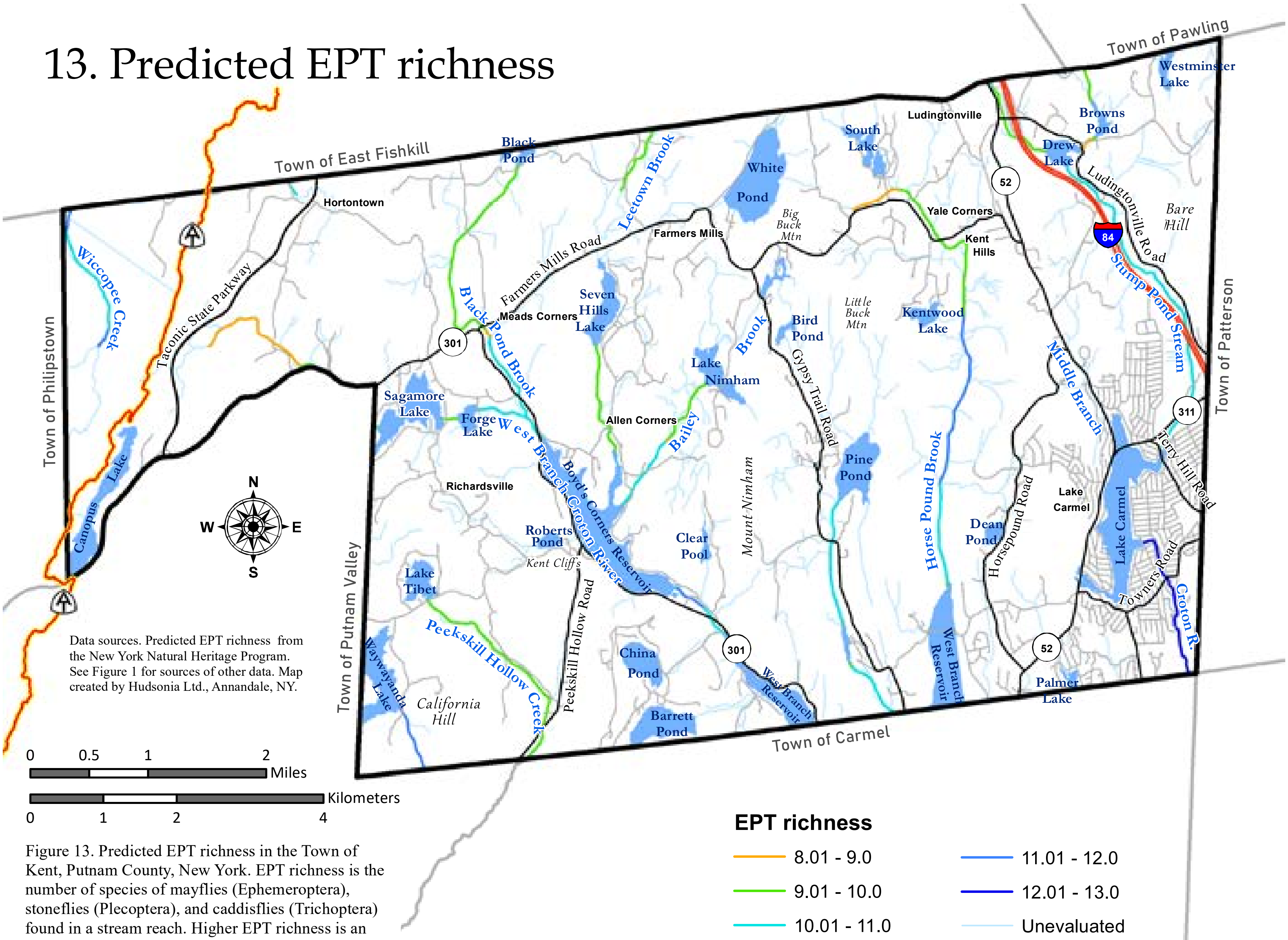


Figure 13. Predicted EPT richness in the Town of Kent, Putnam County, New York. EPT richness is the number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in a stream reach. Higher EPT richness is an indicator of better water quality. Kent Natural Resources Inventory, 2023.

Canada lily. Photo © Beth Herr.

Warm temperatures combined with excessive concentrations of those nutrients are also the causes of Harmful Algal Blooms (HABs). HABs occur when colonies of algae or cyanobacteria grow out of control and produce toxic or other harmful effects on fish, birds, people, and other organisms. The occurrence of HABs seems to be increasing with the prolonged periods of warmer temperatures that we are experiencing with the changing climate. In 2022, HABs were reported to NYSDEC in Barrett Pond, Lake Carmel, and Seven Hills Lake.

Another way that the NYSDEC assesses the water quality of streams is by assessing the community of aquatic macroinvertebrates. Because different species or groups of macroinvertebrates have different sensitivities to pollutants, the composition of the aquatic community is a useful indicator of water quality. Some macroinvertebrate orders, such as Diptera (true flies), are generally tolerant of higher levels of pollutants, and other orders, such as Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are very sensitive to many pollutants in the stream environment. NYSDEC monitors streams in each major watershed on a five-year schedule as part of the Rotating Integrated Basin Studies (RIBS) program. The data also inform the Waterbody Inventory/Priority Waterbodies assessment.

The NYNHP used the NYSDEC macroinvertebrate data to predict the “EPT Richness” as an estimate of water quality. Richness is expressed as a percentage of the sensitive orders—Ephemeroptera, Plecoptera, and Trichoptera—of the total macroinvertebrate taxa found. A high percentage of EPT taxa indicates good water quality. Figure 13 shows the predicted EPT Richness for several of Kent’s streams.

Biological Resources

The term "biological resources" encompasses all the living organisms, biological communities, habitats, and ecosystems that constitute the living landscape. Although we discuss them separately in this section, the types and condition of biological resources in Kent are inseparable from physical features such as bedrock, soils, water, climate, and landscape setting.

Information about the plants, animals, and habitats of the region can be obtained from several easily-accessed literature sources. The Biodiversity Assessment Manual for the Hudson River Estuary Corridor[44] describes many of the habitats of the region, some of the plants and animals of conservation concern that use those habitats, and principles and measures for effective conservation. Ecological Communities of New York State[45] describes natural communities throughout the state.

NYSDEC has sponsored two editions of the New York Breeding Bird Atlas, for the periods 1980–1985 and 2000–2005, and the next edition (2020–2025) is in progress. NYSDEC also sponsored the New York Herp Atlas (1990–1999) and the New York Dragonfly and Damselfly Survey (2005–2009). Those three documents map the results of focused surveys by biologists and trained volunteers.

The NYNHP has surveyed many sites throughout the state to discover new occurrences and to confirm past records of rare species of plants and animals, and natural communities of especially high quality. Bill Buck and Beth Herr are gathering lots of new information about the plants, animals, and other organisms of Kent (see below). But much of the biological diversity of the Town of Kent and the region as whole is yet unsurveyed and unknown. For example, many groups of insects and other invertebrates are still unstudied, and knowledge of fungi and algae here is rudimentary, despite the fundamental importance of these groups to Kent ecosystems.

Great blue heron. Photo © Barbara Gabarino.

Kent Biodiversity Project

Ongoing biological surveys by Bill Buck and Beth Herr are greatly expanding the knowledge of Kent's biological diversity.

Since 2011, retired biologist Bill Buck and naturalist Beth Herr have been conducting informal surveys for plants and animals in Kent, and have greatly expanded the knowledge of biological diversity in the town. Their studies are ongoing, but they have working lists of mosses, liverworts, hornworts, vascular plants, insects, other invertebrates, reptiles, amphibians, fishes, birds, and mammals, and even a few algae, fungi, and bryozoans. Some of their findings are in Appendix C, and a complete list of their Town of Kent observations to date is on the Kent CAC website. Some interesting, unusual, and rare finds are discussed in the **Plants** and **Animals** sections below.

Bill Buck and Beth Herr identifying an insect. Photo © Judy Kelley-Moberg.

Grape tube galls are formed after the grape gall midge deposits its eggs into the grape leaf tissue. The gall protects the eggs and developing larvae until the adults are ready to emerge. Photo © Beth Herr.

Ring-necked snake is an elegant snake that spends much of its time hidden beneath rocks and logs. Photo © Beth Herr.





Top left: Black-capped chickadee feeding on poison-ivy. Photo © John Kenny. Top right: Bristly haircap moss occurs on sandy, gravelly, or rocky soil in full sun. Photo © Beth Herr. Center: Muskrat occupies marshes and slow-moving segments of perennial streams, and consumes the roots, stems, and leaves of aquatic vegetation. Photo © John Kenny. Bottom left: Swamp milkweed is a food resource for monarch butterflies, native bees, honey bees, and many other insect pollinators. Photo © Beth Herr. Bottom right: Bill Buck collecting rock tripe lichen. Photo © Beth Herr.

Doing a Biodiversity Survey

Bill Buck and Beth Herr

When the Town of Kent applied to the NYSDEC Hudson River Estuary Program to get funding for preparation of a Natural Resources Inventory, the Town had to provide a 15 percent match. This could either be in the form of cash or in volunteer hours. For several years, we—Bill Buck and Beth Herr—have been interested in expanding the early online Kent Nature Almanac into a more complete biodiversity inventory. Consequently, we proposed that our hours working toward such a biodiversity inventory would be the match needed for the *NRI* grant. It turned out that no one had previously suggested such an idea and the Hudson River Estuary Program went for it, thus funding the *NRI* you have in your hands.

Although Bill is a professional botanist with a specialization in mosses, and Beth is a general naturalist with a good knowledge of birds, neither of us would have guessed what it took to even scratch the surface of life in Kent. Since both of us had a better background in vascular plants than in animals, we started there and the first year was primarily collecting and pressing plants.

There are a number of ways in which species can be included in an inventory. The "gold" standard is a voucher specimen deposited in a public herbarium or museum. That way, researchers in the future don't have to trust our determinations but can look at the original specimen to verify its identity. Vascular plants are relatively well known in eastern North America and there are multiple manuals to aid in identification. Nevertheless, some groups, such as grasses and asters, can be challenging for non-specialists. We were able to get the assistance of Dr. Rob Naczi (at the New York Botanical Garden) for some difficult plant groups.

The following year we boldly moved onto insects. Insects are probably well over 95 percent of all animal diversity, and many are very small (think: no-see-ums) or live underground. Although many insects are well known and of large economic importance, there are still groups for which there are no scientific authorities and thus identification is all but impossible. We were fortunate to contact the natural history collection at the University of Connecticut. We initially asked if they would accept our insect vouchers. Not only were they willing to do that, but the invertebrate curator, Dr. Katrina Menard, an entomologist specializing in true bugs (Hemiptera), has helped with insect identification, and has come into the field with us.

Without the help of various specialists, this project would not have been possible, or it would have had a lot less content. A good example of this is that we had Dr. Steven Selva, a retired lichenologist from the University of Maine at Fort Kent, come here recently to look for his specialty, pinhead or stubble lichens (*Caliciales*). Along the Kent portion of the Appalachian Trail, Dr. Selva searched on juniper bark and found *Cryptocalicium blascoi*, first described in 2021 from Spain, and ours was only the second North American record! (The first was from Minnesota.)

A couple of summers ago, we went to the Eagle Hill Institute in Maine to take a class on insect mines and galls. We were so impressed with both the subject and the instructor, that we invited the instructor, Charley Eiseman, to come to Kent for two days of collecting. In those two days, Eiseman added about 200 species of insects and mites to our inventory of insects that form leaf mines or plant galls.

Dr. Steven L. Stephenson, the North American authority on myxomycetes, or slime molds, has had us send him bark samples which he puts in moist chambers and sees what emerges. To date, about 20 species of myxomycetes have come from Kent bark samples. We could cite many other examples of experts who have volunteered their time for the Kent biodiversity project. No matter how much knowledge a couple of people can have, no one can know every group of organisms on this planet. The message here is that a biodiversity inventory requires a village.

Hawk Rock trail through upland hardwood forest. Photo © Beth Herr.

Habitats

A "habitat" is the place where an organism or population lives or where a biological community occurs. A habitat is defined according to both its biological and non-biological components—e.g., the vegetation, the climate or microclimate, the kind of rock, soil, or water substrate, and the hydrology. There exists no townwide map of habitats in Kent, but Figure 14 is a coarse representation of land cover identified by the US Geological Survey from automated interpretation of satellite imagery. The cover types were identified entirely by remote sensing without field verification, and the data contain many errors and omissions but still provide a picture of the general distribution of land cover or habitats in the town.

Below are brief profiles of Kent habitats compiled from field observations of Buck, Herr, and Hudsonia biologists. Each profile describes the habitat, its general distribution in the town, and some of the plants and animals that are characteristic of the habitat, as well as others that are rare or otherwise of conservation concern. A dagger symbol (†) indicates a species with a statewide rarity rank. Table 5 lists the plants and animals of conservation concern that occur in these habitats in the region. The habitat descriptions below use mainly the common names of plants, but Appendix Table C-1 has a full list of the scientific names of the plants mentioned in this narrative.

Upland Habitats

In this *NRI*, the term "upland" is equivalent to "non-wetland." The term bears no relationship to elevation; upland habitats may occur at any elevation in Kent, from the floodplains of lowland streams to high in the hills.

Upland Hardwood Forest

Upland hardwood forests are extremely variable in species composition, sizes and ages of trees, vegetation structure, soil drainage and texture, and other habitat factors. Common trees of these forests in Kent include maples (sugar, red), oaks (black, red, white), hickories (shagbark, pignut, bitternut),

Tulip tree, with its showy springtime flowers, is a common species of upland hardwood forests. Photo © Beth Herr.

American beech, white ash, black birch, and black cherry. American chestnut, once a dominant tree here, now occurs only in the form of stump sprouts that typically succumb to the chestnut blight before reaching reproductive maturity. Individuals and small groves of eastern hemlock and eastern white pine are here and there within the hardwood forests. Some of the common shrubs of upland hardwood forests are mountain laurel, witch-hazel, maple-leaf viburnum, serviceberries, lowbush blueberries, and spicebush.

Lady fern (Athyrium angustum) is a common native fern of upland hardwood forests. Photo © Alexander Milligan.

Forests on floodplains of streams include both wetland forests (swamps) and non-wetland forests, often closely intermingled. Typical floodplain forests include a mixture of upland and wetland plant species along with floodplain specialists such as American sycamore and eastern cottonwood. Other common trees on floodplains include black locust, slippery elm, red maple, green ash, and American hornbeam.

Upland Conifer Forest

Eastern hemlock is the dominant tree species in most of the conifer forests of Kent. Eastern hemlock forests are few and small, and typically occur on north-facing slopes, on ravine walls, and in other cool areas. Hemlock forests typically have little vegetation in the shrub and herb layers, due to the deep shade created by the hemlock canopy, allelopathic effects, and perhaps soil acidity and soil moisture,[46] but openings in those forests have hardwood saplings and trees and diverse shrubs and herbs. The hemlock woolly adelgid, a non-native insect, has infested many hemlock forests in the region, and is expected to cause widespread loss of these forests in the coming decades. The warming climate may hasten the spread of the insect into previously uninfested areas.

Eastern white pine is uncommon in Kent, but does occur as individuals and in small groves. Spontaneous (i.e., unplanted) groves are most likely to occur on abandoned farmland and on coarse-textured soils formed in lowland glacial outwash or on kames.

Small plantations of white pine, Norway spruce, and European larch (and perhaps other species) are here and there in Kent. If left undisturbed, conifer plantations can develop many of the same ecological attributes as naturally-occurring conifer forests.

Upland Mixed Forest

The term “upland mixed forest” refers to non-wetland forested areas with both hardwood and conifer species in the overstory, where conifer cover is 25-75 percent of the canopy. Mixed forests are less densely shaded at ground level than conifer forests

Barred owl, like many other owls, is more often detected by its call than by sight. Photo © Jennifer Escaravage.

and tend to support a higher diversity and greater abundance of understory plants than pure conifer stands.

Forest Values

Forests are the most effective type of land cover for maintaining clean and abundant surface water (in streams, lakes, ponds, and wetlands) and groundwater. Forests with intact canopy, understory, ground vegetation, and floors promote infiltration of rainwater and snowmelt to the organic duff and soils[47,48,49,50] and may be the best insurance for maintaining groundwater quality and quantity, for reducing rapid runoff and soil erosion, and for maintaining flow volumes, cool temperatures, water quality, bank stability, and habitat quality in streams. Forests and other intact habitats in floodplains and adjacent areas help to slow and disperse floodwaters. Forests help to moderate local and regional air temperatures, and also provide long-term storage of large amounts of carbon in above-ground and below-ground biomass and in soil organic matter.

Forests provide habitats for many kinds of wildlife. Standing live and dead trees are habitat for lichens,

Spotted turtles sometimes spend long periods of the summer resting in upland forests. Photo © Beth Herr.

algae, mosses, liverworts, fungi, invertebrates, cavity-using amphibians, songbirds, raptors, and mammals; and downed wood provides food for invertebrates, fungi, and slime molds, and habitat for amphibians, reptiles, mammals, and many other animals. Eastern box turtle† spends most of its time in upland forests and meadows, finding shelter under logs and organic litter, and spotted turtle† uses upland forests for summer dormancy and travel. Many snake species, such as northern copperhead,† eastern rat snake,† and red-bellied snake, forage widely in upland forests and other habitats.

Upland forests provide important 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, flycatchers, and woodpeckers. American woodcock† forages and nests in young hardwood forests, shrublands, and swamps.

Forests of all sizes and species composition can provide valuable ecological services and habitats for plants and wildlife, but large forests are especially important for area-sensitive wildlife and provide movement corridors for many other kinds of wildlife. Wood thrush† and scarlet tanager† are among the bird species that require large forest-interior areas to nest successfully and maintain populations in the long term. Mammals such as black bear,† bobcat,† and fisher† require large expanses of forest, although they also hunt, forage, and roam through

Scarlet tanager. Photo © John Kenny.

human-settled areas with small forest patches. Many small mammals are associated with upland hardwood forests, including eastern chipmunk, southern flying squirrel, and white-footed mouse. Hardwood trees larger than five inches diameter at breast height—especially those with loose, platy bark such as shagbark hickory, deeply furrowed bark such as black locust, or snags with cavities or peeling bark—can be used for summer roosting and nursery colonies by several bat species, and several other bat species roost in tree foliage.

Forests cover approximately 74 percent of the town, and upland hardwood forest is by far the most common habitat type (Figure 14). Figure 15 shows the extensive forests of Kent and indicates the size (in acres) of each forest block. Forests of 300+ acres are common throughout the town, and several forest blocks are over 1000 acres and extend into adjacent towns.

The NYNHP conducted an analysis of forests throughout the Hudson River Estuary watershed, and assigned a "condition" score to forest patches based on remote indicators of age, connectivity, core area, known occurrence of sensitive species, and apparent stressors. The results of this Forest Condition Index analysis for Kent forests are shown in Figure 16. Nearly half of the forest area in Kent ranks in the 90th percentile or higher in these measures against other forests in the region.

Nearly half of Kent's forests rank in the 90th percentile or higher in measures of age, connectivity, core area, and known occurrence of sensitive species, compared with other forests in the region.

Figure 17 shows Kent forests in a regional context and classified by The Nature Conservancy (TNC) and the NYNHP as "matrix forests" and "linkage zones." Matrix forests are contiguous forest areas whose large size and intact condition allow them to support ecological processes and viable large-forest communities of plants and animals that cannot necessarily persist in smaller or poorer-quality forests. The linkage zones are the next-largest adjoining and nearby patches that may provide the best avenue of connectivity for the populations of plants and animals of the matrix forests; that is, the parts of the landscape that are most permeable for safe and efficient movement of migrating organisms between larger forest blocks.[51]

The large forests of Fahnestock State Park constitute the matrix forests in Putnam County, and the linkage zone that runs through northern Kent connects these forests to the large forests of eastern Dutchess County. The matrix forests and linkage zones may become even more important with the warming climate, as plants and wildlife are forced to shift their ranges northward or to higher elevations.

Crest, Ledge, and Talus

Crests, ledges, and talus are rocky habitats that often occur together where soils are very shallow and bedrock is partially exposed at the ground surface, either at the summit of a hill or knoll (crest) or elsewhere (ledge). "Talus" is the term for the fields of large rock fragments that often accumulate on slopes below steep ledges and cliffs. Some crest, ledge, and talus habitats support well-developed forests, while others have only sparse, patchy, and stunted vegetation. These rocky habitats often appear to be harsh and inhospitable, but they can support an extraordinary diversity of uncommon and rare plants and animals. Some species, such as brittle bladder fern,† blunt cliff fern,† and northern slimy salamander are found only in and near rocky places in the region. The communities and species that occur at any particular location are determined by many factors, including bedrock type, outcrop size, soils, aspect, exposure, slope, elevation, biotic influences, and kinds and intensity of human disturbance.

Rocky habitats with larger fissures, cavities, and exposed (unforested) ledges may provide shelter, den, and basking habitat for black rat snake,† northern copperhead,† and other snakes of conservation concern. Northern slimy salamander occurs in wooded ledge and talus areas. Breeding birds of crest habitats include blackburnian warbler,† worm-eating warbler,† and cerulean warbler.† Bobcat and fisher use crests and ledges for travel, hunting, and cover, and porcupine and bobcat use ledge and talus habitats for denning. Southern red-backed vole is found in talus (and other habitats), and eastern small-footed bat† uses talus for summer roosting.

Crest, ledge, and talus habitats occur at all elevations in Kent, and are often embedded within other habitat types such as upland forests. Figure 5 shows a coarse representation of the areas where exposed bedrock is likely to occur (coded as "bedrock outcrop [r]") and Figure 18 is perhaps a closer approximation of ledgy areas—where steep slopes coincide with shallow soils as mapped by the NRCS. Figure 19 shows the location of a particular kind of talus habitat—an acidic talus slope woodland; and other examples of this habitat are likely in Kent.

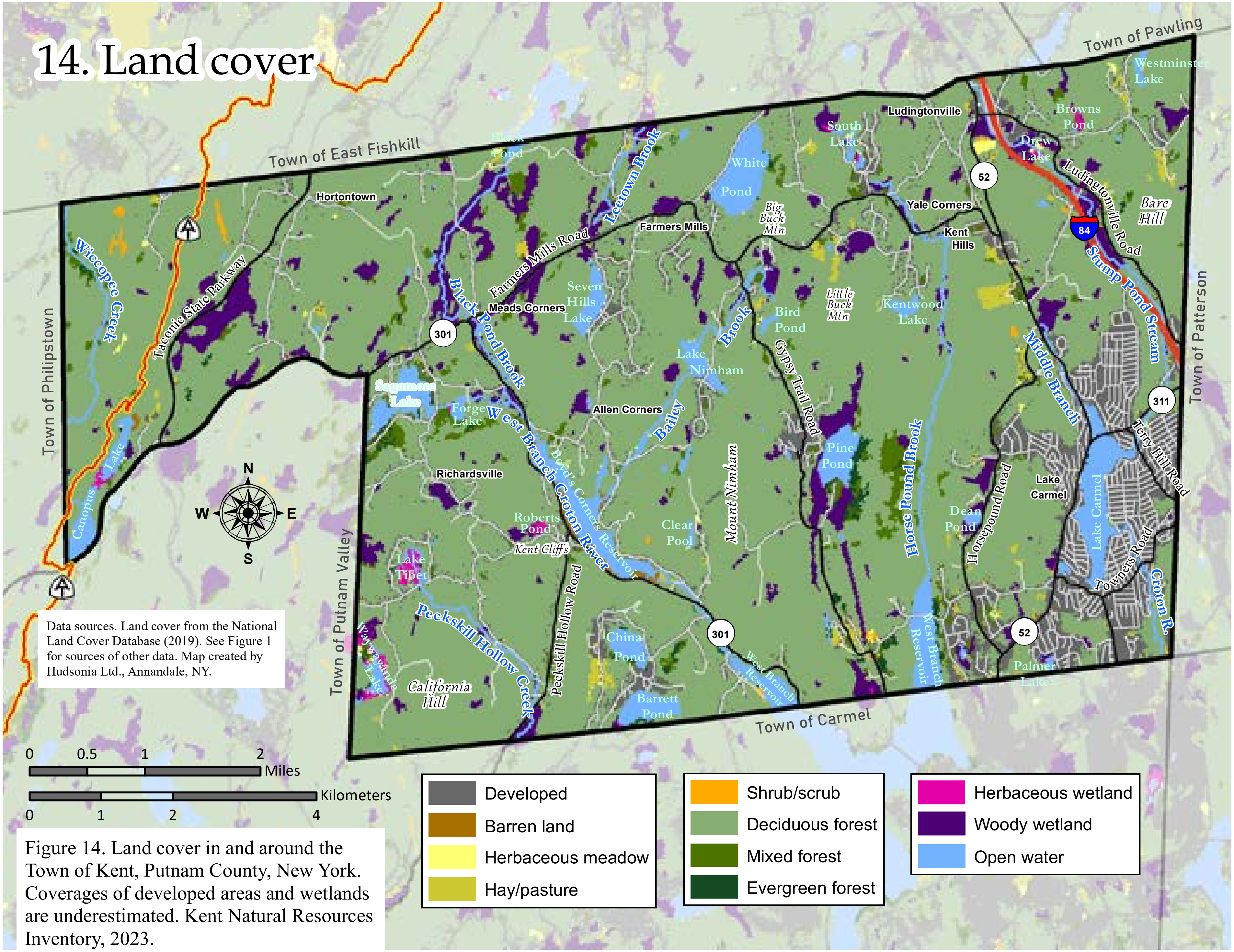
Rocky Barrens

A special subset of rocky crest habitats is the "rocky barren" which occurs on ridgetops and hillsides with exposed bedrock, shallow soils, and vegetation dominated by some combination of pitch pine, eastern white pine, eastern red cedar, chestnut oak, scarlet oak, red oak, scrub oak, blueberries, black huckleberry, early azalea, deerberry, and sweetfern. Trees, if present, are often sparse and stunted. Common herbs include Pennsylvania sedge, poverty grass, common hairgrass, little bluestem, and bracken. Lichens and mosses are sometimes abundant. Due to the open canopy, exposed rock, and dry soils, rocky barrens tend to have a much warmer, drier microclimate in summer than the surrounding forested habitats and a colder microclimate in winter. The barrens are also exposed to extreme wind and ice conditions and, at least historically, wildfires. This environment of extremes has a strong influence on the composition and structure of the plant community.

Like some of our other harsh-looking habitats, rocky barrens often support rare and uncommon species of plants and animals.

Rocky barrens can have significant habitat value for black rat snake,† black racer,† and other snakes. Deep rock fissures can provide crucial overwintering sites for these species, and the exposed, unshaded ledges provide basking and breeding habitat in the spring and early summer, and basking habitat in the fall. Birds of these habitats include common yellowthroat, Nashville warbler, prairie warbler,† field sparrow,† eastern towhee,† and whip-poor-will.† Several rare butterflies that use scrub oak, little bluestem, lowbush blueberry, or pitch pine as their primary food plant tend to concentrate in rocky barrens.

14. Land cover



Data sources. Land cover from the National Land Cover Database (2019). See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 14. Land cover in and around the Town of Kent, Putnam County, New York. Coverages of developed areas and wetlands are underestimated. Kent Natural Resources Inventory, 2023.

15. Large forests

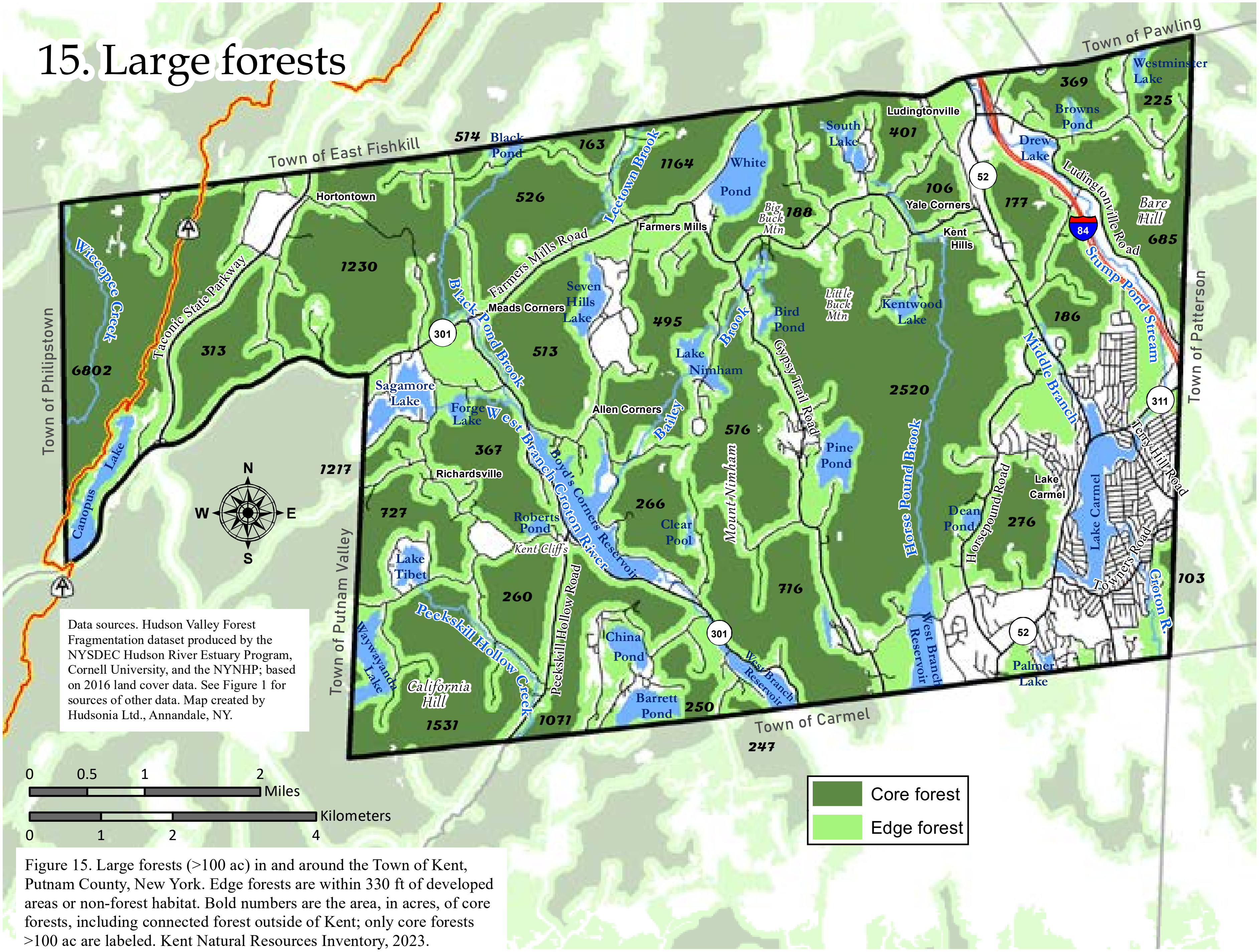


Figure 15. Large forests (>100 ac) in and around the Town of Kent, Putnam County, New York. Edge forests are within 330 ft of developed areas or non-forest habitat. Bold numbers are the area, in acres, of core forests, including connected forest outside of Kent; only core forests >100 ac are labeled. Kent Natural Resources Inventory, 2023.

16. Forest Condition Index

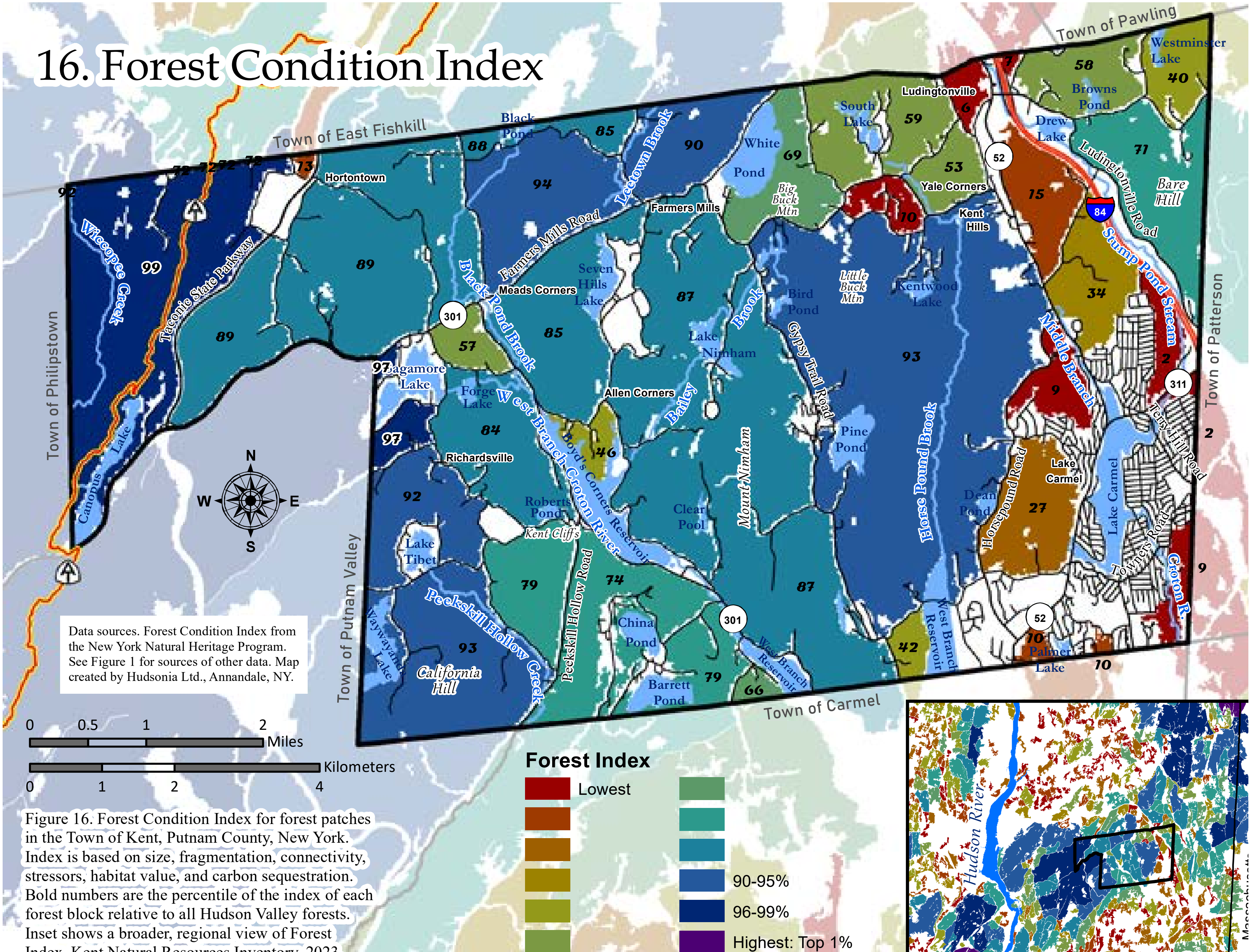


Figure 16. Forest Condition Index for forest patches in the Town of Kent, Putnam County, New York. Index is based on size, fragmentation, connectivity, stressors, habitat value, and carbon sequestration. Bold numbers are the percentile of the index of each forest block relative to all Hudson Valley forests. Inset shows a broader, regional view of Forest Index. Kent Natural Resources Inventory, 2023.

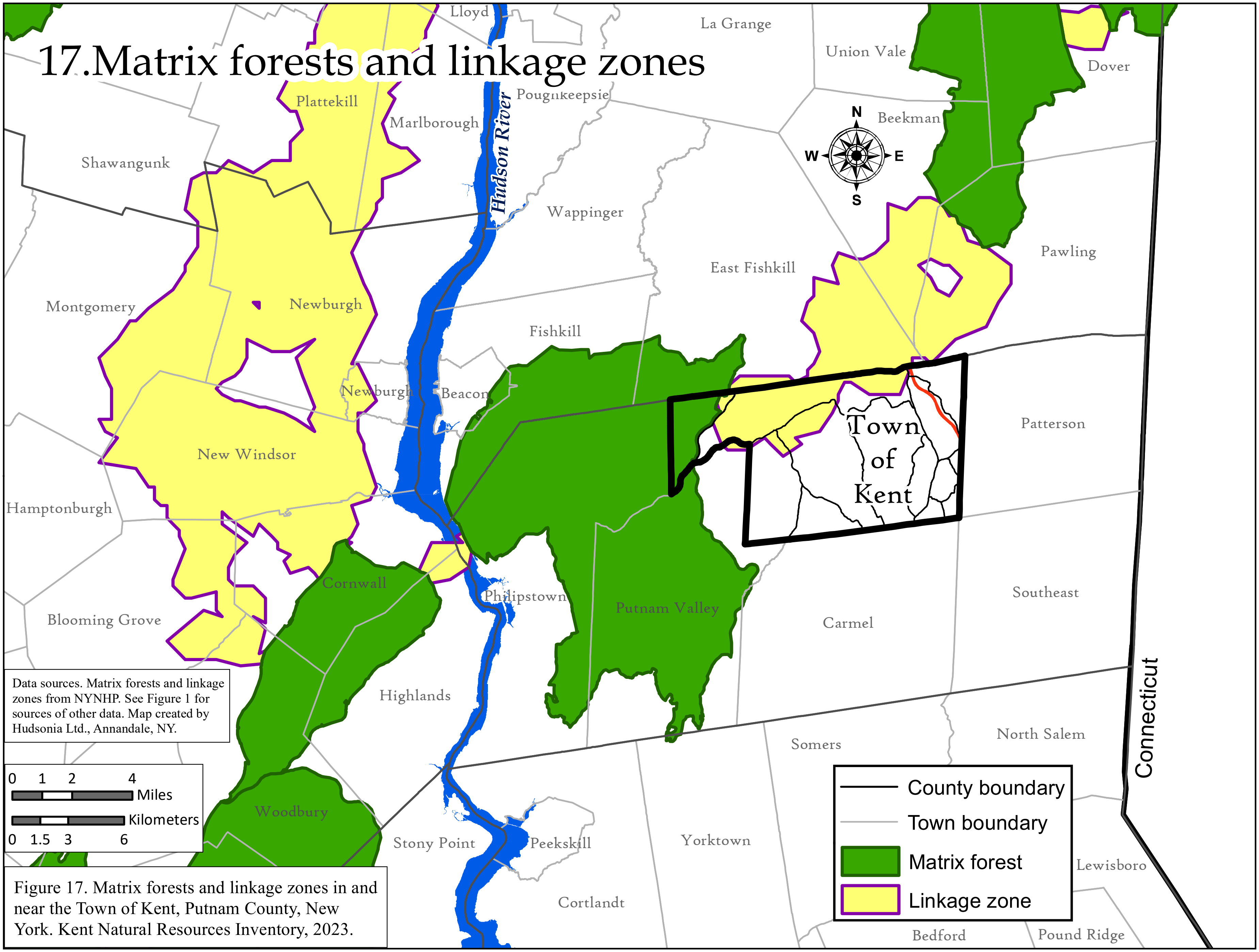
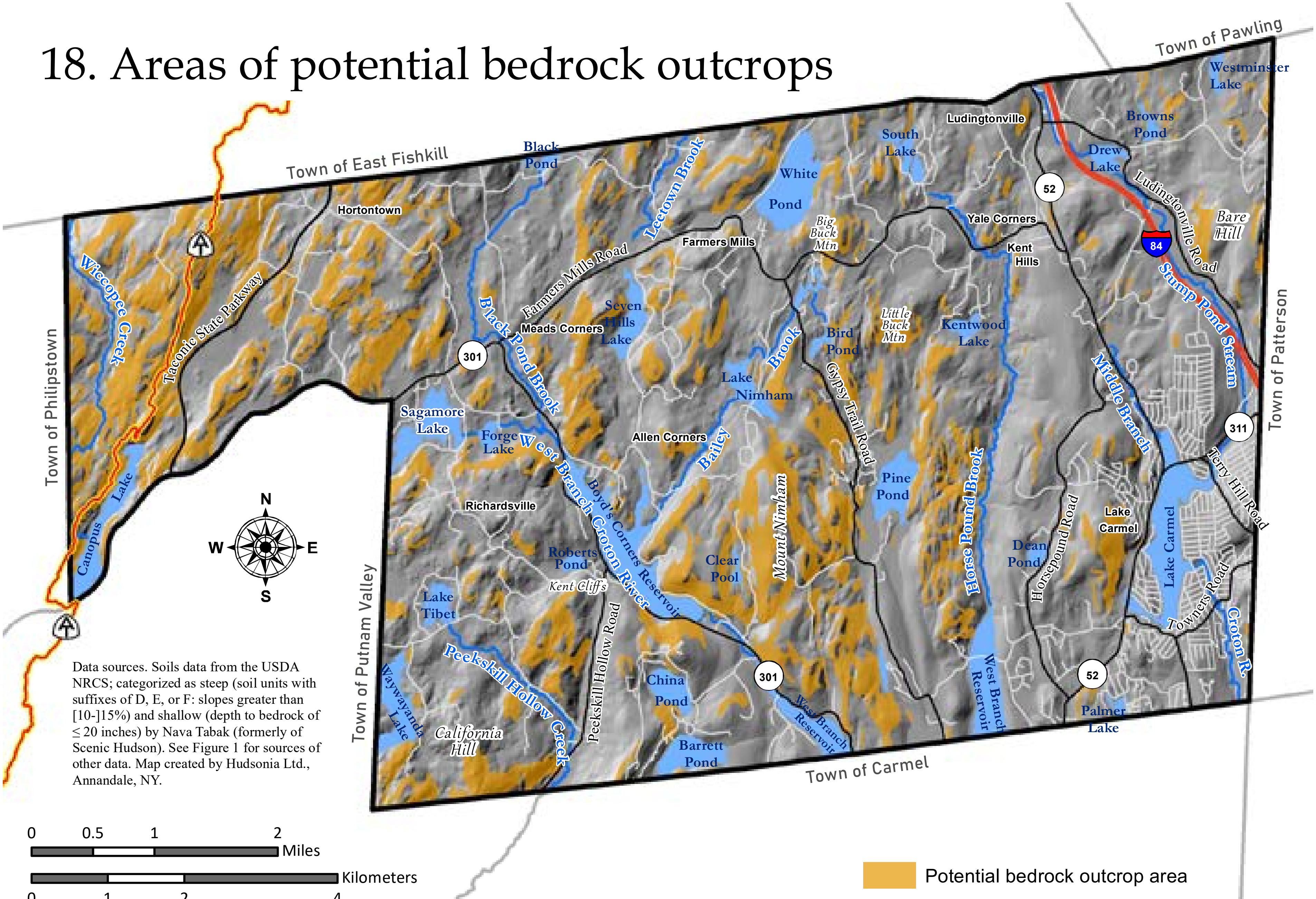


Figure 17. Matrix forests and linkage zones in and near the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

18. Areas of potential bedrock outcrops



Data sources. Soils data from the USDA NRCS; categorized as steep (soil units with suffixes of D, E, or F: slopes greater than [10-]15%) and shallow (depth to bedrock of ≤ 20 inches) by Nava Tabak (formerly of Scenic Hudson). See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 18. Areas of both steep slopes and shallow soils in the Town of Kent, Putnam County, New York. These are the places most likely to have areas of exposed bedrock. Kent Natural Resources Inventory, 2023.

Above: Utility corridors act to fragment and degrade the forest habitats that they run through, but do often support shrubland, meadow, and ledge habitats that can be of value to native plants and wildlife. Photo © Beth Herr. Right: The sweet song of the yellow warbler is often heard in shrub thickets. Photo © John Kenny.

Rocky barrens can also serve as habitat for rare oak-dependent moths. Rare and uncommon plants of rocky barrens in the region include rusty woodsia,† clustered sedge,† and dwarf shadbush.

Rocky barrens occur along the high ridge of the Kent panhandle where extensive areas of bedrock are exposed. Figure 19 shows the locations of some of the barrens, along with other unusual habitats.

Upland Shrubland

The term “upland shrubland” refers to shrub-dominated upland (i.e., non-wetland) habitats. In most cases these are lands in transition between meadow and young forest, but shrublands also occur along utility corridors maintained by cutting or herbicides, in areas of recent forest clearing or blowdowns, and in ledgy areas with shallow soils. Soil characteristics and historical and recent land uses are important factors influencing the species composition of shrub communities.

Shrublands may have diverse native shrubs such as meadowsweet, gray dogwood, northern blackberry, and raspberries; and seedlings and saplings of eastern red cedar, eastern white pine, hawthorns, gray birch, red maple, quaking aspen, and oaks, along with native grasses and forbs; or may be dominated by non-native, invasive species such as Japanese barberry, Bell’s honeysuckle, autumn-olive, oriental bittersweet, multiflora rose, and the non-native grasses and forbs of oldfields. Many non-native, invasive plants thrive in agricultural areas that were heavily grazed in the past or where agriculture was abandoned in the 1930s or 1940s, when many of our non-natives were starting to take hold in the region. Recently-logged areas tend to develop a shrub layer including abundant tree saplings and northern blackberry.

Many shrublands retain meadow-like areas between the shrub individuals and thickets, and support many of the insects and other wildlife of meadows (see below). Rare butterflies may occur in shrublands where their larval host plants are present. Upland shrublands and other non-forested upland habitats may be used by turtles for nesting or summer aestivation (e.g., painted turtle, wood turtle,† spotted turtle,† and eastern box turtle†) or for foraging (eastern box turtle†). Many bird species of conservation concern nest in upland shrublands, including brown thrasher,† blue-winged warbler,† golden-winged warbler,† prairie warbler,† and eastern towhee.† Most of these birds avoid nesting near forest edges,[52] so large areas of shrubland (>12.5 ac) and those that form large complexes with meadow habitats may be particularly important for successful nesting.[53] American kestrel and several species of hawks use upland shrublands and adjacent meadows for hunting small mammals such as meadow vole, white-footed mouse, and eastern cottontail. The New England cottontail† (NYS Special Concern) uses shrub thickets and young forests with dense shrub layers. It is known to occur at several locations in Kent. Figure 19 shows locations where large shrublands and forests with dense shrubby understories were identified by remote sensing.

According to the land cover mapping of the USGS (Figure 14), shrublands are few and small in Kent. If left unmowed, some of the areas that are now meadows may slowly transition to shrublands, although the herbaceous communities may also persist for many years.

Upland Meadow

The term "upland meadow" can refer to upland non-forested, non-shrubby areas of all kinds, including cultivated fields, hayfields, pastures, oldfields, and rocky crests. Meadows can be variously dominated by any combination of grasses, sedges, and forbs. Non-native grasses of pastures, hayfields, and oldfields include species such as Kentucky bluegrass, orchard grass, smooth brome, bentgrasses, and timothy. Fallow fields and oldfields retain such grasses and also tend to develop diverse forb communities with, for example, goldenrods, asters, ox-eye daisy, wild madder, knapweeds, and clovers. Meadows with shallow, nutrient-poor soils often support a higher abundance and diversity of native, warm-season grasses such as little bluestem, common hairgrass, and poverty grass, and other native plants. Bill Buck has observed that oldfields also support ephemeral mosses—tiny mosses that complete their life cycle within a few months.

Meadows with abundant thatch are good habitat for meadow vole, a primary prey species for red fox. Photo © John Kenny.

Eastern bluebird nests in cavities in or near meadows edges. Photo © John Kenny.

The ecological values of these habitats can differ widely according to the types of vegetation present, disturbance histories (e.g., tilling, mowing, grazing, pesticide applications, trampling), and meadow size. Meadows of any size can be valuable habitats for small mammals, butterflies, moths, dragonflies, native bees, and many other invertebrates. Undisturbed meadows develop diverse plant communities and support an array of wildlife, including invertebrates, frogs, snakes, turtles, mammals, and birds.

Intensively cultivated crop fields have comparatively little wildlife habitat value, although even they are used for foraging by white-tailed deer, raccoon, wild turkey, Canada goose, songbirds, and other wildlife. Upland meadows are used for nesting by wood turtle,† spotted turtle,† eastern box turtle,† painted turtle, and snapping turtle.† Meadows often have large populations of small mammals (e.g., meadow vole) and can be important hunting grounds for raptors, foxes, and eastern coyote.

Many butterfly species nectar on wildflowers of upland meadows, and butterflies of conservation concern, such as Aphrodite fritillary† and monarch† use upland meadows that support their particular larval host plants. Birds such as eastern kingbird, eastern bluebird, and American kestrel hunt over meadows, and killdeer nests in pastures and other meadows with low or sparse vegetation. Wild turkey forages on invertebrates and seeds in upland and wet meadows, and American woodcock† uses meadows for foraging and courtship displays.

Large meadows (10+ acres) have particular value for grassland breeding birds, whose Northeastern populations have experienced sharp declines in recent decades due primarily to loss of suitable habitats. Species such as savannah sparrow, eastern meadowlark,† and bobolink† use large meadow habitats for nesting and foraging. Large meadows can also serve as hunting sites for raptors in winter, including hawks, northern harrier, and short-eared owl. Different bird species require meadows of different sizes and conditions (vegetation heights, grasses vs. forbs vs. shrubs, depth of thatch).

Like shrublands, upland meadow habitats (mapped as “hay/pasture” and “herbaceous meadow” in Figure 14) are also few and small in Kent, where most former meadows and shrublands have reverted to forest.

Wetlands, Ponds, and Streams

A "wetland" is a vegetated area where the surface soils are inundated or saturated for a prolonged period during the growing season. Wetlands come in many guises—swamps, marshes, wet meadows, fens, and bogs—each of which is distinguished by the hydrology, the plant community, and in some cases the chemistry of the soil and water. Some wetlands have permanent standing water, and some have standing water for only brief periods after rain events, or none at all, and many have hydroperiods somewhere between those extremes.

Wetlands support a huge array of wildlife and plants, including some species that are highly specialized to specific habitat conditions—that is, they occur within a very particular kind of wetland with its particular pattern of water depth and water fluctuations, its water and soil chemistry, its plant community, and its adjacent and nearby habitats. Mollusks, crustaceans, insects, frogs, salamanders, turtles, snakes, fishes, muskrat, American beaver, herons, and nesting songbirds and raptors inhabit the particular kinds of wetlands that meet their habitat needs. White-tailed deer forage in swamps, and bobcat, foxes, and coyotes hunt in swamps for mice, voles, frogs, and other small animals. Wood duck often nests in tree cavities of hardwood swamps, and red-shouldered hawk seems to prefer nesting in or near swamps that are part of large forested areas. Four-toed salamander—uncommon in the region—hangs out in swamps that have lots of moss-covered logs and rocks.

In addition to their widely-recognized values for wildlife, wetlands serve many other functions important to local ecosystems and the human community. Depending on their landscape position, some wetlands are able to store large amounts of water which they then release slowly to streams and (sometimes) groundwater. The water storage in large and small wetlands throughout the landscape significantly reduces the water volumes that would otherwise contribute to downstream floods. Wetlands that do not regularly dry up during the warm months can accumulate deep layers of peat which act as long-term carbon repositories.

Wetlands are one of the few kinds of land cover that receive any legal protection from state, federal, or local governments, but many wetlands in Kent are entirely unprotected due to their small size or their isolation from other waterbodies. Wetlands

A ponded area of the "poor fen" near Clear Pool. Photo © Beth Herr.

appearing on the National Wetland Inventory maps and the New York State Freshwater Wetland Maps are shown in Figure 10.

The Town of Kent regulates activities in those wetlands, and also in additional wetlands of 40,000 ft^2 (approximately one acre) and larger, many of which do not appear in Figure 10. The town defines jurisdictional wetlands to include areas with "poorly drained" or "very poorly drained" soils or alluvial soils. Figure 10 shows those areas as mapped by the NRCS. Poorly and very poorly drained soils are the "hydric" soils that support wetlands; some areas of somewhat poorly drained soils are also hydric and support wetlands. The soil maps are somewhat coarsely drawn, but nonetheless show the places within which additional wetlands not appearing on the federal or New York State wetland maps are most likely to occur. Many small wetlands, however, such as intermittent woodland pools, wet meadows, or small, isolated swamps, are likely to occur outside the areas mapped as wetland soils, because they are smaller than the size threshold for the soil units in the county soil survey. Users of these and other public maps should be aware that many wetlands do not appear on any wetland maps or soil maps and are only identified from onsite observations or from detailed site-specific remote sensing.

Described below are some of the general wetland types in Kent. A discussion of wetland regulations is in the **Existing Protections** section, below.

Swamp

A "swamp" is a wetland dominated by woody vegetation (trees or shrubs). The most common kind of swamp in Kent is a hardwood swamp, and the most common woody species of hardwood swamps are red maple, green ash, American elm, slippery elm, and swamp white oak (trees), and winterberry holly, highbush blueberry, silky dogwood, alders, swamp azalea, sweet pepperbush, and willows (shrubs). American sycamore, pin oak, and black gum may also be present. Some typical herbs are skunk-cabbage, beggar-ticks, false-nettle, common jewelweed, tussock sedge, and cinnamon, sensitive, royal, crested, and marsh ferns. The trees of conifer swamps are usually eastern hemlock with occasional white pine. A very rare tree—Atlantic white cedar—occurs in nearby swamps in Putnam County but is not known to occur in Kent.

Swamps are important to a wide variety of birds, mammals, amphibians, reptiles, and invertebrates, especially swamps that are contiguous with other wetland types 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 by several pool-breeding amphibian species. Jefferson/blue-spotted salamander† breeds in pools of forested or shrubby swamps, and four-toed salamander† inhabits swamps with abundant, moss-covered rocks, downed wood, or woody hummocks. Eastern ribbon snake† forages for frogs in swamps. Red-shouldered hawk,† barred owl,† great blue heron,† wood duck,† American black duck,† red-headed woodpecker,† and Canada warbler† nest in hardwood swamps. New England cottontail uses shrub swamps and other swamps with a dense shrub layer, as well as nearby mature forests. Bobcat hunts in swamps and other wetlands.

Like other forested and shrubby habitats in the floodplains of streams, riparian swamps are especially valuable for stabilizing streambanks and floodplain soils, dampening flood flows, and keeping stream temperatures cool. Wetlands of all kinds are effective at removing excess nitrogen—by means of denitrification and plant uptake—from runoff before it enters a stream. Swamps can also intercept and settle out suspended sediments in surface runoff before it reaches a stream. Swamps both within and outside the floodplain are important for carbon sequestration and climate moderation, and some swamps are sites of groundwater recharge.

Hardwood and shrub swamps are common and widespread in Kent, occurring in a variety of settings—on seepy slopes, along streams, in

Three views of a hemlock-hardwood swamp. The structural complexity of some swamps contributes to their biodiversity values. Photos © Chris Graham.

depressions, and as part of large wetland complexes. Figure 14 lumps all swamps (hardwood, conifer, mixed forest, shrub swamp) together in the dark purple polygons. There are likely to be many more swamps that do not appear in Figure 14 or on the wetlands map (Figure 10).

Locations of four less-common kinds of swamps—mixed forest swamp, buttonbush pool, pool-like swamp, and acidic shrub swamp—are shown in Figure 19. A mixed forest swamp has a canopy of both hardwood and conifer trees. The conifers may be eastern white pine, eastern hemlock, eastern red cedar, or American larch, but pine or hemlock are the most likely in Kent. Mixed forest swamps share many of the ecological values of hardwood and conifer swamps. Buttonbush is a semi-aquatic shrub that can withstand long periods of standing water through the growing season. It occurs in many kinds of shrub swamps and vernal pools and at the edges of some waterbodies, but where a wetland has a thicket of buttonbush and long-standing water we call it a "buttonbush pool." Elsewhere in the region, and perhaps in Kent, these wetlands are often used by spotted turtle,[†] other turtles, wood duck,[†] and many other kinds of wildlife. Figure 19 shows just one buttonbush pool, identified remotely, but there may be others in Kent. A "pool-like swamp" is a hardwood swamp that is substantially isolated from streams and other waterbodies, and has one or more temporary open pool areas that may be used by the pool-breeding amphibians, invertebrates, and other animals of intermittent woodland pools (vernal pools).

Occurrences of "highbush blueberry bog thicket" are shown on figures 19 and 22 near the Appalachian Trail. One of these had a dense thicket of highbush blueberry and swamp azalea over a carpet of peat mosses (*Sphagnum*). Small openings had patches of tussock sedge, marsh St. Johnswort, and other herbaceous plants, and at least one patch of the regionally-rare Virginia chain fern. Black tupelo trees lined the edges of the thicket. Another bog thicket had been deeply flooded at one end, perhaps by beaver (old beaver stumps were present). Highbush blueberry was abundant, and red maples were occasional.

Intermittent Woodland Pool

An "intermittent woodland pool" is a small wetland partially or entirely surrounded by upland forest, typically with no surface water inlet or outlet (or an ephemeral one), and with standing water during fall, winter, and spring that dries up by mid- to late summer in most years. This habitat is a forested subset of the widely-recognized "vernal pool" habitat that may occur in forested or open settings. Intermittent woodland pools may be devoid of vegetation or may have a few trees or patches of sedges, grasses, ferns, forbs or shrubs.

The seasonal drying and lack of stream connections ensure that these pools do not support fish, which are major predators on amphibian eggs and larvae. The fish-free environment makes these pools the critical breeding habitat for a special group of pool-breeding amphibians—Jefferson/blue-spotted salamander,† spotted salamander, marbled salamander,† and wood frog—that cannot easily cohabit with fish. These pools often support a rich invertebrate fauna, including animals especially adapted to the seasonal drying, such as fairy shrimp, clam shrimp, and fingernail clam. They can also be important foraging, resting, and rehydrating habitats for terrestrial wildlife. The surrounding forest supplies organic detritus to the pools—the base of the pool's food web—and is the critical year-round habitat for adults of the pool-breeding amphibians. Several rare plants are known from Hudson Valley woodland pools, including swamp cottonwood,† false hop sedge,† cattail sedge,† and weak stellate sedge.

Although intermittent pools in open (unforested) settings have been little studied in the Hudson Valley, these are potential habitats for rare clam shrimps and diverse other invertebrates, and are used for breeding by American toad, and for foraging by shorebirds and other animals.

Intermittent woodland pools occur in forests in all parts of Kent, in low, high, and all elevations in between. Many intermittent woodland pools do not appear on public wetland maps (such as Figure 10) because of their small size and their isolation from other wetlands, streams, or lakes, so they must be identified independently by remote sensing or field observations.

Poor Fen

A "poor fen" is a rare wetland type in Putnam County that is fed by acidic groundwater and typically has extensive mats of peat mosses (*Sphagnum*), sedges, shrubs, and stunted trees. These wetlands sometimes have bog-like plants such as cranberries, sheep laurel, leatherleaf, sundews, and purple pitcher-plant. Dragon's mouth orchid (*Arethusa bulbosa*) and other rare plants are known to occur in some poor fens in New York. The perpetual wetness and acidic environment lead to development of deep layers of peat. Buck and Herr know of just one poor fen in Kent, located northwest of Clear Pool. In 2012, NYCDEP biologists found fragrant pond-lily in the ponded perimeter and swamp azalea, highbush blueberry, red maple, and peat mosses in the shrubby interior. Other species noted were woolgrass, bur-reed, beak-rush, round-leaved sundew, and royal fern.[54]

Marsh vegetation at the edge of White Pond. Photo © Beth Herr.

Marsh

A "marsh" is a wetland that 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 waterbodies (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. Cattails, tussock sedge, lakeside sedge, woolgrass, reed canary-grass, common reed, bur-reeds, water-plantains, and purple loosestrife are some typical emergent marsh plants in Kent. Some marshes are dominated by floating-leaved plants such as pond-lilies, water-shield, watermeals, and duckweeds.

The diverse plant communities of some marshes provide habitat for butterflies such as the Baltimore, monarch, and northern pearly eye. Marshes are also important habitats for reptiles and amphibians, including northern water snake, painted turtle, snapping turtle, spotted turtle,† green frog, pickerel frog, and spring peeper. Numerous bird species, including marsh wren, common gallinule, American bittern,† least bittern,† great blue heron, Virginia rail, sora, American black duck,† and wood duck† use marshes for nesting and nursery habitat. Pied-billed grebe† also uses this habitat where it occurs adjacent to open water areas. Many raptors, wading birds, and mammals use marshes for hunting or foraging. Several rare plant species are known from marshes in the region.

Marshes are often closely associated with small and large streams, occurring both adjacent to the stream channel and elsewhere in the floodplain. They are thus intimately tied to the stream ecology, providing habitat for stream organisms and organic materials for the stream food web. As in other wetlands, the organic soil layer of marshes is especially effective at removing nitrogen from water via denitrification. Plant uptake of nitrogen and phosphorus can also significantly reduce nutrient concentrations in streams and ponds.[55,56] Marshes with dense vegetation can dampen flood flows and remove sediments from flood waters.

Wet Meadow

A "wet meadow" is a wetland that is dominated by herbaceous (non-woody) vegetation, and that retains little or no standing water during most of the

Large purple fringed orchid is a stunning plant of wet meadows and other moist-to-wet habitats. Photo © Beth Herr.

Great blue heron is frequently seen feeding in Kent's marshes, ponds, lakes, and streams. Photo © Barbara Garbarino.

growing season. The typical period of inundation or soil saturation is longer than that of an upland meadow but shorter than that of a marsh. Some wet meadows have lots of purple loosestrife, common reed, reed canary-grass, or tussock sedge, while others have a diverse mixture of wetland grasses, sedges, rushes, forbs, and scattered shrubs. Mannagrasses, woolgrass, reed canary-grass, soft rush, spotted Joe-Pye-weed, common jewelweed, sensitive fern, and marsh fern are some typical native plants of wet meadows. *Carex* sedges are common to abundant in some wet meadows.

Some wet meadows have rich invertebrate faunas. Blue flag and certain sedges and grasses of wet meadows are larval food plants for regionally-rare butterflies. Wet meadows provide nesting and foraging habitat for songbirds such as red-winged blackbird, and wading birds such as American bittern.† Wet meadows that are part of extensive meadow areas (both upland and wetland) are especially important to species of grassland breeding birds and to foraging raptors.

Wet meadows in and near floodplains have particular value for treating polluted surface runoff before it enters the stream. Wet meadows and other wetlands are important sites for denitrification as well as plant uptake of nutrients, and densely-vegetated wet meadows are especially effective at capturing sediments. Floodplain wet meadows can help absorb and dampen floodwaters in mild to moderate flood events but are overwhelmed by severe flooding.[57]

Springs and Seeps

Springs and seeps are places where groundwater discharges to the ground surface under gravitational or hydrostatic pressure, either at a single point (a spring) or diffusely (a seep). Springs often discharge unseen into ponds, streams, and wetlands but are more conspicuous where they discharge to upland locations. Springs and seeps originating from deep groundwater sources flow more or less continuously and emerge at a fairly constant temperature, creating an environment that is cooler in summer and warmer in winter than the surroundings. For this reason, seeps and springs sometimes support aquatic species that are ordinarily found at more northern or southern latitudes. The habitats created at springs and seeps are determined in part by the hydroperiod and by the chemistry of the soils and bedrock through which the groundwater flows before discharging. Springs and seeps are water sources for many streams, and they help maintain the cool water temperatures that are such an important habitat characteristic for certain rare and declining fishes, amphibians, and other aquatic organisms. Springs and seeps with long hydroperiods also serve as water sources for animals during droughts and in winters when other water sources are frozen.

Golden saxifrage is a plant more-or-less restricted to springs and groundwater-fed wetlands and streams, and smaller forget-me-not seems especially tied to seeps and springs. A few rare invertebrates are restricted to springs in the region: the Piedmont groundwater amphipod could occur in the area,[58] and gray petaltail† and tiger spiketail† are two rare dragonflies of seeps. Northern dusky salamander† uses seeps, springs, and cool streams.

Springs and seeps occur at all elevations and landscape settings in Kent—forested and open lands, on level ground, at the foot of slopes, and on hillsides, shoulders, and ledges. Although vegetated seeps that flow for long periods are wetlands, they (especially those that occur on hillsides) are rarely shown on public wetland maps. Figure 19 shows the locations of a few springs and hillside seeps identified remotely, but there are likely to be many more in the town.

Red-winged blackbird is one of the earliest migratory songbirds to arrive in marshes and wet meadows each spring. Photo © John Kenny.

Ponds and Lakes

Described here are open water habitats that occur as naturally-formed or constructed ponds and lakes, and large pools lacking floating or emergent vegetation within marshes and swamps.

Open water areas can be important habitat for many common species, including invertebrates, fishes, frogs, turtles, waterfowl, muskrat, beaver, and bats. Open water areas sometimes support submerged aquatic vegetation that can provide important habitat for aquatic invertebrates and fish. Spotted turtle† uses ponds and lakes during both drought and non-drought periods, and wood turtle† may overwinter and mate in open water areas. Wood duck,† American black duck,† pied-billed grebe,† osprey,† bald eagle,† American bittern,† and great blue heron† use open water areas as foraging habitat. Waterfowl use lakes and ponds as stop-over sites during spring and fall migrations. Bats, American mink, and river otter† also forage at open water habitats.

"Constructed ponds" are waterbodies that have been created by humans by excavation or damming, either in existing wetlands or stream beds or in upland terrain, for fishing, watering livestock, irrigation, swimming, boating, and aesthetics. Some

Sunrise over the West Branch Croton River Reservoir. Photo © Alexander Milligan.

are constructed near houses or other structures for ornamental or recreational purposes, or to serve as a source of water in the event of a fire. Some were created inadvertently where mining excavations intersected the water table. Of course, most of Kent's lakes and reservoirs are constructed ponds created by damming a stream.

If constructed ponds are not intensively managed by humans, they can be valuable habitats for many of the common and rare species associated with naturally-formed open water habitats (see below).

In general, the habitat value of a constructed pond is higher when the pond has an undeveloped, unmanaged shoreline, is relatively undisturbed by human activities, has more vascular vegetation, and is embedded within an area of intact habitat. Because many constructed ponds are not buffered by sufficient natural vegetation and undisturbed soils, they are vulnerable to the adverse impacts of septic leachate, and pesticide or fertilizer runoff from lawns, gardens, and agricultural fields. Many ponds maintained for ornamental purposes are treated with herbicides and algicides, or contain non-native fish such as grass carp and various game and forage fishes. Constructed ponds that are kept devoid of emergent or submerged vegetation have little habitat value but are sometimes used as drought refuges by turtles, amphibians, and other wildlife, and as stop-over resting sites for migrating waterfowl. Those with significant vegetation may have nesting waterfowl and resident turtles, frogs, and salamanders. Since constructed ponds can serve as habitat for a variety of common and rare native species, applications of pesticides should be avoided or minimized, and polluted runoff from roads, lawns, and farm fields should be directed elsewhere.

Although landowners often create ponds, in part, to "improve wildlife habitat," 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 the pre-existing natural habitats far outweighs any habitat value gained in the artificially created environments.

Streams

"Perennial streams" flow continuously throughout years with normal precipitation, although some may dry up during extreme droughts. They provide essential water for wildlife throughout the year, and are critical habitat for many plant, vertebrate, and invertebrate species. "Intermittent streams" may flow for a few days or for many months during the year, but ordinarily dry up at some time during years of normal precipitation. They are the headwaters of most perennial streams and are significant water sources for lakes, ponds, and wetlands. The condition of these small streams therefore influences the water quantity and quality of those larger streams, waterbodies, and wetlands.

Streams serve many recreational, aesthetic, and water-supply functions for the human community; and are a critical component of the ecological landscape, providing habitats for wildlife and supporting processes that maintain floodplain habitats and associated ponds and wetlands. Our treatment of stream channels and banks, floodplains, and whole watersheds has a large influence on flood volumes and flood damage along streams.

The aquatic communities of perennial streams can be diverse, especially in clean-water streams with unsilted bottoms. Brook trout† and slimy sculpin are two native fish species that require clear, cool streams for successful spawning. Wood turtle† uses perennial streams with deep pools and recumbent logs, and undercut banks or muskrat or beaver burrows. Perennial streams and their riparian zones, including sand and gravel bars, provide nesting sites for turtles, and 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. Bats use perennial stream corridors for foraging, and muskrat, American beaver, American mink, and river otter† regularly use stream corridors.

Intermittent streams provide microhabitats not present in perennial streams, supply aquatic organisms and organic drift to downstream reaches, and can be important local water sources for wildlife.[59] Their loss or degradation in a portion of the landscape can affect the presence and behavior of wildlife populations over a large area.[60] Some intermittent streams support rich aquatic invertebrate communities, including regionally-rare mollusks[61] 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.

Habitats in a stream corridor perform a range of ecological functions that serve the stream and the surrounding landscape, and play a large role in local and downstream flood dynamics; for example:

- stabilizing streambanks and reducing stream channel erosion
- storing flood waters and reducing the velocity of floodflows
- moderating stream water temperatures
- trapping and removing sediment from runoff and floodwaters
- trapping and removing nutrients, pesticides, and other contaminants from runoff and floodwaters
- contributing woody debris and other organic detritus to the habitat structure and food base for stream organisms
- providing habitat for terrestrial organisms[62]

River otter is rarely found far from perennial streams, ponds, or lakes. Photo © John Kenny.

Characteristics of the topography, soils, and vegetation at any particular location determine the effectiveness of the streamside and floodplain habitats for providing these services.

Poorly vegetated stream banks are vulnerable to erosion during high water events. Woody vegetation (trees and shrubs) on stream banks helps to reduce the velocity (and thus the erosive force) of flood waters, and the roots of woody vegetation help to hold erodible soils in place. The "roughness" created by the microtopography of the ground surface, the above-ground woody and herbaceous vegetation, woody debris, and rocks in the floodplain, as well as floodplain width, determine the degree to which the floodplain will reduce the velocity of floodflows. Areas densely vegetated with a combination of woody and herbaceous plants are most effective at slowing floodwater and thus reducing downstream flood forces.

Well-vegetated riparian zones can reduce pollution, stabilize streambanks, and contribute to the habitat quality of streams.

Well-vegetated riparian zones can reduce stream sedimentation by trapping sediments before they reach the stream; by reducing the velocity of sediment-bearing storm flows and thus allowing sediments to settle out; by stabilizing streambanks; and by contributing large woody debris to streams, which can temporarily capture large amounts of instream sediments.

Forests next to streams can help to reduce the temperature of stream water, both by directly shading the stream and by shading the floodplain and other areas through which the stream is fed by tributaries, overland flow, and shallow groundwater. High water temperatures reduce dissolved oxygen, a critical resource for stream organisms.[63] Certain species of mollusks, amphibians, fish, and aquatic insects that do not tolerate high temperatures have declined or disappeared from many Hudson Valley streams where previously forested riparian zones have been cleared.

Horse Pound Brook, Bailey Brook, Black Pond Brook, Peekskill Hollow Creek, and the Middle Branch and West Branch Croton River are some of Kent's perennial streams. All are fed by a multitude of smaller streams, both perennial and intermittent. The land cover and land uses in the stream corridors and the entire watersheds of these streams greatly influence their response to large rainstorms and snowmelt events.

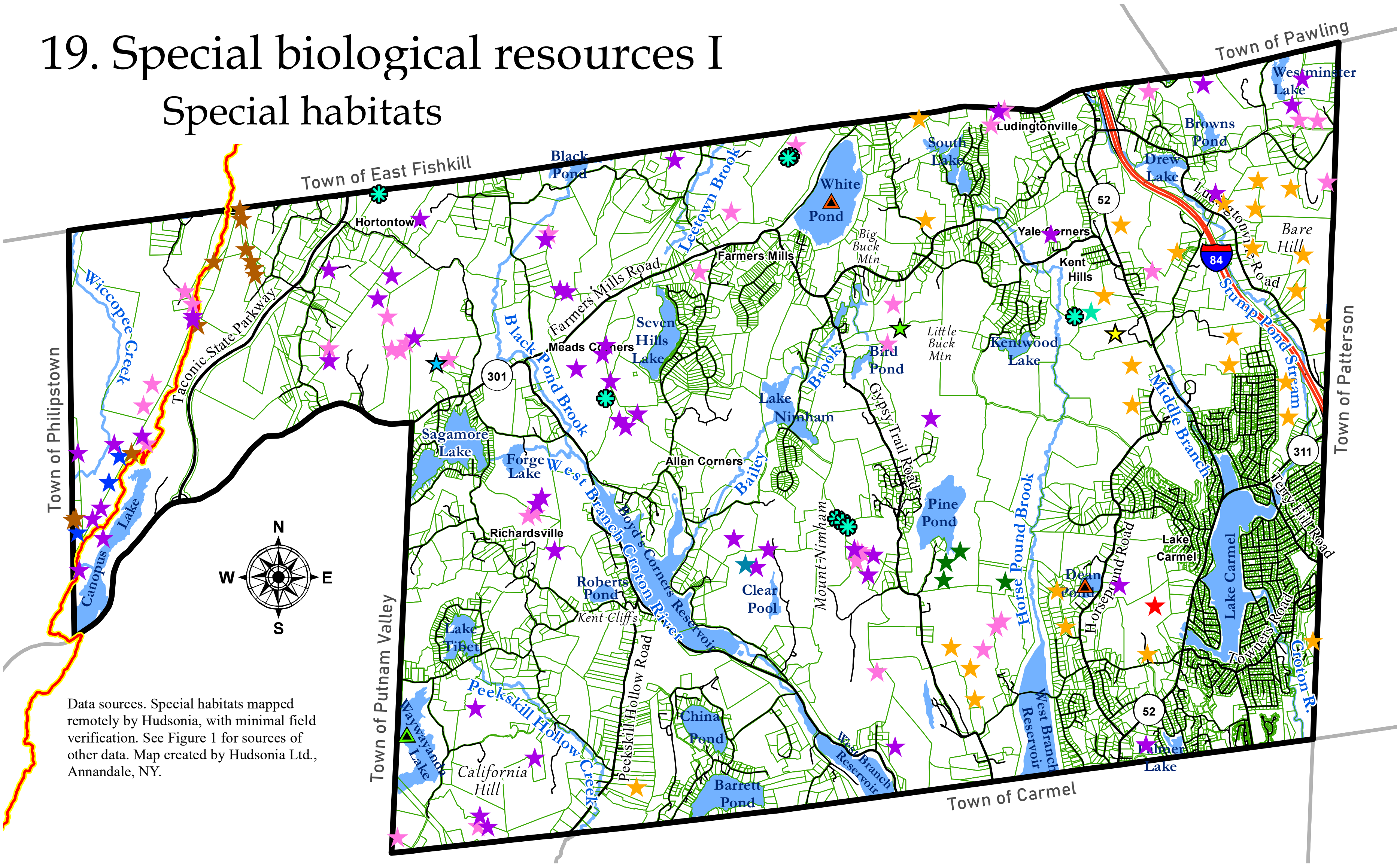
Special Habitats

There is no townwide habitat map for Kent, but for this *NRI* project Hudsonia conducted a remote analysis of the Kent landscape to locate some of the uncommon and rare habitats, that may deserve special conservation attention. These include, for example, large meadows that could support grassland breeding birds, large shrublands that could support the New England cottontail, talus slope woodland that could be summer roosting habitat for the eastern small-footed bat, and intermittent woodland pools and pool-like swamps that could be breeding habitat for pool-breeding amphibians.

The habitats were identified by means of remote analysis of bedrock and surficial geology, topography, soils, and aerial photo images. A few of these places have been seen on-the-ground by Hudsonia or by Buck and Herr, but most remain to be examined and confirmed. The habitat types are described generically in the **Habitats** section, above, and the locations are shown in Figure 19. It is likely that some such habitats are missing from the map, and some may have been misidentified, but the map can serve as a guide to places that should be checked closely if land use changes are proposed in the future. Unusual and rare habitats often support plants and animals of conservation concern.

19. Special biological resources I

Special habitats



0 0.5 1 2 Miles

0 1 2 4 Kilometers

Habitat

- acidic shrub swamp
- bog lake
- buttonbush pool
- highbush blueberry bog thicket
- intermittent woodland pool
- large meadow
- large shrubland or shrubby forest
- mixed forest swamp
- pool-like swamp
- poor fen
- rocky barren
- seepy hillside
- spring
- spring-fed lake
- talus slope woodland

Figure 19. Selected special habitats in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

Plants

There is no comprehensive list of the plants of Kent, but Bill Buck and Beth Herr are developing a checklist of plants and other organisms from their biodiversity studies. The working list is available on the Kent CAC website, and some highlights of their findings are reported here and there throughout this *NRI*. As of summer 2023, they had recorded 41 species of ferns and fern allies, 668 species of other vascular plants, and 186 species of mosses and liverworts.

All of our plant species are tied to particular kinds of environments. Thus, you will find most grass species in meadows, marshes, and shrublands but not in deeply-shaded hemlock forests; you will find pond-lilies in marshes and ponds but not in wet meadows that lack standing water; and you will find chestnut oak in dry, rocky hillside forests but not in forested swamps. Conditions of moisture, temperature, light, and the chemistry and texture of soil or rock substrates are some of the obvious factors governing where a plant species might occur and persist. Among the less-obvious factors are relationships with other organisms; for example, beechdrops obtains its nutrients solely from the roots of beech trees, and pink lady's-slipper requires certain soil fungi for successful germination. Even the effects of long-ago land uses and catastrophic events (hurricanes, tornadoes, floods, wildfires) can be detected in plant communities of today. Also, the climate gradients in the town — south-to-north, low-to-high-elevation — may have a noticeable influence on the occurrence of certain plant species. While many of our plants are fairly common in suitable habitats, some are quite rare in the region and the state. Many of the rarities occur where either the general habitat or the microhabitat is unusual.

Bloodroot (left) and hepatica (right) are spring wildflowers that bloom before the forest trees have leafed out. Photos © Beth Herr.

Appendix Table C-1 gives the scientific names of all plant species mentioned in the *NRI*, and Table 5 lists the plant species of conservation concern known to occur in Kent, and the habitat(s) where those species are most likely.

Non-toxic and least-toxic methods for managing invasive plants are outlined in a Best Management Practices document available from Hudsonia.

Non-native Plants

The wild flora of Kent includes a mix of native plant species and non-natives that have been introduced in the last 350+ years, mostly from other parts of North America or from Eurasia. Many of the non-native grasses and forbs of pastures and hayfields were intentionally brought here to promote European-style agriculture. Many others were brought here as ornamental plants and have since spread into forests, shrublands, meadows, wetlands, and roadsides. Others were brought here unintentionally as hitchhikers on ships or other vehicles, with imported goods, or in travelers' luggage.

Many of these non-native plants are apparently harmless in their new environments, occurring as single individuals or in small stands that do not readily spread. Some are even beneficial, such as those that can quickly colonize and stabilize disturbed soil before native plants have time to establish. But some — the "non-native invasive species" — reproduce and spread rapidly, and threaten native plants and communities directly through competition, or indirectly by altering soil chemistry, soil microbiota, nutrient cycling, vegetation structure, or plant community composition.[64]In many cases where a non-native invasive species takes over a site, it is merely a symptom of a larger problem — such as damaged or contaminated soils, or excess nutrients from polluted runoff. Appendix Table C-2 lists many of the non-native invasive plants that occur in southeastern New York and their invasive status in the region. Although these plants are known to have invasive tendencies, some are still offered for sale by nurseries and other gardening retailers. Removing them from landscaped areas will reduce their chances of spreading into nearby habitats and disrupting native biological communities.

The Lower Hudson Partnership for Regional Invasive Species Management (LHPRISM)—serves as a clearinghouse for information on non-native invasive species in the southern Hudson Valley and provides information and services for education,

*The foxtail grasses (*Setaria*) are beautiful but non-native to this continent. They are significant weeds in cropland, and the bristly fruiting parts are hazardous to grazing livestock. Photo © Alexander Milligan.*

Novelties Underfoot

Bill Buck and Beth Herr

Most of us are led to believe that most of our local biodiversity is already known and species new to science are mainly found in remote regions of the globe. However, undescribed species are all around us. The smaller the organism, the more likely it is that it has been overlooked by generations of biologists. We have a great example right here in Kent.

Most years the New York City Department of Environmental Protection (NYCDEP) lowers the water level in our local reservoirs. When this happens, the previously-inundated shorelines become covered in vegetation. The seeds and spores that create this vegetation are in the soil and are just waiting for the right conditions to germinate. Each year these conditions vary and so the plants found differ year by year.

Two years ago, while searching the shoreline of Boyd's Corner Reservoir, off Nimham Road, we noticed a large number of ephemeral mosses on the soil. These are mosses that go through their entire life cycle in a few months and are no more than 1/8 of an inch tall, each topped by a small spore capsule. The most common one was *Ephemerum spinulosum*, maybe 1/16 of an inch tall. Upon looking more closely, we found that many of the plants had a small, yellowish fungus growing on the filamentous mat from which the leafy plants emerge. Fungi that attack mosses are a very specialized field and so we mailed our material to Germany for Dr. Jan Eckstein to examine. He confirmed that we have an undescribed species of fungus (i.e., new to science). The fertile apothecia are only about 0.5 mm in diameter. It will eventually be described as *Octospora cantiensis*; "Cantia" is the Latinized form of "Kent."

early detection, and control of non-native invasive plants and animals. LHPRISM has published a Best Management Practices document for managing selected invasive plant species that occur in the region, focusing on least-toxic methods.[65]

Native Species Sustain Native Wildlife

Bill Buck and Beth Herr

The remarkable link between native plant species and wildlife is highlighted by startling findings in Kent. While surveying Kent's forests with a professional entomologist, we found just one species of insect associated with the non-native European linden planted at the Putnam County Veterans Memorial Park, versus eleven species of insects associated with the native linden (American basswood) in the forests at California Hill.

Those insects, and others, have associations with even more insects, plants, fungi, and vertebrates, and that is what makes a healthy ecosystem for people and wildlife. The lesson is that planting native trees and shrubs in our yards is likely to be much more beneficial to wildlife than non-native species and cultivars. This is just one illustration of how the choices we make as homeowners and town planners can profoundly impact biodiversity.

Animals

Like most organisms, each animal species has a distinctive life history tied to a particular habitat or complex of habitats that fulfills its particular needs. A population will persist only if its habitats remain intact and its movement corridors safe. The wood turtle,† for example, needs low-gradient perennial streams and intact riparian corridors with a variety of wetland and non-wetland habitats to meet its needs for foraging, nesting, resting, and overwintering. The cerulean warbler needs deciduous forests with mature trees for nesting and foraging here in its summer habitat, before migrating to the tropics for winter.

The *New York State Wildlife Action Plan*[66] identified conservation actions that would prevent more animal species from becoming critically imperiled in the state. The Plan provides a list of NYS Species of Greatest Conservation Need (SGCN) that includes rare, declining, and at-risk species. The SGCN includes all New York State species on the federal or state lists of Threatened and Endangered species, as well as others identified by NYSDEC and the NYNHP as species of regional conservation concern.[67] The SGCN species are the focus of many ongoing and planned actions by New York State to identify, improve, restore, and protect important habitats. Included among these actions are education and technical assistance for local agencies and conservation organizations. Recognizing that land in private ownership supports much of New York's biological diversity, an important goal of the *State Wildlife Action Plan* is to engage the public in biodiversity conservation.

Profiled below are just a few of the animal groups that represent different kinds of life histories and habitats of Kent. A dagger symbol (†) denotes animals that are listed as SGCN or as NYS Species of Special Concern. A more complete list of species of conservation concern is in Table 5, and explanations of the rarity ranks are in Appendix D.

Invertebrates

The term "invertebrates" refers to all the animals that lack a spinal column—an immense group that constitutes 97 percent of all animal species on Earth.[68]

It includes insects, crustaceans, earthworms, millipedes, spiders, mollusks, and many other groups. The ecological importance of invertebrates cannot be overstated. They act as decomposers, soil builders, pollinators, distributors of seeds, grazers, predators, and prey. So far, Buck and Herr have catalogued over 1200 species of invertebrates in Kent—an impressive number but still a small percentage of the town's total invertebrate fauna.

Invertebrates constitute 97 percent of all animal species on Earth and serve indispensable roles in all ecosystems.

We view some invertebrates such as butterflies and dragonflies as charismatic; some such as bees or earthworms as useful; and others such as termites, cockroaches, and mosquitoes as bothersome; but most invertebrates go about their lives unnoticed by us at all, despite their indispensable roles in our ecosystems. Indeed, some groups of invertebrates are so poorly known that many species in the region and elsewhere have yet to be recognized and described by scientists. Mentioned below are discussions of just a few of the invertebrate groups that are known to serve outsized functions in Kent habitats.

Bees

Bees are the most important pollinators of wild and domestic plants, because they collect both nectar and pollen as food and have physical structures especially evolved for transporting pollen.[69] In the process of visiting flowers to feed themselves and collecting pollen to feed their young, bees transport pollen between plants as they move from flower to flower on their collecting rounds. Many other insects, including butterflies, moths, beetles, wasps, and flies, visit flowers for the nectar and also carry pollen incidentally between flowers, but they are usually less efficient as pollinators because they lack the highly developed structures for transporting large amounts of pollen.

New York State is home to over 450 bee species. Of these, approximately 21 species are non-native (including the honey bee) and the rest are considered native.[70] Buck and Herr have recorded 42 species of bees in Kent as of summer 2023. Native bees are more effective pollinators of many plants, including some domestic crops, than are honey bees, and many species of native bees are also able to forage earlier and later in the day, earlier and later in the season, and in wetter and colder conditions than honey bees.[71]

Native bees feed on and collect nectar from a variety of plant species, but a few specialize on a particular species, genus, or family of plants for their pollen sources. For example, squash bees specialize on pollen from squashes, pumpkins, and cucumbers; a species of sweat bee specializes on primroses, and the pickerel bee specializes on pickerelweed. Some native bees are more efficient pollinators than honey bees for certain plants with tightly-held pollen, such as tomatoes, potatoes, and blueberries, because they are able to use a special "buzz-pollination" technique, vibrating their flight muscles at a certain frequency to induce the plant to release pollen that is largely inaccessible to honey bees and other pollinating insects.

Populations of many native bee species in North American have been declining at local and regional scales due to causes such as habitat loss, pesticides, invasive species, pathogens, and climate change.[72] Exposure to these multiple threats can make the bees more vulnerable to any particular threat.

Bees are especially sensitive to pesticides (fungicides, herbicides, algicides, insecticides, rodenticides) and other toxins, which they can absorb through their exoskeleton and also consume in contaminated nectar or pollen. The exposure is not only from above-ground applications to plants, but also from soil fumigants that can harm ground-nesting bees and other beneficial soil biota.[73] "Neonicotinoid" pesticides, now the most widely used class of pesticides worldwide, are absorbed by the treated plants and eventually stored in the plant tissue as well as the nectar and pollen, thus passing on the toxins to all organisms consuming those materials. Furthermore, only about 5 percent of the substance is absorbed by the target plants; the remainder disperses into the environment where it affects many other organisms.[74]

Avoiding pesticide use and maintaining habitats free of toxic contaminants will help sustain native bee populations.

Roundup™ and other herbicides are widely used by farmers and homeowners for managing weeds. A basic problem with all herbicides is their toxic effects on non-target plants and other organisms. Glyphosate, the major active ingredient in the herbicide Roundup™, is toxic to most plants and many animals, as well as fungi and the microorganisms of a healthy soil. Effects on animals in laboratory and field studies, for example, include carcinogenicity, inflammation of airways, embryonic and developmental abnormalities, DNA damage, impaired thermoregulation, and lack of reproduction.[75]

Native bees and honey bees visit flowers in all habitats of the town, but the nesting habitats of individual species are more specialized. Most native bee species are ground nesters and need suitable soil conditions to support their tunnels and brood cells. Habitats with bare or sparsely vegetated, friable soil are used for nesting by many bees, wasps, and other insects. Other bees nest in hollow stems of woody or herbaceous plants or in channels created by beetles or other animals in standing trees or downwood.[76] In general, maintaining diverse open and forested habitats that are free of toxic contaminants may be the best way to help sustain our populations of native bees, honey bees, and other insects that we rely on for pollination and a host of other services.

Cranefly. Photo © Valter Jacinto.

Unexpected Diversity

Bill Buck and Beth Herr

When we started the Kent biodiversity project, we never would have guessed that craneflies were so diverse in our area. Craneflies are true flies, like houseflies, mosquitoes and midges, defined by one rather than two pairs of wings. The second pair of wings is modified into halteres, a balance organ.

Most of us think of craneflies as mosquitoes on steroids as shown in the photograph above. However, adult craneflies do not eat at all or only sip nectar. They have no biting mouth parts. Although we tend to think of craneflies as relatively large, they vary from quite large, with bodies over an inch long, to very small, smaller than most mosquitoes. An early monograph of the group indicates that there are about 300 species of craneflies in New York State. To date, we have collected about 150 species here in Kent. Since there are no modern identification guides to North American craneflies, we would never have been able to do this without an authority, Dr. Fenja Brodo of Ottawa, to name our specimens. In addition to many well-known species, we have collected an undescribed parthenogenic (reproduces without males) species and some European introductions that have not been reported from North America before.

Dragonflies and Damselflies

Dragonflies and damselflies ("odonates") play key roles in ecosystems. They are predators in both their nymph and adult stages, and are themselves important prey of fish, amphibians, birds, bats, and other organisms. They are sensitive to the water chemistry, temperatures, and flows in their stream, pond, or wetland environments, as well as the kinds of vegetation and the kinds of aquatic predators present. For these reasons odonates are sometimes used as indicators of habitat quality and the condition of aquatic ecosystems.

Dragonflies and damselflies are aquatic in the larval (nymph) stage, and each species has its own affinities for moving or still water; rocky, sandy, or silty substrates; sun or shade. Some are more sensitive than others to conditions of water temperature, water clarity, or dissolved oxygen levels. Some are closely tied to special habitats such as acidic bogs, seeps, or rocky streams. As adults, many stay around wetlands, ponds, and streams, but some are more often seen hunting over upland meadows or along hedgerows or forest edges. As with most other animals, understanding their habitats can help you predict where certain odonate species are likely to occur.

Eastern pondhawk is a common dragonfly of marshes. Photo © John Kenny.

Putnam County was included in the 2005-2009 New York Dragonfly and Damselfly Survey conducted throughout the state by NYSDEC and NYNHP, other professional biologists, and trained volunteers,[77] but none of the survey sites were in Kent. Altogether, that survey reported 69 odonate species in Putnam County including those listed in prior records and the 2005-2009 survey. As of summer 2023, Buck and Herr have observed 46 odonate species in Kent, including 14 species not previously documented in Putnam County, bringing the county total to 83 species.

Appendix Table C-3 lists the dragonflies and damselflies known to occur in the county along with the habitats where they are most likely to be found. Some species are abundant, common, or occasional here, but many have been seen only rarely, and a few are recognized to be of statewide conservation concern.

Loss and degradation of wetland habitats seem to be responsible for the declines of many North American odonate species. According to the Xerces Society, at least 20 percent of all North American odonates are considered to be at risk of extinction.[78] The larvae of most dragonfly and damselfly species are sensitive to changes in the hydroperiods of their stream and pond habitats, and to water pollution and siltation. The adults eat a great variety of insect prey but sometimes face limited food availability. They do best where diverse habitats—such as streams, marshes, wet meadows, upland meadows, shrublands, and forest—are in close proximity to each other, providing plentiful perching and basking sites and varied prey throughout the active season.

The best measures for supporting local odonate populations are maintaining water levels, seasonal hydroperiods, and good water quality in streams and ponds; avoiding the introduction of predatory fishes; and maintaining diverse, intact terrestrial habitats near streams and ponds.

The mourning cloak overwinters as an adult, and is one of the earliest butterflies to emerge in spring. Photo © Beth Herr.

Tiger swallowtail is a common butterfly of flower gardens, forests, and forest edges. Major food plants for the larva are black cherry and tulip tree. Photo © David Silver.

Butterflies and Moths

Butterflies and moths are some of our most charismatic and conspicuous insects, and they play important but often hidden roles in ecosystems. They contribute to the pollination of certain plants, serve as prey to other organisms—including other insects, spiders, reptiles, amphibians, mammals, and birds—and, especially through their voracious caterpillars, consume and process large amounts of vegetation, making nutrients available to other parts of the food web. Some species of butterflies and moths are closely tied to particular habitats or plant species, and many are very sensitive to environmental contaminants, such as pesticides.

Adults of butterflies feed primarily on nectar and, although a few specialize on particular plant species, most are generalists, visiting whatever nectar-producing flowers are available during the adult flight periods. The larvae (caterpillars) of many species are much more specialized, however, and require particular plant species or genera or families. For example, the caterpillars of the monarch butterfly feed on milkweeds; those of the Baltimore checkerspot feed on white turtlehead and English plantain; those of the tawny emperor feed on hackberry; and those of the deceptive snout moth feed on basswood. Some other host plants for butterfly larvae are nettles (for red admiral, eastern comma), cherries (tiger swallowtail), oaks (certain hairstreaks and duskywings), ashes (mourning cloak), and grasses (many skippers). Clovers, asters, violets, and willows are also hosts for many other butterfly species of the region. Appendix Table C-4 lists the known host plants for Putnam County butterflies. Good sources of larval food plants and nectar sources are key components of butterfly habitat, and local butterfly populations will persist only if their host plant species are present. Land management to encourage such species will help to ensure that butterfly food sources are not limiting.

Monarch nectaring on a thistle. Photo © Beth Herr.

Most butterfly species overwinter here as eggs, pupae, or adults[79] so, in addition to food sources during the active seasons, butterflies also need safe places for egg-deposition, pupation, and overwintering. Although not well understood, sites for basking and mating may also be important; for example, some butterflies are "hilltoppers" and congregate on open hilltops for mating. Pupation usually occurs in tall herbaceous vegetation, shrubs, trees, or woody debris. The few butterflies and moths that overwinter as adults find shelter in tree cavities, under loose bark, or under logs, rocks, or similar features, so leaving untidy patches of undisturbed soils and vegetation in fields or at field edges and in gardens and yards will help to maintain appropriate microhabitats for those purposes.

Managing land to encourage nectar sources and larval food plants for butterflies and moths, as well as untidy undisturbed patches for resting, pupation, and overwintering will help these essential animals persist.

Our eastern monarch butterfly migrates to upland forests of Mexico for the winter. The population is under stress from loss of forest habitat in their wintering grounds, mortality from exposure to cold and wet conditions during large storms in recent years, exposure to pesticides, and loss of milkweed in their summer habitat due to intensification of agriculture. Although the monarch's epic migration journey is unusual, the monarch life history helps illustrate the complexity of ecological relationships that also affect many other butterfly and moth populations.

New York State has over 2500 species of butterflies and moths occurring in all kinds of wetland and upland habitats. Appendix Table C-4 lists many of the butterflies of Putnam County.

Acorn Ants

Bill Buck and Beth Herr

There is astonishing diversity right at our feet, and miniature worlds all around us. One astounding example is the really teeny acorn ant, *Temnothorax curvispinosa*. Yes—in Kent there are ants so small that a whole colony, with a queen, 1000 workers, and slaves taken from other colonies, can thrive inside one acorn! (Actually, we found three species of acorn ants in our town.) These ants also nest in rotten wood, but are most often found in acorns that have been hollowed out by weevils. Watch for fallen acorns on your autumn walks. If you spy one with a small hole, peer inside. A whole other world awaits.

Mollusks

Mollusks are a diverse group of invertebrates that includes clams, mussels, snails, and slugs. They occur in upland, wetland, and aquatic habitats and play important roles in aquatic and terrestrial ecosystems. Freshwater snails, for example, are a food source for many other animals—e.g., crayfishes, fishes, amphibians, waterfowl, turtles, and mammals—and they consume algae and organic debris obtained from the surfaces of rocks, plants, and other substrates. Many snail species—those with gills—are sensitive to low levels of dissolved oxygen and even small amounts of petroleum hydrocarbons, certain metals, agricultural fertilizers and pesticides, and suspended sediments. They are thus considered to be good indicators of water quality. The snail species with lungs are more tolerant of pollution.[80]

Most land snails (including shelled snails and slugs) live in the leaf litter of forests, organic debris (thatch) of oldfields, and in wetlands, but some also use gardens, agricultural fields, and lawns. They feed on live and dead herbaceous material, bark, rotting wood, fungi, and algae, and are eaten by a large array of invertebrate predators, along with salamanders, turtles, small mammals, and birds.[81] Most of our land snails are native to the region, but a few non-natives have become pests to farmers and gardeners.

Aquatic snails can be good indicators of water quality because of their sensitivity to pollutants and low levels of dissolved oxygen.

Fishes

The fishes of Kent occupy the swift-running hillside streams and the more sluggish and meandering lowland streams, as well as lakes and ponds. Which fish populations occur and persist in any stream, lake, or pond depends on habitat characteristics such as hydroperiod, water temperature, flow velocity, turbidity, dissolved oxygen levels, and substrate qualities.

"Diadromous" is the umbrella term for fishes that migrate between the ocean and freshwater systems for different life stages—spawning, nursery, maturation. "Anadromous" fishes are those such as alewife and blueback herring that come from the ocean to spawn; spend their early years in freshwater streams and rivers; and then migrate to the ocean where they grow to maturity. "Catadromous" fishes spawn in the ocean but migrate to freshwater habitats to mature. The Hudson has just one catadromous species—the American eel†—which arrives here from the Sargasso Sea in the tiny, translucent "glass eel" stage. The eel then spends many years in the Hudson River and tributaries, where it grows to adulthood before migrating back to its ocean spawning grounds. Hudson River tributaries are important to the lives and well-being of these fishes and to the ecology of the Hudson River. Only two diadromous fish species are known to reach the streams and lakes of Kent: American eel and alewife.

Other fishes of Kent do not depend on migrations between the Hudson River and the ocean but spend their entire lives in nontidal streams, lakes, and ponds. Some, such as bridle shiner and fathead minnow, inhabit slow-moving streams or ponds and are somewhat tolerant of polluted waters. Others such as brook trout† and slimy sculpin need faster-flowing, clean, cool, well-oxygenated streams. Within a single stream, fishes and other aquatic animals need to migrate between different reaches as they search for suitable water depths, water temperatures, shelter, and feeding areas for different seasons, environmental conditions, and life stages.

Dams on streams, some of which have been in place for centuries, present insurmountable barriers to the upstream movement of most fish species and have disrupted the spawning migrations that occurred for thousands of years before European settlement. Culverts suspended above the stream bed pose similar barriers to fish migrations.

Figure 20 illustrates the distribution of the larger Kent streams classified according to size, gradient, and temperature—habitat characteristics that influence the entire aquatic communities of each stream segment. Stream size affects the kinds of invertebrates and fish and the trophic structure of the stream community. Stream gradient influences the shape of the stream bed, the flow velocity and the kinds of substrate materials. For example, high-gradient streams often have swift water, step pools, and bedrock, boulder, and cobble substrates, while low-gradient streams tend to have slow water with riffles and pools, and with alluvium, sand, gravel, and cobble substrates. Stream temperature affects levels of dissolved oxygen and determines which fish and invertebrate species can survive; triggers the onset of migration and developmental stages in stream organisms; influences the growth rates of eggs and juvenile fishes; and affects the body size and fecundity of fishes.[82] Knowing the size, gradient, and temperature of a stream can help you predict the kinds of fishes and other aquatic animals that are likely to occur there. Most of Kent's streams are yet unassessed in this program, but those that have been assessed are in the cool-to-cold range (Figure 20).

To support recreational fishing, NYSDEC stocks trout and a few other species annually in selected streams and lakes throughout the state. In spring 2022, brown trout were stocked in the West Branch Croton River, the West Branch Reservoir, and Peekskill Hollow Brook. The plan for 2023 stocking was the same for those waterbodies. Land-locked Atlantic salmon are also stocked in the West Branch Croton Reservoir. Although the non-native brown trout are appreciated by anglers, they compete with the native brook trout for habitat and food resources, and may interfere with the growth of slimy sculpin, another native fish of coldwater streams.[83]

Reptiles and Amphibians

Of the 69 native species of amphibians and reptiles occurring in New York State,[84] at least 32 (46 percent) occur in the Town of Kent. The town has ten species of salamanders, nine toads and frogs, six turtles, and nine snakes. Although each species has its own habitat affinities, as a group these animals use all parts of the landscape, including intermittent and perennial streams, wetlands of all kinds, upland meadows, shrublands, forests, and exposed ledges and talus. Appendix Table C-6 lists each of these species and their habitats, and below are brief descriptions of just a few that represent various parts of the Kent landscape.

The northern dusky salamander is closely tied to forested streams and seeps, where adults spend much of the daytime beneath rocks and woody debris, and emerge at night to forage, rarely moving more than a few feet from the stream or seep. The two-lined salamander is another species of forested streams and seeps, but is sometimes found in unforested streams or even long distances from water.[85] Jefferson salamander,[†] spotted salamander, marbled salamander,[†] and wood frog are in the special group of "vernal pool-breeding amphibians" in this region because of their need for intermittent woodland pools (vernal pools in forested settings) for breeding and nursery habitat. These are typically small, isolated pools that hold water in the winter and spring but dry up during the summer and, consequently, do not support fish. These four

The gray treefrog can be heard calling from the tree canopy throughout the spring and summer. Photo © Beth Herr.

amphibian species are especially vulnerable to fish predation on their eggs and larvae, so the fish-free environment eliminates one important threat to reproductive success. Although they use the pools for breeding and nursery habitat, the adults and metamorphosed juveniles spend the rest of the year in the surrounding upland forests, so the pool and forest are equally important to maintaining local populations.

Both the vernal pool and surrounding forest are equally important habitats for maintaining populations of pool-breeding amphibians.

While some of our amphibians spend most of their time in and near water, the red-backed salamander and slimy salamander spend all their time in upland (non-wetland) habitats. Many others, including the pool-breeding group (above), gray treefrog, and spring peeper, are also terrestrial, but need wetlands and ponds for breeding.

Common garter snake and DeKay's brown snake are probably the two most abundant snakes in Kent, but garter snake is the one we see most often. Both

20. Stream habitats

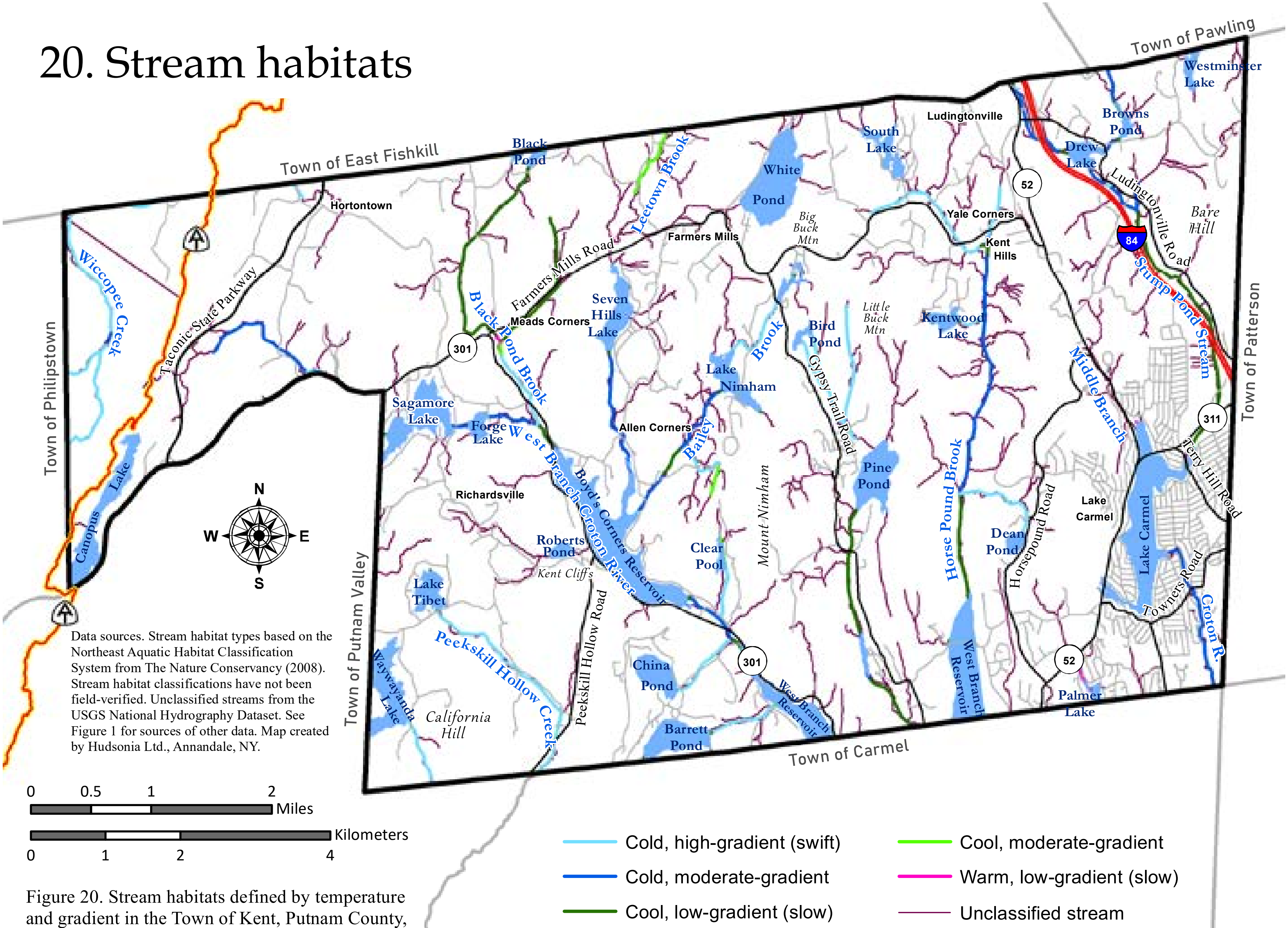


Figure 20. Stream habitats defined by temperature and gradient in the Town of Kent, Putnam County, New York. Habitats were classified only for the larger streams. Kent Natural Resources Inventory, 2023.

The common garter snake uses a variety of forested and open habitats, and is the snake most often seen in lawns and gardens. Photo © John Kenny.

While all of our snakes can swim, the northern water snake is the only New York snake that spends much of its time in and near standing water. Photo © Beth Herr.

species use all kinds of upland habitats, and even our yards and gardens. Black rat snake† and black racer† use all kinds of upland habitats during the warm months, and overwinter in deep rock crevices or rock talus, or sometimes other sheltered areas including the basements of buildings.[86] Although many of our snakes are capable swimmers, the northern watersnake is the only aquatic snake in the county. It occupies a great variety of habitats with permanent water—lakes, ponds, streams, marshes, and other wetlands—and, although sometimes found on land, it rarely moves very far from wet areas.

The turtles most commonly seen in Kent are the painted turtle and snapping turtle.† These species use a wide range of wetland, pond, and sluggish stream habitats. Painted turtles are often seen basking on logs, rocks, or shorelines, and both species are often seen crossing roads during their nesting migrations in the spring or early summer. They nest in unshaded upland areas, including roadsides, lawns, and meadows. The non-native red-eared slider uses similar wetland and upland habitats. Although its native range is southern and mid-western states, the red-eared slider has been able to survive and reproduce in the wild since it was introduced. It is also continually re-introduced when people release pet sliders to the wild.

The musk turtle†—named for the odorous musk emitted when it is disturbed—is an aquatic turtle of large streams, lakes, and associated wetlands, and rarely moves far from those habitats. The wood turtle† spends much time in and near perennial streams and overwinters in streambanks, but during the warm months it also travels widely to other wetland and upland habitats for foraging and nesting. The spotted turtle† uses a variety of wetland and upland habitats. It overwinters in a wetland; nests in unshaded wetland or upland habitats in the spring; spends long periods in upland habitats, and moves between wetland habitats for foraging in summer. The box turtle†—uncommon in

Our most common turtle—the painted turtle—lives in ponds and wetlands, and nests in nearby unshaded upland areas. Photo © John Kenny.

the county—is the most terrestrial of the turtles in Kent, spending most of its life in upland forests, shrubland, and meadows, but it uses wetlands or ponds at times in the summer, especially during heat waves or droughts. The turtles that regularly travel between wetland and upland habitats on their journeys to and from nesting sites—wood turtle, spotted turtle, painted turtle, snapping turtle—are exposed to the many hazards posed by vehicles on roads, driveways, agricultural fields, and golf courses. All of Kent's turtles except for the painted turtle are listed as NYS SGCN.

Birds

Like other animals, most bird species are associated with particular kinds of habitats that suit the species' life history. Some species (American robin, blue jay) are well-adapted to human-settled landscapes, where they take advantage of lawns, gardens, shade trees, hedgerows, pastures, cropfields, or even buildings and bridges. Others need permanent water (pied-billed grebe†) or the interior areas of large meadows (eastern meadowlark†) or large forests (worm-eating warbler†) to help protect their nests from predators that frequent the habitat edges. Some prefer forests with mature trees (cerulean warbler†) and others do best in young forests or shrublands (American woodcock†). Some prefer forests with abundant shrubs in the understory, and some prefer open understories. Knowledge of habitat types and characteristics can help you predict the kinds of birds that are likely to nest, roost, or hunt in any location.

The population status of Kent's bird species—that is, their presence, abundance, or rarity—depends on a great variety of factors, including some that are beyond our control. Stresses from loss or degradation of wintering habitats in the southern US or the tropics or stop-over habitats on migration routes can weaken the migratory birds or reduce the numbers that reach their Kent breeding grounds and nest successfully. For some species this region is near the southern or northern limits of their breeding range and climate tolerances, so the birds may be especially vulnerable to weather extremes and other stresses. For many birds the habitat conditions here are a large factor in determining their population status, and our uses of the land may strongly influence the survival and persistence of local populations.

Factors affecting bird habitats include fragmentation (e.g., for large meadows or large forests), loss of suitable habitat due to succession (as of meadow to shrubland to forest), human disturbances, pesticides, water pollution, and climate change, among others. In many cases, combinations of factors may be at play. Observations of eastern whip-poor-will,† for example, in the two Breeding Bird Atlas surveys declined by 57 percent throughout the state. Reasons for the declines are unknown, but some possible causes are forest maturation, increases in industrial pollution and pesticide use, decline in saturniid moths (a major food source), loss of open-understory forest due to fire suppression, and loss of forests due to land development and agriculture.[87,88] Declines of ruffed grouse have been attributed to loss of young forest habitat.

The term "grassland breeding birds" refers to several ground-nesting bird species that require large meadow areas to reproduce successfully and maintain local populations in the long term. These include species such as bobolink† and eastern meadowlark† that use meadows for nesting and feeding. The dramatic declines of grassland breeding birds in the Northeast since the 1960s have been attributed to loss of large meadows due to intensification of agriculture, abandonment of agriculture and subsequent transitions to shrubland and young forest, conversion to developed uses, and burgeoning populations of human-subsidized predators such as raccoon and striped skunk.

Meadows are also essential foraging, hunting, and courtship habitat for several other birds. For example, American woodcock† uses meadows for springtime courtship displays, and meadow edges (along with shrublands and forests) for foraging throughout their active season. Meadows in near proximity to shrublands, young forests, and streams

Eastern kingbird hunts for insects over upland meadows. Photo © John Kenny.

may be preferred. American kestrel† hunts in meadows and uses hedgerows, forest edges, or isolated large trees for hunting perches and nesting. Eastern bluebird nests in tree cavities or artificial nest boxes in or at the edges of large meadows. Eastern kingbird nests in trees or shrubs of meadows, shrublands, or orchards, often at edges of wetlands and waterways, and hunts in open areas.

Among the birds that nest in shrublands are common species such as gray catbird, northern cardinal, common yellowthroat, song sparrow, and chestnut-sided warbler, and the less common or rare species such as prairie warbler,† blue-winged warbler,† golden-winged warbler,† and brown thrasher.† The populations of many shrubland-nesting birds have declined in recent decades with the disappearance of shrubland; fire suppression and declining agriculture over the last 60-80 years has reduced shrubland extent to an 80-year low in the Northeast.[89,90] Most upland shrublands are temporary habitats that, without occasional natural (e.g., fire, tornado) or artificial (e.g., brush-hogging) disturbance will transition to young forest over two to three decades.

Wetlands and waterbodies of all kinds are used by birds for nesting and/or foraging. Lakes and ponds are foraging habitat for summer resident waterfowl, and are also resting and stop-over sites for migrating waterfowl such as snow goose and canvasback. Wood duck† uses forested and shrub swamps for nesting (as well as nearby upland forests), and a variety of wetlands for nursery habitat. Golden-winged warbler† and alder flycatcher nest in shrub swamps, and Louisiana waterthrush† nests and forages along forested streams.

Appendix Table C-6 lists the birds known to nest in Kent, according to 1980-1985 and 2000-2005 NYS Breeding Bird Atlas data. These data are likely to be incomplete because the entire town has not been covered by the Atlas observers.

Mammals

Wild mammals occur in all kinds of habitats in Kent, including human-made structures. Many mammal species—e.g., white-tailed deer, raccoon, gray squirrel, striped chipmunk, white-footed mouse—are well-adapted to human-settled landscapes where they thrive on the bounty of our gardens and cropfields, and some find shelter in our buildings. Others, such as bobcat, black bear, eastern coyote, and foxes, range widely over the landscape for hunting and foraging, although they may retreat to a remote place for denning. The black bear population has been increasing in Kent and the Hudson Valley in general, and bear/human encounters are now commonplace. Meadow vole populations can be immense in large meadows, where they are a favored prey of eastern coyote, foxes, and raptors. Eastern cottontail occurs in non-forested areas throughout the lower elevations, and its rare cousin, the New England cottontail,† prefers shrubby thickets and young forests with generous shrub layer and ground vegetation. American beaver, muskrat, river otter, and American mink are rarely far from streams, ponds, lakes, or marshes. Appendix Table C-8 lists all the mammals known or likely to occur in Kent and Putnam County.

Left: The black bear population has notably increased in the region over the last 30 years. Photo © Anne Campbell. Right: White-tailed deer have been an important part of Kent's forests for millennia, but human alterations of local ecosystems have led to the expansion of the deer population beyond the carrying capacity of the land. Photo © John Kenny.

Most of our mammals spend their entire lives in the Northeast, but three bat species—eastern red,† silver-haired,† and hoary bats†—migrate to southern places for the winter. Bats are the mammals of greatest conservation concern in the county. Of the nine bat species known or likely to occur in Kent, all but two are listed as NYS SGCN, and the Indiana bat and northern long-eared bat are also listed as Endangered on the federal list. Bats that spend the winter in New York caves are subject to the white-nose syndrome (WNS), a fungal disease that has spread rapidly through eastern caves since 2006 and has devastated the populations of many bat species. The long-eared bat,† for example, has suffered 99 percent mortality from WNS in some hibernacula. New York State regulates land uses near known bat-occupied caves and sets rules for cave visitation to protect bats.[91,92]

White-tailed deer occupy a unique place in the ecology and history of the region. They are an indigenous component of Northeastern ecosystems, have long provided humans with food, clothing, shelter, and tools, and are still a significant resource for recreational hunting. They were hunted to local extinction in the region in the 1800s, and were re-introduced in the 1960s from western New York. Due to absence of predators, decline of hunting, and suburbanizing landscapes that offer abundant forage and protection, deer populations have exploded in and near our settled landscapes in recent decades, creating nuisances for property owners and gardeners, economic losses for farmers, road hazards, and ecological problems in forests.

Grazing and browsing ("herbivory") by white-tailed deer profoundly affects forest structure and succession. When deer populations are high, their selective browsing and seed predation prevent the regeneration of many of our forest tree, shrub, and wildflower species and encourage infestations of non-native plants. Those alterations to the plant community also affect bird nesting habitat, the invertebrate fauna, and the prevalence of tick-borne diseases.[93] Ecological threats from the large deer population are discussed further in the **Threats to Natural Resources** section.

Biological Resources of Conservation Concern

Rare Species and Significant Natural Communities

The New York Natural Heritage Program serves as a clearinghouse for information on rare species in the state. They conduct on-the-ground surveys to find, track, and monitor populations of plants and animals of conservation concern, assess and identify significant habitats, and provide information to others to help protect the state's biological diversity.

The NYNHP manages a database of past and present-day rare species occurrences throughout the state based on data from their own research, from museum and herbarium records, and from reports of other biologists. Some rare species are vulnerable to illegal collecting, harassment, killing, or removal, so the NYNHP and NYSDEC are careful to keep exact locations confidential unless there is an important reason to make them known to a landowner, a regulatory agency, or the public. If there is a potential or imminent threat to a known occurrence, further information can be obtained from the NYNHP. For the same reasons, this *NRI* also does not reveal the exact locations of rare species. Instead, we discuss some of the kinds of habitats where they occur, or may occur, to inform conservation planning and land use decision-making by landowners, developers, municipal agencies, and others. Table 5 lists the rare species known to occur in Kent and their habitats. Because most places have never been surveyed for rare species, however, it is expected that they occur in many other locations in Kent. The Special Habitat locations shown in Figure 19 are places where closer examination for rare species may be warranted.

Bald eagles have become a common sight hunting over Kent's lakes and perching on lakeside trees. Photo © Barbara Garbarino.

Fowler's toad is a regionally uncommon species that frequents upland habitats with coarse (sandy) soils, rocky areas, and breeds in shallow pools or wetlands with semi-permanent water. Photo © Beth Herr.

Table 5. Rare plants and animals of Kent.

Data are from the New York Natural Heritage Program, NYSDEC wildlife biologists, the 2000-2005 New York State Breeding Bird Atlas, the 1990-1999 New York Amphibian and Reptile Atlas, and from observations of Buck and Herr. Most places in Kent have never been surveyed for rare species, and only a few groups of species are tracked by the NYNHP and NYSDEC, so this list is necessarily incomplete.

PLANTS

Common Name	Scientific Name	General Habitat	NYS Ranks[1] SGCN	NYS Ranks[1] E,T,SC,R	NYNHP Rank[2]
compact dodder	*Cuscuta compacta*	streambank, other wet habitats		R	S3
creeping bush clover	*Lespedeza repens*	forest, talus slope, disturbed area		R	S3
lined sedge	*Carex striatula*	ravine wall, rich hardwood or mixed forest		E	SH
log fern	*Dryopteris celsa*	rotting log, swamp		E	S1
lowland fragile fern	*Cystopteris protrusa*	rotting log, swamp		E	S1
ovate spikerush	*Eleocharis ovata*	marsh, pond edge, other wet places		T	S2S3
red-rooted flat sedge	*Cyperus erythrorhizos*	wet areas, stream banks and bars, lake or pond shores		R	S3
sharp-angled spike rush	*Eleocharis tenuis* var. *pseudoptera*	pond, meadow		E	S1
smooth beggar-ticks	*Bidens laevis*	edge of lake, pond, marsh, stream		T	S2
spiny water nymph	*Najas marina*	lake, pond		E	S1
toothcup	*Rotala ramosior*	shore of lake, pond, stream		T	S2
Virginia three-seeded mercury	*Acalypha virginica*	moist, disturbed habitat, shore of stream, lake, or pond		E	S1

Continued

Table 5. Rare plants and animals of Kent, continued.

DRAGONFLIES, DAMSELFLIES & BEETLES

Common Name	Scientific Name	General Habitat	NYS Ranks[1] SGCN	NYS Ranks[1] E,T,SC,R	NYNHP Rank[2]
comet darner	*Anax longipes*	grassy, fishless pond, soil mine	SGCN		S2S3
dusky dancer	*Argia translata*	stream, lake, pond	SGCN		S1
great blue skimmer	*Libellula vibrans*	swamp pool, slow forested stream			S3
lilypad forktail	*Ischnura killicotti*	lake, pond, marsh with pond-lilies			S3*
Rambur's forktail	*Ischnura ramburii*	lake, marsh, slow stream	SGCN		S2S3
southern sprite	*Nehalennia integricollis*	grassy pond, lake, marsh, bog	SGCN	SC	S1
spatterdock darner	*Rhionaeschna mutata*	fishless pond, bog pond	SGCN		S2
spiny basket-tail	*Epitheca spinigera*	marshy lake, pond, slow stream			S3
taiga bluet	*Coenagrion resolutum*	marsh, bog, pond, swamp			S3*
two-spotted lady beetle	*Anax longipes*	grassy, fishless pond, soil mine	SGCN		S2S3

FISHES

Common Name	Scientific Name	General Habitat	NYS Ranks[1] SGCN	NYS Ranks[1] E,T,SC,R	NYNHP Rank[2]
alewife	*Alosa pseudo-harengus*	coast, stream, lake	SGCN		
American eel	*Anguilla rostrata*	stream, lake, pond	SGCN[HP]		S2S3
brook trout	*Salvelinus fontinalis*	stream	SGCN		

Continued

Table 5. Rare plants and animals of Kent, continued.

REPTILES & AMPHIBIANS					
Common Name	**Scientific Name**	**General Habitat**	**NYS Ranks[1] SGCN**	**NYS Ranks[1] E,T,SC,R**	**NYNHP Rank[2]**
eastern box turtle	*Terrapene carolina carolina*	forest, young forest, forest/meadow edge	SGCN[HP]	SC	
eastern racer	*Coluber constrictor*	forest, upland meadow, ledge	SGCN		
eastern ratsnake	*Elaphe alleganiensis*	forest, forest edge, ledge, talus	SGCN		
eastern hog-nose snake	*Heterodon platirhinos*	forest	SGCN[HP]	SC	
smooth green snake	*Liochlorophis vernalis*	wet meadow, upland meadow	SGCN		
timber rattle-snake	*Crotalus horridus*	unshaded ledges, forest, meadow	SGCN[HP]	T	S3
eastern box turtle	*Terrapene carolina*	forest, meadow	SGCN[HP] SGCN[HP]	SC	
snapping turtle	*Chelydra serpentina*	wetland, stream, pond, lake	SGCN		
spotted turtle	*Clemmys guttata*	vernal pool, swamp, wet meadow, upland forest		SC	
wood turtle	*Clemmys insculpta*	stream, riparian area	SGCN[HP]	SC	
Atlantic coast leopard frog	*Lithobates kauffeldi*	marsh, wet meadow, stream	SGCN[HP]		S1S2
four-toed salamander	*Hemidactylium scutatum*	wetland	SGCN[HP]		
Fowler's toad	*Anaxyrus fowleri*	forest, meadow, pond	SGCN		
marbled salamander	*Ambystoma opacum*	vernal pool, forest	SGCN	SC	

Continued

Table 5. Rare plants and animals of Kent, continued.

BIRDS					
Common Name	**Scientific Name**	**General Habitat**	**NYS Ranks[1] SGCN**	**NYS Ranks[1] E,T,SC,R**	**NYNHP Rank[2]**
American black duck	*Anas rubripes*	wetland	SGCN[HP]		
American kestrel	*Falco sparverius*	meadow, cavities in large trees and buildings	SGCN		
American woodcock	*Scolopax minor*	young forest, shrubland, swamp	SGCN		
bald eagle	*Haliaeetus leucocephalus*	lake, stream, forest	SGCN	T	S2S3B, S2N
barn owl	*Tyto alba*	grassland, buildings	SGCN[HP]		S1S2
black-billed cuckoo	*Coccyzus erythropthalmus*	young forest, shrubland	SGCN		
black-throated blue warbler	*Dendroica caerulescens*	forest	SGCN		
blue-winged warbler	*Vermivora pinus*	young forest, shrubland	SGCN		
brown thrasher	*Toxostoma rufum*	young forest, shrubland	SGCN[HP]		
Canada warbler	*Wilsonia canadensis*	young forest, shrubland	SGCN[HP]		
common loon	*Gavia immer*	open water	SGCN	SC	
common nighthawk	*Chordeiles minor*	mixed/urban	SGCN[HP]	SC	
Cooper's hawk	*Accipiter cooperii*	forest		SC	
golden-winged warbler	*Vermivora chrysoptera*	shrubland, wet thicket, forest	SGCN[HP]	SC	
horned lark	*Eremophila alpestris*	grassland	SGCN[HP]	SC	
Louisiana waterthrush	*Seiurus motacilla*	wooded streambank, forest, swamp	SGCN		

Continued

Table 5. Rare plants and animals of Kent, continued.

BIRDS, cont.

Common Name	Scientific Name	General Habitat	NYS Ranks[1] SGCN	NYS Ranks[1] E,T,SC,R	NYNHP Rank[2]
osprey	*Pandion haliaetus*	open water, wetland		SC	
northern goshawk	*Accipiter gentilis*	forest	SGCN	SC	
peregrine falcon	*Falco peregrinus*	cliff, large bridge, large building	SGCN	E	S3B
pied-billed grebe	*Podilymbus podiceps*	wetland	SGCN	T	S3B,S1N
prairie warbler	*Dendroica discolor*	young forest, shrubland	SGCN		
red-headed woodpecker	*Melanerpes erythrocephalus*	forest	SGCN[HP]	SC	
red-shouldered hawk	*Buteo lineatus*	forest, swamp	SGCN	SC	
ruffed grouse	*Bonasa umbellus*	young forest, mature forest, shrubland	SGCN		
scarlet tanager	*Piranga olivacea*	forest	SGCN		
sharp-shinned hawk	*Accipter striatus*	forest		SC	
whip-poor-will	*Caprimulgus vociferus*	young forest, shrubland	SGCN[HP]	SC	
wood thrush	*Hylocichla mustelina*	forest	SGCN		
worm-eating warbler	*Helmitheros vermivorum*	forest	SGCN		

Continued

Table 5. Rare plants and animals of Kent, continued.

MAMMALS					
Common Name	**Scientific Name**	**General Habitat**	**NYS Ranks[1] SGCN**	**NYS Ranks[1] E,T,SC,R**	**NYNHP Rank[2]**
eastern small-footed myotis	*Myotis leibii*	cave, talus, forest	SGCN	SC	S1S3
hoary bat	*Lasiurus cinereus*	tree foliage, conifer and hardwood forest, open area	SGCN		
Indiana bat	*Myotis sodalis*	cave, forest, stream, wetlands, trees in open areas	$SGCN^{HP}$	E	S1
little brown bat	*Myotis lucifugus*	cave, forest, stream, wetlands, trees in open areas	$SGCN^{HP}$		
northern long-eared bat	*Myotis septentrionalis*	cave, forest	$SGCN^{HP}$	E	S1
red bat	*Lasiurus borealis*	tree foliage, buildings, trees in openings, open	SGCN		
silver-haired bat	*Lasionycteris noctivagans*	conifer forest, hardwood forest, lake, pond, stream	SGCN		S2S3B
tri-colored bat (eastern pipistrelle)	*Pipistrellus subflavus*	cave, wooded stream corridor, forest	$SGCN^{HP}$		S1
New England cottontail	Sylvilagus transitionalis	shrubland, shrub swamp, young forest	$SGCN^{HP}$	SC	S1S2

[1] New York State ranks: SGCN = Species of Greatest Conservation Need; $SGCN^{HP}$ = High Priority Species of Greatest Conservation Need
E = Endangered; T = Threatened; SC = Special Concern; R = Rare
[2] New York Natural Heritage Program (NYNHP) ranks are explained in Appendix D.

Forest in winter. Photo © Eli Campbell.

Areas of Known Importance

To identify the places most important for species of conservation concern, the NYNHP has developed maps of "Areas of Known Importance." Using occurrence records of rare and vulnerable species, and knowledge of their life histories and habitats and the physical features of the landscape, the NYNHP identified the areas deemed to be most essential to the continued persistence of rare plants, rare animals, and exemplary ecological communities. Figure 21 shows the Areas of Known Importance in Kent. The actual species of concern in each area are not divulged here because of the sensitivity of the information.

Among the Areas of Known Importance are corridors along Peekskill Hollow Creek and a tributary that are identified for support of Sensitive Coldwater Stream Habitats (Figure 21). The mapped areas include locations with wild brook trout populations recorded in NYSDEC fish surveys since 1980, and streamside areas most likely to affect the quality of the stream habitat. (Some of the mapped areas have no public fishing rights, however, and many are unsuitable for recreational trout fishing due to small fish populations and small fish size.)

Also shown in Figure 21 are Areas of Known Importance for diadromous fishes along the West Branch Croton River and the stream draining Waywayanda Lake (formerly Cranberry Swamp). Tiny American eels have made their way from the Hudson River to these streams in Kent where they will spend many years, growing to maturity until they are ready to make the long journey back to the ocean to spawn.

Nine bat species are known to occur in Putnam County, and eight of those are of statewide conservation concern. Three species—eastern red,[†] silver-haired,† and hoary bats†—migrate south for the winter, the rest overwinter in New York caves, and all spend the warm months in the countryside, raising their young and foraging for insects over a variety of habitats and roosting in trees, in rock talus, and on or in human-made structures. The western one-third of Kent is within a larger area that may be especially important for foraging and roosting for the Indiana bat† and northern long-eared bat† in spring, summer, and fall (Figure 21).

The NYNHP has also recognized several occurrences of exemplary ecological communities in Kent (Figure 22):

- chestnut oak forest
- hemlock-northern hardwood forest
- highbush blueberry bog thicket
- oak-tulip tree forest
- pitch pine-oak-heath-rocky summit

These are occurrences that the NYNHP has recognized as significant from a statewide perspective because they are either a rare community type (such as the pitch pine-oak-heath-rocky summit) or are of especially high quality due to their size, habitat condition, or the quality of the surrounding landscape. Generic descriptions of each are in the Ecological Communities of New York State,[94] and in NYNHP online conservation guides.[95]

Most areas of Kent have never been surveyed for rare species, so no one knows all the places where rarities may occur.

When new land uses are contemplated within an Area of Known Importance, people are encouraged to contact the NYNHP to learn more about the particular elements of concern in the vicinity. These areas are not to be interpreted, however, as the only areas of conservation concern, or the only areas where rare species may occur. Many parts of the landscape have never been surveyed for significant communities or rare species, so other occurrences are simply unknown. For these reasons, the map of Areas of Known Importance should never be used as a substitute for onsite habitat assessments or rare species surveys where such studies seem warranted.

Important Bird Areas

Figure 23 shows the Important Bird Areas (IBAs) delineated by Audubon New York and partner organizations and agencies as critical for bird breeding, migratory stop-over, feeding, or overwintering. The large forests of Fahnestock State Park support a huge array of breeding birds of conservation concern, including ruffed grouse,† several hawk species, whip-poor-will,† Kentucky warbler,† and Louisiana waterthrush,† among many others. The IBA designations are intended to draw attention to these areas for public education and for conservation planning and action.

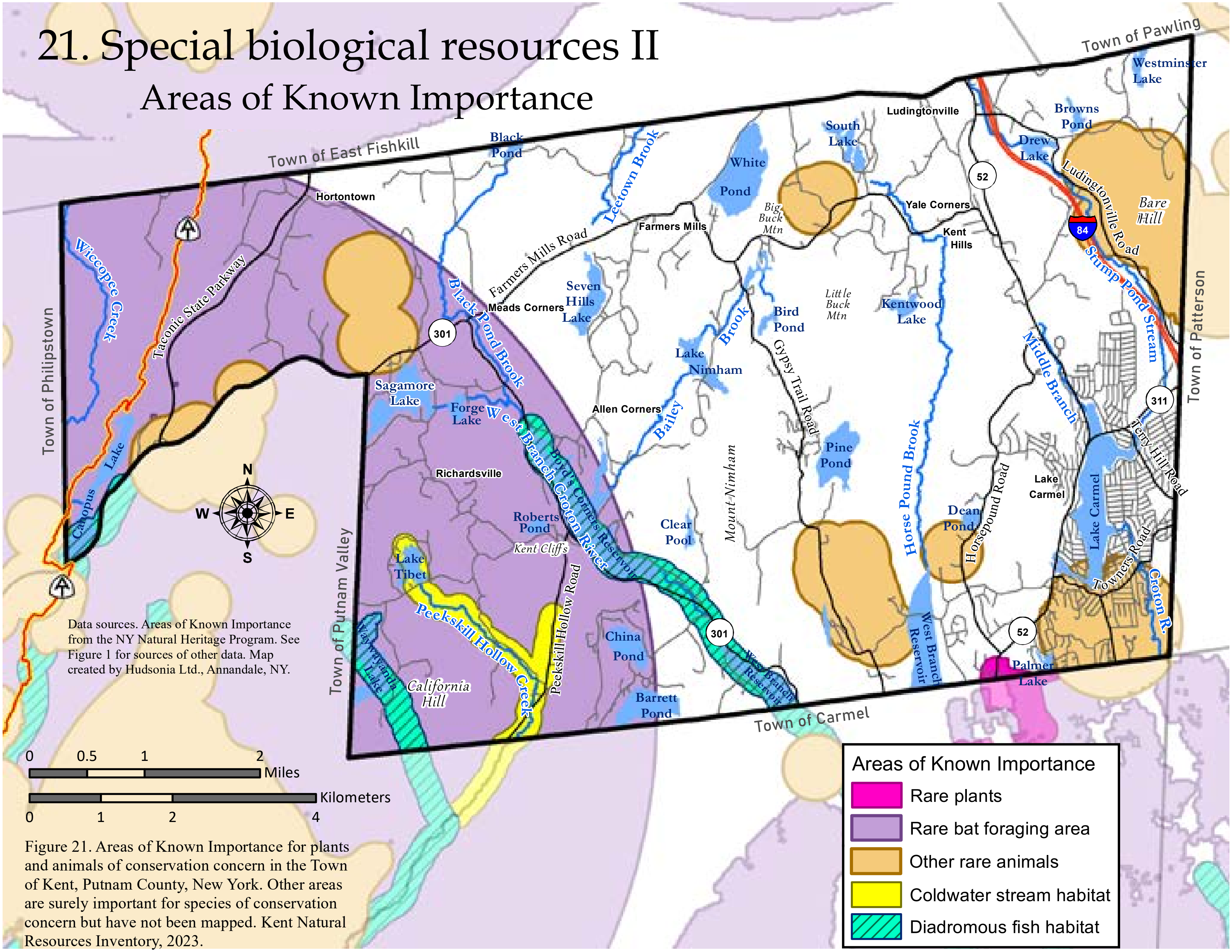
Significant Biodiversity Area

NYSDEC has identified twenty-three "Significant Biodiversity Areas" (SBAs) throughout the ten counties of the Hudson River estuary corridor. All of Kent and most of Putnam County lie within the Hudson Highlands East Significant Biodiversity Area (Figure 23), recognized for its large unfragmented forests, concentration of exemplary ecological communities, relatively undisturbed wetlands, and support of disturbance-sensitive species of conservation concern that depend on these habitats.

The Areas of Known Importance and the Significant Biodiversity Area designations carry no legal weight, but are intended to guide planning, environmental reviews of land development projects, and other land use decision-making, and to promote conservation and stewardship of lands including and surrounding these areas. The maps can alert landowners, developers, municipal agencies, and other land use decision-makers to the potential for impacts to rare species and rare communities, so that the most sensitive areas can be protected.

21. Special biological resources II

Areas of Known Importance

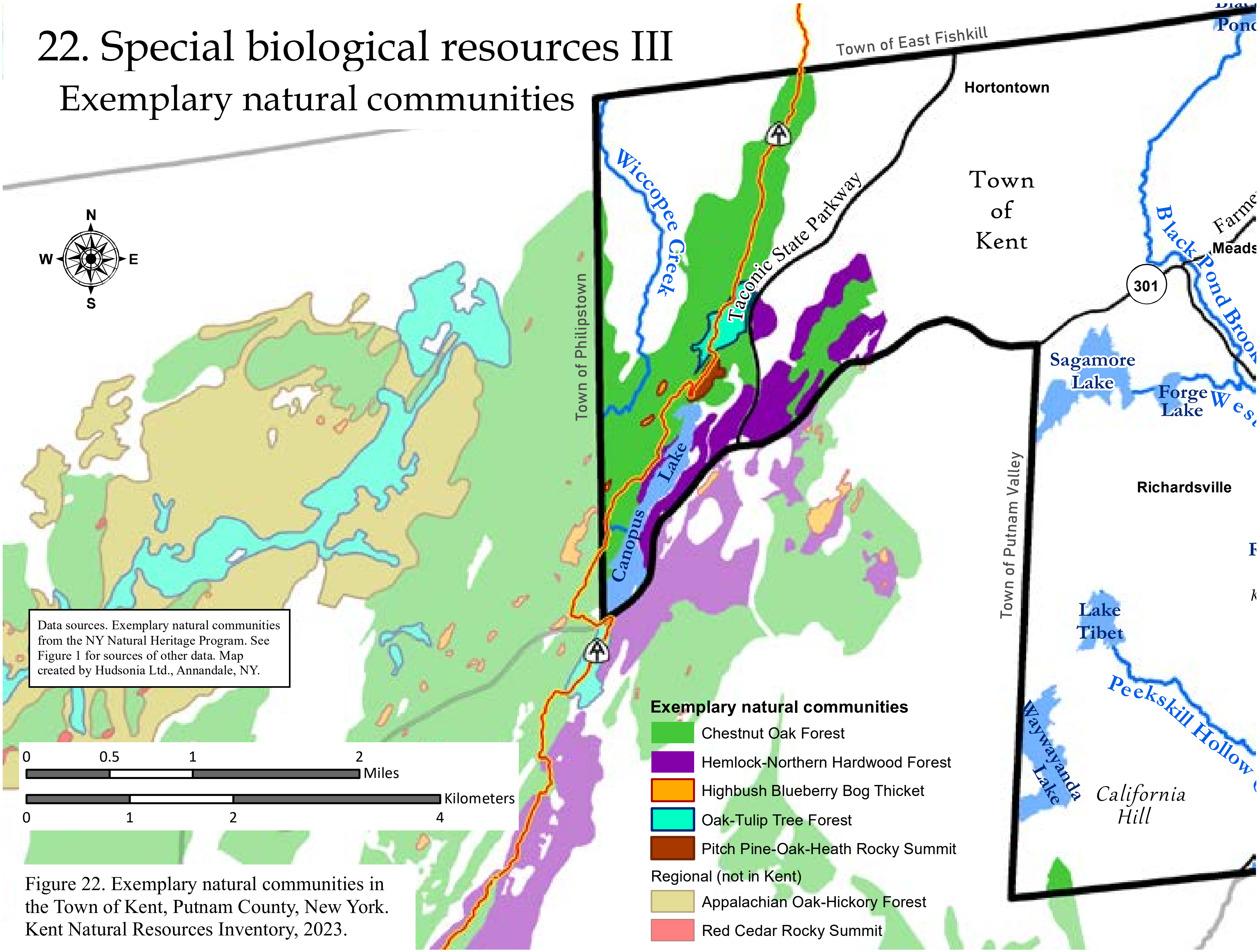


Data sources. Areas of Known Importance from the NY Natural Heritage Program. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 21. Areas of Known Importance for plants and animals of conservation concern in the Town of Kent, Putnam County, New York. Other areas are surely important for species of conservation concern but have not been mapped. Kent Natural Resources Inventory, 2023.

22. Special biological resources III

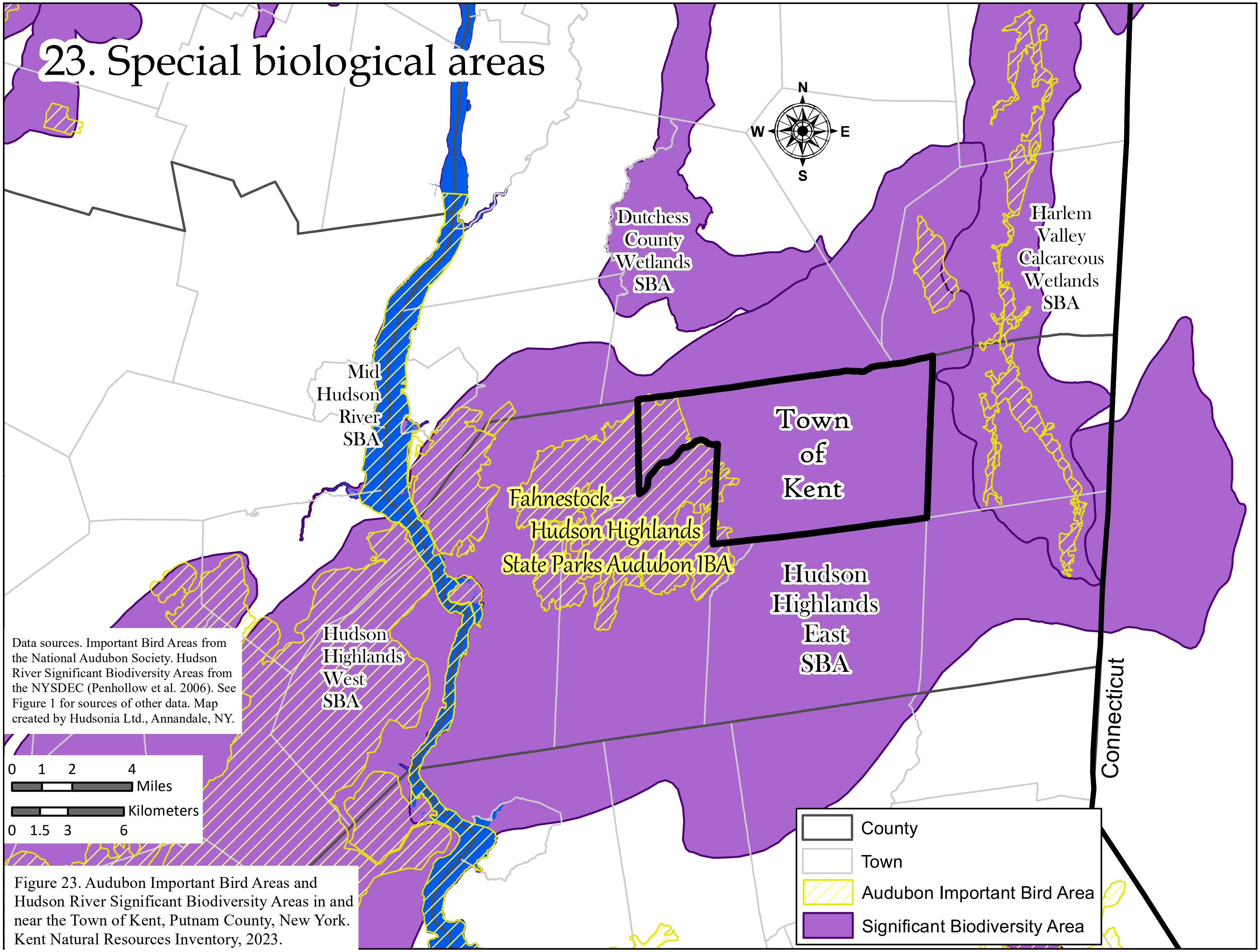
Exemplary natural communities



Data sources. Exemplary natural communities from the NY Natural Heritage Program. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 22. Exemplary natural communities in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

23. Special biological areas



Data sources. Important Bird Areas from the National Audubon Society. Hudson River Significant Biodiversity Areas from the NYSDEC (Penhollow et al. 2006). See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 23. Audubon Important Bird Areas and Hudson River Significant Biodiversity Areas in and near the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

Horse farm on Schrade Road. Photo © Anne Campbell.

Farmland Resources

Kent was a farming community for the first 150+ years after the town was incorporated. Much of the land was cleared for pasture and crops, and many of the local mills depended on materials—wood, grains, wool, flax— from local forests and farms. But farming declined in the early 1900s due to a variety of local and distant factors (see the **Historical and Present-Day Uses of Natural Resources** section), and most of the formerly open pastures and cropfields have become forested over the last 100+ years. The rocky, hilly, and steep terrain has always been difficult to farm, and good farmland soils are mostly in fairly small areas on gentler terrain at the lower elevations.

"Prime Farmland Soils" are those that have been identified by the NRCS as having the "best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and [are] also available for these uses." Typically they are deep soils on level or gently-sloped land, and are well-drained, fertile, and stable. These soils have "the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management."[96] Farmland Soils of Statewide Importance are considered to be nearly as productive as Prime Farmland Soils and produce high yields of crops when properly managed.[97]

Table 6. Prime Farmland Soils and Farmland Soils of Statewide Importance of Putnam County

Map symbols are those on the county soil survey maps[98] and on the Web Soil Survey of the NRCS.

PRIME FARMLAND SOILS	
Soil Name	**Map Symbol**
Charlton fine sandy loam	ChB
Fredon silt loam (if drained)	Fr
Knickerbocker fine sandy loam	KnB
Leicester loam	LcA, LcB
Paxton fine sandy loam	PnB
Pompton silt loam	Pw
Raynham silt loam	Ra
Riverhead loam	RhA, RhB
Stockbridge silt loam	SbB
Sutton loam	SuA, SuB
Unadilla silt loam	UdB
Woodbridge loam	WdA, WdB

FARMLAND SOILS OF STATEWIDE IMPORTANCE	
Soil Name	**Map Symbol**
Charlton fine sandy loam	ChC
Hinkley loamy sand	HnB
Knickerbocker fine sandy loam	KnC
Paxton fine sandy loam	PnC
Ridgebury complex	RdA, RdB
Riverhead loam	RhC
Stockbridge silt loam	SbC
Sun loam	Sm
Woodbridge loam	WdC

Dick Harris with cabbage. Backyard gardens are the largest agricultural land use in Kent. Photo © Beth Herr.

Table 6 lists the "Prime" and "Statewide Important" farmland soils in Putnam County. The soil types at any location can be viewed on an interactive map at the Web Soil Survey page of the NRCS. The map symbols in Table 6 correspond to those on the Web Soil Survey map and in the *Soil Survey of Putnam and Westchester Counties*.[99] Note that some soil types, such as Charlton and Knickerbocker fine sandy loams, are listed as both "Prime" and "Statewide Important" but the map symbol differs for each listing. The differences in those cases are the slopes on which the soils occur, indicated by the final upper case letter (A, B, C) in the map symbol. Prime Farmland Soils are on flat to gently-sloped terrain, up to 8 percent slopes (e.g., ChB, KnB), and some of the Farmland Soils of Statewide Importance are on moderate slopes, up to 15 percent (e.g., ChC, KnC).

Areas identified as Prime Farmland may be cultivated land, pasture, forest, or other land potentially available for growing crops, but does not include developed land or surface water areas. The soil maps, however, do not account for development that has occurred since the soils were mapped in the 1980s. The soils identified as "Prime Farmland if Drained" are too wet unless artificially drained enough to meet the Prime Farmland standard. (Those areas are often wetlands and draining is not recommended.) The largest areas of Prime Farmland Soils and Farmland Soils of Statewide Importance are in the Middle Branch and West Branch corridors and Whang Hollow. Figure 24 shows the distribution of the best farmland soils in Kent.

Today only a few commercial farms are active in Kent, raising cattle, sheep, pigs, chickens, and horses.

An Agricultural District is a land area identified through New York's Agricultural Districts Law (Article 25-AA) to help protect current and future farmland from non-agricultural development by reducing competition for limited land resources and helping to prevent the adoption of local laws that would inhibit farming and raise farm taxes. Agricultural Districts are established when interested landowners, who collectively own at least 500 acres of land, request formation of such a district. Farmers and rural landowners enrolled in a state-certified Agricultural District receive important "right-to-farm" protections. Also, because of the state's interest in maintaining the viability of farmland, proposals for new non-agricultural land uses or actions in an Agricultural District may be subject to closer scrutiny in the State Environmental Quality Review (SEQR) process (6 CRR-NY 617.4[b][8]). As of 2023, 454 acres in Kent were in Agricultural District 1 (the only Putnam County district) (Figure 24).

The New York Commissioner of Agriculture is authorized to review local comprehensive plans, legislation, regulations, and approve or disapprove them according to whether they unreasonably restrict or regulate farm operations within an Agricultural District. The Commissioner also reviews any purchase by a municipal or state agency of active farmland larger than one acre, or any land over ten acres within an Agricultural District, to assess the potential impacts on local agricultural resources.

The Agricultural Districts Law allows reduced property tax bills for land in agricultural production by limiting the property tax assessment of such land to its prescribed agricultural assessment value. Owners whose land satisfies the eligibility requirements may apply for an agricultural assessment. To qualify,

- land must consist of seven or more acres that were used in the preceding two years for the production for sale of crops, livestock, or livestock products; and
- the annual gross sales of agricultural products generally must average $10,000 or more for the preceding two years. If an agricultural enterprise is less than seven acres, it may quality if average annual gross sales equal $50,000 or more.

Agricultural assessments are limited to land used in agricultural production, which is defined to include cropland, pasture, orchards, vineyards, sugarbush, support land, and crop acreage either set aside or retired under federal supply management or soil conservation programs.

Farms provide local produce for the people of Kent, contribute to Kent's cultural life, help to maintain a connection to the town's agricultural past, and are part of Kent's scenic landscapes. Even though Kent has just a few active farms today, new markets, changing local needs, and other unforeseen circumstances could reinvigorate local farming in the future. Protecting areas with the best farmland soils will help to preserve the ability to efficiently produce high-quality local food and other agricultural products.

Agriculture can also be a significant contributor to native biodiversity. Farming creates and maintains open habitats—pastures, hayfields, row cropfields, fallow fields, and oldfields—that are used in various ways by native plants and animals. Depending on how they are managed, meadows can provide important habitats for invertebrates, mammals, grassland birds, and other wildlife, as well as for plants of conservation concern (see the **Habitats** section above).

Maintaining intact habitat areas and building living soils in cropland areas can reduce agricultural pests and foster populations of native insects that are beneficial to agricultural crops, including pollinators, pest predators, and parasitoids. Reducing tillage can improve soil health, reduce the need for artificial soil amendments, and reduce soil loss due to erosion. It also increases carbon storage and is thus a climate-friendly practice. (No-till techniques that rely on herbicides, however, may harm the soil life and many other non-target organisms.) There is now considerable literature on agricultural practices that support local ecosystems and native biological diversity, and use ecological processes and interactions to boost farmland productivity.[100,101,102,103,104,105]

24. Farmland soils

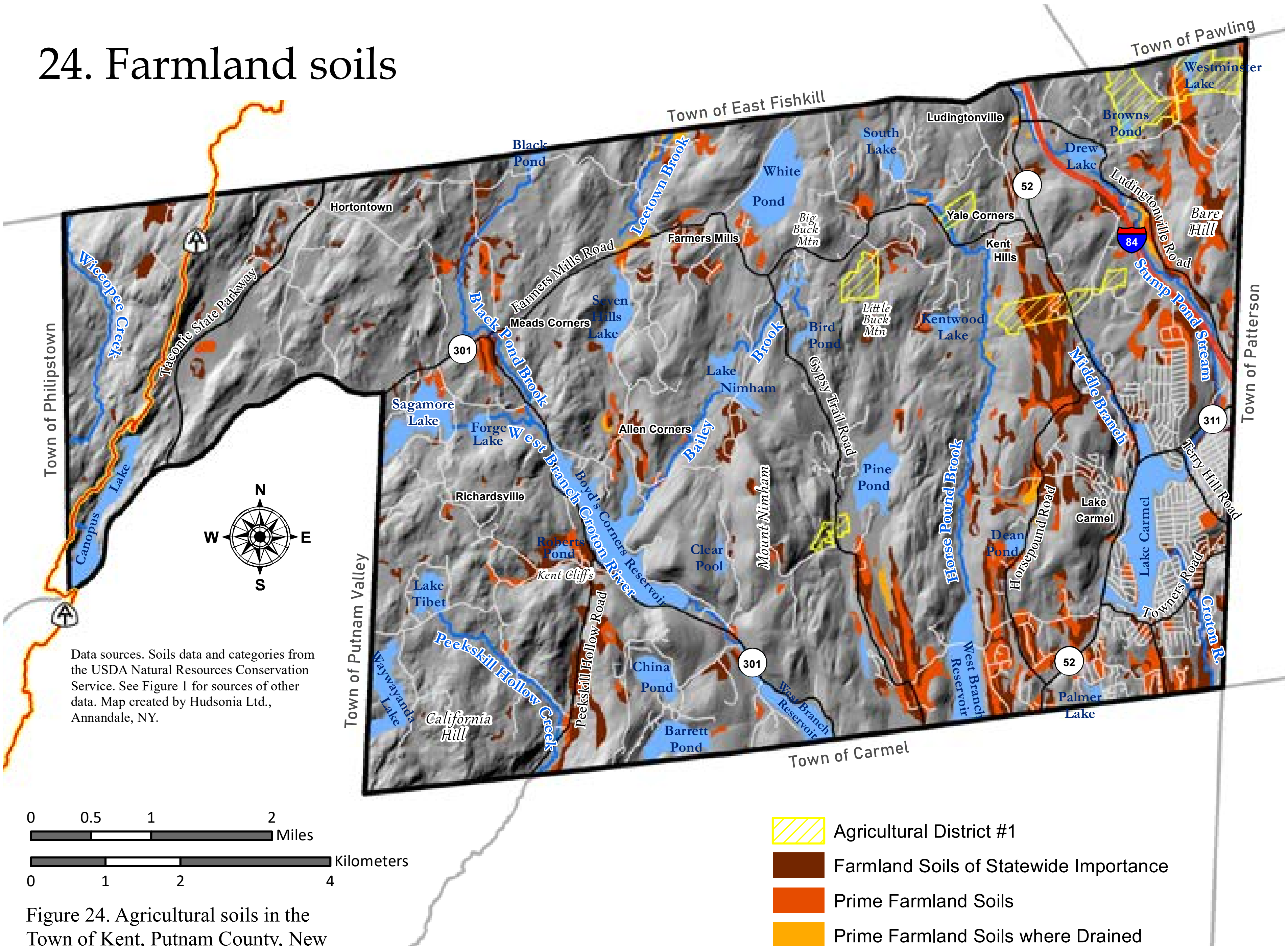


Figure 24. Agricultural soils in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

View looking east from the Nimham Mountain fire tower. Photo © Beth Herr.

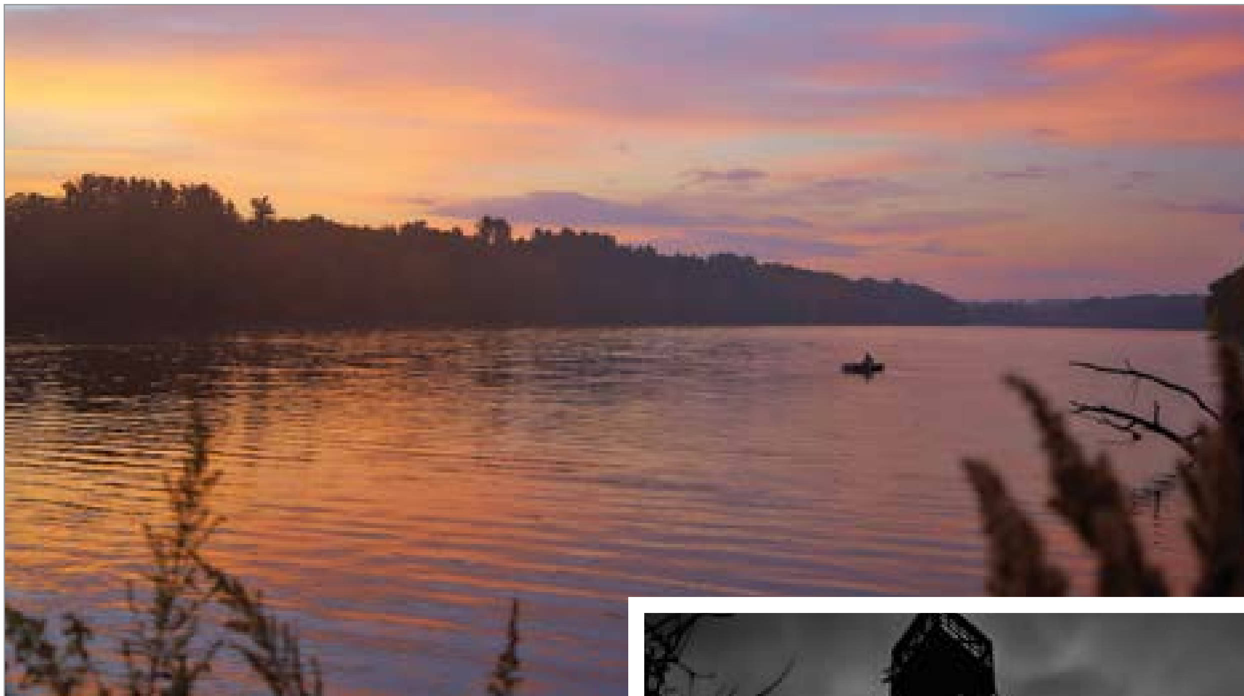
Scenic Resources

Scenic beauty is the natural resource that may be most appreciated in the daily lives of the people of Kent. The lakes and reservoirs, the forested hills, the vistas from high places, and the more intimate views of rocky streams, mossy ledges, and old stone walls comprise the visual signature of the town and provide an immediate connection to the land for residents and visitors. The public roads and the large areas of parks, NYCDEP lands, and other public-use areas in Kent make the beauty of the landscape accessible to everyone.

The scenic qualities of the town are prominent among the concerns expressed in the 2008 Kent Comprehensive Plan, which recommends the adoption of policies to protect the hills, ravines, rock outcrops, wetlands, streams, and lakes that are so important to the visual and ecological character of this place.

The Comprehensive Plan also recommends designation of Scenic Byways on selected road segments. A Scenic Byway is a transportation corridor recognized by the NYS Department of Transportation for exceptional scenic, recreational, natural, or cultural features. The corridor is managed to protect such characteristics and to encourage economic development through tourism and recreation. Under the Scenic Byways program, the Commissioner of Transportation is authorized to review projects occurring along the roadway; construct facilities for the use of pedestrians and bicyclists, rest areas, turnouts, highway shoulder improvements, passing lanes, overlooks, and interpretive facilities; make improvements that enhance access for purposes of recreation; and protect historical and cultural resources in adjacent areas. The Taconic State Parkway, designated by the NYS Department of Transportation in 1992, is the only Scenic Byway in Kent to date.

Farms and the Nimham Mountain fire tower are the main scenic features noted on the map of scenic and cultural resources in the Comprehensive Plan, but there are many other places that deserve recognition. Certainly the lakes and reservoirs of Kent are important scenic areas. Figure 25 shows the locations of the Scenic Byway, the lakes, the Nimham Mountain fire tower, and two scenic

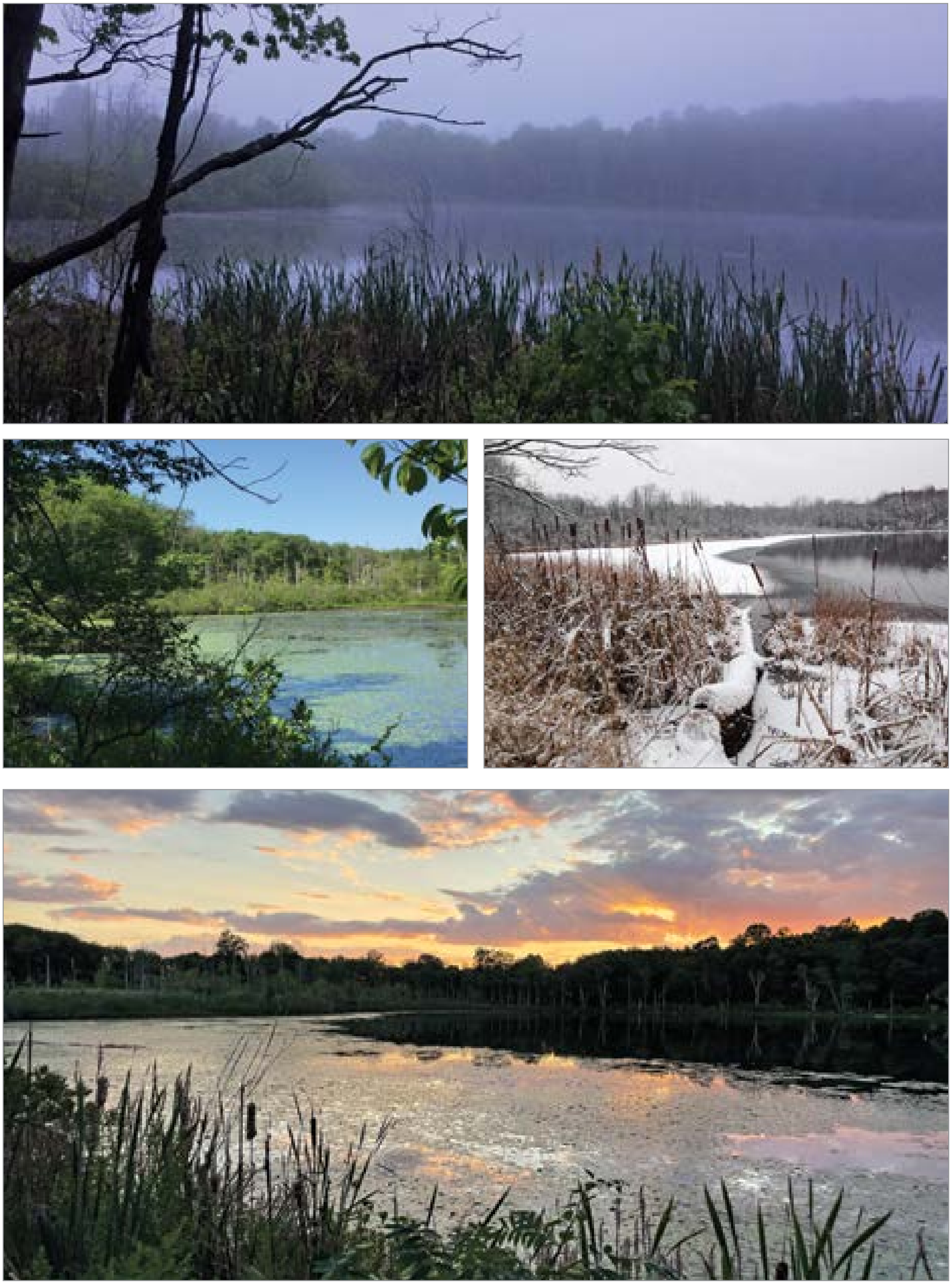


A lone fisherman on the West Branch Croton River Reservoir at sunset. Photo © Alexander Milligan.

lookouts along the Appalachian Trail. A project to survey and map scenic locations could identify all the other places with special publicly-accessible scenic value throughout the town, and could provide the basis for future legislation and site design standards aimed at protecting the places of greatest importance.

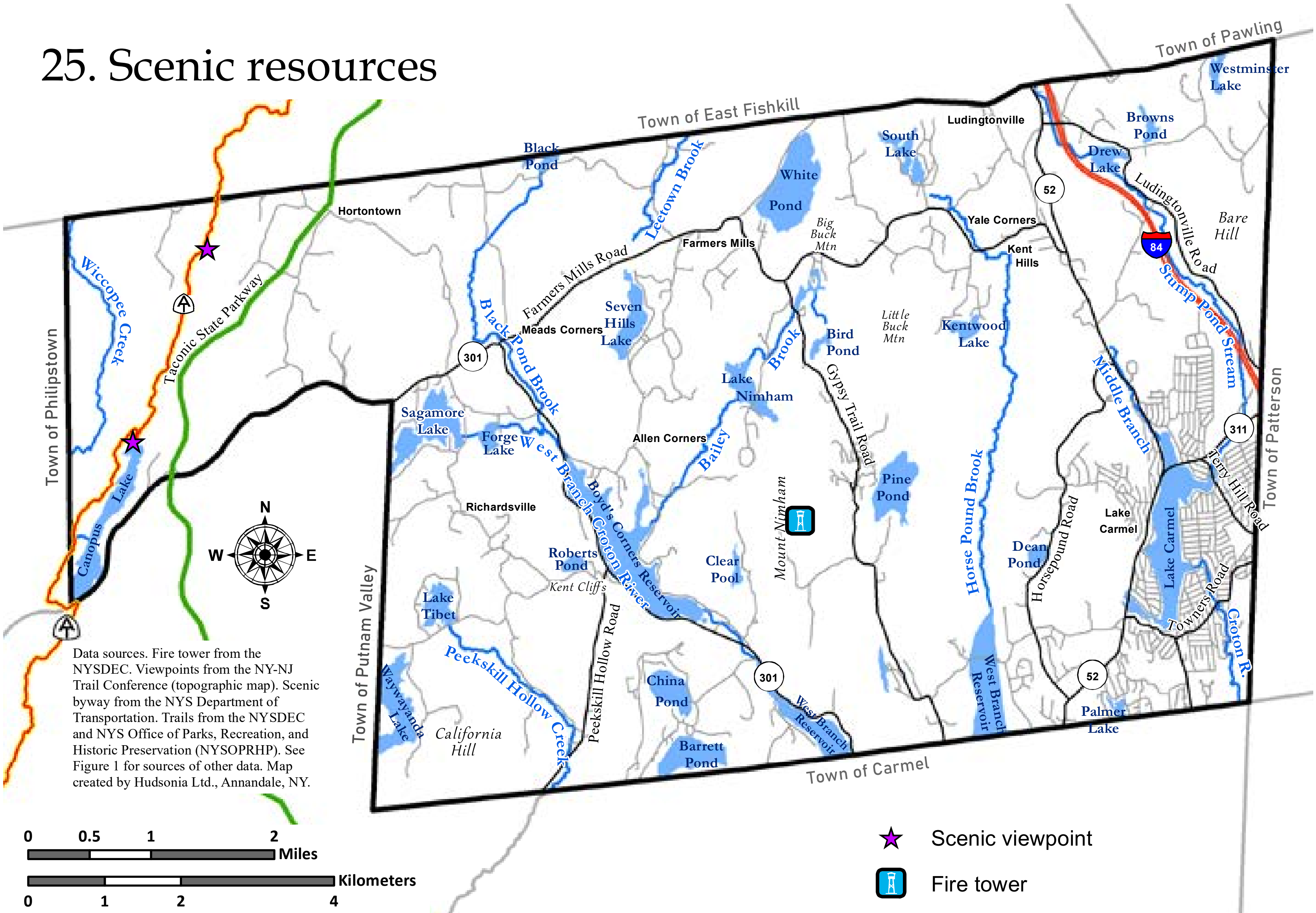
Even before such a survey is completed, the town could adopt policies and legislation to protect the scenic character of the Kent landscape—for example, to discourage rural sprawl, discourage disruption of active farmland by non-farm uses, and discourage or prohibit development of high-elevation areas, ridgetops and other areas that affect large viewsheds. Additional standards could be adopted for locating and screening new structures to minimize their visual impact on the immediate viewshed, and for reducing the ecological and scenic impacts of nighttime lights. Consideration of scenic impacts could be routinely incorporated into environmental reviews of proposed development project. (See the **Threats to Natural Resources** section for discussion of the ecological impacts of outdoor lights.)

Nimham Mountain fire tower on a cloudy full-moon night. Photo © Bill Volckmann.



Four views of Dean Pond. Photos © Beth Herr.

25. Scenic resources



Data sources. Fire tower from the NYSDEC. Viewpoints from the NY-NJ Trail Conference (topographic map). Scenic byway from the NYS Department of Transportation. Trails from the NYSDEC and NYS Office of Parks, Recreation, and Historic Preservation (NYSOPRHP). See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 25. Scenic resources in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

White Pond is a popular site for swimming, fishing, and kayaking. Photo © Diane Starr.

Recreational Resources

The state, county, and town parks, the NYS Multiple Use Areas, and many of the NYCDEP-owned land parcels provide an extraordinary array of opportunities for public enjoyment of the outdoors in Kent (Figure 26). Some of these areas are described below. Not described here are the privately-owned recreation areas owned and managed by sporting clubs, golf clubs, and other organizations for use by members or paying guests.

State Parks

Clarence Fahnestock Memorial State Park is a 14,086-acre park spanning the towns of Putnam Valley, Philipstown, Kent, and Carmel. It was established in 1930 when approximately 2,400 acres around Canopus Lake were donated by Dr. Ernest Fahnestock in memory of his brother, Clarence, for the development of the parkway and a state park. More land was added in increments in the 1960s-2000s to bring it up to the current size. Approximately 1532 acres of the park are in Kent.

The park is largely rugged, forested terrain with hiking trails, picnic areas, tent and RV campgrounds, opportunities for boating, hunting and fishing, and groomed trails for cross-country skiing and snowshoeing. A segment of the Appalachian Trail runs through the park. Large areas of the park have been designated by Audubon New York as an Important Bird Area (Figure 23) because of its support of large numbers of birds of conservation concern.

Wonder Lake State Park is a 1113-acre park straddling the boundary between Kent and Patterson. It was established in 2006 on the land of a summer estate, and additional land was added in 2010. The park is centered on Wonder Lake, a 30-acre lake formed from a dammed stream, and the three-acre Laurel Pond. The park is hilly and forested, and provides opportunities for hiking, hunting, and fishing. It includes a segment of the Highlands Trail, a trail project that will eventually extend over 200 miles, connecting the Highlands from the Delaware River in Pennsylvania through New Jersey and New York to Connecticut.

State Forest and Multiple Use Areas

Big Buck Mountain Multiple Use Area is a 146-acre site that has no formal trails but is open for non-motorized recreation, including primitive camping, hunting, trapping, hiking, cross-country skiing, and horseback riding. The MUA serves as a connecting corridor between protected areas at White Pond and South Lake.

California Hill State Forest is a 982-acre site that includes the 94-acre Waywayanda Lake (called Pudding Street Pond or Cranberry Swamp on some maps). The site is mostly forested, and has formal and informal trails and unpaved forest roads. It is open for hiking, primitive camping, non-motorized and electric boating, hunting, trapping, and fishing.

Nimham Mountain Multiple Use Area is a 1054-acre site that encompasses Nimham Mountain and nearby areas. The hilly site is mostly deciduous forests, with a few conifer plantations. Some of the forest areas are managed by thinning and harvesting. The MUA has networks of trails and old roads for mountain biking, horseback riding, and hiking, including two trails for use by people with disabilities who have a permit from the Motorized Access Program for People With Disabilities. The site is also open for primitive camping, fishing, hunting, and paddling on Rinaldi Pond. The road to the Nimham Mountain summit and the fire tower at the summit were built by the Civilian Conservation Corps in 1940. The fire tower had deteriorated and was closed in 1989, but was restored in the 2000s by the Kent CAC, and is now open for public use. The MUA is adjacent to large areas protected by New York City, as well as the county Veterans Memorial Park, creating an immense contiguous area of substantially undeveloped land.

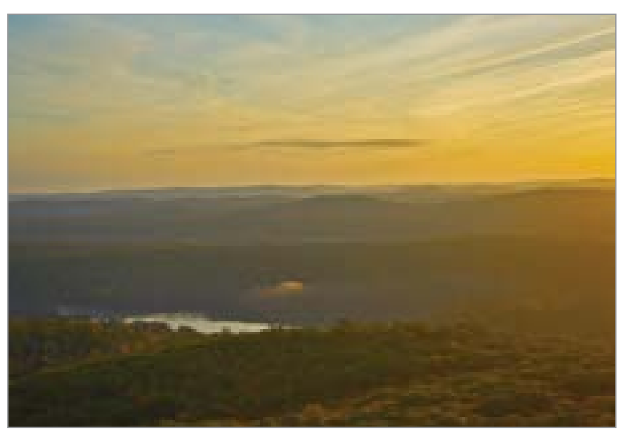
White Pond Multiple Use Area is a 263-acre site centered on the 129-acre White Pond and bordering the outlet stream that runs through Farmers Mills. The MUA is open for hiking, non-motorized and electric boating, hunting, trapping, and fishing. A 1.5-mile trail loops partway around the pond perimeter.

New York City Lands

New York City owns 6338 acres of land in Kent, managed by NYCDEP (Figure 26). Eighteen of the NYCDEP sites, totaling 4000 acres, are open for public recreation, but most of those are undeveloped with trails or other amenities, and most have no official parking areas. Recreational use of areas adjacent to drinking water reservoirs requires a Public Access Permit from NYCDEP, but other areas can be used without a permit. Table 7 lists the NYC-owned lands that are open to public recreation, and the kinds of uses that are allowed.

Veterans Memorial Park

The Putnam County Veterans Memorial Park is a 222-acre site straddling Gipsy Trail Road that is highly developed with historical and memorial displays. A central feature is the Putnam County Veterans Memorial Museum with exhibits of pre-Civil War to the present. There are also several memorial monuments, statues, and sculptures, Victory Gardens to honor all veterans, and a Cobra 318 helicopter that served in the Vietnam War. The park hosts an annual 4-H fair, and has several pavilions that can be rented for other group events. There is a hiking trail, and a ca. 10-acre lake that is open for swimming and fishing in season.



Views from the Nimham Mountain fire tower. Photos © Alexander Milligan.

Table 7. Public recreation opportunities on New York City-owned lands

(https://www.nyc.gov/assets/dep/downloads/pdf/recreation/open-rec-areas-maps.pdf).

Recreation Area	Location	Hike	Fish	Hunt	Trap	Acres
Adams	Nichols Street	Y	Y	Y	N	175
Boyd's Corners North	Nimham Road	Y	N	Y	N	642
Boyd's Corners Outlet	E Boyd's Road & Clearpool Road	N	Y	N	N	30
Boyd's Corners South	State Route 301	Y	Y	N	N	327
Dean Pond	Horse Pound Road	Y	Y	Y	N	198
Farmers Mills	Dean, Williams Cross, & Farmers Mills Roads	Y	N	Y	N	164
Horse Pound Brook	Horse Pound, Whangtown, & Schrade Roads	Y	Y	Y	N	1024
Kent Cliffs	Richardsville Road	Y	N	N	N	381
Kent Hills	NYS Route 52	Y	N	N	N	118
Knapp Road	South Knapp Road	Y	N	Y	N	187
Little Nichols Fill	Gipsy Trail Road	Y	N	N	N	20
Ludingtonville	Church Hill Rd, Kent Shore, & Kent Lake Drives	Y	N	N	N	169
Mount Nimham	Nimham Mountain Multiple Use Area	Y	N	Y	N	86
North Putnam	Big Buck Mountain Multiple Use Area	Y	N	Y	N	32
Richardsville	Richardsville Road	Y	N	Y	N	193
Summit	Summit Road & Pudding Street	Y	N	Y	N	57
Taconic	Hortontown Hill Road	Y	N	Y	N	117
White Pond	White Pond Multiple Use Area	Y	N	Y	N	197

Town Parks

The **Huestis Town Park** is a 82-acre site off Farmers Mills Road with ballfields, soccer fields, an Ultimate Frisbee field, a volleyball court, a basketball court, a childrens' playground, and several hiking trails through hilly forested terrain.

The **Edward Ryan Memorial Park** is an 18-acre site on Park Road in the Lake Carmel hamlet. It has baseball and softball fields, a tee-ball/wiffle-ball/kick-ball field, a soccer field, an Ultimate Frisbee field, a volleyball court, a basketball court, a tennis court, a fitness trail, a childrens' playground, and a pavilion with grills and picnic tables.

The **Town Hall Park**, on the Town Hall property at Sybil's Crossing, has a childrens' playground and hiking trails through the forests of the 65-acre property.

A fish hunter, the osprey prefers to live near rivers, lakes or coastal areas. Photo © John Kenny.

Highlands Trail

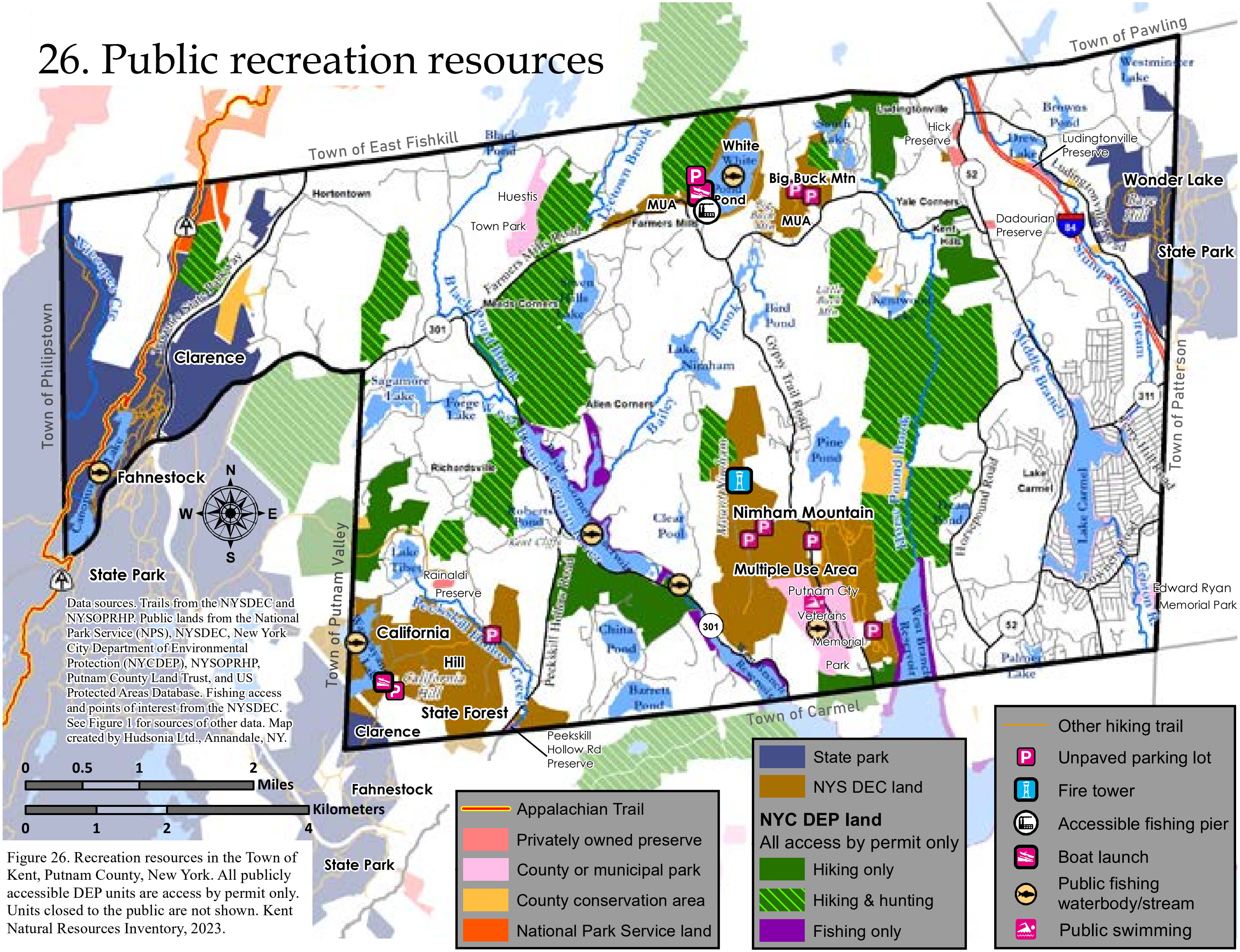
The **Highlands Trail** is a collaborative project of the New York Highlands Network and other partners. The trail (in progress) is envisioned as a 600+ mile trail across the Highlands of Pennsylvania, New Jersey, New York, and Connecticut. It is being completed in segments and, as of 2023, is about 50 percent complete overall. The segment east of the Hudson River is about 10 percent complete, including six miles in Wonder Lake State Park, and one mile in Hudson Highlands State Park. The segment running through Kent is in the planning stages. More information can be obtained from the New York/New Jersey Trail Conference, including trail maps for segments west of the Hudson River.

The yellow-billed cuckoo is found in dense, shrubby areas near water. Photo © John Kenny.

Other Potential Hiking Trails

The Kent CAC began but has not completed an inventory of the abandoned roads and non-abandoned "remnant roads" in town to see which ones would be suitable for conversion to public trails, horse-riding paths, bike paths, and connections to existing parks or other public-access areas.

26. Public recreation resources



Data sources. Trails from the NYSDEC and NYSOPRHP. Public lands from the National Park Service (NPS), NYSDEC, New York City Department of Environmental Protection (NYCDEP), NYSOPRHP, Putnam County Land Trust, and US Protected Areas Database. Fishing access and points of interest from the NYSDEC. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

Figure 26. Recreation resources in the Town of Kent, Putnam County, New York. All publicly accessible DEP units are access by permit only. Units closed to the public are not shown. Kent Natural Resources Inventory, 2023.

HISTORICAL AND PRESENT-DAY USES OF NATURAL RESOURCES

The First People

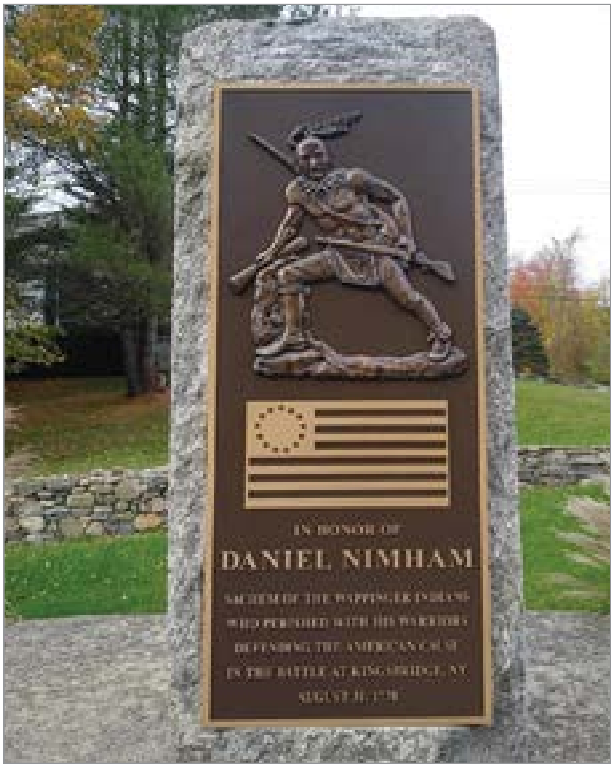
Indigenous people occupied the Hudson Valley since approximately 12,000 years ago, arriving soon after the last glaciation,[106] and remained here until they were forced from the region by the European newcomers in the 1700s and 1800s.[107] The land cover, wildlife, and human uses of the land shifted significantly during those thousands of years. The land was barren immediately after the last glacier receded, and the first vegetation to cover the region was an arctic-alpine flora of lichens, mosses, sedges, and grasses.[108] Spruce-fir communities were the first forests to establish, followed by northern hardwood-hemlock forest communities. Pollen analysis indicates that, by 8000 years ago, oaks were fairly abundant in the region and that other tree and shrub species were similar to those of oak-hemlock forests of today except that American chestnut was present and hickories were fewer.[109]

Fur trading for the European market led to the regional extirpation of the American beaver but the population has slowly recovered, to the great benefit of local ecosystems. Photo © John Kenny.

Mastodon and caribou roamed the land in the early millennia after the Ice Age, but mastodons apparently disappeared from the Northeast around 11,000 years ago.[110] Although there is no evidence that mastodons were hunted by humans in the Northeast, caribou were apparently a mainstay of human sustenance for several thousand years until the herds moved north with the warming climate.[111]

Deer were taken for food, skins, and tool-making and, in the period 6000-3000 years ago, game was apparently abundant and diverse—remains of elk, deer, bear, raccoon, woodchuck, turkey, grouse, goose, turtle, clams, and fish from that period have been found in a Dutchess County rock shelter.[112] Mast foods (acorns, tree nuts) were apparently also important in the human diets, as indicated by evidence from ca. 4500 years ago[113] and remained so into the modern era. Remains of acorns, hickory nuts, walnut, butternut, and hazelnuts from 650-500 years ago have been found at encampments and dwellings in the region.[114] Agriculture was a relatively recent development. In some parts of the Hudson Valley, fields were burned for planting crops and attracting wildlife starting around 2000-1600 years ago.[115] The first evidence of beans from a Hudson Valley site (Esopus) dates to the period 1580-1620, and the oldest evidence of maize in the region dates to about 1100 years ago.[116]

The area that is now Kent was eventually the home of the Nochpeem tribe of the Wappinger Confederacy.[117] The Wappingers (the name means "east of the river") occupied the territory south of today's Columbia County between the Hudson and Connecticut rivers.[118] The Nochpeem lived in small villages, usually located on a south- or east-facing hillside, above a wetland, stream, or lake. They occupied the villages during the warm months, and moved to "forts" for the winter.[119] Their main sustenance was from hunting and fishing, but they also gathered nuts, fruits, and wild herbs and roots for food, medicine, and other



Daniel Nimham memorial at the Putnam County Veterans Memorial Park. Photo © Ed Spaeth.

uses. We do not know if or to what degree the Nochpeem practiced agriculture.

Starting in the early 1600s, the fur trade with the Dutch greatly altered the relationship of the Wappingers with the land, with wildlife, and with neighboring groups. To meet the demands of the European market for pelts, driven by European fashions of the day, increased trapping and hunting by Indigenous people and Europeans led to increased strife between neighboring Indigenous groups who fought over hunting and trapping territory,[120] and also led to depletion of fur-bearing game species and the near-extirpation of the American beaver in the Hudson Valley by 1640. Over the next 250 years, white-tailed deer, eastern wolf, mountain lion, and wild turkey were similarly hunted and trapped to the point of local extirpation.

In the period 1609-1664, Dutch fur traders took the Wappinger lands by force, by fraudulent deeds, and by paying only nominal fees to the inhabitants, and established the New Netherlands Colony. Many of the Wappingers moved away in that period; some died of new diseases (smallpox, malaria) brought by the Europeans; some were captured and sold into slavery; some were killed in battles with the Dutch.[121,122]

The Nochpeem Chief Daniel Nimham and a band of Wappingers fought on the side of the American patriots in the Revolutionary War (1775-1783), and he and many of his men were killed. Upon returning from their service, the surviving Wappingers found that their settlements were now occupied by European tenant farmers and, while some of the other war veterans were given land grants as payment for their war service, the Indigenous veterans were not, and were also denied US citizenship.[123]

Most of the Wappingers had left the region by the end of the war, moving first to Connecticut,[124] then to Stockbridge, Massachusetts, and eventually to Wisconsin where some of their descendants remain.[125] According to Pelletreau's 1886 *History of Putnam County*, the last village of Indigenous people, occupied until 1811, was in the vicinity of Boyd's Corners (now Kent Cliffs).[126] Thomas Maxson reports that a small band remained at a location near Sagamore Lake until 1812.[127]

Mines, Mills, and Other Industries

European prospectors may have arrived in Kent in the early 1700s before any European settlers. Mines for lead, iron, graphite, copper, sulfur, and arsenic operated here in the 1700s and 1800s.[128] Most were small and worked by family members and a small staff.[129] Serpentine was mined at Brown's Quarry (Figure 7), where the *History of Putnam County* reported 25-30 acres of serpentine.[130] Ore that looked like silver was found at the "Silver Mine" (1848[131]) but turned out to be mostly arsenic. Arsenical ore was used to manufacture shot, flint, glass, and for medicinal preparations,[132] but could only be processed efficiently in England, so the Silver Mine had a short life.[133] Flagging and curbstones were mined at Boyd's Corners, and iron was mined in the area of today's Putnam County Veteran's Memorial Park.[134]

Serpentine

A greenish, translucent group of minerals in various combinations. Because serpentine polishes to a lustrous sheen, it has been used as a gemstone and an ornamental architectural stone, sometimes as a substitute for marble. Fibrous varieties do not burn and are poor conductors of heat, so have been used to make asbestos.

Ore from the Hudson River Mining Co. mine, one half mile southwest of Pine Pond, went to a smelter and forge at the north end of what is now the Boyd's Corners Reservoir. Tailings, slag, and other evidence from the mine are still visible along the stream and on Rt 301 in Kent Cliffs.[135] Other 19th century forges were on the outlet of Forge Lake[136] and at Farmers Mills.[137] Ore was also taken to Danbury, Connecticut and to the West Point Foundry in Cold Spring.[138] Granite and gneiss were mined for local construction and also shipped to New York City.[139] Even though transportation was slow and arduous and the success of mines difficult, mining may still have been the second largest employer in Kent for about 100 years.[140]

Water power was the main source of energy for local industry in the 1700s-1800s, and saw mills were among the earliest uses, turning the abundant local timber into construction materials for dwellings, farm structures, tools, and many other items. Grist mills (for grinding grains into flour and meal), and woolen mills (for fulling, carding, and weaving), and other industrial plants were also water-powered, producing goods for local use and for distant commercial markets. Most streams with year-round flow were exploited for their water power, and many supported multiple mills by the mid-1800s.

The first mill in Kent may have been Jonathan Tuttle's in the 1700s near the head spring of Whang Brook (then called Philipse Mill River).[141] In 1776 a saw mill and grist mill were built in the hamlet that came to be called Ludingtonville, and the grist mill supplied grain to the Continental armies during the Revolutionary War.[142] Boyd's Corners had a saw mill at a dam on the West Branch Croton River.[143]

Before the Revolution (before 1775), the Cole family established a mill on the outlet of Barrett Pond, and then soon after the Revolution (after 1783) a grist mill, saw mill, and fulling mill on the West Branch of the Croton River.[144] That location became the Cole's Mills hamlet, and those mills operated until the area was inundated by the West Branch Reservoir.[145]

Farmers Mills was a choice location for water-powered mills and other industries because the stream issuing from spring-fed White Pond had a constant flow, unlike other streams in the region which had seasonal flow fluctuations.[146] The first mill was built there in 1784[147] and Farmers Mills eventually had a grist mill, fulling mill, saw mill, forge, turning shop, mechanic shop, blacksmith, tannery, and brickyard.[148] The brickyard exploited a bed of clay near the stream.[149]

Marker (left) and foundation (above) of old Ludington Mill. Photos © Ed Spaeth.

The hamlet was originally called "Milltown" but came to be called "Farmers Mills" after a part of it was sold to an association of neighboring farmers in 1838. By then the hamlet also had the Elgin Gilt-edged Cheese and Butter Factory, a branch of Bordens Condensed Milk Company.[150] The location of Farmers Mills on the Philipstown Turnpike between Cold Spring and Danbury was advantageous for commerce at first, but the hamlet became stranded after 1849 when the Harlem and Hudson River railroads took business elsewhere.[151]

From the earliest days of European settlement, timber was cut throughout Kent to provide firewood, lumber, fencing, tools, and a host of other practical uses.[152] Later on it was cut to provide barrel hoops and railroad ties, tannin for tanneries, fuel for boats and train engines, and charcoal.[153]

Charcoal was the other primary industrial fuel in the 1800s, used especially for iron smelting, but also for other purposes requiring extreme heat, such as blacksmithing, brickmaking, and metal manufacturing. Large areas of forests around each charcoal kiln were cut for charcoal production.

Tanning—the process by which animal skins are transformed into pliable and durable leather—used tannins in the bark of eastern hemlock and oak species, and may have been responsible by itself for large areas of forest cutting. There was a tannery at Farmers Mills.

Ice was harvested from lakes and ponds from the time of the earliest European settlements and used for residential, agricultural, and commercial refrigeration throughout the year until rural electrification in the mid-20th century allowed the installation of electric-powered refrigerators. Commercial ice-harvesting at Dean Pond ceased around 1912.[154]

The arrival of widespread steam power in the 1880s, and the damming of the West Branch Croton River for the New York City reservoir system 1865-1890 meant the beginning of the end of water-powered milling in Kent, except in Ludingtonville where the last of Kent's 100 mills ceased operation in the 1930s.[155]

Newly opened roads in the early 1900s further eroded the market advantage for the industries of Farmers Mills and other Kent hamlets, which couldn't compete with the new factories on roads and rail lines and nearer to the large markets of the New York City metropolitan area.

Charcoaling

Charcoal was made by slowly heating logs in an outdoor earthen kiln—a pile of logs covered with soil and green vegetation. A smoldering fire would vaporize the moisture in the logs leaving only charcoal, which burns longer and hotter than firewood.

Agriculture

Early European settlers were farmers by necessity, and were largely self-sufficient, obtaining most of what they needed for shelter, clothing, tools, food, and medicine from the land. Settlers raised oxen, cattle, horses, pigs, sheep, and chickens, and grew subsistence crops of vegetables, fruits, grains, and livestock feed, in addition to a few market crops. Farmers also cut timber for on-farm uses and to serve regional markets, and for charcoal production. Stones from clearing fields were used to build foundations, dwellings, barns, and outbuildings, and to build fences to demarcate crop fields and property lines, and to keep livestock out of cropfields and away from dangerous areas such as wetlands and precipices.[156]

By the 1830s, most of Kent's forests had been cleared.

Sheep farming and wool production started expanding in the region prior to the Revolutionary War (1775), when many colonists were motivated by patriotism to wear homegrown woolen clothing instead of clothing imported from England.[157] Demand increased further during the war because of the need to clothe

Maintenance work on a corbelled stone chamber. Photo © Beth Herr.

the military.[158] Carding, spinning, weaving, and knitting were first done in the home—in 1810, there were 95 looms in Kent homes, producing 20,000 yards of cloth.[159] Much of that work was shifted to water-powered mills with the introduction of carding machines (1793), power looms (1820s), and power knitting machinery (1830s).

In 1824-1828, federal duties on imported wool and wool cloth raised the price of domestic wool and led to an explosion of sheep farming here, throughout the Hudson Valley, and in much of the Northeast. Sheep pastures were expanded into previously forested areas, including rocky hillsides and summits where the soils were too poor for other kinds of agriculture. By the 1830s, most of Kent's forests had been cleared.

According to the 1845 county census, Kent's 143 farmers produced beans, turnips, wheat, rye, flax, buckwheat, potatoes, corn, oats, cattle, dairy cows, butter cheese, horses, hogs, sheep, and wool. The town had one distillery, five grist mills, six saw mills, two fulling mills, two carding mills, and two tanneries. The town also produced shoes, harnesses, saddles, and trunks made from cow and sheep hides.[160]

Corbelled Stone Chambers

A historical curiosity in Kent and elsewhere in Putnam County is the "corbelled stone chambers." These are structures with roofs of large stone slabs, and with stone side walls angled slightly inward. The age, the creators, and the original purposes of the chambers are unknown, and continue to be the subject of much speculation. Theories about the creators range from Native Americans of the distant past, Norsemen in the 10th century, Welshmen in the 12th century, and early European settlers. There are at least 62 of these structures in Kent and could be as many as 200 in all of Putnam County.

There was significant beef production in Kent in the early 1800s, but both beef and sheep farming had severely declined by 1875, and dairying took over as the predominant agricultural enterprise into the early 1900s. Bordens Condensed Milk in Brewster, established in 1860, took most of the milk produced in the eastern part of Putnam County, canned it, and later bottled it for the New York City market.[161] Milk production in Kent peaked around 1900, and then declined, due in part to New York City's purchase of many farms as well as imposition of new regulations to protect the water quality of their reservoirs. Fruit and poultry gained prominence in the early 1900s with the decline of dairy farming.[162] The Elgin Gilt-edged Cheese and Butter Factory at Farmers Mills closed in 1907, the Bordens plant in Brewster closed in 1917,[163] and most of Kent's dairy farms were gone by the 1920s.

Local residents reported that stills were operated on Mount Nimham in the Prohibition era, 1920–1933, taking advantage of springs and other water sources.[164] It is likely that there were stills at many other places in Kent during that period.

The US Department of Agriculture (USDA) 2017 agricultural census found that Putnam County had just 147 sheep, down from 172,000 at the height of the sheep boom in the mid-1800s. Looking at the forested landscape today, it may be hard to imagine that most of the land was open 100 years ago, and that agriculture was the major land use in Kent until about 1930.[165] The ecological consequences of forest loss over those two centuries were far-reaching, affecting Kent's soils, habitats, wildlife, and streams.

A robin on winterberry holly. Photo © John Kenny.

New York City Water

The burgeoning population in New York City, and outbreaks of cholera (1832) and other infectious diseases—due in part to contaminated well water—led the city to seek outside sources of drinking water for city residents. In 1865, New York City purchased 420 acres of land in Kent, and began construction of the dam for the Boyd's Corners Reservoir. The dam, which included stone quarried from the nearby hills, was completed by 1873 and the impoundment was filled by 1874.[166]

Then, in response to a drought in 1876–77, the NYS Assembly authorized New York City to take water from any lake in its watershed, so the city began buying up farms, residences, and commercial properties around White Pond and China Pond. In 1890, needing still more water, the city began construction on the dam for the West Branch Reservoir, which was completed in 1895. These reservoir projects entailed moving roads, houses, barns, churches, schools, and cemeteries. The water-powered mills in the way of the reservoir impoundments were submerged.

Because farms, other industries, and privies at private residences threatened to pollute the lakes and reservoirs that the city was using, the city imposed restrictions on those land uses. Farmers who could no longer operate within certain distances of the reservoirs and lakes had to sell their land at bargain prices. Some of the land was sold to the city, but some was sold to city dwellers for country homes, and to entrepreneurs who developed country clubs, resorts and other accommodations for vacationers, and lakeside residential communities. These changes further accelerated the transformation of Kent from a farming and industrial community, where the livelihoods of most residents was tied to the land and local natural resources, to a bedroom, vacationers', second-home, and retiree community where the sources of people's livelihoods are elsewhere.[167] The incremental abandonment of farms and, in some cases, conversion to other uses led to the slow return of forests in most parts of Kent. Anthropologist April Beisaw believes that, in these

Mallards in flight. Photo © John Kenny.

ways, the New York City water system is responsible for the transformation of the town from an agricultural to a forested landscape.[168]

The Town

The first road in Kent may have been built in 1744 during the French and Indian War, and the first reported European settlers arrived in the 1740s-1750s.[169,170] The Frederickstown Precinct, chartered in 1772, included what is today the Town of Carmel and parts of Patterson and Southeast. Carmel and Patterson split off in 1795, and the remainder was called the Town of Frederick. The name was changed to Kent in 1817, and a small part of Philipstown was transferred to Kent in 1877.[171]

In 1867, Kent was a town of dairy farms, mills, and mines, and much of the population was concentrated in seven named hamlets and villages: Boyd's Corners, Forshay Corners, Hazen Corners, Farmers Mills, Coles Mills, Dicktown, and Ludingtonville.[172]

The economic and cultural life of the town began to change after the 1870s when the NYS Assembly authorized New York City (NYC) to take water from upstate lakes. The city began buying up farmland around the lakes, and imposing new land use regulations on farmers and other landowners to protect the lake water quality. The regulations made farming more difficult according to the practices of the day. The encroachments of the NYC water supply system starting in the 1870s and the advent of steam power in the 1880s meant the end of most of the mills.[173]

As early as 1830, upstate vacationing was popular with NYC dwellers,[174] but development of resorts and promotion of second homes starting in the late 1800s further accelerated the process of converting farmland and farmhouses to non-farm uses. Roads that were built or improved by the city for better access to their water supplies helped to boost real estate prices and contributed to the shift from farming to other land uses.

Most of Kent's lakes were constructed by damming streams and sometimes by additional excavation; for example, Barrett Pond, Lake Carmel, China Pond, Lockwood Pond, Lake Nimham, Pine Pond, Sagamore Lake, Seven Hills Lake, Stump Pond, Lake Tibet, and Waywayanda Lake.[175] A few were created in the 1800s, presumably for water power, but more than half were created since 1931 (Table 2), presumably to attract lakeside residents and recreationists.

In addition to the land acquired by New York City around Kent's lakes and reservoirs, the State of New York started acquiring land for conservation and other purposes. Much of the land on Mount Nimham was purchased by the state in the early 1900s to create the Nimham Mountain Multiple Use Area. Wonder Lake State Park was established in the 1920s and Fahnestock State Park in 1931. Today approximately 38 percent of the town is owned by New York State or New York City, and an additional 4 percent has conservation easements or some other kind of permanent conservation status.

Route 52 was first paved in 1909, and by 1912 there were 50 miles of paved roads in Kent.[176] The Taconic Parkway was constructed through Putnam County 1932–35, and Interstate 84 in the 1960s. The increasing ease of travel made Kent that much more attractive for weekenders, vacationers, and even commuters to jobs in the city.

Many of the lakeside communities that were originally for weekend or seasonal use are now predominantly year-round residences. The hamlet of Lake Carmel, Kent's main population center, was established in the 1920s by a real estate firm that purchased and subdivided farms, dammed the Middle Branch Croton River, and excavated a former swamp to create the lake as an attractive amenity for a residential community.[177]

The Kent population has fluctuated over the years, from an early peak of 1,928 in 1830, to a low of 696 in 1920, to an all-time high of 14,009 in 2000. As of the 2020 census, the population had fallen slightly to 12,910 (Table 8).

Table 8. Town of Kent population, 1820–2020.

Data are from the US Decennial Census.

Year	Population	10-Year Change
1820	1801	-
1830	1928	+7.1%
1840	1830	-5.1%
1850	1557	-14.9%
1860	1479	-5.0%
1870	1547	+4.6%
1880	1361	-12.0%
1890	1147	-15.7%
1900	1026	-10.5%
1910	968	-5.7%
1920	696	-28.1%
1930	770	+10.6%
1940	1546	+100.8%
1950	2146	+38.8%
1960	3924	+82.9%
1970	8106	+106.6%
1980	12433	+53.4%
1990	13183	+6.0%
2000	14009	+6.3%
2010	13507	-3.6%
2020	12910	-0.1%

THREATS TO NATURAL RESOURCES

Streams, lakes, wetlands, upland habitats, wildlife, farmland, scenic areas, and recreation areas are subject to numerous direct and indirect threats from human activities that include the obvious, such as filling a wetland, or the less obvious such as septic system leachate entering a lake. They include threats that may go unnoticed for years until the effects become apparent, such as depletion of groundwater supplies due to incremental additions of impervious surfaces, or loss of bird populations due to forest fragmentation, human-subsidized predators, or use of pesticides. Climate change poses over-arching and wide-ranging threats to water supplies, agriculture, wildlife, and human health. Some of the threats from climate change and other sources are described below. Ways to reduce these stresses or improve ecosystem resiliency are described in the **Conservation of Natural Resources** section.

Climate Change

Some of the general threats posed by climate change are described here, and the more specific threats to water, biological resources, and agriculture are described in later sections.

Large rainstorms and snowstorms, ice storms, heat waves, and droughts have long been characteristic of the Northeast in general, but overall climate patterns remained fairly consistent since European settlement until the latter part of the 20th century.[178] The climate is now changing rapidly, and some aspects are changing more rapidly in the Northeast than in the rest of the US or the world.[179]

Climate change is significantly driven by emissions of greenhouse gases (GHGs) to the atmosphere—especially carbon dioxide, methane, and nitrous oxide—that trap heat near the Earth's surface and lead to global warming. The increased emissions are largely due to human activities, such as production, transport, and burning of fossil fuels for electrical power, heating, and powering motor vehicles; and the accumulated effects of many other activities, such as deforestation, emissions from agriculture, and burning of wood and other organic materials. If worldwide GHG emissions are lowered in the coming years, then the changes we experience will still be significant but reduced. But if emissions continue to grow at the current rate, these changes are likely to increase dramatically over the coming decades.

Climate Change vs. Global Warming

The two terms are often used interchangeably, but have different meanings.

Global warming is the long-term heating of Earth's surface, which has been observed since the pre-industrial period (between 1850 and 1900). It has been caused by human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere.

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional, and global climates. Changes observed in Earth's climate since the mid-20th century have been primarily driven by global warming. Natural processes, such as volcanic activity, changes in the Sun's energy output, and variations in the Earth's orbit, can also contribute to climate change.

(https://climate.nasa.gov/global-warming-vs-climate-change/)

The effects of global warming are likely to be felt more acutely in the coming years—larger and more frequent floods, higher temperatures, more severe droughts, more frequent and extensive wildfires and severe rainstorms, as well as some less dramatic symptoms such as increases in invasive pests; pathogens affecting humans, livestock, and wildlife; and depletion of native biological diversity.[180] Average temperatures in the United States are expected to increase between 3 °F and 12 °F by the end of this century, depending on whether the world's future greenhouse gas output follows a higher or lower trajectory.[181] Precipitation in New York is expected to increase in intensity during rainfall events and areas will experience more intense heat waves.[182] It is projected that today's rainstorm of a one-in-fifty-year intensity in this region will be the one-in-five-year intensity rainstorm of 2050.[183]

Much of the climate data in the discussion below is from the publication Responding to Climate Change in New York State—called the ClimAID report, published by the NYS Energy Research and Development Agency (NYSERDA),[184] and the Region 2 Climate Adaptation Implementation Plan.[185] The ClimAID projections for air temperature, precipitation, heat waves, sea-level rise, and flooding for the state through 2100 were developed with regional data in a global model used for the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report. Putnam County is in ClimAID Region 5 that encompasses the Hudson Valley counties east of the Hudson River and other areas.

Some additional information applicable to the Northeast in general is from the Fourth National Climate Assessment (NCA4), published in November 2018—a product of the US Global Change Research Program. The message in Chapter 18 of the NCA4, which applies to the northeastern US, is similar to that of the New York ClimAID report, except that the changes are happening more rapidly than predicted a few years earlier.[186]

Global air temperatures have been increasing for decades and temperature rise in the northeastern US has been much more rapid than national or global averages. In New York, annual average temperatures have risen 2 °F since 1970, and average winter temperatures have increased 5 °F. Higher temperatures are creating new problems for human health, agriculture, energy demand, and recreation, as well as for plants, animals, and habitats of natural areas. The average annual temperature in Putnam County is projected to increase approximately 3–7 °F by mid-century and upwards of 4–11 °F by the 2080s (Table 9).

Summer heat waves are expected to be more frequent, more intense, and lengthier. Even at the lowest projected rate of carbon emissions, Putnam County summers by 2100 could be similar to those of North Carolina today.[187]

In the northeastern US, precipitation has increased only slightly in recent decades but has become much more variable and more extreme. Precipitation patterns are difficult to predict, and the climate models are being continually refined on the basis

Table 9. Average annual air temperature and precipitation projections for ClimAID Region 5 (includes Putnam County), from the 2014 ClimAID report.

Baseline (1971–2000) = 47.6 °F

Period	Change in Average Annual Temp	Change in Average Annual Precip
2020s	+1.7 – 3.7 °F	-1 percent - +10 percent
2050s	+3.5 – 7.1 °F	+2 percent - + 15 percent
2080s	+4.1 – 11.4 °F	+3 percent - +17 percent
2100	+4.4 – 13.6 °F	-1 percent - +26 percent

Table 10. Projections of extreme events for ClimAID Region 5 (includes Putnam County), from the 2014 ClimAID report.

Period	Events	Baseline (1971–2000)	Low Estimate (10th percentile)	Middle Range (25th – 27th percentile)	High Estimate (90th percentile)
2020s	Days over 90 ºF	10	22	27 – 41	50
	No. of heat waves	1	3	4 – 6	7
	Duration of heat waves	4 days	5	5 – 6	6
	Days over 1" rainfall	10	10	11 – 12	13
	Days over 2" rainfall	1	1	1 – 2	2
2080s	Days over 90 ºF	10	27	35 – 70	82
	No. of heat waves	1	4	5 – 8	9
	Duration of heat waves	4 days	5	5 – 7	9
	Days over 1" rainfall	10	10	11 – 13	14
	Days over 2" rainfall	1	1	1 - 2	2

of up-to-date regional data, but models predict that total annual precipitation could increase as much as 15 percent by 2050 and 26 percent by 2100 (Table 10). The models also project more droughts, heavier rains in the intervening periods, and reduced snow cover in winter.[188]

Periods of drought are predicted to become more frequent and more severe in New York. Droughts can threaten local drinking water supplies, crop production, and livestock, and can severely stress aquatic communities of streams and ponds, as well as plants and wildlife in upland and wetland habitats. Droughts can extend the low-flow period of streams and further stress the fish and other organisms that may already be suffering from pollution, warmer stream temperatures, and artificial stream barriers. Drought may become a long-term concern for agriculture and could threaten drinking water supplies in Kent, including both the groundwater wells for Kent residences, and the surface water reservoirs that serve New York City. In a higher-emissions scenario, long-term droughts (longer than three months) that now occur every 20–30 years could occur every 6–10 years.[189]

Wetlands with perennially-saturated soils develop deep layers of peat (decaying organic matter) that continue to accumulate over hundreds and thousands of years if the wetland hydrology and vegetation remain intact. Due to this capability for peat accumulation, wetlands have the greatest capacity of any ecosystem for long-term carbon storage, and are believed to hold 20–30 percent or more of the total stored organic carbon in the Earth's soils.[190] But the drying of wetlands due to a warmer climate and longer and more frequent droughts could result in large releases of carbon to the atmosphere, further exacerbating the conditions for global warming. Although both intact and disturbed wetlands can also be large sources of methane emissions to the atmosphere (methane is the third most important greenhouse gas), those emissions are far outweighed by the carbon storage services of an intact wetland.[191]

More frequent and intense heat waves pose threats to human health, agriculture, and native plants and animals, and are likely to alter many aspects of the natural landscape. Warmer, shorter winters are predicted to increase the occurrence of rainfall while the ground is frozen, which has numerous implications: hastening snowmelt, reducing groundwater recharge, heightening the likelihood of flooding, and increasing the frequency and consequences of drought. Warmer winters with less snow will alter the habitat suitability for native plants and animals. The frequency of extreme precipitation will continue to increase and may dramatically affect the quality and quantity of water supplies as well as the plants and animals of upland, wetland, and aquatic habitats. Alterations to air temperatures, snow cover, and freeze/thaw patterns are likely to disrupt the seasonal synchrony between pollinators and plants and between predators and prey. Warming temperatures are likely to significantly affect the composition and distribution of habitats and wildlife and force many species to migrate to cooler parts of the landscape, to more northern latitudes, or to higher elevations as former habitats become unsuitable.

Climate-related changes in weather patterns and their impacts on air quality, water quality, and the incidence of vector-borne diseases are already affecting the health and well-being of the people of this region.[192] While everyone will be affected to some extent, many of the health effects of climate change fall disproportionately on the poor, the elderly, the very young, the disabled, and the uninsured. The northeastern US is projected to experience the largest increases in heat-related mortality in the country, for example, particularly among vulnerable populations.

Threats to Water Resources

Human activities on the land have been changing the character, habitat quality, and water quality of streams, lakes, ponds, and wetlands for centuries—by obstructing stream flows, altering patterns and volumes of surface water runoff, increasing soil erosion and siltation of streams, altering surface water temperatures, reducing groundwater infiltration, and contaminating surface water and groundwater. These threats continue today, and climate change is both exacerbating those stresses and adding new ones.

Groundwater

Groundwater can be depleted by reducing recharge from the ground surface (e.g., by expansion of impervious surfaces such as pavement and roofs) and by excessive groundwater withdrawals (e.g., for industrial processes or commercial products or from crowded wells in residential areas). The last could become a more common problem in the more densely-settled areas of Kent with the increasing frequency and severity of droughts predicted by climate scientists.

Groundwater is vulnerable to point source and non-point source pollution such as applications of fertilizers and pesticides to lawns and farm fields, nitrates, phosphates, and bacteria from septic systems, de-icing salts from roads and driveways, and volatile polluting substances, such as organic compounds from leaks and improper disposal of petroleum and other fluids. Groundwater is especially vulnerable to pollution in areas of coarse-textured soils (sand, gravel).

The most significant potential sources of groundwater contamination in Kent may be from lawn and garden applications of fertilizers and pesticides, leaking fuel storage tanks, and storage and applications of road salt. Other possible sources are from wastewater discharges (e.g., from crowded, failing, or institutional septic systems) and from inactive mines. Unfortunately, a small volume of a harmful substance can contaminate a large volume of groundwater and, once contaminated, groundwater can be very difficult and costly to clean up.[193] All of Kent residents and businesses obtain their drinking water from groundwater wells, so the quality and quantity of groundwater should be of great concern to residents, businesses, and town agencies.

Surface Water

Adding impervious surfaces (roads, driveways, parking lots, and roofs) usually reduces groundwater infiltration and increases surface runoff, leading to erosion of streambanks and siltation of stream bottoms, degrading stream habitat quality and water quality, and reducing the base flows of streams. Furthermore, runoff from impervious surfaces is often polluted (e.g., with petroleum, heavy metals, and salts) and can also raise the water temperature of nearby streams, leading to reduced levels of dissolved oxygen and degraded habitat for sensitive stream organisms.

Clearing vegetation and disturbing soils on steep slopes or in areas of shallow soils (e.g., during construction of roads, driveways, or houses) often increase the surface runoff of precipitation and snowmelt, leading to erosion of soils, and destabilization and siltation of nearby streams. The consequences are reduced groundwater recharge, soil loss, and degradation of stream habitats for fish and other stream organisms. Stormwater management measures employed at development sites are often inadequate to restore and maintain the patterns, volumes, and quality of surface runoff and groundwater recharge that occurred prior to development.

Roadside ditches often carry contaminants such as motor oil, heavy metals, road salt and other de-icing chemicals, sand, and silt into nearby streams and wetlands. Applications of fertilizers and pesticides to agricultural fields, lawns, and gardens can degrade the water quality of groundwater and streams and alter the biological communities of streams, wetlands, and ponds. Leachate from failing septic systems often introduces elevated levels of nutrients, especially phosphorus and nitrogen compounds, into streams, lakes, and ponds, leading to a cascade of effects on water chemistry, biota, and whole aquatic ecosystems. A Dutchess County, NY, study found that the amount of nutrients and sediments entering a stream is affected by the amount of development within 300 feet of the stream.[194] Streams, lakes, and ponds are also subject to atmospheric deposition of substances such as sulfur dioxide, mercury, and nitrogen from fossil-fuel-burning power plants in the Midwest and nitrogen compounds from distant agriculture.[195]

Removal of shade-providing vegetation along a stream or pond shore for landscaping or other purposes can lead to elevated water temperatures and can severely impact the aquatic invertebrate, amphibian, and fish communities that depend on cool environments. Clearing of vegetation and conversion of riparian areas to developed uses can also reduce the important exchange of nutrients and organic materials between the stream and the floodplain, diminish the capacity for flood attenuation, and increase downstream flooding.

Forested land is very effective at facilitating the infiltration of rainwater and snowmelt to the soils, thus making the water available for uptake by vegetation, for recharging the groundwater, and for slowly feeding streams, lakes, and ponds. Clearing of forests can greatly reduce infiltration to the soils and increase the rapid runoff of surface water. This leads to “flashy” streams that run at high volumes during runoff events and then dry up at other times because groundwater is unavailable to feed the base flow.

Climate Change and Water

A warming climate is expected to affect both the quantity and quality of Kent’s groundwater and surface water resources, as well as the habitat quality of streams and ponds. Both total annual rainfall and rainstorm intensity are predicted to increase in New York in the coming years, with multiple consequences to the land, water resources, and agriculture.

The “100-year flood zone” shown on maps created by FEMA is the area that, based on historical flood data, is deemed to have a one percent chance of flooding in any given year. The FEMA flood zone maps for Kent (Figure 9) are based on past flood data, and the extent of flooding hazards may increase due to the increasing intensity of large rainstorms. Although flood zones have been mapped for very few areas in Kent, many other streamside areas are also subject to flooding during large storms and thaws.

The magnitude of flooding at any location will depend on the timing and intensity of large storms and the condition of the land—the ability to absorb large water volumes at the time of the storm—as well as the structures or other obstacles in the flood zone that may act to divert, concentrate, and accelerate flood flows. Large floods can damage roads, bridges, and other infrastructure, destroy agricultural crops, wash away topsoil, carry pollutants and large volumes of sediments into streams, and damage or destroy buildings and other structures in the flood zone. Much of the water volume from large rainfall or snowmelt events will run off quickly into streams and be unavailable for recharging groundwater. Large rainfall and snowmelt events will also put greater pressure on Kent's dams, some of which are already in a hazardous conditions (see Table 3).

More extended and more frequent droughts are also predicted[196] and are likely to affect drinking water wells as well as streams, other natural habitats, and native plants and animals. More extreme floods and droughts, as well as increases in water temperatures, are likely to adversely impact populations of trout and other sensitive stream organisms that rely on cool, clear streams and unsilted stream substrates.

Threats to Biological Resources

The plants and animals of upland forests, meadows, shrublands, and other habitats are subject to many of the threats to water resources outlined above. Additional threats include habitat loss and degradation of habitats, over-harvesting, non-native pests, and diseases, and numerous effects of global warming.

Habitat Loss

Loss of habitat occurs when new roads or residential, commercial, or industrial development eliminates former meadow or forest habitat, for example, or when wetlands are drained, filled, or converted to ornamental ponds. Local, state, and federal laws provide limited protection to certain wetlands and streams and the habitats of listed rare animal species, but most upland (i.e., non-wetland) habitats and many small or isolated wetlands lack any legal protection and are especially vulnerable to loss. The local or regional disappearance of a habitat can lead to the local or regional extirpation of species that depend on that habitat.

The full consequences of the loss of particular species or habitats are unknown, but each organism plays a particular role in maintaining its biological community, and the maintenance of each community at the regional scale enables ecosystems to withstand stresses and adapt to changing environmental conditions.

Habitat Degradation

Less obvious but more insidious than direct loss of habitat is the problem of habitat degradation, which can occur by many mechanisms and have consequences that are often invisible in the near term.

Habitats that are not entirely lost to other uses can nonetheless be severely degraded by chemical or thermal pollution, sedimentation, and other direct and indirect disturbances such as trampling, cutting, nighttime lights, noise, invasive species, and fragmentation. These can alter the biological communities, ecological functions, and ecosystem services of the habitat and lead to local disappearance of sensitive species of plants and animals.

Habitat Fragmentation

Habitat fragmentation occurs when an intact habitat area is split by a road, driveway, yard, utility corridor, or other feature, dividing it into smaller sections. The subdivision of a large meadow or a large forest into residential lots (and subsequent development), for example, results in smaller habitat blocks that may be unsuitable for the "area-sensitive wildlife" species that require large habitat areas and are sensitive to human contact or disturbances. Fragmentation of large forests into smaller blocks increases the area of forest "edge" habitat where there are higher light and noise levels and drier conditions, and where invasion by non-native plant species and by predators such as raccoons and domestic cats is more likely. Fragmentation makes the formerly deep interior forest areas newly accessible to songbird nest predators (such as raccoon) and brood parasites (such as the brown-headed cowbird) whose activities are ordinarily confined to open areas and forest edges. Roads and other developed areas dividing forests can also act as significant barriers and hazards to wildlife movement, and many animals avoid breeding near human activities.

The "edge effects" of human disturbance (from roads, residential areas, and other development) can reach well over 300 feet into forest patches.[197] A road or driveway through a large meadow can similarly reduce the habitat values of the meadow for grassland breeding birds, making the formerly deep interior meadow areas newly accessible to nest predators and other disturbance.

Many species of wildlife require more than one habitat to fulfill their life history needs, and some species are far-ranging, with territories or movement areas spanning hundreds or thousands of acres. The fragmentation of habitat areas inhibits the movement of wildlife across the landscape. For some wildlife, the fragmenting features (roads, driveways, fences, walls) can disrupt their travelways and render critical parts of their habitats inaccessible or expose them to mortality from vehicles, predation, or desiccation.

Another kind of habitat fragmentation occurs along streams where dams, culverts, or bridges interrupt the continuity of stream habitats. From headwaters to mouth, a stream is a continuous ecosystem dependent on free movement of nutrients, organic detritus, sediments, and animals. Many of our fishes need different parts of a stream for feeding, spawning, nursery areas, drought refuge, shelter from predators, and overwintering. They need access to cool pools in summer, deep pools in winter, suitable substrates for spawning, and shallow nursery areas inaccessible to predators. Invertebrate drift from upstream reaches can also be essential to maintaining fish populations. Similarly, invertebrates, amphibians, reptiles, and other animals need to move freely to take advantage of various stream habitats and materials in different life history stages, seasons, and stream conditions.

Dams are an obvious impediment to these movements, but bridges and culverts, if improperly sized, designed, and installed, can also act as partial or total barriers, severely altering stream flows and disrupting the stream ecology. Culverts that are suspended above the stream bottom prevent the movement of organisms and materials. Undersized bridges or culverts disrupt natural flow patterns, causing upstream impoundment during flood events and increasing downstream velocities, often leading to streambed scouring and bank erosion, as well as damage to bridges, roads, and other infrastructure. These are widespread causes of degraded stream habitats that have led to the loss of whole populations of fish unable to navigate those barriers or tolerate the habitat alterations.

To accommodate floodflows and the movement of stream organisms, a culvert should be large enough so that stream flows are unimpeded, even during flood events, and the lower invert should be buried in the stream bottom so that water depth and substrate are similar within and outside the culvert. Additional information on sizing, design, and installation of culverts and bridges can be obtained at http://www.dec.ny.gov/permits/49066.html.

Over the last several years the North Atlantic Aquatic Connectivity Collaborative (NAACC) has partnered with state and county agencies to identify culverts that are too small to carry expected floodflows or are suspended above the streambed. The culvert survey results are provided to local, county, and state agencies to help them prioritize culverts for replacement or retrofitting so that stream continuity is restored and risk to infrastructure is reduced. Many of the culverts have been identified and mapped, but few have yet been assessed in the NAACC program. Figure 11 shows the locations of barriers identified so far on Kent streams.

Maintaining habitat connectivity is critical not only for the routine movement of organisms between habitat areas, but also for maintaining genetic exchange among distant populations and facilitating the migration of species under deteriorating environmental conditions or climate change. Species that *are* able to cross human-created barriers (such as roads) face greater mortality risk from vehicles and predators. Populations of species that are unable to cross barriers such as roads, walls, dams, or culverts, and thus are restricted to smaller habitat patches, may become genetically isolated and face local extirpation. Maintaining broad connections between habitat areas can ensure that the habitat, migration, and behavior requirements of many native plant and animal species are conserved across the landscape.

These days, a primary cause of ongoing habitat fragmentation in the region is rural sprawl—low-density development that occurs outside of population centers such as hamlets or villages. Kent has few recent instances of large residential subdivisions where a property is broken up into 20 or more house lots. Instead, the main pattern of new development is of single houses on approved lots, or subdivisions of 2–4 residential lots in a rural setting. The fragmentation of habitats is most severe when each lot is designed with the house located at the end of a long driveway. Utility corridors, roads, and even walking trails can have a similar fragmenting effect when located in an otherwise intact habitat area. Affluence, contemporary tastes, and today's engineering capabilities have led to more houses being built in places that were previously inaccessible or deemed unsuitable—such as hilltops, steep areas, and areas with shallow soils, where environmental damage is often greater.

Other Threats to Habitats

Forest habitats can be degraded in many ways besides fragmentation. Clearing the forest understory to create an appealing, park-like landscape destroys habitat for birds such as wood thrush,† which nests in dense understory vegetation, and hermit thrush, black-and-white warbler† and ovenbird,† which nest on the forest floor. Removal of native shrubs can also be an invitation to non-native invasive shrubs and forbs. Removal of mature and especially large trees eliminates habitat for lichens, fungi, and bryophytes, as well as the many kinds of animals that use cavities or that forage in and around large and decaying trees. Soil compaction and removal of dead and downed wood and debris eliminates habitat for mosses, lichens, fungi, birds, amphibians, reptiles, small mammals, and insects. Logging can damage the forest understory and cause soil erosion, compaction, and rutting, and sedimentation of streams. The soil disturbance, opened canopy, and introduced propagules carried by skidders and other equipment often leads to establishment of non-native invasive plants in previously uninfested areas. Human habitation in fire-prone forests leads to the suppression of naturally-occurring wildfires, which can be important for some forest species and the forest ecosystem as a whole. Threats from recreational uses of forests are described in the **Impacts of Recreation** section.

Crest, ledge, and talus habitats (including rocky barrens) often occur in locations that are valued by humans for recreational uses, scenic vistas, communication towers, and even for house sites. Construction of trails, roads, and houses destroys crest, ledge, and talus habitats directly, and causes fragmentation of these habitats and the forested areas of which they are often a part. Rare plants of crests are vulnerable to trampling and collecting; rare snakes are susceptible to road mortality, intentional killing, and collecting; and rare breeding birds of crests are easily disturbed by human activities nearby. The shallow soils of these habitats are extremely fragile and susceptible to erosion from construction and logging activities and from foot traffic and all terrain vehicles (ATV) traffic. The specialized biological communities of rocky barrens are maintained by occasional wildfires, but such fires are suppressed where they occur near houses, barns, and other vulnerable structures. The scarcity of fires enables other, less-specialized forest species to colonize these areas and leads to the loss of the unusual communities especially adapted to the rare barrens habitats.

Mowing of large upland meadows (10+ acres) during the bird nesting season (April – August) can cause extensive mortality of eggs, nestlings, and fledglings of ground-nesting grassland birds. Mowing of oldfields early or late in the season can deprive the early- and late-flying native bees and other pollinators of important nectar and pollen sources at critical periods in their life cycles. Another threat to upland meadow habitats is the soil compaction and erosion caused by use of ATVs, farm equipment, and other vehicles, which can harm the soil structure and reduce the habitat value for invertebrates, small mammals, nesting birds, and nesting turtles.

Light pollution creates big ecological problems around developed areas. Night lights can disorient, repel, attract, entrap, or kill a wide range of organisms including moths, fireflies, other insects, birds, frogs, and fish. They can reduce reproductive success of birds and amphibians, disrupt communication between animals, disrupt bird migration, and interfere with predator-prey relationships.[198] Lights are very disruptive to the wildlife that depend on darkness for hunting and shelter, and for whom lights trigger certain metabolic or behavioral reactions. Light pollution has been associated with huge reductions in local insect populations, and is a significant contributor to worldwide insect declines.[199,200]

Where outdoor lights are needed, their impacts on wildlife will be reduced if the lights are motion-activated, shielded and directed downward (instead of outward or upward), and they use insect-friendly light technology. LED lights that are filtered to be yellow or amber attract many fewer flying insects than blue or ultraviolet lights. The website of the International Dark Sky Association provides other information and tips for preventing or minimizing light pollution.

Pollution of air, water, and soils can come from a variety of sources, including farmland, lawns, septic systems, industry, roads, and vehicles.

Invasive Species, Insect Pests, and Diseases

Disturbances to soils from forest clearing and the construction of new houses and roadways, as well as domestic plantings in yards and gardens, often result in the spread of non-native invasive plant species. Establishment of many of these plants is favored by soil disturbance and unshaded conditions, and seeds and vegetative propagules of invasives are often transported by vehicles and earth-moving machinery from one site to another. Non-native species such as common reed, reed canary-grass, Japanese stiltgrass, Japanese knotweed, purple loosestrife, multiflora rose, Bell's honeysuckle, Japanese barberry, and tree-of-heaven are now widespread in Kent but are most concentrated in areas in and near developed land and disturbance. Land development has the potential to promote the spread of these species into many high-quality habitats and reduce the overall value of those habitats to native biodiversity.

Land development often spreads invasive plant species into high-quality habitat areas.

We have many native species of submerged aquatic plants, such as pondweeds, watermilfoils, naiads, and bladderworts, which are important components of pond and lake ecosystems. Non-native submerged aquatics such as Eurasian watermilfoil and curly-leaf pondweed have been introduced to many of Kent's lakes and, where nutrient levels are high (usually due to leachate from septic systems and fertilizer-laden runoff), the populations of non-natives often explodes. Over-abundant aquatic weeds displace native species of plants and animals, choke waterways, and disrupt other aspects of the lake ecology.

Beech Leaf Disease

Bill Buck and Beth Herr

Beech leaf disease is now everywhere in Kent. It causes the leaves of affected trees to wither, wilt, and quickly die. The foliar nematode *Litylenchus crenatae* ssp. *mccannii*, which is responsible for the disease, was first detected in southwestern Connecticut in 2019. Additional stresses such as drought, winter injury, twig/branch cankering fungi (e.g., *Phomopsis*, *Botryosphaeria* and *Diplodia*), ambrosia beetle infestation, and other insect pests and pathogens may be accelerating the decline of infested trees. In the few years of the Kent biodiversity surveys, the incidence and effects of the disease have exploded and already the beech forests are noticeably in decline. It will be important to see what replaces the American beech, *Fagus grandifolia*, on our cool, moist forest slopes.

Non-native invasive species often lack significant predators, consumers, and diseases in their new environments, enabling them to outcompete native species for limited resources or space, resulting in the decline of native biological diversity.

The changing climate conditions may allow some insect pests and insect disease vectors to complete more generations per season and allow greater winter survival.[201] Pathogens that are encouraged by less-severe winters will take advantage of the weakened condition of trees and other plants stressed by rising temperatures and droughts. Forest pests such as the hemlock woolly adelgid, the emerald ash borer, spotted lanternfly, beech leaf disease, and the oak wilt disease fungus are likely to transform our forest communities with wide-ranging ecosystem consequences. The emerald ash borer has already killed many of Kent's ash trees. Certain invasive plants such as mile-a-minute-weed are expected to thrive under elevated atmospheric levels of carbon dioxide.[202] Although the longer growing seasons may increase overall forest productivity, increases in pests and pathogens may cancel out the potential benefits to the timber industry.

Only four species of earthworms are known to be native to the Northeast.[203] Most of the earthworms we see in our lawns, gardens, meadows, and forests were imported, intentionally and not, from other places, starting with European settlers who brought plants (with soils) from home. European earthworms may also have been present in soils used as ship ballast. Introductions of worms continues through the present with the importation of horticultural plants

Healthy beech leaves and nuts (left) and the characteristic striped appearance of leaves infected with the beech leaf disease (right). Photos © Beth Herr.

from around the world and from other parts of North America, the transport and sale of worms for vermiculture and fishing bait, and probably in vehicle treads and by other inadvertent means.

While non-native earthworms have been highly valued by farmers and gardeners because of their ability to aerate soils and speed up nutrient cycling, those same actions can damage the soils, soil life, and plant communities of forests. The biota of our forest soils have adapted to slow decomposition of organic matter and slow processing of nutrients, which allows the accumulation of a deep layer of organic duff—leaves, twigs, and other organic debris in various stages of decay—on the soil surface. The duff is an important habitat component for vertebrates, invertebrates, fungi, and microbes of the forest floor, and helps to prevent soil erosion, maintain soil moisture, and provide nutrients for woody and herbaceous plants, soil biota. When earthworms are introduced to forest soils, they rapidly consume the organic duff, leaving bare soil that is no longer suitable for many native wildflowers, tree seedlings, ferns, fungi, ground-nesting or foraging birds, and amphibians.[204]

A Michigan study found that earthworm infestations were associated with crown die-back of sugar maples, perhaps because the loss of organic duff exposed these shallow-rooted trees to desiccation.[205] A recent arrival in New York, the snake worm or jumping worm (*Amynthas* spp.), is an especially large and voracious earthworm, and its parthenogenic reproduction allows a single adult to initiate a large local population. An infestation can remove the forest duff, alter the soil structure and chemistry, and create a forest floor habitat inviting to non-native plants such as garlic-mustard and Japanese stiltgrass.[206,207]

Human-Subsidized Wildlife

Human-caused changes to the landscape alter habitats and animal communities, favoring those species most adapted to open landscapes, small habitat patches, and human presence. For example, Canada goose, white-tailed deer, raccoon, and gray squirrel thrive in agricultural and residential areas and, when overabundant, cause cascades of ecological changes.

Human uses directly and unintentionally offer "resource subsidies" by providing food (such as household garbage, food or agricultural waste, stored feed, livestock, and pets) and winter shelter or den sites (such as attics, basements, barns, and sheds), as well as intentionally by feeding birds and other wild animals. Native mammals that benefit from these subsidies include white-footed mouse, squirrels, and mesopredators including raccoon, Virginia opossum, striped skunk, and eastern coyote. Populations of these mammals are often large around human settlements, and can have negative effects on populations of other wildlife and on humans.

Many wildlife species that do well around human habitation prey on songbirds and reduce their nesting success.

Many of the wildlife species that have become abundant in our residential and agricultural landscapes are "generalist scavengers" that also prey on songbirds. Some of these nest predators are American crow, blue jay, common grackle, raccoon, eastern gray squirrel, red squirrel, and Virginia opossum—as well as hawks and owls. In rural landscapes, songbird nest failure has been shown to increase with the abundance of potential nest predators.[208]

Eastern coyote successfully and rapidly colonized eastern North America starting in the early 1900s, due to the expansion of its preferred habitat (a mosaic of open, shrubby, and forested land), the extirpation of its main competitor, the eastern wolf, a growing population of white-tailed deer, and human-provided resource subsidies. Coyotes may cause declines in bobcat and red fox populations, and they sometimes prey on livestock. But they are also valuable as the only non-human predator that regularly preys on deer, and they help control deer populations where winter weather is severe.[209]

Raccoon populations have expanded rapidly in the Northeast since the 1930s, and often achieve the highest densities in urban and suburban areas, but they also thrive in rural residential and agricultural settings. They cause considerable agricultural damage, are a commonly reported nuisance in residential areas, spread disease, and depredate waterfowl, songbirds, other birds, and turtles. Striped skunk and Virginia opossum are also numerous in rural and urban areas, although less so than raccoons, and all three species use similar food resources and den sites. These mesopredators are vectors for numerous viruses (including rabies and canine distemper) and parasites, which affect other wildlife, pets, and humans. They also have large ecological influences on populations of their various prey species and of other carnivores.[210]

The brown-headed cowbird is a native blackbird that originally occurred only in the open grasslands of the central and western US and Canada but moved east as the forested land was cleared by European settlers; it now inhabits most of North America. It makes no nest of its own, but lays its eggs in the nests of other species. The eggs are early to hatch and the nestlings quick to develop, outcompeting the young of the host species for food. The cowbird frequents open areas and forest edges, thus benefiting from forest fragmentation. It has been implicated in the decline of many songbird species in the Northeast.

Brown-headed cowbird. Photo © John Kenny.

Feeding birds has been shown to increase local population sizes in some of the songbirds that consume birdseed, although the effect may be due to immigration, leaving the overall population unchanged. Provisioning may either increase or reduce the breeding success of these birds, depending on the species and situation. Feeding birds can increase nest predation on songbirds by increasing populations of the nest predators mentioned above.

Feeding large animals such as deer and bear leads to more frequent aggressive encounters and the need to remove problem individuals.[211] Domesticated cats and dogs, whether feral or pets with access to the outdoors, pose serious threats to wildlife. Cats kill up to four billion birds and 22 billion mammals annually in the US. Free-ranging dogs kill fewer individuals but often chase or injure other animals. The presence of cats or dogs can cause wild species to shift their ranges, exhibit physiological or behavioral changes, or have reduced reproductive success. Rabies, canine distemper, and other viruses and parasites are regularly transmitted from pets to wildlife via contact or feces.[212]

The white-tailed deer is native to this region and has been a part of our forest ecosystems since long before European arrival on this continent. The present-day over-population of deer, however, has severely affected our forest communities. The reasons for the large population are many: for example, extirpation of major predators—eastern wolf and eastern cougar; abundant food sources in our cropfields, roadsides, lawns, and gardens; decline of subsistence and recreational deer hunting; and expansion of human-settled areas where deer are partially shielded from hunters and predators.

Selective browsing by deer prevents the regeneration of many of our forest tree, shrub, and wildflower species, and encourages infestations of non-native plants.[213] Deer herbivory on native understory herbs and shrubs (and perhaps non-browsing effects from deer, such as litter disturbance, soil compaction, and changes in soil chemistry) also promotes the invasion and spread of some non-native plants such as garlic-mustard and Japanese barberry, although palatable non-natives such as multiflora rose and Eurasian honeysuckles may be kept in check by deer in some situations.[214,215]

Excessive deer herbivory also affects breeding bird communities, invertebrates that depend on understory plants, squirrel populations (which in turn affect bird nesting success), and tick abundance and the prevalence of tick-borne diseases.[216] For example, where deer are more abundant, songbirds that use understory foliage—such as white-eyed vireo, hooded warbler, and prairie warbler—are less abundant.[217] Deer also cause agricultural losses, collisions with vehicles, and damage to home gardens and landscaping.[218]

Today the population of white-tailed deer is at a pestilential level throughout the region, but reducing the population to a reasonable level has been an intractable problem. Should successful control measures eventually be discovered, a prudent goal would be to foster and maintain a modest, self-sustaining deer population that matches the carrying capacity of the land.

Impacts of Recreation

Outdoor recreation is of great value to the residents and visitors of Kent, and may be how most people of the town recognize their connection to natural resources. Outdoor recreation can increase our understanding and appreciation of the natural world; improve our physical and mental health; and promote family and community bonding. Use of public-access lands seems to have increased significantly during and since the Covid-19 pandemic of 2020–2022, when people gained a new appreciation for all the nearby opportunities.

The great extent of publicly-held lands with public access is a huge environmental and recreation asset for the town. Although management of most of those lands is in the hands of state agencies or New York City, Kent residents and second-home owners do control the uses and management of their own land, and those with year-round or vacation homes along the shores of lakes and reservoirs directly influence the condition of the waterbody by their treatment of the land.

Although the goals of land management for recreation and for biodiversity conservation are sometimes compatible, the use of natural areas for recreation inevitably comes with environmental costs. Many of the impacts can be anticipated by land managers, however, and mitigated by appropriate planning, design, and management techniques.

Trails for biking, ATVs, snowmobiling, horseback riding, hunting, and even walking can be disruptive to plants and wildlife. Noise and pollution from motorized vehicles can disturb wildlife and harm forest habitats. Even quiet, non-consumptive recreation such as hiking or birdwatching during the breeding and nesting season can disrupt the courtship behavior of adult birds and lead to abandonment of eggs or nestlings, eventually skewing natural communities in favor of disturbance-tolerant species.[219] Trampling and vehicle use can damage vegetation, reduce organic duff, and cause compaction and other changes to soils. These in turn can change plant communities along trails and other trampled areas, promote the introduction and spread of non-native plants, and alter patterns of surface runoff in ways that increase erosion and stream sedimentation. Trails provide an avenue into forests for non-native invasive plants, and trails that create an open canopy over the trail can invite nest predators and brood parasites into the forest interior. Walking trails located near the forest edge instead of the interior, however, cause much less disturbance to the sensitive forest-interior wildlife species.

Campsites cause similar disturbances, in addition to the effects of firewood collection, campfires, and improper waste disposal. Intentional or unintentional feeding of wildlife contributes to the dominance of subsidized species at the expense of others, changes ecological relationships, facilitates the spread of diseases, and increases the likelihood of nuisance behavior or attacks on people.

Noise and light pollution associated with recreation activities have greater ecological effects than most people realize. See the discussion of the effects of artificial night lighting on wildlife in the **Threats to Biological Resources** section above. Anthropogenic noise alters behavior, reduces habitat quality, and causes physiological impacts across a range of species. Noise levels that are annoying to humans (40–100 decibels [dB]) also disturb wildlife, and negative health effects occur in both humans and wildlife when levels exceed 52–80 dB. (For comparison, a floor fan can produce about 50 dB, an air conditioning unit 60, conversation 65, a lawn mower 90). At these levels, which are well below ATV or motorboat noise, birds, bats, and frogs have been found to suffer effects such as changed vocalization patterns, difficulty locating mates, reduced reproductive success, and altered abundance, distribution, physiology, and development.[220]

Trails and campsites may be especially damaging when located in riparian zones (contributing to sedimentation, elevated phosphate concentrations, and *E. coli* in streams), on rocky ridges or other places with shallow soils, and near other fragile habitats or near easily-disturbed species of conservation concern (e.g., nesting raptors or great blue heron). In general, a trail represents a linear corridor of disturbance, but the “area of influence” in the vicinity of the trail may extend 300–1000 feet or more from trails in open areas, and shorter distances in forest.[221] Mountain biking can be more disruptive to the environment than hiking in several ways. The speed of bikes makes it easier to startle animals; creation of “rogue trails” is part of the thrill-seeking and conquest culture of mountain biking; and new bike technology continues to expand the accessibility of more difficult (and often more sensitive) terrain. Motorized vehicle use on trails and access roads usually has larger impacts than other uses, in terms of soil disturbance, vegetation damage, noise, air and water pollution, and disturbance of wildlife.[222] But for some animals such as nesting raptors, a pedestrian can cause more disturbance than a vehicle.

Spent bullets and lost fishing tackle are significant sources of lead released to the environment. Water birds often eat lead tackle, which can cause morbidity and death. Lead bullets fragment on impact, resulting in an average of 235 fragments in an animal carcass and 170 in the viscera. Scavenging birds such as eagles, vultures, and ravens can accumulate sufficient lead during the hunting season to suffer neurological effects and mortality. The sale of lead fishing tackle is now prohibited in the state, but the use is still legal in New York waters as of 2023. The sale and use of lead ammunition is also allowed. Lead-free bullets and fishing tackle are available but still not widely used in most parts of the US.[223]

Additional effects on aquatic systems are associated with water-based recreation. Non-motorized boating may have the least impact on aquatic communities, but even canoeing can cause stress responses in fish, waterfowl, wading birds, and other wildlife. Swimming can introduce chemicals from sunscreens, soaps, and cosmetics, affecting invertebrates; and swimmer presence may change the behavior and physiology of turtles and fishes. Recreational fishing and stocking of non-native fish can severely affect native fish populations as well those of their prey and predators, lowering overall diversity, transmitting fish diseases, and introducing excess nutrients, invasive aquatic species, and earthworms (from bait).[224]

Motorized watercraft use and shoreline development cause by far the greatest problems for the water quality and ecological integrity of streams and lakes. Engine noise, wave action, suspension of sediment, spilled and leaked fuel and engine oil, and destruction of aquatic vegetation are the main sources of damage from gasoline-powered craft. They can pollute water, change behavior and communication in fishes, kill fishes and turtles, disrupt bird nesting, and disperse invasive plant species—resulting in the disruption of food webs and a decline in diversity of plants and animals.[225] Land development or other significant disturbance to the riparian or shoreline vegetation can interfere with migration and behavior of animals that regularly use both aquatic and terrestrial habitats. Failing septic systems and fertilizer-laden runoff from lawns often lead to over-abundant algae and aquatic weeds in lakes and ponds, which can be harmful to the pond ecology and nuisances for recreation, and can lead to Harmful Algal Blooms (HABs) which may be toxic to humans and animals.

Opportunities for public outdoor recreation are highly valued by Kent residents and visitors, but the conservation challenge is how to protect habitats, natural communities, wildlife, and water quality while maintaining high-quality recreation opportunities. Some ideas for blending recreation with natural resource protection are described in the **Conservation of Natural Resources** section, below.

Taking Too Much

The Hudson Valley region has a long history of over-fishing, over-hunting, and over-gathering, which, at times, has imperiled or extinguished regional populations of certain species and has dramatically altered the ecology of the region.

Hudson Valley beaver were trapped to regional extinction by the mid-1700s to supply the fur trade with Europe, even before widespread settlement by European colonists. The eastern wolf and eastern cougar were hunted to regional extinction throughout the Northeast by the 1890s. Wild turkey was also eliminated by over-hunting throughout the state in that period, and white-tailed deer was extinguished or nearly so in the Hudson Valley and nearby areas. The deer population has since recovered. Some of the wild turkeys from Pennsylvania that later repopulated areas of western New York were captured and transplanted in the 1950s–60s by NYSDEC to restore populations throughout the state. The wild turkey population in Putnam County is now large and apparently thriving. Beaver have since returned and the regional population may be secure for the time being, although their ecological roles are somewhat curtailed due to widespread human interventions to limit flooding from beaver dams. The permanent loss of the wolf and cougar—top predators here for thousands of years—has had devastating effects on the ecology of Northeastern landscapes, affecting, for example, deer populations, forest regeneration, spread of tick-borne diseases, and invasive forest plant infestations.

By 1900, over-fishing had so severely depleted the Hudson River fishery that the NYS fish and game agency established a fish hatchery to artificially replenish or introduce certain species in the Hudson River and tributaries (Stott 2007). Fish stocking in Hudson Valley streams continues today to support the recreational fishery.

Over-collection of certain wildflowers led to statewide restrictions on collecting “Exploitably Vulnerable” plants without landowner permission. Over-harvesting of ramps (wild leek) and American ginseng continues to deplete local populations, however, and over-harvesting of edible mushrooms and fiddleheads may have similar local effects.

Collecting of rare species of plants and animals has long been of concern to NYSDEC and the NYNHP. It is illegal to collect or harm state-listed Endangered or Threatened plants without the landowner’s permission and to collect or harm state-listed Endangered or Threatened animals, but a black market for some rare species, especially rare reptiles, amphibians, and orchids, continues to thrive.

Climate Change and Ecosystems

Climate change is having widespread global and local impacts, and effects on local ecosystems will be increasingly severe. The timing and magnitude of effects will depend in part on the worldwide levels of greenhouse gas emissions to the atmosphere over the coming decades. Mentioned below are just a few of the expected changes, many of which are already occurring in the region.

Warmer summer and winter temperatures, longer growing seasons, and elevated levels of atmospheric carbon dioxide will favor certain plants and disfavor others, and are thus likely to alter the composition of plant communities. Many of our native plants and animals have adapted over thousands of years to the seasonal temperature ranges of the Northeast and are ill-equipped to adapt quickly to the present-day pace of warming—several orders of magnitude faster than the temperature changes

Ruby throated hummingbird. Photo © John Kenny.

experienced during the most recent Ice Age.[226] The widespread fragmentation of today's landscape by roads and land development poses additional obstacles to adaptation and migration in response to climate change.

While floods and droughts are normal and expected events in this region, extreme floods and droughts just add to the multiple stresses on ecosystems from human activities. Warming in the region is predicted to significantly affect the composition and distribution of habitats and wildlife, and will force many species to migrate to cooler microclimates, higher elevations, or higher latitudes as former habitats become unsuitable. Cold-adapted species such as sugar maple, brook trout, and fisher are especially at risk. Together with non-climate stressors such as habitat fragmentation, water pollution, invasive species, and over-harvesting, climate change will have synergistic effects that magnify the stresses and hazards to wildlife.[227]

Already, many plant species now bloom 2–3 weeks earlier than they did a century ago[228]—an effect that may have far-reaching ecological consequences. For example, insect pollinators whose activity periods are closely tied to the historical flowering periods of their food plants may find that their pollen and nectar foods are unavailable at critical times in the pollinators' life cycles. This would add to the existing stresses from more frequent and more severe weather events and could severely harm regional populations of these insects.

Heat stress effects on native plants and animals may eliminate some of the cold-adapted species and communities from our landscapes. Warmer, shorter winters and prolonged winter thaws may make some perennial plants more vulnerable to mid-winter freeze damage by disrupting their accustomed dormancy period, and may subject the early leaves and flower buds to frost damage.[229] Reduced snow cover will harm small mammals and other animals that depend on snow for insulation and protection from predators, but may favor their predators, such as foxes and eastern coyote, and may also favor white-tailed deer—already over-abundant—whose intense grazing pressure has been transforming our forests for decades.

Surface water temperatures will rise along with air temperatures. Higher water temperatures reduce the concentrations of dissolved oxygen—a key habitat component for fish and other aquatic organisms—in streams, lakes, and ponds. The life cycles of many stream invertebrates are closely tied to water temperatures and the seasonal patterns of water temperature fluctuations. Alterations to water temperatures will have large effects on the fish, salamanders, turtles, and other biota of streams and ponds—organisms that are already stressed by water pollution, siltation, and competition from non-native fish.

In general, most at risk will be the plants, animals, and communities with more specialized habitat or food requirements or specialized interactions with other species (e.g., butterflies and their host plants) that are likely to be disrupted by climate change, those with poor dispersal ability (i.e., with limited ability to move from a degraded habitat to a more suitable one), and those with already-low population levels, including Endangered, Threatened, and Special Concern species. Plants and animals likely to benefit from climate change are those that are habitat- and food-generalists, such as white-tailed deer, warmwater fishes (e.g., bass, pickerel, sunfish, white perch), adaptable songbirds (e.g., northern cardinal, American robin, house sparrow, and European starling), and non-native invasive plant species.[230]

Threats to Agriculture, Farms, and Farmland

Agriculture was once the dominant land use in Kent but, due to a combination of local circumstances and distant market forces, has dwindled over the last century to just a few locations, and forests have retaken much of the landscape.

Although the rocky and steep areas of Kent do not lend themselves to efficient commercial farming today, the town still has significant areas of good farmland soils (Figure 24). The future of international, national, and local economic forces are especially unpredictable in these days of a rapidly changing climate and shifting political dynamics. The Kent population does not rely on local food production these days, but the ability to produce food locally could be more important in the future with rising transportation costs and the imperative to reduce the use of fossil fuels for processing, packaging, and transporting produce.

Farmland is sometimes abandoned by farmers and non-farming landowners for a variety of reasons and then, if left undeveloped and unmanaged, it usually reverts to oldfield, shrubland, and eventually forest. All of those stages offer valuable habitat for native plants and animals, and the land can be returned to agricultural uses at any time, although reclearing a shrubland or forest is labor-intensive.

But farmland is lost permanently if the soils are excavated, covered, or contaminated, or if the land is developed with structures, pavement, roads, and driveways. Soils can be easily damaged by poor farming practices, compaction, and toxic contamination, and can be easily lost to erosion where unvegetated cropfields are exposed to large rainstorms or snowmelt events or to the forces of floodwaters. Agricultural land is often lost to developed uses both because of the financial needs of retiring farmers and because open farmland is easy to convert to non-agricultural uses.

Protecting areas with good farmland soils is a fundamental requirement if the town wishes to maintain the potential for viable local agriculture and its benefits for the town's economy, local and regional food security, and the scenic character of the landscape.

The growth in demand for high-quality local and organic food in the Hudson Valley and the greater New York metropolitan region during the last several decades comes at a time when escalating property values have made maintaining large farm properties unaffordable to many farmers. New farmers also face a critical shortage of accessible and affordable farmland.

Subdivision of large farmland parcels into smaller lots poses another threat to the viability of land for farming. While some types of farming, such as commercial flower- or herb- growing, are practical on small acreages, many types of farm operations need large areas, so subdivision of a property can mean the end of farming there. Establishment of conservation easements can protect the land itself from subdivision or development, but easements are expensive, and beyond the financial reach of many landowners.

The development of community- or utility-scale solar energy facilities is often in conflict with farmland and agriculture. Although farmers sometimes welcome such projects because of the additional income from a part of their land, solar arrays can alter or destroy the prospects for farming the land, temporarily or permanently. Some solar facilities can be designed to allow livestock grazing or crop production between the solar arrays. The combination of agricultural and solar energy production, called "agrivoltaics," has been very successful in Europe and is beginning to catch on in the US.

Climate Change and Agriculture

Climate change is likely to affect agriculture in a variety of ways—some even beneficial; for example, warmer summers, warmer winters, longer growing seasons, and higher atmospheric carbon dioxide (CO_2) levels will favor some crops. But the mechanisms will be complex, with differential effects on crop growth, weeds, invertebrates, and pathogens. For example, higher CO_2 levels may benefit aggressive weeds even more than the crops and may increase the weeds' resistance to herbicides.[231] Warmer temperatures will be harmful to many existing crops and livestock—especially dairy cows—adapted to cool climates, and will require adjustments to longstanding farm practices. For dairy cows heat stress can lead to lower milk production, reduced calving, and increased risk for health disorders. Heat stress similarly affects the well-being and productivity of other livestock, including beef cattle, pigs, and chickens.[232]

Increased frequency of summer droughts will stress many crops, and more frequent large rainstorms and flood events will lead to direct losses of crops, soils, and nutrients, as well as costly delays in field access for farm equipment due to wet soils. Some insect pests, pathogens, and weeds will be favored by less-severe winters. Rising winter temperatures are already allowing the northward expansion of agricultural pests that reduce crop production. Disruption of heat/thaw patterns may be especially harmful to woody plants (e.g., fruit trees) and perennial herbs.[233] Warming temperatures may have the effect of uncoupling the activity periods of insect pollinators from the flowering periods of both crop plants and native plants that rely on those pollinators.

Perennial fruit crops are affected by the climate year-round, and the stresses experienced in one growing season may affect growth and productivity for two or more years afterward. While apple trees may benefit from longer growing seasons and increased atmospheric carbon dioxide, warm winters may reduce fruit production the following summer, especially for the cold-adapted varieties, and summer heat stress and drought may harm the fruit quality. Greater variation in springtime temperatures can be especially harmful to fruit crops; when warm springs are punctuated by hard frosts, fruit damage becomes more likely. Transitioning to warm-climate fruit varieties is an appropriate response, but will nonetheless be costly to farmers. These kinds of effects will put additional financial strain on farm operations whose profitability is already marginal.

Disruption of the late winter/early spring freeze-thaw cycles will reduce the quality and quantity of maple syrup production. Indeed, sugar maples may be entirely displaced from the region by 2100, with suitable cool, moist habitat remaining only on the highest peaks in the Adirondacks.[234]

Threats to Scenic Resources

Kent is fortunate that many of the town's scenic areas are on lands protected by New York State or New York City. But there are other scenic areas visible from public roads and other public-access areas that are and will remain privately owned and without conservation status, and it is safe to assume that many of those properties will eventually be developed with one or more residences or other structures.

Threats posed by such development to the scenic landscapes of Kent include, for example, the visual disruption of meadows, forested ridgetops and hillsides, and roadside forests by buildings, yards, and clearings, and by outdoor lighting. These disruptions can affect large viewsheds as well as the nearby views along roadways, and can transform the visual character of the town from rural to suburban.

The extent of the visual impacts of land development depends on the landscape setting, the kind and extent of development or other land disturbance, the color and reflection-potential of exterior materials used (windows, siding, roofing), the location and size of windows (because of their ability to transmit nighttime lights to the surrounding landscape), the amount and style of outdoor lighting, and the amount and effectiveness of vegetation screening.

The aesthetic values of Kent's lakes are an important amenity for many of the lakeside neighborhoods, but the continued existence of the lakes depends on maintaining the dams that impound the lake water. Some of the dams are in poor and even hazardous condition.[235]

CONSERVATION OF NATURAL RESOURCES

While some of the threats to natural resources of concern are entirely within our power to eliminate, reduce, or mitigate, others such as climate change are beyond our immediate local control. Nevertheless, all actions to reduce greenhouse gas emissions will help to slow the warming of the planet, and our conservation of land and water can reduce the non-climate stressors and improve the resiliency of ecosystems to the effects of the changing climate.

This section outlines some of the basic conservation principles and measures that can be applied throughout Kent for use and effective conservation of resources of concern, including measures that will help to address anticipated impacts of climate change. Many of these measures can be applied widely on individual land parcels—large and small—in private or public ownership, and others relate to townwide or regionwide land use planning and policy.

Conservation of Water Resources

Forests are key to maintaining clean and abundant surface water and groundwater.

Perhaps the most effective means of sustaining groundwater supplies, ample water in lakes and ponds, and cool, clean streams with stable banks is by maintaining substantially forested watersheds, and maintaining riparian zones with undisturbed vegetation and soils. Forests with intact canopy, understory, and ground vegetation, and intact forest floors are extremely effective at promoting infiltration of precipitation to the soils, and for maintaining the quality and quantity of water in streams, lakes, ponds, and groundwater. Springs and seeps in the watershed are also key to maintaining the cool stream temperatures that are critical for sensitive stream invertebrates, fishes, and amphibians.

Groundwater

Quantity and quality of groundwater everywhere will best be protected by maintaining forested landscapes wherever possible, reducing or avoiding use of fertilizers and pesticides as much as possible, and carefully designing stormwater management systems to reduce surface runoff and ensure that precipitation and snowmelt infiltrate the soils instead of running rapidly off the ground surface.

Most of the drinking water wells in Kent draw from bedrock aquifers, but a few tap unconsolidated aquifers (Figure 6) where the water is held in coarse-textured glacial deposits. While groundwater throughout the town is of conservation concern, the areas of unconsolidated aquifers deserve particular attention as they are especially important for recharging groundwater; they hold large water volumes; and they are also the most vulnerable to contamination. The sand and gravel deposits can be efficient conduits for contaminants introduced by above-ground human activities. Protection of groundwater requires ample surface water infiltration to the soils everywhere, and avoiding contamination of the soils in these most vulnerable land areas overlying the unconsolidated aquifers. To protect the groundwater quality, land uses with higher risk for soil or water contamination should be steered away from the unconsolidated aquifer areas wherever possible.

In anticipation of prolonged droughts, the town could establish water conservation programs to increase water usage efficiency, and harvest rainwater for domestic, agricultural, and business uses. The programs could include use of green infrastructure where appropriate, minimizing impervious surfaces, and stormwater management policies that require onsite infiltration of rainwater and snowmelt to match pre-development conditions.

Common bluecurls. Photo © Beth Herr.

Streams and Floodplains

We are experiencing increasing frequency and intensity of extreme storm events in this region, and climate scientists predict the trend to continue in response to the warming climate. A storm of a intensity that was once considered a 1 in 100 year event is now likely to occur almost twice as often—i.e., once every 50 years, and storms of a severity that in the past might have occurred once in 25 years, on average, might now occur once in 12–13 years.[236] These large storms are likely to reduce the volumes of groundwater available to feed the streams, wetlands, reservoirs, and drinking water wells; increase the severity of streambank erosion and siltation; and degrade the instream habitat quality for sensitive species of fishes, amphibians, invertebrates, and other organisms.

Conserving intact habitats in and near flood-prone areas, and removing engineered features, buildings, and other structures, can help reduce local and downstream flood damage while promoting groundwater recharge, improving stream health, and providing valuable wildlife habitats.

Maintaining "soft" stream banks (i.e., without concrete, riprap, or other revetments) and full connectivity between streams and their floodplains allows floodwaters to spread out and thus dampens downstream floodflows, and reduces bank erosion and potential downstream flood damage to property and infrastructure. It also facilitates movement of animals between stream and floodplain habitats, and the exchange of organic materials and sediments between the stream and floodplain, thus benefiting the habitats of both.

Maintaining broad buffer zones of undisturbed vegetation along streams, and dense vegetation cover in roadside and agricultural ditches will reduce erosion and reduce the volume of sediments carried into streams from eroded banks. Directing ditch flow into vegetated swales or detention basins will further reduce harm to streams from large runoff events.

Impervious surfaces such as roads, driveways, parking lots, and roofs impede water infiltration to the soils, reduce groundwater recharge, and promote rapid runoff of rainwater and snowmelt into ditches, streams, and wetlands. These effects create "flashy" streams with brief periods of high flow volumes during runoff events followed by prolonged periods of low flow or no flow. Minimizing impervious surfaces and maximizing water infiltration to the soils will reduce those effects, promote groundwater recharge, and help to maintain normal stream flow volumes and seasonal fluctuations.

The federal Floodplain Management Regulations of the Federal Emergency Management and Assistance Law establishes minimum standards for flood protection but encourages communities to adopt more restrictive floodplain management regulations than those set forth in the federal law when warranted to better protect people and property from local flood hazards (44 CFR 60.1[d]). Under the Community Rating System, insurance premium discounts are available to policy-holders in communities that have enacted floodplain management programs that exceed FEMA standards. Participating in the program can improve safety for people, structures, and materials in and near flood zones, in addition to reducing insurance costs, both for the public and the municipality.

General Measures for Water Resource Conservation

- Throughout the landscape, maintain forests with intact vegetation and undisturbed forest floors wherever possible.
- Minimize applications of polluting substances, such as de-icing salts to roads, parking lots, and driveways, and pesticides and fertilizers to lawns, gardens, and agricultural fields.
- In areas of unconsolidated aquifers (Figure 6), avoid siting land uses with potential for contaminating soils and water. Educate landowners in these areas about the vulnerability of groundwater resources.
- On development sites, minimize impervious surfaces and manage stormwater in ways that maintain pre-development patterns and volumes of surface runoff and infiltration to the soils.
- Direct runoff from agricultural fields into basins and well-vegetated swales, instead of directly into streams or wetlands, to prevent the introduction of excess nutrients, toxins, and sediments.
- Maintain broad buffer zones of undisturbed vegetation and soils along streams, and around wetlands, lakes, and ponds.
- Design new culverts and bridges and retrofit existing ones to accommodate storms of 500-year intensity in anticipation of more severe storms in coming decades.
- Design, install, and retrofit culverts to maintain the continuity of stream gradients and substrates.
- Redesign and retrofit roadside ditches and other stormwater systems to maximize water infiltration to the soils, and minimize rapid and direct runoff into streams, ponds, and wetlands.
- Consider the 500-year flood zone when planning land management and land uses along streams.
- To minimize soil loss in large storm or flood events, keep floodplain meadows well-vegetated; minimize tillage; seed immediately after tilling; leave abundant thatch to cover exposed soils; and use cover crops in winter.
- Prohibit the building of new structures in flood zones, and remove structures, pavement, and hazardous materials from flood zones wherever possible.
- In flood zones, shift to resilient land uses that can withstand moderate to severe flooding; for example, parks, ballfields, hiking trails, picnic areas, fishing access sites, pastures, and hayfields.
- Regulate and monitor extractive commercial, industrial, and institutional water uses to ensure that water withdrawals from groundwater or surface water sources are at sustainable levels.

Conservation of Biological Resources

The best overall approach to ensuring resiliency in the face of existing and new environmental stresses brought on by climate change is to protect large contiguous areas representing all elevational gradients and significant land forms (such as mountain summits, side slopes, ravines, high- and low-elevation valleys), bedrock types, soil types, and hydrological conditions, and to maximize the connectivity between intact habitat areas. This approach will help to maintain and protect important biodiversity elements in the present, and provide the greatest opportunities for adaptations and safe migration of wildlife and plants to suitable habitats in the rapidly changing environment.

Protecting large intact habitat areas will help area-sensitive wildlife species fulfill their life history needs, and will also protect the array of natural communities in each area, including those of which we are yet unaware. Protecting high-quality representatives of all ecologically significant habitats or communities (such as rocky barrens, ledges, upland deciduous forests, conifer swamps, woodland pools, intermittent streams), and areas with concentrations of unusual and rare habitats will help ensure that the most imperiled biological communities will not disappear.

Warming air temperatures are leading wildlife to seek out cool places. In some cases these movements involve significant geographic shifts from south to north or from low to high elevations, and in others just moving from, say, the west slope to the north slope of a hill, or to a neighboring ledge with a deeper crevice. Physiographic complexity increases the habitat and microhabitat options for plants and animals on the local and regional scale. The cooler parts of the landscape, such as north slopes, ravines, and other areas shaded by topography may be especially important to organisms as the climate warms.

Understanding that many species of plants and animals need to move to adjust to new habitat conditions, ecologists and conservationists are seeking ways to identify the most important parts of the landscape to allow safe migrations and to maintain intact habitat areas in the changing environment. The Nature Conservancy undertook a study to identify key areas for conservation based on landscape characteristics associated with diversity and the ability to buffer against climate effects.[237] Their aim was to identify places that encompass the full spectrum of landscapes and habitats needed to accommodate the safe movements and survival of species, so that conservation efforts can be focused where they will be most effective.

One assumption of the study—based on empirical evidence—is that complex and unfragmented landscapes are most likely to provide the array of habitats and microhabitats needed to support species in a changing climate. “Complex” in this context refers to complexity of landforms, elevation ranges, habitat diversity, and wetland density. The term “resilience” in this context means “the capacity of a system to adapt to climate change while still maintaining diversity.” The investigators considered landscape complexity—the number of microhabitats and climatic gradients available within a given area—and landscape permeability, a measure of the freedom from barriers and fragmentation within a landscape. Barriers include roads, developed land, dams, suspended culverts, and other structures that interrupt, redirect, or prevent the movement of organisms.

The intention was to identify the places where conservation of biodiversity and ecosystems is most likely to succeed not just in the near term but over centuries. After identifying “resilient” sites and areas representing all geophysical settings, and then identifying networks of such sites in the larger landscape, the researchers created maps showing areas with high or low predicted resilience. Figure 27 shows the results of TNC’s analysis of the Kent landscape for climate resilience.

Protecting habitats and habitat complexes critical to particular plant and animal species of conservation concern provides umbrellas for many other species using the same habitats and landscapes. For example:

- For the wood turtle,† a broad (e.g., 1600-ft wide) zone centered on low-gradient perennial streams with undeveloped riparian habitats would encompass most of the turtle's foraging and nesting migrations, as well as habitat areas for a wide range of wildlife species of riparian corridors, such as river otter, American mink, and Louisiana waterthrush.†
- For pool-breeding amphibians such as wood frog and Jefferson salamander, maintaining intact forested connections between clusters of intermittent woodland pools (pools within 1500-ft of each other) would protect critical breeding, foraging, and overwintering habitats and the broad corridors between pools that facilitate population dispersal and genetic exchange. It would also maintain habitat and travelways for the spotted turtle† and other wildlife that use both the pools and forest.
- For snakes such as the black racer† and other ledge-associated snakes, protecting large areas of contiguous habitats around rocky barrens habitats and other ledges with southern exposures would encompass the snake's denning and breeding areas, as well as critical areas for foraging and dispersal migrations. While land development is expected to proceed, siting and design of new development with an eye to the snake's needs will help to protect the snakes and minimize human/snake encounters which are often fatal to the snakes.
- For grassland breeding birds, maintaining large meadows in grassy vegetation and, where possible (i.e., where intensive hay harvest is not necessary), postpone mowing until late summer or fall to avoid harming ground nests and nestlings.
- For bees, wasps, butterflies, moths, and other insect pollinators, (where intensive hay harvest is not necessary) postpone mowing meadows and oldfields until late fall, to provide nectar and pollen food sources for early- and late-flying species.

Eastern cottontail. Photo © John Kenny.

- For bats, maintaining mature forest trees and dead standing snags for roosting, along with foraging habitats such as the ponds, meadows, and intact riparian corridors, will help to support Kent's bats, as well as other cavity-using wildlife, dragonflies, damselflies, and the many other wildlife species that share those habitats.
- For the New England cottontail,† maintaining large areas of dense shrub thickets will provide the protection from predators that may be critical to the rabbit's survival, and will help other shrubland species of conservation concern such as ruffed grouse† and golden-winged warbler.†

Different organisms have different sensitivities and responses to effects of climate change; some species will be stressed by certain changes, and aided by others. Some populations will be able to adapt to the changing conditions, and others will be unable to adapt quickly enough and will disappear from the local or regional landscape. In general, most at risk will be the plants and animals with specialized habitat or food requirements, or specialized interactions with other species, those that are already rare, and those with limited ability to move. Successful adaptations will take many forms, but will require range shifts for some wildlife and concurrent shifts of forage and prey.

Ecologists generally agree that the best ways to preserve ecosystem functions and native biodiversity in the changing environment are to maintain intact and well-connected areas with complex physical geography and diverse habitats. This will help to ensure the continuity of ecosystems, even as the composition of biological communities changes.

Many of the basic principles for biological resource conservation can be summarized in a few points:

- Large tracts of undeveloped land, and connectivity among diverse habitats are important to many species of rare, declining, and vulnerable plants and animals of Kent.
- Broad corridors for seasonal or annual migrations and for population dispersal can be just as important to populations of certain mobile species as their primary breeding, foraging or overwintering habitats themselves.
- Broad buffer zones of undisturbed vegetation adjacent to streams, woodland pools, lakes, and ponds are important to preserving the integrity of the aquatic and upland habitats required by sensitive species of those habitats.
- Natural disturbances (e.g., wildfires, floods, wind, ice scour, landslides) are essential features of certain habitats, and help to create the environmental conditions that allow some species and communities to persist.
- Old systems, such as mature forests or old wetlands with deep organic soils, are less common in the region than younger counterparts of those systems, such as a young forest or a recently created marsh, and provide habitat values for biodiversity not duplicated by the younger habitats.
- Maintaining "soft" streambanks and intact floodplains helps to maintain high-quality instream habitats and water quality, as well as the array of habitats and species of riparian corridors.
- Areas with complex topography and microtopography provide a greater selection of microhabitats and microclimates for use by organisms needing to shift their locations in response to climate change.
- Cool parts of the landscape such as cool ravines and north-facing slopes may provide temporary or longer term refuge for animals and plants in the warming environment.
- Reducing non-climate stressors such as pollution, habitat fragmentation, pesticides, and invasive species will improve the resiliency of organisms and landscapes to the effects of climate change.
- Landscaping with native shrubs, perennials, and annual plants instead of non-natives and cultivars will provide better support for native insects and other wildlife. (See the Putnam County Pollinator Pathway program of the Cornell Cooperative Extension.)

The Hudson Highlands Land Trust analyzed the regional landscape to identify the most important lands and waters for providing habitat connections and movement corridors for wildlife. The study used the NYNHP's Areas of Known Importance data for nine animal species of conservation concern—including the tiger spiketail dragonfly, American eel, timber rattlesnake, eastern worm snake, wood turtle, spotted salamander, bald eagle, wood thrush, and New England cottontail—to represent different kinds of habitat needs, movement modes, and movement ranges. The results are published in the *Green Corridors Plan for the Eastern Hudson Highlands*. The map for wildlife connectivity in Kent is presented in Figure 28, and connectivity for the larger region is in Figure 29. These results indicate that most of the unprotected land in Kent has high to very high connectivity value for wildlife movement. Exceptions are in the Lake Carmel/Rt 52 corridor, around China Pond and Barrett Pond, in the Seven Hills Lake vicinity, and a few other places. (Other parts of the Green Corridors study considered priority areas for conservation identified in existing municipal documents, in other landscape analyses by the NYNHP and conservation NGOs, and by other stakeholders.) The data in figures 28 and 29 can help the Town of Kent identify open space priorities for town planning and for environmental reviews of development projects.

General Measures for Biological Resource Conservation

- Protect habitat areas in large, broad configurations, with broad connections to other habitat areas whenever possible.
- Avoid fragmenting large forests by roads, long driveways, or other disturbed corridors.
- Avoid fragmenting large meadows and active farmland by roads, driveways, or other non-farm uses.
- Protect large habitat areas that encompass south-to-north and low-to-high-elevation travelways for wildlife.
- Protect intact habitats, especially forests, in cool parts of the landscape such as deep ravines and north-facing slopes.
- Direct human uses toward the least sensitive areas, and minimize alteration of natural features, including vegetation, soils, bedrock, and waterways.
- Maintain broad buffer zones of undisturbed vegetation and soils around ecologically sensitive areas.
- Maintain or restore forested corridors along streams of all sizes.
- Employ sustainable agricultural practices that build living soils, conserve water, and minimize uses of fertilizers and toxic pest controls.
- Promote wildlife-friendly landscaping, including native trees, shrubs, forbs, and graminoids, pollinator gardens and meadows, and non-toxic maintenance methods.
- Protect habitat complexes for species of conservation concern wherever possible.
- Minimize impervious surfaces and design new land uses (and retrofit existing uses wherever possible) to ensure that surface runoff of precipitation and snowmelt does not exceed pre-development patterns and volumes of runoff.
- Concentrate new development along existing roads and near other developed areas; discourage construction of new roads or long driveways in undeveloped areas.
- Employ sustainable forestry practices in working forests that promote biological and structural diversity.
- Maintain natural disturbances, such as wildfires, floods, seasonal drawdowns, ice scour, and wind exposure, which help to create and maintain habitat for important components of native biological diversity.
- Consider environmental concerns early in the planning process for new development projects, and incorporate conservation principles into choice of development sites, site design, stormwater management, and construction practices.
- Educate town agencies, landowners, developers, and the general public about the town's exceptional native biodiversity to heighten awareness and build support for conservation measures.

27. Climate change resilience

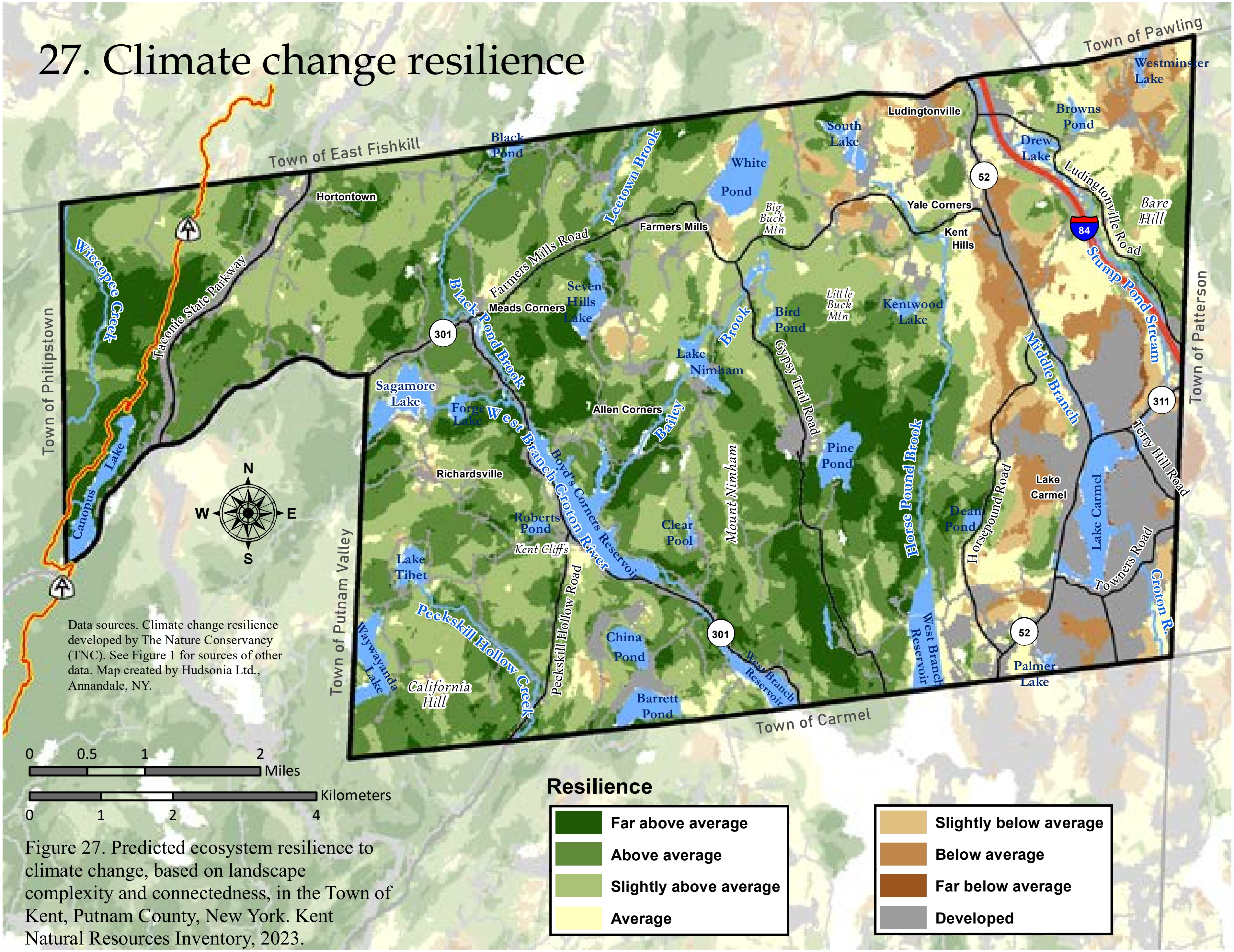


Figure 27. Predicted ecosystem resilience to climate change, based on landscape complexity and connectedness, in the Town of Kent, Putnam County, New York. Kent Natural Resources Inventory, 2023.

28. Wildlife connectivity priority areas

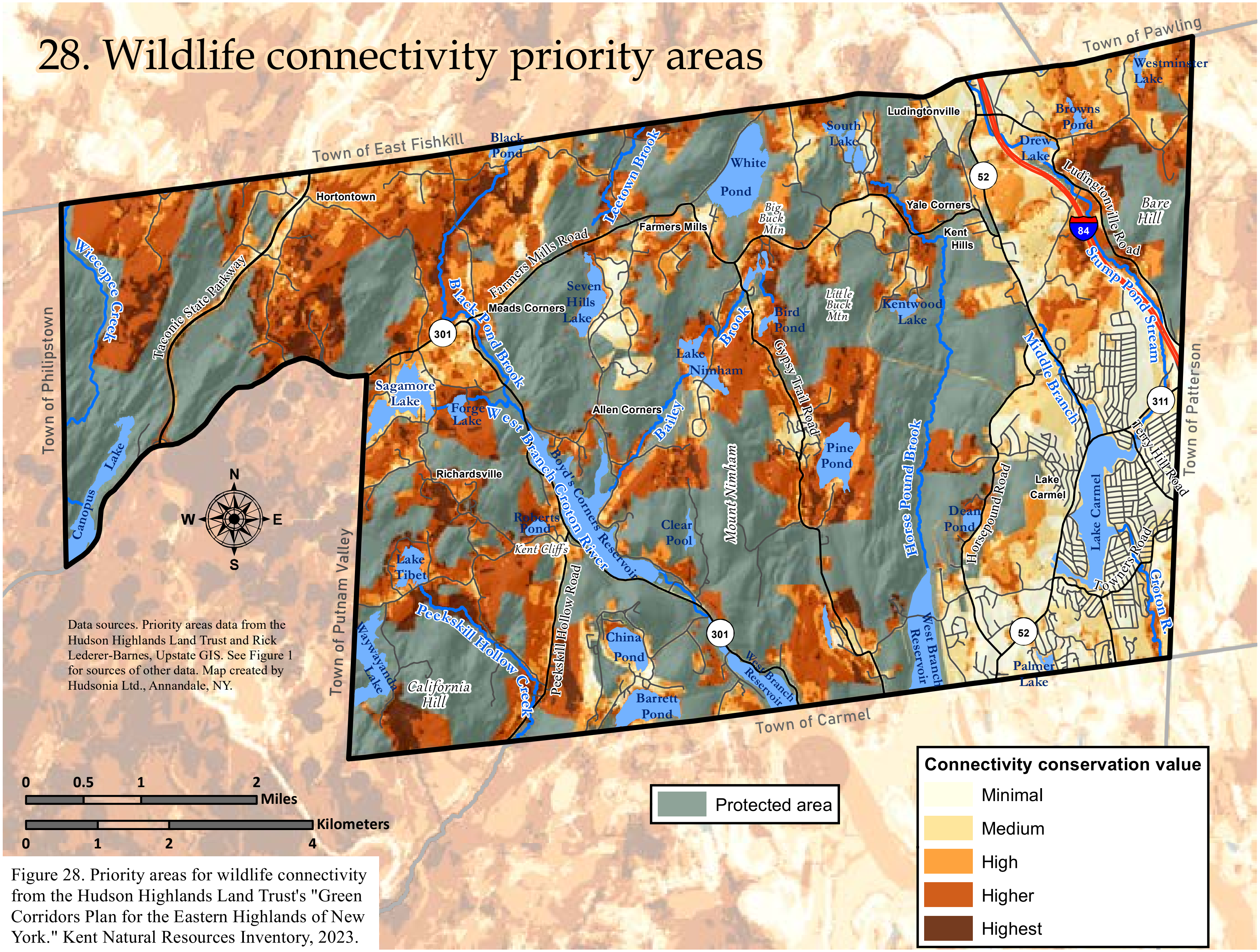


Figure 28. Priority areas for wildlife connectivity from the Hudson Highlands Land Trust's "Green Corridors Plan for the Eastern Highlands of New York." Kent Natural Resources Inventory, 2023.

29. Region-wide wildlife connectivity priority areas

Data sources. Priority areas data from the Hudson Highlands Land Trust and Rick Lederer-Barnes, Upstate GIS. See Figure 1 for sources of other data. Map created by Hudsonia Ltd., Annandale, NY.

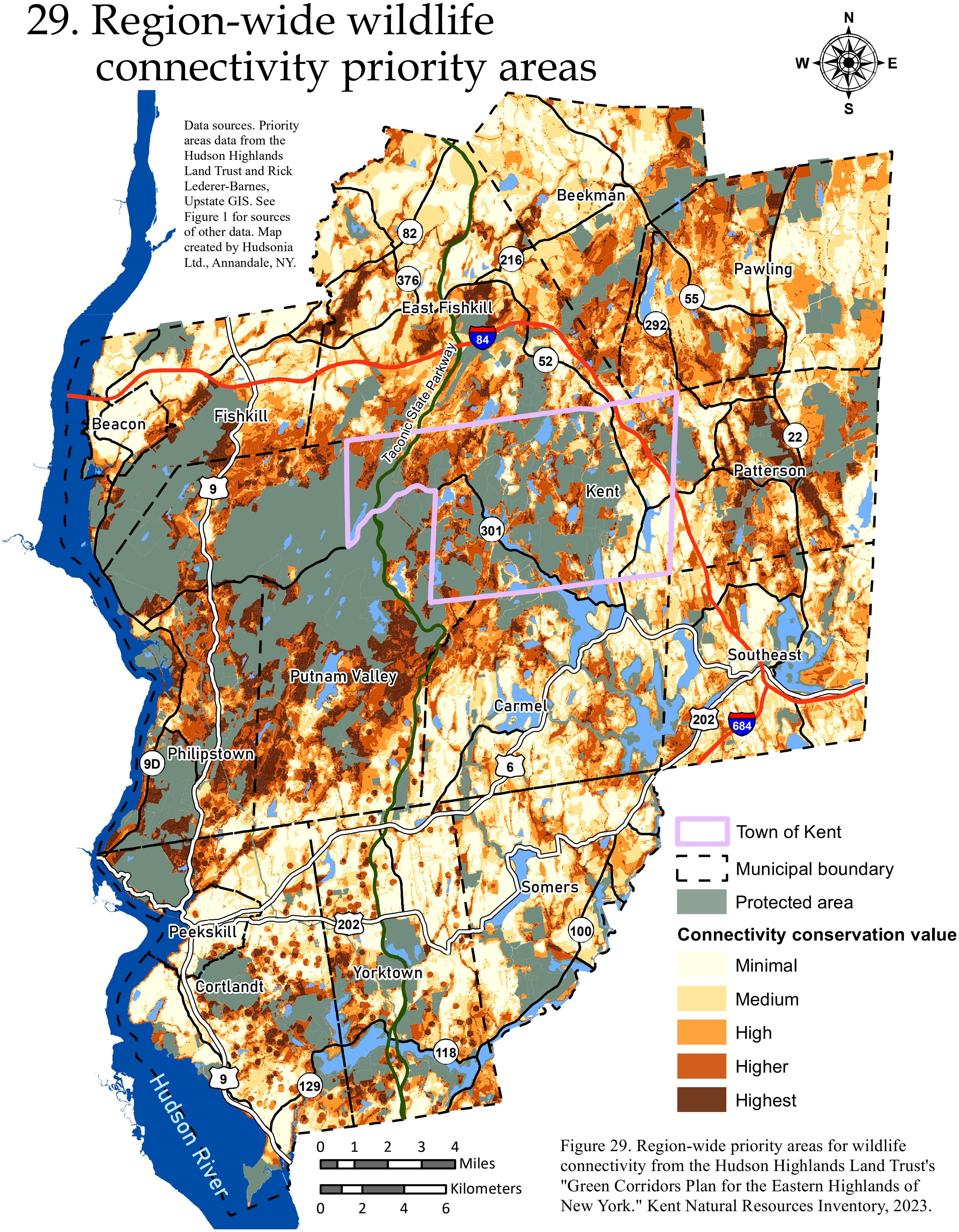


Figure 29. Region-wide priority areas for wildlife connectivity from the Hudson Highlands Land Trust's "Green Corridors Plan for the Eastern Highlands of New York." Kent Natural Resources Inventory, 2023.

Conservation of Farmland Resources

Maintaining viable local agriculture has obvious benefits for the local economy, local food security, the scenic character of the landscape, and the culture of the human community. Active and abandoned farmland can also contribute significantly to native biodiversity, and intact habitats in the vicinities of farms can in turn provide critical and irreplaceable services and resources to farm enterprises—for example, climate moderation, clean water, flood attenuation, and habitat for pollinators.

Supporting active farms and protecting the best farmland soils from development will help to preserve the potential for farming in the town. But the fragile economies of small farms, and the vagaries of weather and markets pose significant threats to local agriculture. The continuing viability of farming in Kent may require other measures to foster the economic success of existing and new farm operations, and to pair farmers with available farmland.

General Measures for Farmland Conservation

Municipal Actions

- Adopt local farm-friendly policies and programs; for example, lowering tax assessments for active farmland, assisting farmers with grant acquisition, and promoting local markets for local agricultural products, including uses by restaurants and institutions such as schools.
- Protect active farmland from non-farm development wherever possible.
- Design new subdivisions and other development sites in ways that preserve the areas of Prime Farmland Soils, and Farmland Soils of Statewide Importance intact and unfragmented as much as possible.
- Require substantial buffer zones between farmed land and new houses on adjacent parcels.
- Support secondary on-farm enterprises, such as sales of value-added farm goods, bed-and-breakfast enterprises, or agritourism through advertising and zoning revisions.

Farmer Actions

- Where possible, shift tilled land in floodplains to other uses (such as pastures, hayfields) more resilient to flooding.
- Maintain intact habitats in and near cropland and orchards to help support pollinators, other beneficial insects, and wildlife.
- Employ farming practices that conserve water, prevent soil erosion and soil loss, and build living soils.
- Minimize applications of fertilizers and pesticides, and especially in the more sensitive areas such as floodplain meadows, and near streams and wetlands.
- Maintain cover crops and thatch to minimize soil loss during heavy precipitation or flood events.

The American Farmland Trust published *Planning for Agriculture in New York: A Toolkit for Towns and Counties*[238] which describes the many options for regulatory and non-regulatory means available to municipalities to support and promote agriculture. These include measures such as maintaining buffers between new houses and farmed land to prevent future conflicts; keeping new water, sewer, and road infrastructure inside or at the edges of hamlets instead of extending them into farming areas (to limit the spread of development on productive farmland); promoting agritourism; allowing other on-farm enterprises such as bed-and-breakfasts and sale of value-added products; and encouraging environmentally sound stewardship of soil, water and other natural resources to maintain the intact ecosystem that provides clean water, pollinators, and living soils that help to support present-day and future agriculture.

The NYCDEP has a program to help farms within the watersheds of the city's drinking water reservoirs (which cover most of the Town of Kent) develop on-farm measures to reduce existing and potential sources of pollution from farm operations. Farms with average gross annual sales of $5,000 or more are eligible to participate in Whole Farm Planning, in which NYCDEP works with farmers to create a plan incorporating best management practices, and provides technical and financial assistance to help implement those measures and monitor the results.

Conservation of Scenic Resources

The scenic beauty of the town is intimately tied to the other resources described in this *NRI*—the forested hills and valleys, streams and lakes, marshes, and farmland. Protection of many of those features will help to protect the scenic areas, but some places deserve special conservation attention because of their exceptional scenic importance to the human community.

The scenic character of the town that is prized by Kent residents consists not only of the visual landscape from public places, but also the ecological condition of the land, and the land uses such as farming and forestry that directly depend on the land and have long shaped the culture and character of the town. Supporting the enterprises that maintain working landscapes and land-dependent uses will allow some landowners to keep the land undeveloped and maintain some of Kent's rural traditions.

General Measures for Scenic Resource Conservation

- Conduct a formal survey of scenic areas viewable from public-access locations, identify and map the most important areas, and develop policies and plans for protection.
- When siting and designing any new structure or new land use in the town, consider the impacts on the entire viewshed.
- Concentrate new development in the vicinity of existing hamlets and other developed areas so that large natural areas remain intact.
- Maintain intact (undeveloped) natural areas and farmland visible from public roads and public-access lands wherever possible.
- Maintain intact hilltops and sideslopes wherever possible, as these areas tend to have the largest viewsheds.
- Minimize outdoor lighting, and design any necessary outdoor lighting to minimize visibility of lights in nearby habitat areas and offsite areas throughout the viewshed.

Skier on NYCDEP land above the West Branch Reservoir. Photo © Fritz Beshar.

Conservation of Recreation Resources

Kent has large areas available for public recreation in Fahnestock State Park, the state-owned Multiple Use Areas, and the NYCDEP lands, in addition to three town parks and the Putnam County Veteran's Memorial Park (Figure 26). Altogether these provide public access to many of the beautiful, unusual, and rare natural features of the town, and opportunities for a range of active and passive recreation uses.

A few measures can help protect natural features from the kinds of damage sometimes caused by recreational uses. For example, locating new hiking trails and access areas at habitat edges instead of interiors, and avoiding rare and sensitive habitats, wildlife travel corridors, and breeding areas for sensitive species will lead to fewer adverse impacts to biological resources. Minimizing noise and artificial lights will cause less disruption of wildlife. Managers who identify acceptable and unacceptable levels of impact, and monitor recreational uses and conditions, can take steps to reduce impacts when the resource is threatened by over-use.

Limiting the spatial extent of public uses on a site may be more important than managing the timing or intensity of use. Predictable disturbances, such as human presence on an established trail, are better tolerated by wildlife than unpredictable ones.[239] Thus, a spatially extensive network of "social" trails and campsites has greater adverse impacts than a few clearly-marked and well-maintained formal trails and campsites, even with more annual visitors.[240] Visitor education—about wildlife sensitivity to disturbance, the value of staying on trails and using established campsites, proper waste disposal, and other "Leave No Trace" principles[241]—can be very helpful because many impacts are unintentional and avoidable. Although educational signs and brochures may be the only options in some places, being talked to by a ranger or volunteer is often more effective at changing visitor behavior.[242]

Public recreation and natural resource protection are often but not always compatible, and the different goals of each should not be confused. Some areas may be quite resilient to human disturbance, while other areas may be inappropriate for public uses due to the sensitivity of habitats, plants, wildlife, or other resources. Even low levels of foot traffic can destroy the plant community on a rocky crest, or disrupt the nesting behavior of a sensitive songbird. But good planning and design of infrastructure, trails, and other use areas, along with public education about outdoor etiquette, can improve the compatibility of human recreation and intact habitats, and help to protect the natural areas that are abundant and widely valued in Kent.

Ponies in Kent woods. Photo © Peter Lehner.

Conservation and Enhancement of Outdoor Recreation Resources

- Design new trails and access areas with the area of influence (e.g., 330 feet from trails) in mind. Where possible, follow existing habitat edges and avoid water resources, rare and sensitive habitats, wildlife travel corridors, and breeding areas for sensitive species.
- In existing recreation areas, properly maintain trails, campsites, and picnic areas and discourage use of informal trails and other non-designated areas.
- Establish thresholds for acceptable and unacceptable levels of impact from public uses, and reduce public access when regular monitoring shows unacceptable damage.
- Educate the public about ways to avoid disturbing wildlife and Leave No Trace principles (https://lnt.org/learn/7-principles) and following management rules (stay on marked trails; keep dogs on leash, etc.) of public recreation areas.
- Enact legislation or policies that promote or facilitate economic development tied to natural resources, such as bed and breakfasts near hiking trails, or small businesses related to outdoor recreation.
- Educate landowners about protection from liability under NYS General Obligations Law to reduce the perceived need for No Trespassing signs.

EXISTING PROTECTIONS FOR NATURAL RESOURCES

Protected Lands

Approximately 12,132 acres of land in Kent has some kind of formal protected status or is managed for public recreation. This includes the Appalachian Trail corridor, New York City-owned, state-owned, county-owned, and town properties, preserves held by the Putnam County Land Trust, as well as privately-owned lands with conservation easements (Figure 30).

Nearly all of Kent is within the watershed of the New York City drinking water reservoirs. The only exceptions are the watershed areas of Whortlekill Creek, Wiccopee Creek in the Kent panhandle, and Peekskill Hollow Creek in the southwest corner of the town (Figure 6). New York City is the largest landholder in town, with 6,338 acres owned in Kent and managed for the primary purpose of protecting the New York City water supply. Many but not all of the city-owned lands are open for public recreational uses, including fishing, hunting, non-motorized or electric-powered boating, hiking, horseback riding, and camping. Permits from NYCDEP are required for all activities except for hiking. In addition, NYCDEP also holds conservation easements on 1043 acres in privately-owned parcels.

The State of New York is the next-largest landholder, with ca. 4,260 acres owned in Kent. The state-owned parcels include the California Hill State Forest, Big Buck Mountain MUA, Nimham Mountain MUA, White Pond MUA, Clarence Fahnestock State Park, and Wonder Lake State Park. The state lands are managed variously for biodiversity, recreation, and forest products.

The 1000-ft-wide corridor dedicated to the Appalachian Trail and adjacent parcels owned by the National Park Service total approximately 376 acres in Kent.

The Putnam County Land Trust (PCLT) owns 48 acres in-fee in Kent, and manages the land for conservation and public recreation. The PCLT holds no conservation easements on lands in Kent.

The 222-acre Putnam County Veterans Memorial Park is managed for historical commemoration and education as well as recreation, and the three town parks—Huestis, Ed Ryan, and Town Hall—are managed primarily or wholly for recreation.

Altogether these protected lands contain many of the features of conservation concern outlined in this *NRI*—stream corridors, low and high elevations, diverse bedrock types, good farmland soils, large forests, wetlands, rare habitats, and rare species locations. Many of the protected parcels are well-connected to other protected lands (Figure 30), thus maintaining large habitat options and safe travelways for wildlife. There may be opportunities to establish and maintain additional connections between protected areas—through, for example, individual landowner actions, conservation easements, and design of conservation subdivisions as well as public acquisition. Although many landowners value their land for a variety of reasons, they may be unaware of the importance of the land for biodiversity or for protection of water resources. The map series and resource descriptions in this *NRI* may alert people to special features on their land, and some of the numerous ways that any landowner can voluntarily protect important natural resources.

Regulatory Protections

Federal, state, and local laws provide some protections for certain kinds of resources, and New York City imposes additional restrictions on lands within the watersheds of the New York City drinking water reservoirs, but many important resources have no regulatory protections at all.

30. Protected lands

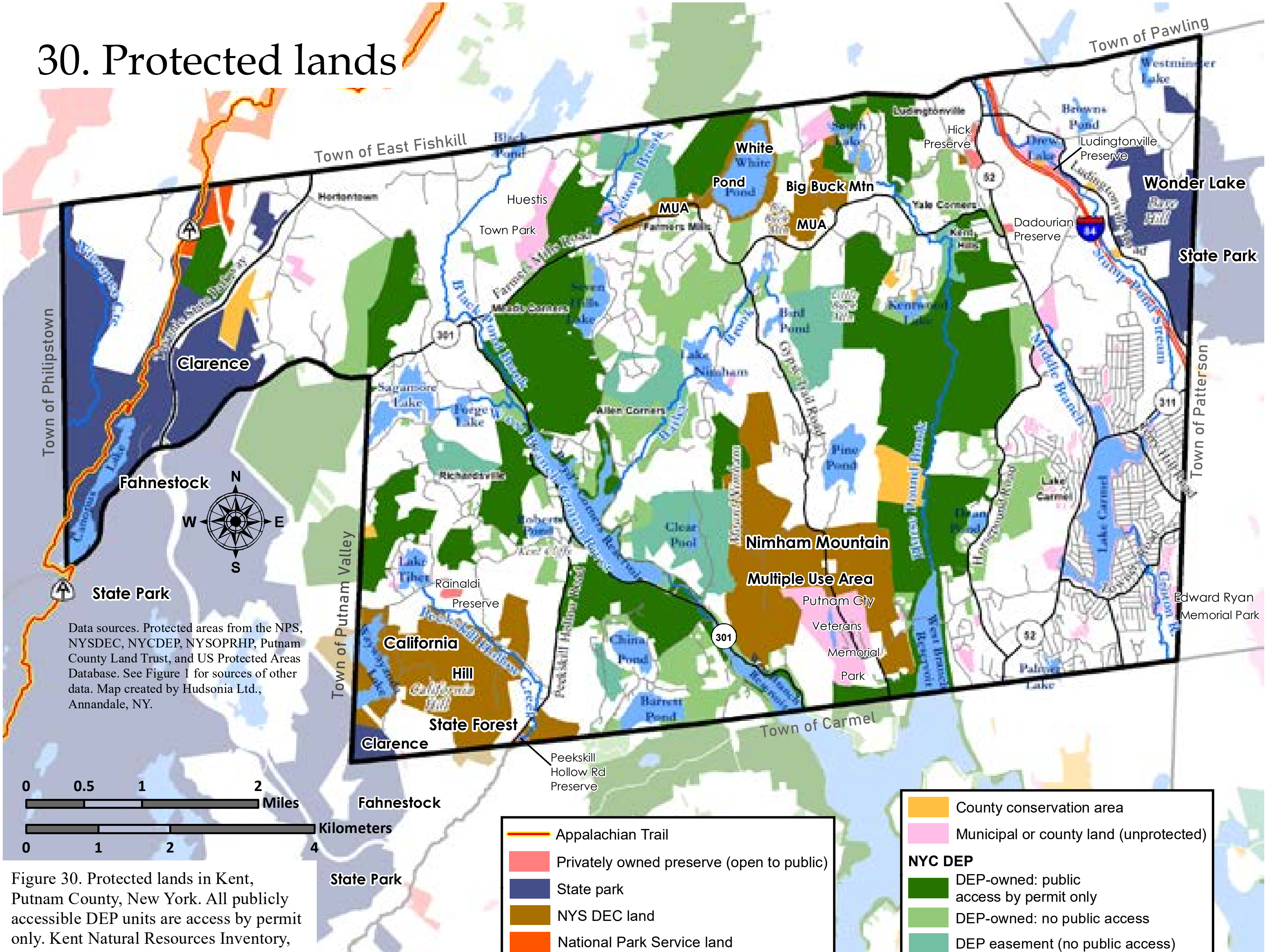


Figure 30. Protected lands in Kent, Putnam County, New York. All publicly accessible DEP units are access by permit only. Kent Natural Resources Inventory, 2023.

Below are outlined some of the existing legal protections for land areas and species in federal, state, and local laws, and additional protections for lands within the NYC reservoir watersheds. See the **Achieving Conservation Goals** section for ideas for local measures that can extend protections to other areas and resources of concern.

Mining

A permit from NYSDEC is required for commercial mining in New York, and mining wastes must be disposed of properly, erosion on mine sites must be controlled, and mined lands must be reclaimed and returned to productive condition according to the mined land reclamation law (Article 23, Title 27 of the Environmental Conservation Law [ECL]). Regulations and a permitting program designed to achieve these goals have been established by NYSDEC (6NYCRR Parts 420-425). Exempted from the permit requirements are excavations of less than 1000 tons or 750 cubic yards per year, whichever is less; or less than 100 cubic yards per year in or adjacent to any body of water not subject to permitting under the Protection of Waters Program (ECL Article 15); or excavation associated with onsite construction or farming.[243]

Commercial mining is now prohibited in the Town of Kent.

As of a 2023 revision to Kent's local code, extraction and removal of mineral material from a site for commercial, industrial, or municipal use is now prohibited, and the spatial extent and volume of excavations for other purposes is limited without a permit.

Navigable Waters

As defined in Section 404 of the federal Clean Water Act, "navigable waters are...those waters that are subject to the ebb and flow of the tide and/or are presently used or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce."

Wetlands

Federal Wetland Regulatory Program

Section 404 of the federal Clean Water Act (CWA) is the basis for the federal wetland regulatory program, which is administered by the US Army Corps of Engineers (ACOE), sometimes in consultation with the US EPA and other federal agencies. The federal government regulates activities in "navigable waters" and wetlands of any size that are connected to those waters.

The CWA prohibits certain kinds of activities (especially filling) in jurisdictional wetlands without a permit. It imposes no standard setback or buffer zone around wetlands or along streams, although those may be imposed on a case-by-case basis at the discretion of the ACOE.

The interpretations of criteria for navigability and connectivity under the CWA have been in flux in recent decades. At the time of the publication of this *NRI*, we are governed by a May 2023 decision by the US Supreme Court (*Sackett vs. Environmental Protection Agency*), which holds that only wetlands with a continous surface connection to navigable waters are jurisdictional under the CWA. This is a huge departure from longstanding interpretations of the CWA by federal agencies and the courts, and effectively eliminates federal protections from most streams and wetlands. Excluded from federal jurisdiction are many intermittent streams, many wetlands that are connected to perennial waters only by intermittent streams, and many wetlands—such as vernal pools—that lack a surface water connection to intermittent or perennial streams or other permanent waters.

The NWI maps (Figure 10) created by the US Fish and Wildlife Service show many wetlands but 1) show inaccurate wetland boundaries, 2) omit many small wetlands and even some large ones, 3) include many wetlands that do not fall under federal jurisdiction, and 4) exclude many that do. The ACOE does not use the NWI maps to determine federal jurisdiction.

Under the ACOE's "Nationwide Permit" program, certain kinds of activities in jurisdictional wetlands and streams are allowed if the anticipated impacts fall beneath certain thresholds. There are 54 Nationwide Permits described for the ACOE district that includes Putnam County, each for a different kind of activity and with different thresholds of impacts allowed. For example, Nationwide Permit 29, for residential developments, allows filling of up to ½ acre of nontidal wetland as long as General Permit Conditions are adhered to and "the project is designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable." The permittee must submit a Pre-Construction Notification to the ACOE, and the ACOE may impose additional conditions on the project. Nationwide Permits for this district are described at https://www.nan.usace.army.mil/Missions/Regulatory/Nationwide-Permits/. Projects with wetland impacts exceeding the 1/2–acre threshold must apply for an "individual permit" which requires a lengthier review by the ACOE.

New York State Wetland Regulatory Program

The New York State Freshwater Wetlands Act (Article 24 of the New York ECL) specifies the kinds of activities that can and cannot legally occur in or near state-jurisdictional wetlands—which includes wetlands that are 12.4 acres and larger and a few smaller wetlands "of unusual local importance." The most typical instances of the latter are wetlands connected to a public drinking water supply, or wetlands known to support a state-listed Threatened or Endangered animal. The law also regulates activities in a 100-foot-wide "adjacent zone" around the perimeter of any state-jurisdictional wetland. Most wetlands in New York do not fall under state jurisdiction, however, because they meet neither the size nor the "unusual local importance" criteria and do not appear on the NYS Freshwater Wetlands Maps.

Most wetlands in New York are unprotected by federal and state wetland laws.

Thus, due to their small size or hydrological isolation, most of our intermittent woodland pools (vernal pools), isolated swamps, and isolated wet meadows receive no protection in federal or state law. Small, isolated wetlands can have great value for biodiversity and for water management, however, and it is often the very isolation that imparts their special value to certain plants or animals. In the case of vernal pools, for example, the isolation from streams and other wetlands helps to maintain the fish-free environment that is a critical factor for the pool-breeding amphibians of conservation concern. (See discussion of these pools in the **Biological Resources** section, above.)

The New York State Freshwater Wetland Maps show the wetlands that are protected under the NYS ECL. Like the federal NWI maps, the state wetland maps show inaccurate wetland boundaries and exclude some wetlands that would otherwise meet the jurisdictional criteria. Although NYSDEC uses the maps to determine which wetlands are jurisdictional, it does not rely on those maps to determine the actual boundaries of the wetlands, but instead requires on-the-ground, site-specific delineations. The online versions of the Freshwater Wetland Maps also show a ca. 500-foot-wide "check zone" around each mapped wetland (such as on the NYSDEC Environmental Mapper or the Hudson Valley Natural Resource Mapper). The check zone is an area within which the actual wetland boundary may occur, and the NYSDEC recommends an onsite wetland delineation prior to planning any regulated disturbance within the mapped wetland or check zone area.

State wetland protections are slated to change in 2025 and 2028.

In 2022, the New York State Assembly included provisions in the 2022–23 budget that represent significant reforms to the freshwater wetland regulatory program. For example, the reforms would:

- eliminate the jurisdictional use of the existing state Freshwater Wetlands Maps as of 2025;
- lower the minimum size for jurisdictional wetlands from 12.4 to 7.4 acres as of 2028;
- include additional criteria for identifying smaller wetlands of "unusual local importance," such as attenuation of flooding, filtering drinking water, providing habitat for rare species, increasing climate resiliency, sequestering carbon, or location in an urban area; and
- provide funding for wetlands management and local mapping of freshwater wetlands through the Climate Smart Communities Program in the NYS Environmental Protection Fund (Part QQ of Chapter 58 of the Laws of 2022).

A fuller description of the history of NYS wetlands regulations and the 2022 reforms is in an article in the *New York Law Journal*.[244]

New York City Watershed Regulations

For land within the watersheds of drinking water reservoirs in the New York City system, the NYCDEP regulates land uses with potential to affect the water quality and quantity in the reservoirs. These include siting of septic systems and sewage treatment systems; impervious surfaces near streams, ponds, or wetlands or near a NYC reservoir; diverting, piping, or crossing of streams; land clearing near reservoirs or on steep slopes; siting and design of landfills; and application or storage of hazardous materials. The regulations impose significant setbacks (e.g., 100-ft and 300-ft) from sensitive water resources, and require stormwater plans for new features in certain settings.

Town of Kent Wetlands Protections

The Town of Kent extends protections to many of the wetlands that are unprotected under the federal or state programs. The Kent town code defines locally jurisdictional wetlands as contiguous areas of 40,000 ft^2 and larger with wetland trees, shrubs, and/or emergent vegetation and a water table within six inches of the ground surface for at least three consecutive months of the year, or soil types that are poorly drained or very poorly drained, or are alluvial or floodplain soils. The full definition is in Chapter 39A-4 of the town code. Although this definition captures many wetlands that are excluded from federal or state regulations, it still leaves many small wetlands—including many vernal pools—unprotected.

The Town of Kent regulates activities in wetlands of 40,000 square feet (approximately one acre) and larger.

Streams

Federal Protection of Streams

Under Section 404 of the federal CWA, the federal government regulates activities in "waters of the United States" which include tidal wetlands and streams, and nontidal wetlands and streams affecting "navigable waters" and interstate waters, but the interpretation has been in flux for many years. See the discussion in the previous **Wetlands** section.

As of the May 2023 US Supreme Court decision (*Sackett vs. Environmental Protection Agency*), only perennial streams—those that run all year—are "navigable" and thus jurisdictional. Many of Kent's streams are now unprotected under the current interpretation of the federal CWA.

As for wetlands, some kinds of stream disturbance may fall under a Nationwide Permit (see above) and thus not require the lengthier "individual permit" process with the ACOE. For residential projects, for example, Nationwide Permit 29 applies to disturbances affecting up to 300 linear feet of a stream bed or banks. The federal government imposes no standard buffer zones along streams but can require a buffer zone on a case-by-case basis.

Among the General Conditions that apply to all Nationwide Permits is a requirement to maintain aquatic connectivity, which would apply to the design and installation of culverts: "[no] activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species. If a bottomless culvert cannot be used, then the crossing should be designed and constructed to minimize adverse effects to aquatic life movements."[245]

Northern water snakes prefer slow-moving or standing water, and slow-moving rivers and streams. Photo © John Kenny.

New York State Protection of Streams

A Protection of Waters permit is required for excavating or filling in "navigable waters" of the state and adjacent wetlands (Article 15 of the ECL). In this case, "navigable waters" include any rivers, lakes, ponds, and streams that can float a watercraft holding one or more persons. (This is different from the federal definition of navigable waters.) Exempted from this requirement are any waterbodies that are entirely surrounded by land held in a single private ownership.[246]

Maintaining aquatic connectivity is a requirement in the federal Nationwide Permit program.

Certain activities in and around streams and waterbodies are regulated based on the classification and use standard for those streams and waterbodies. A NYS Protection of Waters Permit from NYSDEC is required for excavating, filling, or disturbing the bed or banks of any stream with a classification of AA, A or B, or with a classification of C with a standard of (T) or (TS) (see the **Water Resources** section for explanation of these classes). These are collectively referred to as "protected streams." The bed and banks of protected streams are defined as the areas immediately adjacent to and sloping toward the stream. See Protection of Waters: Disturbance of the Bed or Banks of a Protected Stream or Other Watercourse for more information. NYSDEC water quality certification permits and ACOE permits may also be required for work involving streams.

The state law has no setback or buffer zone requirement along streams. No permit is required for disturbance of streams of other classes or for unclassified streams. Small ponds or lakes of ten acres or smaller and located within the course of a stream are considered to be part of the stream and are subject to the same regulations as that reach of the stream.

New York City Protection of Streams

In addition to any state and federal regulations, NYCDEP has separate regulatory authority over land uses with potential to affect the water quality and quantity in the drinking water reservoirs in the New York City water system. Within the watersheds of those reservoirs, the NYC jurisdiction extends to, for example:

- siting and operation of septic systems and sewage treatment systems;
- impervious surfaces near streams, ponds, wetlands or near a NYC reservoir;
- diverting, piping, or crossing a stream;
- building of structures near a stream;
- land clearing near reservoirs or on steep slopes;
- siting and design of landfills; and
- application or storage of hazardous materials, including fertilizers or pesticides.

Details of the NYC watershed regulations are at https://www.nyc.gov/assets/dep/downloads/pdf/watershed-protection/regulations/rules-and-regulations-of-the-nyc-water-supply.pdf.

Town of Kent Protection of Streams and Lakes

The Kent local code defines jurisdictional streams ("watercourses") as those that run in an identifiable channel for at least nine months of the year (Ch. 39A-4). The restrictions are similar to those for wetlands. A permit is required for draining, dredging, excavation, removal or deposition of materials, or any activity that might pollute the stream (Ch. 39A-5).

The Kent local code regulates activities in waterbodies of 5000 square feet and larger that hold standing water at least nine months of the year. The town also regulates activities in a buffer area measuring 100 feet wide along or around those waterbodies, or that has an elevation of less than three feet above the normal waterline (Ch 39A-4).

Water Quality

Certain activities that affect the water quality of streams and lakes require a permit from New York State; for example, constructing or using an outlet pipe for wastewater, a sewage treatment plant, or a concentrated animal feeding operation; construction activities disturbing one or more acres of soil; or stormwater runoff from industrial or municipal storm sewers. Siting and design of residential septic systems are subject to review and approval by the Putnam County Department of Health and the town. Pesticides applied to surface waters require a NYSDEC permit and may only be applied by a certified pesticide applicator. NYCDEP has additional regulatory authority in the reservoir watersheds for stormwater, septic systems, impervious surfaces, and application and storage of toxic materials (see above).

Habitats

Two tools that can help to protect important habitat areas when land is being subdivided are **cluster subdivision** and **conservation subdivision** design. The Kent town code defines a "cluster subdivision" design, but is vague on when it should be requested or required by the lead agency. A cluster subdivision is defined in the code as "A residential subdivision...where the dwelling units that would result on a given parcel under a conventional subdivision plan are allowed to be concentrated on a smaller and more compact portion of the land, and where a majority of the remaining land is left in its natural open space condition in perpetuity. Cluster subdivision development results in a flexibility of design and development to promote the most appropriate use of land, to facilitate the adequate and economic provisions of streets and utilities, and to preserve the natural and scenic qualities of open lands."

A "conservation subdivision" is not separately defined in the town code, but is a type of cluster subdivision that requires identifying, prioritizing, and protecting the most important natural areas and features of a site, and designing the clustered subdivision to set aside and permanently protect those areas from development.[247]

Woodchuck. Photo © John Kenny.

Wildlife

Under state law, it is illegal to take (i.e., kill, capture, trap, or disturb) many species of wildlife in New York, including but not limited to listed rare species (discussed above), songbirds, hawks, owls, snakes, lizards, most turtles, and salamanders. Animals considered "game" in New York can be taken, but only according to specific regulations including permits, bag limits, seasons, and hunting or trapping methods. Game species include deer, bear, bobcat, coyote, red fox, gray fox, raccoon, opossum, skunk, weasel, mink, muskrat, gray squirrel, eastern cottontail, wild turkey, ruffed grouse, ducks, geese, swans, ring-necked pheasant, shorebirds, blue jay, crows, rails, coots, most fishes, snapping turtle, most frogs, and others. A few wildlife species are afforded no protection by the state, including porcupine, red squirrel, woodchuck, house sparrow, starling, rock pigeon, and monk parakeet.

It is also illegal to collect, possess, or sell fish, wildlife, shellfish, crustaceans, aquatic insects, migratory birds, bird nests or eggs, or captive bred or disabled animals without a special license granted for education, exhibition, scientific research, or propagation purposes. Special protections for rare species of wildlife are described in the **Rare Species** section below.

Rare Species

The federal and New York State governments maintain lists of protected rare species and have laws intended to prevent harm to individuals and populations of those species. Most places in New York, however, have never been surveyed for rare species, so many of the locations where rare species occur are unknown. Hence, most land disturbance and land development takes place without anyone knowing whether or not rare species occur in the vicinity and could be harmed by the project. Many rare species are also difficult to detect, and determining their presence or absence often requires lengthy surveys conducted by experts during specific seasons.

Most sites have never been surveyed for rare species, but a habitat assessment can help determine whether certain rare species are likely to occur on a site.

Most species, however, are associated with particular kinds of habitats, so information on habitats can help determine where particular species are likely to occur. For example, a spotted turtle may use a marsh for foraging and a nearby gravel bank for nesting, but is unlikely to be found on a high-elevation ledge. An eastern meadowlark is likely to nest in a large upland meadow but not in a marsh. In these ways, understanding the kinds of habitats that a rare species uses will help to predict the places where the species might occur in Kent.

Unfortunately, there is no comprehensive habitat map for the town that would help significantly with habitat assessments for rare species. Figure 14 gives a rough picture of some of the habitats, based largely on automated remote interpretation of satellite imagery by the US Geological Survey, but the map cannot be relied on for accurate or detailed identification of habitats at a specific location.

Thus, an onsite habitat assessment is necessary to identify habitats of conservation concern prior to approving new development projects.

The NYNHP Conservation Guides for animals and plants are good sources for habitat information for many species. The Biodiversity Assessment Manual for the Hudson River Estuary Corridor provides information and guidance on carrying out habitat assessments, and the Kent town code (at §77-44.7) sets forth a standard for conducting a habitat assessment.

Below are brief descriptions of some of the federal, state, and local laws, policies, and procedures that can help to protect rare species and their habitats.

Federal Endangered Species Act

The Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884) prohibits unauthorized taking, possession, sale, and transport of federally-listed Endangered or Threatened species of plants and animals. The US Fish and Wildlife Service (USFWS) maintains and revises the list of plant and animal species deemed to be rare nationwide under the law, and assigns a rank of "Endangered" or "Threatened" to each. Only a few species in New York are on the federal list. In Kent those are Indiana bat[†] and northern long-eared bat.[†] Land development projects that may interfere with known locations of federally-listed Threatened or Endangered species must be reviewed by the USFWS.

New York State Environmental Conservation Law

Animals ranked as Endangered, Threatened, and Special Concern in New York are listed under 6 NYCRR Part 182 of New York ECL 11-0535. The regulations prohibit the taking of (or engaging in any activity likely to result in the taking of) any animal species listed as Endangered or Threatened in New York without a state-issued permit. The regulations also prohibit importing, transporting, possessing, or selling "any endangered or threatened species of fish or wildlife, or any hide or part thereof..." These regulations do not extend to animal species of Special Concern. These are species that NYSDEC believes deserve conservation attention, but current data does not warrant their listing as Threatened or Endangered. The regulations also do not apply to plants.

Plants ranked as Endangered, Threatened, Rare, or Exploitably Vulnerable are listed under ECL § 9-1503 Part (f): "It is a violation for any person, anywhere in the state to pick, pluck, sever, remove, damage by the application of herbicides or defoliants, or carry away, without the consent of the owner, any protected plant." ("Exploitably Vulnerable" plants are not rare but are vulnerable to being overharvested for commercial and personal purposes.) Thus, plants are considered the property of the landowner and are protected only to the degree that the landowner wishes. Under NYS law, any landowner can lawfully remove, damage, or destroy (or grant permission for others to destroy) state-listed rare plants on their own property, but others are not permitted to harm those plants without the landowner's permission.

Under New York State law, rare animals receive some protections, but protection of rare plants is solely at the discretion of the landowner.

Town of Kent Local Code

The State of New York grants considerable authority to municipalities to adopt zoning and other laws governing land use. For any resource, municipalities may adopt regulations that are equally or more protective than the state regulations of those resources. Many provisions in the Kent municipal code are intended to protect important natural resources of conservation concern, such as streams, ponds, wetlands, lakes, groundwater, and steep slopes.

The tufted titmouse is a common year-round resident in Kent, often seen at backyard birdfeeders. Photo © John Kenny.

The Kent local code contains no specific protections for rare species. It does require, however, that a biodiversity assessment be conducted for development applications involving property located within 300 feet of lakes, ponds, rivers, and streams, or within 800 feet of the edge of vernal pools and town jurisdictional wetlands. At the lead agency's discretion, a biodiversity study can also be required for any other application that comes before the Town Board, Planning Board or Zoning Board of Appeals (§77-44.7).

The biodiversity study is to be conducted by biologists "trained in the concepts of conservation biology and landscape ecology, and who have demonstrated a competence in surveying target species within Putnam County." The study is to include plants and animals listed as federal and state Endangered, Threatened, and Special Concern; "focal" species that may indicate high-quality habitats; and human-subsidized species that may indicate disturbed habitats. The code specifies some of the minimum standards for the study and for the biodiversity report that must be submitted to the lead agency.

Such a study carried out early in the planning for a new project would alert the applicant and the reviewing agency to the habitats and species of conservation concern that might be adversely affected, so that the proposed project could be designed to avoid or minimize those impacts.

Sunset from Nimham Mountain. Photo © Bill Volckmann.

ACHIEVING CONSERVATION GOALS

Male cardinal giving seeds to his mate. Photo © Barbara Gabarino.

Conservation of natural resources can happen on every land parcel in the town, whether it is a half-acre residential lot, a 50-acre wood lot, or a 200-acre farm or estate. It starts first with education, and can happen through a variety of means, including voluntary land management efforts of individual landowners, establishment of conservation easements by willing landowners, land trust acquisition of land from willing landowners by a conservation organization or a public agency, or restrictions imposed by legislation or by permitting decisions. Multiple courses of action and many different regulatory and non-regulatory tools are available to the town, such as 1) outreach to landowners and the general public on matters related to stewardship of important resources, 2) development of effective town policies, procedures, and legislation for natural resource conservation, and 3) collaboration with other agency and organization partners to accomplish goals that are beyond the capacity of the town to undertake by itself.

The 2008 Kent Comprehensive Plan recognizes three major categories of natural resources needing protection by actions of individuals and governments: the New York City drinking water reservoirs, the groundwater that supplies most of Kent's drinking water, and Kent's wetlands, lakes, ponds, and hills. To achieve these protections, the plan recommends

- establishing protections for ridgelines, steep slopes, hillsides, and bedrock outcrops;
- adopting standards, procedures, and regulations to protect the quality and quantity of groundwater;
- adopting septic system regulations; and
- improving stormwater management regulations and enforcement (and appointing a stormwater management inspector).

This *NRI* supports those goals, and provides ideas (below) for how they can be achieved, along with other ideas for sustainable uses and conservation of natural resources.

Conservation Tools

Landowner Education

Educating landowners about their potential stewardship roles can help raise awareness and support for conservation activities, and inspire voluntary action. Education can occur through outreach at community events, through lectures and workshops, through educational mailings, and through materials posted on the town website and on social media. For example, the Town of Ancram Conservation Advisory Council (Columbia County) has held workshops for landowners and others on the ecology and conservation of vernal pools and fens, and produced publications and memos on meadow management for grassland birds; environmental considerations associated with road salt applications; cautions about and alternatives to brush burning; detection and management of invasive species; streamside buffers, vernal pools, and effects of outdoor lighting on wildlife.[248]

Land Acquisition

Although the Town of Kent may rarely have funds available for acquiring lands for conservation purposes, it can nonetheless collaborate with other public and private entities to help with acquisition efforts for lands with special environmental, historic, agricultural, recreational, or scenic importance, or lands that are threatened by inappropriate development.

A decision to purchase a property for conservation purposes requires assessing the conservation values of the property in relation to the town's conservation goals and priorities, and determining the long-term capacity for stewardship of the property. Financial and other forms of collaboration with other agencies, organizations, and landowners can expand the opportunities for and success of land acquisition projects. Properties that have important conservation value but do not meet the town's criteria for acquisition may be referred to a partner organization.

Conservation Easements

A conservation easement is a legal agreement between a landowner and an entity such as a municipality or a land trust. The easement is developed by the landowner and the receiving agency (such as a land trust), and it permanently restricts the type, location, and amount of development and types of land uses that can occur on the property so that conservation values recognized by both entities—such as wildlife habitat, scenic views, agricultural value, and water resources—are protected forever. An easement may be donated by the landowner to the receiving agency, or may be purchased from the landowner by the receiving agency.

Easement lands remain in private ownership and on local tax rolls. The landowner retains full title to the land and is free to sell, lease, or mortgage the property, or pass it on to heirs. An easement "runs with the land;" that is, the restrictions and responsibilities are conveyed to all future owners of the property. Thus a conservation easement allows the current landowner to maintain ownership and use of the property, and secure a conservation legacy for future generations. Conservation easements with a land trust are completely voluntary, are developed on the landowner's initiative, and are designed to meet the wishes and long-term needs of landowners while adhering to the conservation principles of the land trust. Easements require regular (annual) monitoring to ensure that the terms of the land use agreement continue to be met. At the time of this *NRI* publication, the PCLT held no conservation easements in Kent, but the NYCDEP held conservation easements on 1043 acres in the town.

Land Use Legislation and Other Local Measures

Kent regulates land uses through zoning and other regulations that provide legal standards for reviewing development proposals and balancing private property rights with community concerns for environmental quality, public health, and safety. Carefully designed legislation and project reviews can ensure that any land use restrictions are applied consistently and fairly, and that resources important to town interests in the public welfare are protected.

Another means of drawing attention to significant natural resources is by establishing a Critical Environmental Area (CEA). A CEA is a geographical area with exceptional character with respect to one or more of the following:

- a benefit or threat to human health;
- a natural setting (e.g., fish and wildlife habitat, forest and vegetation, open space and areas of important aesthetic or scenic quality);
- agricultural, social, cultural, historic, archaeological, recreational, or educational values; or
- inherent ecological, geological or hydrological sensitivity that may be adversely affected by any change in land use (https://www.dec.ny.gov/permits/6184.html).

The purpose of establishing a CEA is to raise awareness of the unusual resource values (or hazards) that deserve special attention during environmental reviews and land use decisions. "Once a CEA has been designated, potential impacts on the characteristics of that CEA become relevant areas of concern that warrant specific, articulated consideration in determining the significance of any Type I or Unlisted actions, as classified in the SEQR process, that may affect the CEA."[249]

Thus, for any new development project subject to SEQR, the lead agency must explain in writing the potential impacts of the proposed project on the special characteristics of the CEA. The town can also adopt procedural or regulatory requirements to ensure that the important attributes of the CEA are considered in the siting and design of land development projects in those areas.

Another tool is a **Community Preservation Fund.** With authorization from the State of New York, municipalities can establish a Community Preservation Fund (CPF) by imposing a real estate transfer tax on properties whose sale price exceeds a certain minimum (e.g., the median sale price in town). The funds may be earmarked for establishment of parks or preserves, or purchase of recreation lands, aquifer recharge areas, important habitat areas, scenic areas, or historic sites, or purchase of conservation easements, and other purposes related to conservation of natural or cultural resources. Use of such a fund must be preceded by establishment of a **Community Preservation Plan** that identifies every project that the municipality plans to undertake with the CPF. All municipalities in Putnam County are authorized by the NYS Assembly to establish a CPF using the protocols established by the state.

The town may wish to develop an **Open Space Inventory** and an **Open Space Plan**. For this purpose, the NYS General Municipal Law, Section 247, defines open space as "any space or area characterized by (1) natural scenic beauty or, (2) whose existing openness, natural condition, or present state of use, if retained, would enhance the present or potential value of abutting or surrounding urban development, or would maintain or enhance the conservation of natural or scenic resources." An Open Space "Inventory" simply catalogs and maps the important open space resources in a municipality or other area of interest, and the land parcels that are involved. An Open Space "Plan" prioritizes areas for open space conservation and outlines ways to accomplish the conservation goals. Preparation of an Open Space Inventory and Plan is a natural follow-up to a Natural Resources Inventory. For such a project, the town would appoint an Open Space Committee to gather, compile, and analyze relevant information, and prioritize areas for open space protection. The resulting plan would help landowners, developers, conservation NGOs, and town agencies recognize the places that may be most important to protect.

Additional non-regulatory measures that can help to protect natural resources include:

- educating the public and land use applicants about techniques for protecting sensitive areas;
- establishing Best Management Practices for specific activities such as logging and farming, specifically addressing impacts to biodiversity and water resources;

- providing incentives to land use applicants willing to set aside certain important areas of development sites; or
- adopting environmental review procedures that foster a collaborative process between town agencies and applicants to design land development projects in ways that minimize harm to sensitive resources.

Conducting a habitat assessment in the early stages of planning a subdivision or a land development project helps the landowner, developer, and town agencies understand the biological resources and sensitivities of a site, and enables them to design the new project in ways that accommodate those features.

Conservation Partners

The effectiveness and breadth of a municipality's conservation efforts can be greatly extended by collaboration with other entities that have shared conservation goals, and by marshalling the efforts of active volunteers, willing landowners, and partner organizations and agencies in the town, county, region, and state. Some potential partners for Kent initiatives are listed below.

Federal Agencies

US Department of Agriculture (USDA)

The Natural Resource Conservation Service collaborates with farmers, communities, and other individuals and groups to protect natural resources on private lands. They identify natural resource concerns related to water quality and quantity, soil erosion, air quality, wetlands, and wildlife habitat, develop conservation plans for restoring and protecting resources, and help to direct federal funding to local conservation projects.

The federal Forest Legacy Program (FLP) is a grant program, initiated in the 1990 federal Farm Bill (16 U.S.C. Sec. 2103c) to protect important forest land from conversion to non-forest uses. Privately-owned forests in all of Putnam County are eligible for the FLP, and funds are available to conserve land with the assent of willing landowners. Participation in the program is entirely voluntary, and is intended to relieve some of the financial pressure on landowners who might otherwise feel the need to sell their land for development purposes.[250]

State and County Agencies

New York State Department of Environmental Conservation (NYSDEC)

The regional NYSDEC office conducts ongoing reviews of potential land protection projects based on priorities identified in the 2016 NYS Open Space Conservation Plan. Projects that fit the scope of a listed priority conservation project and pass a review process are eligible for funding from the NYS Environmental Protection Fund and other state, federal and local funding sources.

The New York Highlands is among the state-identified open space priorities. The USDA Forest Service also has identified this area as a high priority for conservation efforts, and the federal Highlands Conservation Act of 2004 (reauthorized in 2015) codifies its status as a "nationally significant landscape," with federal funding authorized for further conservation protection. Funding priority will be given to connections of existing protected lands and to the creation of a corridor comprising state parks, NYSDEC lands, Critical Environmental Areas, and Audubon-designated Important Bird Areas (IBAs), and other lands that span the length of the Highlands in New York.

The New York State Open Space Conservation Plan envisions a Northern Putnam Greenway extending from the Taconic Ridge on the east to the Hudson River on the west. The proposed greenway would help protect wildlife corridors, preserve scenic viewsheds in an area of high-growth pressure, protect the area's groundwater and the headwaters of the NYC Croton water supply system, and help to meet the increasing demand for outdoor recreation and education opportunities. It would connect many areas of the protected and semi-protected areas of the Highlands region including, in Kent, the Wonder Lake State Park, Big Buck Multiple Use Area, White Pond Multiple Use Area, Nimham Mountain Multiple Use Area, California Hill State Forest, and the Boyd's Corners region.

The NYSDEC's Climate Smart Communities program is a "state-local partnership to meet the economic, social and environmental challenges that climate change poses for New York's local governments." The program supports local governments and communities as they work to balance the goals of confronting and adapting to climate change, reducing local tax burdens, and advancing other community priorities. Participating communities are alerted to the availability of state and federal grants, have privileged access to certain state grants, and are part of a network of governments working to achieve "climate smart" practices and policies.

The Conservation and Land Use team of the NYSDEC Hudson River Estuary Program offers lots of information, materials, training programs, webinars, and workshops on biodiversity, conservation principles, best practices, and tools to identify and conserve important habitat and water resources, and technical assistance to help municipalities with local initiatives. The materials and programs are especially designed for town boards, city councils, planning boards, zoning boards, environmental commissions, and others engaged in land use planning and decision-making at the municipal level.

Other offices of NYSDEC can provide information and technical assistance with stream and lake monitoring, groundwater protection, floodplain mapping, and habitat protection.

New York State Department of State (DOS)

The DOS offers training opportunities, educational publications, and technical assistance for municipal agencies on a variety of topics including the SEQR process and developing local legislation. SEQR and local legislation can be powerful tools in the protection and stewardship of local resources.

Putnam County Soil and Water Conservation District

The District office provides technical assistance and education on matters related to water, soils, and other natural resources to municipalities, farmers, landowners, and residents, and promotes resource conservation and environmental stewardship. They host educational programs and provide consultations and other services to farmers, gardeners, and landowners.

Conservation Organizations

Hudson Highlands Land Trust (HHLT)

The HHLT seeks to protect watersheds, scenic resources, wildlife habitats, agricultural land, parklands, and natural ecosystems through land conservation, land stewardship, and public education. They work with private landowners, partner with local municipalities, and engage local communities in caring for natural resources. Their primary service area is west of the Taconic Parkway and, to date, they do not hold land or conservation easements in Kent.

New York–New Jersey Trail Conference (NYNJTC)

The NYNJTC is "a federation of member clubs and individuals dedicated to providing recreational hiking opportunities in the region and representing the interests and concerns of the hiking community. It is a volunteer-directed public service organization" that develops, builds, and maintains hiking trails, protects hiking trail lands through support and advocacy, and educates the public in the responsible use of trails and the natural environment. The NYNJTC is one of 31 clubs that maintain the Georgia to Maine Appalachian Trail under an agreement with the Appalachian Trail Conservancy. The Appalachian Train runs south-north through the high-elevation areas of the Kent panhandle.

Putnam County Land Trust (PCLT)

The PCLT seeks to protect forests, wetland, wildlife habitats, and water resources in and around Putnam County through ownership of sensitive lands, conservation easements, and environmental education. They work with governmental agencies, environmental organizations and the public to carry out their work. They own and manage 48 acres in Kent and, to date, have protected over 1100 acres elsewhere in the county. Their primary service area is east of the Taconic Parkway.

Local Businesses

Businesses are sometimes enthusiastic partners in conservation initiatives and should not be overlooked in the quest for funding, publicity, and in-kind assistance. Local business owners may have a deep personal appreciation for and commitment to the town and the region, and also recognize that their business success is closely tied to the town's natural and cultural environment. Contributing to conservation efforts can offer business owners the personal satisfaction that comes with taking care of the places they love; can serve as an investment in the landscape that supports their customers and their livelihood; can demonstrate their commitment to conservation and the community as a prominent aspect of their business profile; and can help build positive relationships with the community.

Landowners and Others

Private owners of large land parcels or of smaller parcels containing important resources play a critical role in the future of land conservation and can be essential partners in conservation action and funding. Landowners can carry out specific measures to protect habitats and water resources on their own land; can collaborate with their neighbors to protect and manage resources in nearby areas; and can assist the town with larger conservation efforts. Landowners in Kent are diverse and represent a broad spectrum of views on conservation. Town-sponsored conservation efforts can benefit from reaching out to landowners on a regular basis to build partnerships and to understand owners' interests, goals, and concerns. Education programs can help landowners understand the role they play in shaping their community's future landscape and the available options for land management and land conservation.

Local professionals, such as biologists, ecologists, teachers, environmental engineers, and landscape architects, as well as amateur naturalists often have a wealth of knowledge and expertise related to local natural resources. Many have a strong personal interest in resource conservation and some can offer their volunteer services to the town for technical assistance, grant-writing, or public education. The town should remember to call on such local expertise when appropriate.

Recommendations for Conservation Action

The Kent *NRI* Steering Committee has studied the natural resources of the town, their roles in local ecosystems, and the ways that they serve the people of Kent. We recognize that taking care of the land is the responsibility of everyone who lives here. Town government can help by educating landowners, strengthening regulatory protections for natural resources, and fostering a culture of sound stewardship. To help ensure that wetlands, streams, groundwater, soils, forests, meadows, and other natural features continue to support the Kent community, the committee has developed the recommendations outlined below. Some are for actions that can be taken by landowners or by developers who are contemplating new land uses; some are for strengthening the existing local code or improving environmental review procedures; and some are for new town initiatives to respond to climate change and other emerging threats. All help to advance the vision and goals set forth in the town's Comprehensive Plan.

Town Legislation

1. Revise the town code to extend protections to small wetlands (smaller than 40,000 sq. ft.), including vernal pools, and intermittent streams because of their critical importance to ecosystems and water supplies. (Pages 54, 56-57, 149, 151)
2. Revise the town code to prohibit construction of new buildings, roads, driveways, and other structures in the 100-year and 500-year flood zones identified by FEMA, and in other places known to be subject to frequent or infrequent flooding along streams and lakes. Encourage the removal of structures, equipment, and materials that could interfere with natural flood dynamics, or create local or downstream hazards during flood events.
3. Strengthen the Cluster Conservation Subdivision Design provisions in the town code so that Conservation Subdivision Design is the default for all proposed subdivisions of ten or more lots, or on parcels of ten acres and larger. (Page 151)
4. Adopt "Dark Skies" legislation to minimize light pollution from new and existing development sites. (Page 121)
5. Revise the town code to allow development of "pollinator yards" with unmowed grasses and forbs that support pollinating insects and other native biodiversity. (Pages 67, 136)
6. Adopt or improve design standards for all land development projects to ensure that harm to sensitive areas is minimized. Standards could address:
    a. habitat fragmentation and landscape connectivity (Pages 76, 118-120, 134,136)
    b. design, sizing, and installation of culverts (to ensure adequate capacity and maintain connectivity of stream habitats) (Pages 72, 119-120)
    c. exterior lighting (to reduce ecological and scenic impacts) (Pages 121, 125)
    d. soil erosion (to reduce soil loss and sedimentation of streams, ponds, and wetlands) (Pages 94, 117, 120, 123)
    e. stormwater management (to reduce surface runoff and promote groundwater recharge) (Pages 117, 131, 155)
    f. scenic resource and ridgeline protection protocols (Pages 130, 142)

7. Strengthen legislation to monitor and improve residential septic systems near waterbodies. (Pages 53, 121, 126, 155)
8. Strengthen the town code to require that any entity undertaking blasting for any purpose monitor the drinking water supplies on nearby properties.
9. Establish a tree ordinance that would discourage forest clearing in floodplains, and prohibit clearcutting of >5000 ft^2 on slopes of ≥ 25 percent, and protect large (≥24” dbh) or old (≥150 years) trees. (Pages 24, 117, 120)
10. Create local funding, such as a Community Preservation Fund (CPF), for land acquisition, purchase of conservation easements, and other measures that the town deems important for natural resource conservation. (Page 157)

Town Policy, Projects, and Procedures

1. Apply the *NRI*'s general conservation measures (in the **Conservation of Natural Resources** section) on lands throughout the town, where applicable. (Pages 133, 137, 141, 142, 144)
2. Conduct a townwide groundwater study and develop a groundwater protection plan that would inform an eventual Groundwater Protection Overlay District or other revisions to the local code. (Pages 20-22, 131)
3. Conduct and document a townwide survey of scenic and historic locations, so that those areas can be considered in land use planning and environmental reviews of land development projects. The survey could lead to nomination of certain road segments as Scenic Byways. (Pages 96-97, 130)
4. Review and update the Kent Comprehensive Plan, and incorporate new information for response and adaptation to climate change. (Pages 113-117, 127-128)
5. Acquire small vacant parcels at strategic locations in densely-settled neighborhoods to use as stormwater detention areas or for other public purposes.
6. Establish an Open Space Committee for the purpose of developing an Open Space Inventory and Plan for the town. (Page 157)
7. Adopt roadway maintenance practices for town roads and town-owned parking lots and driveways that reduce applications of road salt, and especially in the vicinities of streams, ponds, unconsolidated aquifers, and other sensitive areas. (Pages 116-117)
8. Manage stormwater runoff from town roads, town-owned parking areas, and driveways to promote onsite infiltration of water to the soils. (Pages 116-117, 156)
9. Promote establishment of conservation easements on key parcels to protect habitats and prevent contamination of streams and lakes due to overdevelopment. (Page 156)
10. Apply lower property assessment values to lands that qualify for agricultural assessments and properties with conservation easements. (Page 94)
11. Discourage disturbance of floodplain forests.(Page 24)
12. Find municipal grants or other means to help defray the cost to homeowners of septic system upkeep and replacement. (Pages 33, 117, 121, 126)

13. Manage town-owned lands in ways that exemplify sound conservation principles (e.g., buffer zones along streams, and bioretention installations to manage stormwater). (Pages 132, 136)
14. Consider impacts to water resources, sensitive habitats, good farmland soils, and important scenic and recreational resources at the earliest stage of reviewing land development projects. (Pages 97, 136, 157)
15. Encourage members of the Town Board, Planning Board, Zoning Board of Appeals, and Conservation Advisory Committee to attend training webinars and workshops on topics related to biodiversity and water resource conservation. (Page 159)
16. Educate townspeople about alternative environment-friendly de-icing products or methods for business and home use. (Pages 116-117)
17. Educate residents who live along streams and lake shores about land management for water resource protection. The booklet titled *Life at the Water's Edge* is a good starting place.

Landowner and Citizen Actions

1. Apply the NRI's general conservation measures in the **Conservation of Natural Resources** section to lands throughout the town, where applicable. (Pages 133, 137, 141, 142, 144)
2. Remove structures and hazardous substances from floodplains wherever possible, and shift to flood-resilient land uses to minimize economic losses from flood damage, flood hazards to downstream areas, soil loss, and stream contamination. Some appropriate land uses are forests, hayfields, pastures, and unmowed oldfields (without structures). (Pages 132, 136)
3. Maintain and restore floodplain forests wherever possible. (Pages 24, 132)
4. Adopt wildlife-friendly landscaping practices, such as replacing lawn areas with wildflower patches, and using native species of trees, shrubs, and perennial and annual ornamentals instead of non-natives and cultivars. (Page 136)
5. Adopt wildlife-friendly agricultural practices that protect water supplies, build living soils, support native pollinators, and accommodate ground-nesting birds. (Pages 53, 58, 67, 76-77, 94, 121, 130, 133, 141)
6. Eliminate or minimize applications of polluting substances to the land, such as de-icing salts to driveways and walkways, and pesticides and fertilizers to lawns, gardens, and cropfields. Use porous pavement for driveways where possible. (Pages 116, 133)
7. Establish conservation easements with a local land trust on parcels of ten acres and larger, and on smaller parcels with exceptional importance for biodiversity or water resources. (Page 156)

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APPENDICES

APPENDIX A
GLOSSARY

allelopathy
The chemical inhibition of one species by another. In this *NRI*, the term is applied to interactions between plants. Allelopathic chemicals, which can be found in stems, leaves, flowers, roots, or fruits, may influence the germination, growth, survival, or reproduction of other plants.

alluvium
Material, such as sand, silt, clay, and gravel, deposited on land by moving water.

amphibolite
A coarse-grained metamorphic rock composed mainly of green, brown, or black crystalline (amphibole) minerals and plagioclase feldspar.

anadromous
Migrating from the ocean to spawn in freshwater

argillite
A fine-grained compact rock derived from mudstone or shale.

aquifer
A water-bearing formation, e.g., in bedrock fractures or solution cavities, or in unconsolidated surficial material such as sands and gravels.

area-sensitive wildlife
Wildlife species that require large contiguous habitat areas to meet their life history needs and maintain local populations. Some of these species have large home ranges; some require a complex of habitats distributed over the landscape. They may be especially sensitive to human disturbance, or are vulnerable to predators or brood parasites that frequent habitat edges, or do not tolerate other habitat characteristics of habitat edges.

asl
Above sea level.

base flow (of a stream)
The sustained flow of a stream in the absence of direct precipitation or surface runoff. Natural base flow is sustained largely by groundwater discharges (https://water.usgs.gov/edu/dictionary.html).

bedrock
The solid rock either exposed or underlying soil, rock fragments, or other unconsolidated materials.

biodiversity
All the variety of plants, animals, and other living things. The term encompasses diversity at all scales, including landscapes, ecosystems, ecological communities, species, and their genes. From a conservation standpoint, ecologists are mainly concerned about native biodiversity—the biota that have established and developed in the region over millennia, but not the recent introductions since European settlement.

biotite
The name used for a large group of black mica minerals (sheet silicates) that are commonly found in igneous and metamorphic rocks.

bog
A wetland with permanently saturated soils that receives most of its water from precipitation instead of groundwater and typically accumulates a deep layer of peat.

bryophyte

Non-vascular plants, including mosses, liverworts, and hornworts, that reproduce by means of spores instead of flowers or seeds.

calcareous

Calcium-rich; containing high concentrations of calcium salts. The term is generally applied to water, soils, and bedrock. The source of calcium in this region is usually calcium carbonate (e.g., limestone), and thus calcareous environments are generally circumneutral or alkaline.

calcicole

A plant species that does best in calcium-rich environments (i.e., calcareous rock, soil, or water).

carbon sequestration

Capture and long-term storage of atmospheric carbon dioxide or other forms of carbon. Carbon sequestration, whether occurring artificially or by natural biological, chemical, and physical processes (such as the growth of a tree, or the accumulation of peat in a wetland), is a means of mitigating or deferring global warming.

catadromous

Migrating from freshwater streams to the ocean to spawn.

conifer forest

A forest dominated by conifer trees; i.e., where conifer tree species constitute >75% of the forest canopy. Conifers are cone-bearing trees such as white pine, eastern hemlock, tamarack, and eastern red cedar. The native conifers in this region have needle-like or scale-like leaves and are evergreen—that is, they maintain their leaves year-round. An exception is tamarack, which sheds its leaves in the fall. See "deciduous forest" for comparison.

conservation easement

A legal agreement drawn up by a landowner and a qualified public or private agency (such as a land trust) that ensures permanent protection of the land. The landowner retains ownership with many of its rights and responsibilities (including property taxes), and can live on, use, or sell the land or pass it on to heirs, but the conservation easement remains attached to the land in perpetuity. The easement is designed to serve the conservation goals of the landowner and easement holder (e.g., the land trust), and describes permissible and impermissible land uses and land management.

Critical Environmental Area

A geographical area with exceptional character with respect to a benefit or threat to human health; a natural setting; agricultural, social, cultural, historic, archaeological, recreational, or educational values; or inherent ecological, geological or hydrological sensitivity that may be adversely affected by any change in land use. A CEA must be formally delineated, mapped, described, and adopted by the municipal legislative body, and registered with the NYS Department of Environmental Conservation (https://www.dec.ny.gov/docs/permits_ej_operations_pdf/part617seqr.pdf). The purpose of establishing a CEA is to raise awareness of the unusual resource values (or hazards) that deserve special attention during environmental reviews and land use decisions.

deciduous forest

(Also called a "hardwood forest.") A forest dominated by deciduous trees; i.e., where deciduous tree species constitute >75% of the forest canopy. Deciduous trees are those that shed their leaves annually. In this region, deciduous trees include oaks, maples, ashes, cherries, beech, and many others. See "conifer forest" for comparison. (Tamarack is the unusual case of a deciduous conifer.)

denitrification

The process by which nitrate (NO_3) is converted to nitrogen gas (N_2) and returned to the atmosphere.

ecosystem services

The resources and services provided by the natural environment that benefit the human community, such as purification of water and air, cycling of nutrients, mitigation of floods, dispersal of seeds, pollination of agricultural crops, control of agricultural pests and human disease organisms, and production of timber, fish, wild game, and other wild foods.

edge effects

The influences of habitat edges on interior habitats and species. These may include the effects of noise, light (natural or artificial), wandering pets, accessibility to predators and nest parasites, and pollution introduced from human activities at the habitat edges. Certain edge effects occur at the edges between natural habitats as well as those between natural habitats and human-disturbed areas.

Farmland Soils of Statewide Importance

A designation of the Natural Resource Conservation Service for soils that are nearly as productive as "Prime Farmland Soils" and that produce high yields of crops when properly managed.

fen

As used in this *NRI*, an open, herb- and low shrub-dominated wetland fed by calcareous groundwater seepage. This habitat has a distinctive plant community that, in this region, often includes such species as shrubby cinquefoil (*Dasiphora fruticosa*), grass-of-parnassus (*Parnassia glauca*), bog goldenrod (*Solidago uliginosa*), and woolly-fruit sedge (*Carex lasiocarpa*).

flood attenuation

The effects of storing and retaining floodwater and slowly releasing it to the groundwater, a stream, or other water body, thereby reducing the peak downstream flows.

floodplain

The area bordering a stream that is subject to frequent or infrequent flooding.

forb

A broad-leaved herbaceous (non-woody) plant. (Compare to "graminoid.")

forest structure

The arrangement of vertical layers (such as ground layer, shrub layer, subcanopy, and canopy) and horizontal spacing of vegetation.

garnet

A semi-precious crystalline stone, usually dark red and translucent, used in jewelry and as an industrial abrasive.

glacial outwash

Coarse mineral material (gravel, sand) deposited by the melting ice of a glacier.

glacial till

Mixed mineral material (clay, silt, sand, rocks) transported and deposited by glacial ice, or by streams flowing from a melting glacier.

gradient

As used in this *NRI*, the change in the value of a quantity (such as elevation or temperature) with change in a given variable (such as distance or latitude). Thus, a slope gradient may be steep or gentle. Certain climate gradients may be perceptible or measureable between southern and northern geographic areas, or between lower and higher elevations.

graminoid

A grass-like plant. Graminoids includes grasses (Poaceae), sedges (Cyperaceae), and rushes (Juncaceae).

graywacke

An impure gray sandstone.

green infrastructure

An approach to water management that incorporates natural systems (and mimicry of natural systems), sometimes in combination with engineered systems to protect, restore, or maintain water resources and ecosystem functions. Some examples are protection or restoration of floodplains, wetlands, or forests, or use of urban rain gardens, permeable pavement, green roofs, rainwater barrels, graywater retrieval systems, and vegetated swales.

groundwater

The water that resides beneath the soil surface in spaces between sediment particles and in rock fissures and cavities.

groundwater recharge

The process by which water flows or percolates from the ground surface to an aquifer—an underground water-bearing formation in bedrock or loose material such as sand or gravel.

HAB

Harmful algal bloom. Rapid growth of algae or cyanobacteria in waterbodies that can cause harm to people, wildlife, and ecosystems. Some blooms produce toxins or release harmful gases, and the decay of the cyanobacteria or algae tends to deplete dissolved oxygen in the waterbody.

habitat

The place or environment where an organism normally spends all or part of its life. A habitat is defined by both the biological (e.g., plants and animals) and the non-biological (soil, bedrock, water, sunlight, temperatures, etc.) components.

habitat assessment

As used in this *NRI*, an appraisal conducted by means of map analysis and field observations to identify and describe the character and condition of habitats and water features on a site, and the implications for land uses and conservation. A habitat assessment should be carried out by biologists familiar with habitats and biota of the region, and the life history needs of species of conservation concern.

habitat edge

The boundary between two different kinds of habitats or biological communities or between other different landscape elements.

habitat fragmentation
Dividing (by roads, driveways, utility corridors, other developed features) large, continuous habitat areas into smaller, more isolated remnants.

harmful algal bloom
See HAB.

headwaters
The upper reaches of a stream, near the stream's origin.

herbaceous
Non-woody. Herbaceous plants include, for example, forbs, graminoids, mosses, and liverworts.

hornwort
A non-vascular plant, closely related to mosses but differing in thallus (leaf-like) characteristics and reproductive structures. The group is named for the horn-like spore-bearing structure that protrudes from the surface of the thallus.

hydric soils
Soils formed under conditions of saturation for long enough during the growing season to develop anaerobic (oxygen-free) conditions near the ground surface. The presence of hydric soils is one of the three features necessary (along with wetland hydrology and hydrophytic vegetation) for identifying an area as wetland.

hydroperiod
The depth, duration and seasonal pattern of inundation or soil saturation.

impervious surface
A surface such as roofs, pavement, or compacted soils that impedes or prevents the local infiltration of water to the soils or underlying substrate.

intermittent stream
A stream that typically flows for only part of the year.

intermittent woodland pool
A vernal pool (see below) in a forested setting.

invertebrate
An animal that lacks a spinal column. Invertebrates include insects, mollusks, crustaceans, nematodes, spiders, centipedes, protozoans, and a host of other macroscopic and microscopic organisms.

kame
An irregular hill or short ridge composed of mineral material deposited by a glacier.

lacustrine deposits
Sand, silt, and clay particles that settled on the bottom of an ancient lake.

landform
A natural feature on the Earth's surface such as a hill, valley, plain, or ravine.

LiDAR
Light Detection and Ranging—a method of remote sensing that uses pulsed laser to measure variable distances between the instrument (on an aircraft) and the Earth. Images produced by LiDAR depict details of the ground surface that are obscured by vegetation in aerial photographs.

limestone
A fine-grained sedimentary rock composed of calcium carbonate.

liverwort
A non-vascular plant, closely related to mosses but differing in thallus (leaf-like) characteristics and reproductive structures.

marble
A medium-grained metamorphic rock of interlocking calcite crystals derived from limestone.

marsh
A wetland that typically has standing water for a prolonged period during the growing season, and is dominated by herbaceous (non-woody) vegetation with species such as cattail, bur-reed, pond-lily, and arrowhead.

mesopredator
A mid-ranking predator in a food web. Some examples in our habitats are foxes, raccoon, skunk, bobcat, and snakes.

microclimate
The climate of a very localized area: for example the hot, dry conditions on a rocky barren in summer, or the cool, moist conditions beneath a rotting log on the forest floor.

microhabitat
A very localized habitat with characteristics distinct from those of the larger surrounding habitat; for example, a tree cavity within a deciduous forest, or a woody hummock within a swamp.

native species
A plant or animal species that is indigenous to the region; that is, a species that arrived here by natural dispersal processes and not by human agency.

NGO
Non-governmental organization.

non-native species
A plant or animal introduced to the region by human agency, intentionally or unintentionally. (See "native species" for comparison.)

non-point source pollution
Pollution emanating from a diffuse source such as unchannelized runoff from a paved parking lot or an agricultural field. (See point-source pollution.)

NYCDEP
New York City Department of Environmental Protection.

NYNHP
New York Natural Heritage Program, an agency that serves as a repository and clearinghouse for information on the occurrence, distribution, and status of plants, animals, and natural communities in the state.

NYSDEC
New York State Department of Environmental Conservation.

organic duff
The accumulation of organic matter on the forest floor, usually in many stages of decay.

organic material
As used in this *NRI*, carbon-based matter composed of feces and remains of plants, animals, and other organisms—for example, twigs, leaves, and carcasses—in all stages of decay.

parasitoids
An insect whose larvae live as parasites and eventually kill their hosts,

peat
Partially decomposed organic matter that accumulates under conditions of prolonged water saturation.

perennial stream
A stream that typically flows year-round.

phyllite
A fine-grained metamorphic rock intermediate in grade between slate and schist.

point-source pollution
Pollution emanating from a single point, such as an industrial chimney or a discharge pipe from a sewage treatment plant. (See non-point source pollution.)

Prime Farmland Soils
A designation of the Natural Resources Conservation Service for soils that have the best combination of physical and chemical characteristics for producing crops.

quartzite
A hard and durable medium-grained metamorphic rock derived from sandstone.

reach
(As in "stream reach") a segment of stream or river defined by geographic markers, such as river miles, natural features, or political boundaries.

remote sensing
Detecting the physical characteristics of an area from a distance. Typically the term refers to interpretation of satellite or aerial photo imagery and map data to analyze the landscape.

resiliency
As used in this *NRI*, the capacity to withstand, recover from, and adapt to stresses such as those imposed by floods, wildfires, droughts, or climate change.

riparian
Within or adjacent to a stream or river.

riprap
Layer of rock placed along a streambank or shoreline to prevent erosion.

sandstone
A sedimentary rock composed of sand-size grains of cemented mineral and rock particles.

schist
A medium-grained, layered metamorphic rock derived from shale.

seep
Diffuse groundwater discharge to the ground surface. (Compare with "spring.")

SGCN
Species of Greatest Conservation Need: a list drawn up by NYSDEC that includes 1) species on the federal list of endangered or threatened species that occur in New York; 2) species listed as NYS endangered, threatened, or special concern; 3) species with 20 or fewer elemental occurrences in the New York Natural Heritage Program database, and 4) other species deemed by NYSDEC to be of greatest conservation need due to their status, distribution, and vulnerability.

shale
A fine-grained thinly layered sedimentary rock derived from silt and clay.

slate
A fine-grained metamorphic rock derived from shale.

snag
A standing dead tree.

soils
Organic or unconsolidated mineral materials that have been acted on by weathering and organic processes.

spring
Concentrated groundwater discharge to the ground surface (Compare with "seep.")

sub-basin
The watershed of a tributary to a larger stream.

submerged aquatic vegetation
Plants that grow beneath the surface in shallow water areas, but do not emerge above the water surface; "SAV."

surficial deposits
Loose material transported and deposited over bedrock. Material may be transported by glaciers (e.g., glacial till, glacial outwash) or by moving water (alluvium).

swamp
A wetland dominated by woody vegetation (trees or shrubs).

talus
Loose rock debris that accumulates below an exposed bedrock ledge.

thatch
Undecomposed, dead plant material that accumulates on the soil surface of a meadow or lawn.

tributary
A stream that flows into a larger stream, river, or lake.

unconsolidated aquifer
Groundwater stored in saturated sand and gravel deposits.

upland
In this document, "upland" is equivalent to "non-wetland." The term implies nothing about elevation; upland areas can be at any elevation, low or high or anywhere in between.

vernal pool
A wetland—usually small—that is isolated from other wetlands or streams, and that typically holds water in winter and spring, but dries up at some time during the growing season. (See "intermittent woodland pool".)

viewshed
The entire area visible from a specified location and, conversely, the entire area from which that location is visible.

watershed
The entire land area that drains to a particular place such as a stream, wetland, or pond.

wetland
"[An area that is] inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances [does] support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (definition of wetlands regulated under the federal Clean Water Act: at 33 CFR 328.3[c][4]).

wet meadow
A wetland that typically has little or no standing water for most of the growing season, and is dominated by herbaceous (non-woody) vegetation.

APPENDIX B
DATA SHEETS FOR IMPAIRED WATERBODIES

Barrett Pond

(Segment ID 1302-0115) **NEEDS VERIFICATION**

Waterbody Segment Assessment Factsheet based on the 2021 NYSDEC Consolidated Assessment Listing Methodology (CALM)

Revised: December 07, 2021

Water Index No: H- 31-P44-23..P67..P71
Stream Class: B
Waterbody Type: Lake/Reservoir
Size: 72.2 Acres

Segment Description: Entire lake
Drainage Basin: Lower Hudson River
Hydrologic Unit Code: 0203010102
County: Putnam

Assessment of Best Use

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
Fishing	fully supported	unconfirmed	nitrite	IR3	N/A
Secondary Contact Recreation	fully supported	confirmed	phosphorus	IR1	N/A
Primary Contact Recreation	fully supported	confirmed	phosphorus	IR1	N/A

Water Quality Monitoring Data Used

Pollutant(s)	Data Source	Years
Nitrite	Citizen Statewide Lake Assessment Program (CSLAP)	2013
Phosphorus	Citizen Statewide Lake Assessment Program (CSLAP)	2011-2015, 2017

For more information, visit our website:
https://www.dec.ny.gov/chemical/36730.html

Boyd's Corners Reservoir

(Segment ID 1302-0045)

Waterbody Segment Assessment Factsheet based on the 2021 NYSDEC Consolidated Assessment Listing Methodology (CALM)

Revised: December 07, 2021

IMPAIRED SEGMENT (IR CATEGORY 4a)

Water Index Number: H-31-P44-23 (portion 6)/P76
Classification: AA
Waterbody Type: Lake/Reservoir
Size: 217.8 acres

Drainage Basin: Lower Hudson River
Hydrologic Unit Code: 0203010102
County: Putnam
Segment Description: entire reservoir

Assessment of Best Use

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
Fishing	impaired	confirmed	mercury, phosphorus	IR4a	2000, 2007
Secondary Contact Recreation	unassessed	-	-	IR3	N/A
Primary Contact Recreation	unassessed	-	-	IR3	N/A
Source of Water Supply	unassessed	-	-	IR3	N/A

Water Quality Monitoring Data Used

Pollutant(s)	Data Source	Years
Mercury	historical	-
Phosphorus	historical	-

Continued

Boyd's Corners Reservoir, cont.

Supplemental Indicator Information

Total Maximum Daily Load (TMDL) Information

For more information about Total Maximum Daily Loads (TMDLs), visit DEC's Clean Water Plans webpage.

Source	Pollutant(s)	TMDL Name
Non-Point Source	mercury	Northeast Regional Mercury 2007
Point Source and Non-Point Source	phosphorus	NYC Water Supply Phosphorus 2000
	phosphorus	NYC Water Supply Phosphorus 1997

For more information, visit our website:
https://www.dec.ny.gov/chemical/36730.html

Lake Carmel

(Segment ID 1302-0006)

Waterbody Segment Assessment Factsheet based on the 2021 NYSDEC Consolidated Assessment Listing Methodology (CALM)

Revised: December 07, 2021

Water Index Number: H-31-P44-23-P59-6-P62..P62a Drainage Basin: Lower Hudson River
Classification : B
Waterbody Type: Lake/Reservoir
Size: 186.6 acres
Hydrologic Unit Code: 0203010102
County: Putnam
Segment Description: entire lake

Assessment of Best Use

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
fishing	impaired	unconfirmed	dissolved oxygen	IR3	N/A
Secondary Contact Recreation	impaired	confirmed	algal weed growth	IR4c	2016
Primary Contact eRcreation	impaired	confirmed	algal weed growth	IR4c	2016

Water Quality Monitoring Data Used

Pollutant(s)	Data Source
Algal weed growth	historical
Dissolved oxygen	Div of Water's Lake Monitoring and Assessment Section

For more information, visit our website:
https://www.dec.ny.gov/chemical/36730.html

Lake Tibet

(Segment ID 1301-0034) **MINOR IMPACTS**

Revised: 06/02/2008

Water Index No: H-55-P183e
Stream Class: B
Waterbody Type: Lake
Size: 37.4 acres

Segment Description: entire lake
Drainage Basin: Lower Hudson River
Hydrologic Unit Code: 02030101020
County: Putnam
Quad map: Oscawana Lake (P-25-2)

Water Quality Problem/Issue Information

Use(s) Impacted	Severity	Problem Documentation
Public bathing	stressed	known
Recreation	stressed	known

Type of Pollutant(s)

Known: algal/weed growth (aquatic vegetation)

Suspected: problem species

Possible: nutrients

Source(s) of Pollutant(s)

Known: --

Suspected: habitat modification, onsite septic systems

Possible: --

Resolution/Management Information

Issue Resolvability: 3 (strategy being implemented)

Verification Status: 5 (management strategy has been developed)

Lead Agency/Office: ext/WQCC

Resolution Potential: medium

TMDL/303d Status: N/A

Continued

Lake Tibet, cont.

Further Details

Overview

Public bathing and other recreational uses in Lake Tibet are known to experience impacts due to aquatic weed growth. Various chemical and mechanical weed control measures have been undertaken over the years to manage aquatic weed impacts. Due to the lack of any current lake chemistry data, water quality monitoring of the lake is recommended.

Previous Assessment

Heavy aquatic weed growth that restricts recreational uses consistently occurs during the summer months. Chemical (copper sulfate) treatment was used in the 1960s and 1970s. Beginning in the early 1980s mechanical weed harvesting has been employed with varying levels of success. Diquat applications were used in the late 1980s. Lake water quality studies were performed in 1989 (Western Connecticut State University, 1989) and in 1991 (Aquatic Control Technology Inc for the Lake Tibet Association, 1991). The Lake Tibet Property Owners Association currently contracts (with Allied-Biological Inc.) to implement a herbicide program and mechanical measures to maintain the lake. Hydro-raking is being considered in addition to the chemical and mechanical control efforts already in place. (Lake Tibet Property Owners Association, May 2008).

Previous Assessment

This very shallow lake was once a wetland. Homes along the shore of the lake were reported to be served by inadequate and/or failing on-site septic systems (Putnam County WQCC, 1996).

Minor Tribs to Croton Falls Reservoir

(Segment ID 1302-0001)

Waterbody Segment Assessment Factsheet based on the 2021 NYSDEC Consolidated Assessment Listing Methodology (CALM)

Revised: December 07, 2021

Water Index No: H- 31-P44-23-P59-4 thru 10
Stream Class: B
Drainage Basin: Lower Hudson River
Size: 4.8 miles

Segment Description: total length of select tribs, northern/eastern shore
Waterbody Type: River/Stream
Hydrologic Unit Code: 0203010102
County: Putnam

Assessment of Best Use

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
Fishing	impaired	confirmed	dissolved oxygen, phosphorus	IR5	2018
Secondary Contact Recreation	impaired	confirmed	dissolved oxygen, phosphorus	IR5	2018
Primary Contact Recreation	impaired	confirmed	dissolved oxygen, phosphorus	IR5	2018

Water Quality Monitoring Data Used

Pollutant(s)	Data Source	Years
Dissolved oxygen	historical	-
Phosphorus	historical	-

For more information, visit our website:
https://www.dec.ny.gov/chemical/36730.html

Palmer Lake

(Segment ID 1302-0103)

Waterbody Segment Assessment Factsheet based on the 2021 NYSDEC Consolidated Assessment Listing Methodology (CALM)

Revised: December 07, 2021

Water Index No: H- 31-P44-23..P59- 5-P61a
Stream Class: B
Waterbody Type: Lake/Reservoir
Size: 14 acres

Segment Description: entire lake
Drainage Basin: Lower Hudson River
Hydrologic Unit Code: 0203010102
County: Putnam

Assessment of Best Use

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
Fishing	impaired	unconfirmed	dissolved oxygen	IR3	N/A
Secondary Contact Recreation	impaired	confirmed	phosphorus	IR4a	2015
Primary Contact Recreation	impaired	confirmed	phosphorus	IR4a	N/A

Water Quality Monitoring Data Used

Pollutant(s)	Data Source	Years
Dissolved oxygen	Division of Water's Lake Monitoring and Assessment Section	2013
Phosphorus	Citizen Statewide Lake Assessment Program (CSLAP)	2016-2017
Phosphorus	Division of Water's Lake Monitoring and Assessment Section	2013

Supplemental Indicator Information

Total Maximum Daily Load (TMDL) Information

Source	Pollutant(s)	TMDL Name
Point Source and Non-Point Source	phosphorus	Palmer Lake Phosphorus 2015

For more information, visit our website:
https://www.dec.ny.gov/chemical/36730.html

West Branch Croton Reservoir

(Segment ID 1302-0022)

Waterbody Segment Assessment Factsheet based on the 2021 NYSDEC Consolidated Assessment Listing Methodology (CALM)

Revised: December 07, 2021

Water Index No: H- 31-P44-23 (portion 4)/P67
Stream Class: AA
Waterbody Type: Lake/Reservoir
Size: 695.6 acres

Segment Description: entire lake
Drainage Basin: Lower Hudson River
Hydrologic Unit Code: 0203010102
County: Putnam

Assessment of Best Use

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
Fishing	impaired	confirmed	mercury, phosphorus	IR4a	2000, 2007
Secondary Contact Recreation	unassessed	-	no data	IR3	N/A
Primary Contact Recreation	unassessed	-	no data	IR3	N/A
Source of Water Supply	unassessed	-	no data	IR3	N/A

Water Quality Monitoring Data Used

Pollutant(s)	Data Source	Years
Mercury	historical	-
Phosphorus	historical	-

Continued

West Branch Croton Reservoir, cont.

Supplemental Indicator Information

Total Maximum Daily Load (TMDL) Information

Source	Pollutant(s)	TMDL Name
Non-Point Source	mercury	Northeast Regional Mercury 2007
Point Source and Non-Point Source	phosphorus	NYC Water Supply Phosphorus 2000
	phosphorus	NYC Water Supply Phosphorus 1997

For more information, visit our website:
https://www.dec.ny.gov/chemical/36730.html

White Pond

(Segment ID 1302-0122)

Waterbody Segment Assessment Factsheet based on the 2021 NYSDEC Consolidated Assessment Listing Methodology (CALM)

Revised: December 07, 2021

Water Index No: H- 31-P44-23..P79
Stream Class: A
Waterbody Type: Lake/Reservoir
Size: 140 acres

Segment Description: entire lake
Drainage Basin: Lower Hudson River
Hydrologic Unit Code: 0203010102
County: Putnam

Assessment of Best Use

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
Fishing	impaired	unconfirmed	dissolved oxygen	IR3	N/A
Secondary Contact Recreation	impaired	unconfirmed	dissolved oxygen	IR3	N/A
Primary Contact Recreation	impaired	unconfirmed	dissolved oxygen	IR3	N/A
Source of Water supply	impaired	unconfirmed	dissolved oxygen	IR3	N/A

Water Quality Monitoring Data Used

Pollutant(s)	Data Source	Years
Dissolved oxygen	Division of Water's Lake Monitoring and Assessment	2012-2013
Phosphorus	Citizen Statewide Lake Assessment Program (CSLAP)	2011-2015, 2017

For more information, visit our website:
https://www.dec.ny.gov/chemical/36730.html

APPENDIX C
PLANTS & ANIMALS

Appendix Table C-1. Common and scientific names of vascular plants mentioned in the Kent Natural Resources Inventory.

Scientific nomenclature follows the New York Flora Atlas (Werier et al. 2023).

Common Name	Scientific Name
alder	*Alnus*
ash	*Fraxinus*
ash, green	*Fraxinus pensylvanica*
ash, white	*Fraxinus americana*
aspen, quaking	*Populus tremuloides*
aster	*Symphyotrichum*
autumn-olive	*Elaeagnus umbellata*
azalea, early	*Rhododendron prinophyllum*
azalea, swamp	*Rhododendron viscosum*
barberry, Japanese	*Berberis thunbergii*
basswood, American	*Tilia americana* var. *americana*
beak-rush	*Rhyncospora*
beech, American	*Fagus grandifolia*
beechdrops	*Epifagus virginiana*
beggar-ticks	*Bidens*
beggar-ticks, smooth	*Bidens laevis*
bentgrass	*Agrostis*
birch, black	*Betula lenta*
birch, gray	*Betula populifolia*
bittersweet, oriental	*Celastrus orbiculatus*
blackberry, northern	*Rubus flagellaris*

Continued

Appendix Table C-1, Plants mentioned in the *NRI*, continued.

Common Name	Scientific Name
blackgum	*Nyssa sylvatica*
blueberry	*Vaccinium*
blueberry, highbush	*Vaccinium corymbosum*
blueberry, hillside	*Vaccinium pallidum*
blueberry, lowbush	*Vaccinium angustifolium*
bluecurls, common	*Trichostema dichotomum*
bluegrass, Kentucky	*Poa pratensis*
bluestem, little	*Schizachyrium scoparium* var. *scoparium*
brome, smooth	*Bromus inermis*
bur-reed	*Sparganium*
bush-clover, creeping	*Lespedeza repens*
butternut	*Juglans cinerea*
buttonbush	*Cephalanthus occidentalis*
canary-grass, reed	*Phalaris arundinacea*
cattail	*Typha*
cedar, Atlantic white	*Chamaecyperis thyoides*
cedar, eastern red	*Juniperus virginiana* var. *virginiana*
cherry	*Prunus*
cherry, black	*Prunus serotina* var. *serotina*
chestnut, American	*Castanea dentata*
clover	*Trifolium*
cottonwood, eastern	*Populus deltoides* ssp. *deltoides*
cottonwood, swamp	*Populus heterophylla*
cranberry	*Vaccinium*
cranberry, large	*Vaccinium macrocarpon*
cranberry, small	*Vaccinium oxycoccos*

Continued

Appendix Table C-1, Plants mentioned in the *NRI*, continued.

Common Name	Scientific Name
cucumber	*Cucurbita*
daisy, ox-eye	*Leucanthemum vulgare*
deerberry	*Vaccinium stramineum*
dodder, compact	*Cuscuta compacta*
dogwood, gray	*Cornus racemosa*
dogwood, silky	*Cornus amomum* ssp. *amomum*
duckweed	*Lemna or Spirodela*
elm, American	*Ulmus americana*
elm, slippery	*Ulmus rubra*
false-nettle	*Boehmeria cylindrica*
fern, blunt-lobed cliff	*Woodsia obtusa* ssp. *obtusa*
fern, bracken	*Pteridium aquilinum* ssp. *latiusculum*
fern, brittle bladder	*Cystopteris fragilis*
fern, cinnamon	*Osmundastrum cinnamomeum* var. *cinnamomeum*
fern, crested	*Dryopteris cristata*
fern, lady	*Athyrium angustum*
fern, lowland fragile	*Cystopteris protrusa*
fern, marsh	*Thelypteris palustris* var. *pubescens*
fern, royal	*Osmunda regalis* var. *spectabilis*
fern, sensitive	*Onoclea sensibilis*
fern, Virginia chain	*Woodwardia virginica*
flag, blue	*Iris versicolor*
flatsedge, red-rooted	*Cyperus erythrorhizos*
forget-me-not, smaller	*Myosotis laxa*
garlic-mustard	*Alliaria petiolata*
ginseng, American	*Panax quinquefolius*

Continued

Appendix Table C-1, Plants mentioned in the *NRI*, continued.

Common Name	Scientific Name
goldenrod	*Solidago*
goldenseal	*Hydrastis canadensis*
grass	*Poaceae*
grass, orchard	*Dactylus glomerata*
grass, poverty	*Danthonia spicata*
gum, black	*Nyssa sylvatica*
hackberry	*Celtis*
hairgrass, common	*Avenella flexuosa*
hawthorn	*Crataegus*
hazelnut	*Corylus*
heath	*Ericaceae*
hemlock, eastern	*Tsuga canadensis*
hickory	*Carya*
hickory, bitternut	*Carya cordiformis*
hickory, pignut	*Carya glabra*
hickory, shagbark	*Carya ovata* var. *ovata*
holly, winterberry	*Ilex verticillata*
honeysuckle, Bell's	*Lonicera x bella*
hornbeam, American	*Carpinus caroliniana* ssp. *virginiana*
huckleberry, black	*Gaylussacia baccata*
jewelweed, common	*Impatiens capensis*
Joe-Pye-weed	*Eutrochium maculatum* var. *maculatum*
knapweed	*Centaurea*
knotweed, Japanese	*Reynoutria japonica* var. *japonica*
lady's-slipper, pink	*Cypripedium acaule*

Continued

Appendix Table C-1, Plants mentioned in the *NRI*, continued.

Common Name	Scientific Name
larch, American	*Larix laricina*
larch, European	*Larix decidua*
laurel, mountain	*Kalmia latifolia*
laurel, sheep	*Kalmia angustifolia* var. *angustifolia*
leatherleaf	*Chamaedaphne calyculata*
leek, wild	*Allium tricoccum*
lichen, rock tripe	*Umbilicaria*
lily, Canada	*Lilium canadense*
locust, black	*Robinia pseudoacacia*
loosestrife, purple	*Lythrum salicaria*
madder, wild	*Gallium album*
maleberry	*Lyonia ligustrina* var. *ligustrina*
mannagrass	*Glyceria*
maple	*Acer*
maple, red	*Acer rubrum*
maple, sugar	*Acer saccharum*
meadowsweet	*Spiraea alba* var. *latifolia*
mercury, three-seeded	*Acalypha virginica*
milkweed	*Asclepias*
milkweed, swamp	*Asclepias incarnata*
moss, bristly haircap	*Polytrichum piliferum*
moss, peat	*Sphagnum*
nettle, stinging	*Urtica*
oak	*Quercus*
oak, black	*Quercus velutina*

Continued

Appendix Table C-1, Plants mentioned in the *NRI*, continued.

Common Name	Scientific Name
oak, chestnut	*Quercus montana*
oak, pin	*Quercus palustris*
oak, red	*Quercus rubra*
oak, scarlet	*Quercus coccinea*
oak, scrub	*Quercus ilicifolia*
oak, swamp white	*Quercus bicolor*
oak, white	*Quercus alba*
orchid, dragon's mouth	*Arethusa bulbosa*
orchid, large purple-fringed	*Platanthera grandiflora*
pepperbush, sweet	*Clethra alnifolia*
pickerelweed	*Pontederia cordata*
pine, eastern white	*Pinus strobus*
pine, pitch	*Pinus rigida*
pitcher-plant, purple	*Sarracenia purpurea*
pond-lily, fragrant	*Nymphaea odorata* ssp. *odorata*
pond-lily, yellow	*Nuphar variegata*
pondweed, curly-leaf	*Potamogeton crispus*
potato	*Solanum tuberosum*
primrose	*Oenothera*
pumpkin	*Cucurbita*
ramps	*Allium tricoccum*
raspberry	*Rubus*
reed, common	*Phragmites australis*
rose, multiflora	*Rosa multiflora*
rosemary, bog	*Andromeda polifolia* var. *latifolia*

Continued

Appendix Table C-1, Plants mentioned in the *NRI*, continued.

Common Name	Scientific Name
rush, soft	*Juncus effusus* ssp. *solutus*
saxifrage, golden	*Chrysosplenium americanum*
sedge	*Cyperaceae*
sedge, cattail	*Carex typhina*
sedge, clustered	*Carex cumulata*
sedge, Davis's	*Carex davisii*
sedge, false hop	*Carex lupuliformis*
sedge, fox	*Carex vulpinoidea*
sedge, lakeside	*Carex lacustris*
sedge, lined	*Carex striatula*
sedge, Pennsylvania	*Carex pensylvanica*
sedge, tussock	*Carex stricta*
sedge, weak stellate	*Carex seorsa*
serviceberry	*Amelanchier*
shadbush, dwarf	*Amelanchier spicata*
skunk-cabbage	*Symplocarpus foetidus*
spicebush	*Lindera benzoin*
spikerush, ovate	*Eleocharis ovata*
spikerush, sharp-angled	*Eleocharis tenuis* var. *pseudoptera*
spruce, black	*Picea mariana*
spruce, Norway	*Picea abies*
squash	*Cucurbita*
stiltgrass, Japanese	*Microstegium vimineum*
St. Johnswort, marsh	*Triadenum virginicum*
sundew	*Drosera*

Continued

Appendix Table C-1, Plants mentioned in the *NRI*, continued.

Common Name	Scientific Name
sundew, round-leaved	*Drosera rotundifolia*
sweetfern	*Comptonia peregrina*
sycamore, American	*Platanus occidentalis*
tamarack	*Larix*
timothy	*Phleum pratense* ssp. *pratense*
tomato	*Solanum lycopersicum*
toothcup	*Rotala ramosior*
tree-of-heaven	*Ailanthus altissima*
tulip-tree	*Liriodendron tulipifera*
tupelo, black	*Nyssa sylvatica*
turtlehead, white	*Chelone glabra*
viburnum, maple-leaf	*Viburnum acerifolium*
violet	*Viola*
watermeal	*Wolffia*
watermilfoil, Eurasian	*Myriophyllum spicatum*
water-nymph, spiny	*Najas marina*
water-plantain	*Alisma*
watershield	*Brasenia schreberi*
weed, mile-a-minute	*Persicaria perfoliata*
willow	*Salix*
willow-herb, eastern	*Epilobium coloratum*
witch-hazel	*Hamamelis virginiana*
woodsia, rusty	*Woodsia ilvensis*
woolgrass	*Scirpus cyperinus*

Werier, D., K. Webster, T. Weldy, A. Nelson, R. Mitchell, and R. Ingalls. 2023. New York flora atlas. [S.M. Landry and K.N. Campbell (original application development). USF Water Institute, University of South Florida]. New York Flora Association, Albany. https://newyork.plantatlas.usf.edu/

Appendix Table C-2. Prominent non-native invasive plants of southeastern New York.

Species are listed and ranked for management priority (tiers) by the Lower Hudson Partnership for Invasive Species Management (LHPRISM). Updated lists of invasive species are at https://www.lhprism.org/species-information.

TIER 1 (THREATS)	
Common Name	**Scientific Name**
bamboo, heavenly	*Nandina domestica*
basketgrass, wavyleaf	*Oplismenus hirtellus* ssp. *undulatifolus*
crop, swamp	*Crassula helmsii*
dewflower, marsh	*Murdannia keisak*
flower, Japanese chaff	*Achyranthes japonica*
frogbit	*Hydrocharis morsus-ranae*
grass, cogon	*Imperata cylindrica*
grass, fountain	*Pennisetum alopecuroides*
grass, reed manna	*Glyceria maxima*
jewelweed, ornamental	*Impatiens glandulifera*
pepper-grass, broad-leaved	*Lepidium latifolium*
primrose	*Ludwigia peploides*
primrose, water	*Ludwigia adscendens*
saltcedar	*Tamarix* spp. (*T. chinensis, T. parviflora, T. ramossima*)
sedge, Asiatic sand	*Carex kobomugi*
vitex, beach	*Vitex rotundifolia*
watermilfoil, broadleaf/variable-leaf	*Myriophyllum heterophyllum*
willow, Uruguayan primrose	*Ludwigia hexapetala*

Continued

Appendix Table C-2, Non-native plants, continued.

TIER 2 (EMERGING SPECIES)	
Common Name	**Scientific Name**
alder, black	*Alnus glutinosa*
aralia, castor	*Kalopanax septemlobus*
arum, Italian	*Arum italicum*
baby's-breath, tall	*Gypsophila paniculata*
balm	*Elsholtzia ciliata*
brome, slender false	*Brachypodium sylvaticum*
broom, Scotch	*Cytisus scoparius*
bush-clover, Chinese	*Lespedeza cuneata*
carpetgrass, small	*Arthraxon hispidus*
corktree, Amur	*Phellodendron amurense*
crabapple, tea	*Malus hupehensis*
crabapple, Toringo	*Malus sieboldii* (*M. toringo*)
cup-plant	*Silphium perfoliatum*
elodea, Brazilian	*Egeria densa*
fanwort	*Cabomba caroliniana*
hogweed, giant	*Heracleum mantegazzianum*
hydrilla	*Hydrilla verticillata*
keman, purple	*Corydalis incisa*
kudzu	*Pueraria montana*
lovegrass, weeping	*Eragrostis curvula*
mulberry, paper	*Broussonetia papyrifera*

Continued

Appendix Table C-2, Non-native plants, continued.

TIER 2 (EMERGING SPECIES), cont.	
Common Name	**Scientific Name**
olive, Russian	*Elaeagnus angustifolia*
photinia, oriental	*Photinia villosa*
plant, beefsteak	*Perilla frutescens*
primrose, Japanese	*Primula japonica*
privet, Chinese	*Ligustrum sinense*
reed, giant	*Arundo donax*
sage, sticky	*Salvia glutinosa*
sapphireberry	*Symplocos paniculata*
snowball, Japanese	*Viburnum plicatum*
swallow-wort, pale	*Cynanchum rossicum*
teasel, cut-leaf	*Dipsacus laciniatus*
viburnum, linden	*Viburnum dilatatum*
viburnum, Siebold's	*Viburnum sieboldii*
vine, chocolate	*Akebia quinata*
vine, silver	*Actinidia polygama*
vine, tara	*Actinidia arguta*
willow, gray	*Salix atrocinerea*
yam, Chinese	*Dioscorea oppositifolia* (*D. polystachya, D. batatas*)
yellow-loosestrife, garden	*Lysimachia vulgaris*

Continued

Appendix Table C-2, Non-native plants, continued.

TIER 3 (ESTABLISHED)	
Common Name	**Scientific Name**
bittercress, narrowleaf	*Cardamine impatiens*
buckthorn, glossy	*Frangula alnus* (*Rhamnus frangula*)
celandine, lesser	*Ficaria verna*
chervil, wild	*Anthriscus sylvestris*
chestnut, water	*Trapa natans*
creeper, winter	*Euonymus fortunei*
elm, Siberian	*Ulmus pumila*
goutweed	*Aegopodium podagraria*
grass, Chinese silver	*Miscanthus sinensis*
honeysuckle, Amur	*Lonicera maackii*
hops, Japanese	*Humulus japonicus*
jetbead	*Rhodotypos scandens*
maple, sycamore	*Acer pseudoplatanus*
mile-a-minute	*Persicaria perfoliata*
naiad, brittle	*Najas minor*
pear, Bradford	*Pyrus calleryana*
porcelainberry	*Ampelopsis brevipedunculata*
privet, border	*Ligustrum obtusifolium*
spurge, cypress	*Euphorbia cyparissias*
spurge, leafy	*Euphorbia esula*
swallowwort, black	*Cynanchum louiseae*

Continued

Appendix Table C-2, Non-native plants, continued.

TIER 3 (ESTABLISHED) , cont.	
Common Name	**Scientific Name**
tree, Japanese angelica	*Aralia elata*
tree, princess	*Paulownia tomentosa*
virgin's-bower	*Clematis terniflora*

TIER 4 (WIDESPREAD)	
Common Name	**Scientific Name**
barberry, common	*Berberis vulgaris*
barberry, Japanese	*Berberis thunbergii*
bittersweet, oriental	*Celastrus orbiculatus*
buckthorn, common	*Rhamnus cathartica*
burning-bush	*Euonymus alatus*
canarygrass, reed	*Phalaris arundinacea*
cherry, bird	*Prunus avium*
forget-me-not, true	*Myosotis scorpioides*
grass, common reed	*Phragmites australis*
honeysuckle, Bell's	*Lonicera* x *bella*
honeysuckle, Japanese	*Lonicera japonica*
honeysuckle, Morrow's	*Lonicera morrowii*
iris, yellow	*Iris pseudacorus*
knapweed, black	*Centaurea nigra*
knapweed, brown	*Centaurea jacea*
knapweed, spotted	*Centaurea stoebe*

Continued

Appendix Table C-2, Non-native plants, continued.

TIER 4 (WIDESPREAD), cont.	
Common Name	**Scientific Name**
knotweed	*Reynoutria japonica* var. *japonica, R. sachalinensis, R. japonica x R. sachalinensis – R. xbohemica*
locust, black	*Robinia pseudoacacia*
loosestrife, purple	*Lythrum salicaria*
maple, Norway	*Acer platanoides*
mugwort	*Artemisia vulgaris*
mulberry, white	*Morus alba*
mustard, garlic	*Alliaria petiolata*
olive, autumn	*Elaeagnus umbellata*
parsnip, wild	*Pastinaca sativa*
pondweed, curly-leaf	*Potamogeton crispus*
rose, multiflora	*Rosa multiflora*
stiltgrass, Japanese	*Microstegium vimineum*
teasel, fuller’s	*Dipsacus fullonum*
thistle, bull	*Cirsium vulgare*
thistle, Canada	*Cirsium arvense*
tree-of-heaven	*Ailanthus altissima*
watermilfoil, Eurasian	*Myriophyllum spicatum*
wineberry	*Rubus phoenicolasius*
wisteria, Chinese	*Wisteria sinensis*
wisteria, Japanese	*Wisteria floribunda*

Appendix Table C-3. Dragonflies and damselflies of Putnam County.

Data are from the statewide New York Dragonfly and Damselfly Survey 2005-2009 and from the Kent biodiversity surveys of Buck and Herr, 2011-2023.

AESHNIDAE

Common name	Scientific name	Habitat	Statewide status[1]
darner, black-tipped	*Aeshna tuberculifera*	over fields & along edge of water	
darner, comet*	*Anax longipes*	around ponds or over fields	S2S3, SGCN
darner, common green	*Anax junius*	over small ponds, skimming lake edges, or over fields	
darner, cyrano	*Nasiaeschna pentacantha*	ponds & slow streams, forests	S2S3, SGCN
darner, fawn*	*Boyeria vinosa*	in forested swamps & over shaded streams	
darner, green-striped	*Aeshna verticalis*	over fields	
darner, harlequin*	*Gomphaeschna fur-cillata*	edges of forests	
darner, shadow*	*Aeshna umbrosa*	along forest edges, shaded areas	
darner, spatterdock*	*Rhionaeschna mutata*	around water, often with spatter-dock present, forest edges	S2, SGCN
darner, springtime	*Basiaeschna janata*	clear water, open fields	

CALOPTERYGIDEAE

Common name	Scientific name	Habitat	Statewide status[1]
jewelwing, ebony*	*Calopteryx maculata*	in shaded areas & along small streams	

Continued

Appendix Table C-3, Dragonflies and damselflies, continued.

COENAGRIONIDAE			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
bluet, azure*	*Enallagma aspersum*	near most slow-moving water	
bluet, big	*Enallagma durum*	around swampy ponds or slow-moving rivers	S3
bluet, familiar	*Enallagma civile*	around large, slow-moving water bodies	
bluet, Hagen's*	*Enallagma hageni*	along edges of ponds	
bluet, marsh*	*Enallagma ebrium*	around wetlands & open swamps	
bluet, northern	*Enallagma annexum*	around still water & nearby vegetation	
bluet, orange*	*Enallagma signatum*	near all types of still water	
bluet, skimming	*Enallagma geminatum*	around edges of most types of water	
bluet, slender*	*Enallagma traviatum*	vegetated pond & lake edges	
bluet, stream	*Enallagma exsulans*	along sides of streams & lakes	
bluet, taiga*	*Coenagrion resolutum*	around marshes, bogs, & ponds	S3
bluet, turquoise	*Enallagma divagans*	slow-moving streams, lakes	S3
bluet, vesper*	*Enallagma vesperum*	around ponds & lakes	S4
damsel, aurora*	*Chromagrion conditum*	near most water; esp. slow-moving or stagnant ponds	
damselfly, eastern red	*Amphiagrion saucium*	around ponds or other stationary water	
dancer, blue-fronted	*Argia apicalis*	rivers, large streams, esp. deep & muddy	S3

Continued

Appendix Table C-3, Dragonflies and damselflies, continued.

COENAGRIONIDAE, cont.

Common name	Scientific name	Habitat	Statewide status[1]
dancer, dusky*	*Argia translata*	around clear or moving water	S1, SGCN
dancer, powdered*	*Argia moesta*	around medium to large rivers, ponds, & lakes	
dancer, variable*	*Argia fumipennis violacea*	around edges of most slow or still water	
forktail, eastern*	*Ischnura verticalis*	wide variety incl. ponds, edges of slow-moving rivers, & fields	
forktail, fragile*	*Ischnura posita*	wide variety incl. pond edges, forested swamps, streams, & fields	
forktail, lilypad*	*Ischnura kellicotti*	ponds with lily pads	S3
forktail, Rambur's*	*Ischnura ramburii*	brackish ponds & wetlands	S2S3, SGCN
sprite, sedge*	*Nehalennia irene*	in wet, grassy, mostly open areas	
sprite, southern*	*Nehalennia integricollis*	ponds & lakes with dense vegetation	S1, SGCN
sprite, sphagnum	*Nehalennia gracilis*	*Sphagnum* bogs, fens	

CORDULEGASTRIDAE

Common name	Scientific name	Habitat	Statewide status[1]
spiketail, arrowhead	*Cordulegaster obliqua*	streams, seeps, & forest clearings	S3, SGCN
spiketail, delta-spotted*	*Cordulegaster diastatops*	unshaded seeps, small streams	
spiketail, tiger	*Cordulegaster erronea*	forest streams & seeps	S1, SGCN[HP]

Continued

Appendix Table C-3, Dragonflies and damselflies, continued .

CORDULIIDAE			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
baskettail, beaverpond	*Epitheca canis*	bog ponds, slow-moving streams, & marshy lakes	
baskettail, common*	*Epitheca cynosura*	around ponds & nearby fields	
baskettail, prince	*Epicordulia princeps*	tree-tops	
baskettail, spiny*	*Epitheca spinigera*	bogs & boggy wetlands, marshes & slow streams	S3
emerald, clamp-tipped	*Somatochlora tenebrosa*	edge of fields & along shady tree lines	
emerald, petite	*Dorocordulia lepida*	acidic bogs & swamps; forest openings & fields	S3
shadowdragon, umber	*Neurocordulia obsoleta*	small lakes	S1, SGCN

GOMPHIDAE			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
clubtail, ashy*	*Gomphus lividus*	moderately fast-moving streams & sheltered inlets of lakes	
clubtail, lancet*	*Gomphus exilis*	over fields, roads, & on rocks near water	
clubtail, lilypad*	*Arigomphus furcifer*	around still water & slow-moving streams	
clubtail, unicorn	*Arigomphus villosipes*	around ponds & lakes	
dragonhunter*	*Hagenius brevistylus*	along streams, esp. shaded ones	

Continued

Appendix Table C-3, Dragonflies and damselflies, continued.

GOMPHIDAE, cont.			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
spinyleg, black-shouldered	*Dromogomphus spinosus*	around clear rocky streams	

LESTIDAE			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
spreadwing, amber-winged	*Lestes eurinus*	near still water; esp. boggy or temporary ponds	S3S4
spreadwing, elegant*	*Lestes inaequalis*	near still water & in shaded environments	
spreadwing, northern*	*Lestes disjunctus*	vegetated ponds, lakes, & bogs	
spreadwing, slender*	*Lestes rectangularis*	around forested pools & small clearings	
spreadwing, spotted	*Lestes congener*	around still, marshy water	
spreadwing, swamp*	*Lestes vigilax*	near still, swampy bodies of water	
spreadwing, sweetflag*	*Lestes forcipatus*	around still, swampy water	

LIBELLULIDAE			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
amberwing, eastern*	*Perithemis tenera*	around ponds & other still water, or in nearby fields	
corporal, blue	*Ladona deplanata*	ponds, fields & clearings	
corporal, chalk-fronted	*Ladona julia*	near ponds & small lakes	

Continued

Appendix Table C-3, Dragonflies and damselflies, continued.

LIBELLULIDAE, cont.			
Common name	**Scientific name**	**Habitat**	**Statewide status**[1]
dasher, blue*	*Pachydiplax longipennis*	over still ponds	
glider, wandering	*Pantala flavescens*	over fields & wide open areas	
meadowhawk, autumn	*Sympetrum vicinum*	vegetated ponds & lakes near forest	
meadowhawk, band-winged*	*Sympetrum semicinctum*	in meadows & fields	
meadowhawk, cherry-faced	*Sympetrum internum*	around small ponds & nearby fields	
meadowhawk, white-faced*	*Sympetrum obtrusum*	in swamps & wet vegetated areas, or fields	
pennant, banded	*Celithemis fasciata*	marshy ponds	S3
pennant, calico*	*Celithemis elisa*	around ponds or in nearby fields	
pennant, Halloween*	*Celithemis eponina*	in fields & around ponds	
pondhawk, eastern*	*Erythemis simplicicollis*	around ponds or (for females esp.) in fields	
saddlebags, Carolina	*Tramea carolina*	temporary pools, & fields	
saddlebags, black*	*Tramea lacerata*	over fields & meadows	
skimmer, four-spotted	*Libellula quadrimaculata*	around ponds, swamps, & marshy streams	
skimmer, great blue*	*Libellula vibrans*	swampy pools, streams, & fields & forest edges	S3
skimmer, Needham's*	*Libellula needhami*	ponds, lakes, & brackish wetlands	S3, SGCN

Continued

Appendix Table C-3, Dragonflies and damselflies, continued.

LIBELLULIDAE, cont.

Common name	Scientific name	Habitat	Statewide status[1]
skimmer, painted	*Libellula semifasciata*	marshy forested seeps, ponds, & slow-moving streams	
skimmer, slaty*	*Libellula incesta*	around edges of ponds & lakes	
skimmer, spangled*	*Libellula cyanea*	around ponds & streams	
skimmer, twelve-spotted	*Libellula pulchella*	near bodies of water & over fields	
skimmer, widow*	*Libellula luctuosa*	near ponds & lakes & in wide variety of fields	
whiteface, dot-tailed*	*Leucorrhinia intacta*	around ponds or other small stagnant bodies of water	
whiteface, frosted*	*Leucorrhinia frigida*	mud-bottomed lakes & ponds with emergent veg, pools in fens, bogs	
whitetail, common*	*Plathemis lydia*	all types of water (except fast-moving) & in fields	

MACROMIIDAE

Common name	Scientific name	Habitat	Statewide status[1]
cruiser, stream*	*Didymops transversa*	medium to large streams & rivers	

[1] *Statewide Status:*
New York Natural Heritage Program ranks (S1, S2, S3, etc.) are explained in Appendix D.
SGCN = NYS Species of Greatest Conservation Need
$SGCN^{HP}$ = NYS High Priority Species of Greatest Conservation Need

* *An asterisk indicates a species listed by Bill Buck and Beth Herr in the Kent biodiversity surveys.*

Appendix Table C-4. Butterflies of Kent and Putnam County, New York.

Data are from the Kent biodiversity surveys of Buck and Herr, 2011-2023, and from Putnam County records in *Butterflies and Moths of North America*. Flight time, foods, and habitats are from Cech and Tudor (2005).

HESPERIIDAE				
Common name	**Flight time**	**Caterpillar food**	**Habitat**	**Statewide status[1,2]**
broken-dash, northern[3]	early June-mid Aug	panic grasses	oldfield	
duskywing, Juvenal's	late April-early June	oaks	open upland habitats, usually not disturbed	
duskywing, wild indigo	May-Aug	wild indigo, vetches	in or near alfalfa fields	
edge, hoary	June-July	legumes, e.g., tick trefoil	oldfield & field edges	
glassywing, little[3]	late June-July	purple top & other grasses	oldfield & pasture	
skipper, broadwing[3]	mid-July-Aug	reeds, sedges, wild rice	wet areas with Phragmites	S3
skipper, crossline	late June-early Aug	grasses	dry and moist fields	
skipper, Delaware[3]	mainly July	little bluestem, switchgrass, other grasses	open habitats, dry to wet	
skipper, dun	July-Aug	sedges, maybe grasses	oldfield	
skipper, Hobomok	late May-early July	grasses	oldfield	
skipper, least	June-Oct	grasses	wet meadow, grassy marsh	
skipper, Peck's	late May-Sept	grasses	meadow	

Continued

Appendix Table C-4, Butterflies, continued.

HESPERIIDAE, cont.				
Common name	**Flight time**	**Caterpillar food**	**Habitat**	**Statewide status[1,2]**
skipper, roadside	late May-mid June	grasses	forest openings	
skipper, silver-spotted[3]	June-Aug	black locust	shrubby fields	
skipper, Zabulon[3]	late May-mid June; mid Aug-mid Sept	grasses	shrubby fields, roadside	

LYCAENIDAE				
Common name	**Flight time**	**Caterpiller food**	**Habitat**	**Statewide status[1,2]**
azure, northern[3]	Mar-May	blueberry, cherry, & viburnum buds; omnivorous	wooded or scrubby areas	
blue, eastern tailed	May-Sept	legumes	open, disturbed, low growth	
copper, American[3]	May-Sept	*Rumex* (docks)	drier meadows	
elfin, brown[3]	May	heaths	barrens, dry forest	
hairstreak, banded[3]	May-Aug	oaks, hickories	edges, open habitats	
hairstreak, Edward's[3]	July	scrub oak	scrub oak forest, rocky barren	S3S4
hairstreak, gray[3]	early May-mid June	various meadow & shrubland plants	open, weedy, disturbed	
hairstreak, juniper[3]	mid May-June; Aug	eastern red cedar	open uplands with red cedar	

Continued

Appendix Table C-4, Butterflies, continued.

LYCAENIDAE, cont.				
Common name	**Flight time**	**Caterpiller food**	**Habitat**	**Statewide status[1,2]**
hairstreak, red-banded[3]	May-June; Aug-Sept	rotting leaves	open habitats	
hairstreak, striped[3]	late June-mid July	roses, cherries, hawthorns, heaths, American hornbeam	forest openings & edges	

NYMPHALIDAE				
Common name	**Flight time**	**Caterpiller food**	**Habitat**	**Statewide status[1,2]**
admiral, red[3]	May-Oct	nettles	moist forest & meadow, esp. floodplain forests	
brown, Appalachian[3]	late June-Aug	sedges	forested wet areas, near sedges	
buckeye, common[3]	July-Sept	plantains, figworts, vervains	open habitats with some bare ground	
cloak, mourning[3]	year around; most common in summer	willows, other trees	wanders among many habitats	
comma, eastern[3]	3 flights, April-Sept?	elms and nettles	woods, especially floodplain forests	
crescent, northern[3]	mid-June-Jul; Aug	asters	various, woods	
crescent, pearl	mid May-early Sept	asters	meadow	
emperor, tawny[3]	July-Aug	hackberry	hackberry habitats	S2S4

Continued

Appendix Table C-4, Butterflies, continued.

NYMPHALIDAE, cont.				
Common name	**Flight time**	**Caterpiller food**	**Habitat**	**Statewide status[1,2]**
fritillary, Aphrodite[3]	late June-early Sept	violets	upland habitats on acidic soils, moist grasslands	
fritillary, great spangled	late June-early Sept	violets	forest edges	
lady, American	mid May-late Oct	composites (asters, golden-rods, etc.)	(various)	
lady, painted	May-Oct	various meadow plants	open habitats	
mark, question[3]	late June-Oct	elms	forests and edges	
monarch	mid June-Sept	milkweeds	oldfield, edges	SPCN
nymph, common wood[3]	July-early Sept	grasses	meadow with shrubs or other tall vegetation	
pearly-eye, northern[3]	late June-early Aug	grasses	forest, often near water	
purple, red-spotted	mid June-early Aug; mid Aug-mid Sept	cherries	near deciduous, often moist forest	
ringlet, common[3]	late May-early July; late July-Aug	grasses	oldfields	
satyr, little wood	late May-early Aug	grasses	edges, forest openings	
snout, American[3]	late June-mid Oct	hackberry	forested stream edges	
viceroy	late May-early Oct	willow	moist, shrubby habitats	

Continued

Appendix Table C-4, Butterflies, continued.

PAPILIONIDAE				
Common name	**Flight time**	**Caterpiller food**	**Habitat**	**Statewide status[1,2]**
swallowtail, black	May-Sept	parsley, carrot, & related plants	mainly open meadows	
swallowtail, Canada tiger	May-early June?	birch, aspen, cherry	near deciduous trees	
swallowtail, eastern tiger	late May-Oct	black cherry, tulip tree, ash	near deciduous trees	
swallowtail, giant[3]	May-Sept	plants in the rue family	various habitats, often semi-open	
swallowtail, pipevine	June-early Oct	pipevine	gardens, rocky forested uplands	
swallowtail, spicebush	May-Aug	spicebush	various open habitats, usually near forest	

PIERIDAE				
Common name	**Flight time**	**Caterpiller food**	**Habitat**	**Statewide status[1,2]**
sulphur, orange	mid May-early Oct	alfalfa and other legumes	open habitats, weedy, alfalfa meadows	
white, cabbage	May-Oct	mustards	pastures or cultivated fields	
white, mustard	as early as late April-Aug	mustards, e.g. *Dentaria*, *Arabis*, *Cardamine*	edges, streamside habitats, oldfields	

[1] New York Natural Heritage Program ranks (S2, S3, S4) are explained in Appendix D.
[2] NY State Ranks:
SC = Special Concern (Environmental Conservation Law 6NYCRR Part 182.[g])
SGCN = Species of Greatest Conservation Need
SGCN[HP] = Highest Priority Species of Greatest Conservation Need
SPCN = Species of Potential Conservation Need
[3] Indicates those listed at the Butterflies and Moths of North America website (www.butterfliesandmoths.org) as recorded from Putnam County. All others are listed by Bill Buck and Beth Herr in the Kent biodiversity surveys.

Cech, R. and G. Tudor. 2005. Butterflies of the East Coast: An observer's guide. Princeton University Press, Princeton, NJ

Appendix Table C-5. Fishes of the Town of Kent.

Data are from the New York State Fish Atlas (1934-2011) and the Kent biodiversity surveys of Buck and Herr, 2011-2023.

Common name	Scientific name	Native (yes/no)	NYS status[1]	Streams	Ponds, lakes, reservoirs
alewife	*Alosa pseudoharengus*	Y	SGCN		x
bass, largemouth*	*Micropterus salmoides*	N		x	x
bass, rock*	*Ambloplites rupestris*	N		x	x
bass, smallmouth*	*Micropterus dolomieu*	N		x	x
bluegill*	*Lepomis macrochirus*	N		x	x
bullhead, brown*	*Ameiurus nebulosus*	Y		x	x
bullhead, yellow*	*Ameiurus natalis*	Y		x	x
carp, common*	*Cyprinus carpio*	N			x
carp, grass*	*Ctenopharyngodon idella*	N			x
catfish, channel*	*Ictalurus punctatus*	N			x
catfish, white*	*Ameiurus catus*	Y			x
chub, creek*	*Semotilus atromaculatus*	Y		x	x
chubsucker, eastern creek*	*Erimyzon oblongus*	Y		x	x
crappie, black*	*Pomoxis nigromaculatus*	N			x
crappie, white*	*Pomoxis annularis*	N			x

Continued

Appendix Table C-5, Fishes, continued.

Common name	Scientific name	Native (yes/ no)	NYS status[1]	Streams	Ponds, lakes, reservoirs
dace, eastern blacknose*	*Rhinichthys atratulus*	Y		x	x
dace, longnose*	*Rhinichthys cataractae*	Y		x	
darter, tessellated	*Etheostoma olmstedi*	Y		x	x
eel, American*	*Anguilla rostrata*	Y	SGCN[HP]	x	x
fallfish*	*Semotilus corporalis*	Y		x	x
goldfish*	*Carassius auratus*	N		x	x
killifish, banded*	*Fundulus diaphanus*	Y			x
minnow, blunt-nose*	*Pimephales notatus*	Y		x	x
minnow, cutlip	*Exoglossum maxillingua*	Y		x	x
minnow, fathead*	*Pimephales promelas*	N		x	x
mudminnow, central*	*Umbra limi*	N		x	
mummichog	*Fundulus heteroclitus*	Y	SGCN		x
perch, white*	*Morone americana*	Y		x	x
perch, yellow*	*Perca flavescens*	Y		x	x
pickerel, chain*	*Esox niger*	Y		x	x
pickerel, redfin*	*Esox americanus americanus*	Y		x	x
pike, northern*	*Esox lucius*	N			x

Continued

Appendix Table C-5, Fishes, continued.

Common name	Scientific name	Native (yes/ no)	NYS status[1]	Streams	Ponds, lakes, reservoirs
pumpkinseed*	*Lepomis gibbosus*	Y		x	x
shiner, bridle*	*Notropis bifrenatus*	Y	SGCN, S2?	x	x
shiner, common*	*Luxilus cornutus*	Y		x	
shiner, golden*	*Notemigonus crysoleucas*	Y		x	x
shiner, satinfin*	*Cyprinella analostana*	Y		x	
shiner, spottail*	*Notropis hudsonius*	Y		x	
smelt, rainbow*	*Osmerus mordax*	Y			x
sucker, white*	*Catostomus commersonii*	Y		x	x
sunfish, bluespotted*	*Enneacanthus gloriosus*	Y			x
sunfish, green*	*Lepomis cyanellus*	N		x	x
sunfish, red-breast*	*Lepomis auritus*	Y		x	x
trout, brook*	*Salvelinus fontinalis*	Y	SGCN	x	x
trout, brown*	*Salmo trutta*	N		x	x
trout, lake[2]	*Salvelinus namaycush*	Y	SGCN		x
trout, rainbow*	*Oncorhynchus mykiss*	N			x
walleye*	*Sander vitreus*	N			x

** An asterisk denotes a species listed by Bill Buck and Beth Herr in the Kent biodiversity surveys.*
[1] NY State Status:
New York Natural Heritage Program ranks (S1, S2) are explained in Appendix D.
SGCN = Species of Greatest Conservation Need
$SGCN^{HP}$ = Highest Priority Species of Greatest Conservation Need
[2] Lake trout may be present if it has been stocked.

Appendix Table C-6. Amphibians and reptiles of the Town of Kent, Putnam County, New York.

Occurrence data are from the New York State Reptile and Amphibian Atlas, and the Kent biodiversity surveys of Buck and Herr, 2011-2023.

SALAMANDERS			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
blue-spotted salamander[2]	*Ambystoma laterale*	swamp, vernal pool, upland forest	SC
eastern newt*	*Notophthalmus viridescens*	perennial pool, other wetland, upland forest	
eastern red-backed salamander*	*Plethodon cinereus*	upland forest	
four-toed salamander	*Hemidactylium scutatum*	swamp, upland forest	SGCN[HP]
Jefferson salamander[2]	*Ambystoma jeffersonianum*	vernal pool, upland forest	SC
marbled salamander*	*Ambystoma opacum*	vernal pool, upland forest	SC
northern dusky salamander	*Desmognathus fuscus*	cool stream	
northern slimy salamander*	*Plethodon glutinosus*	talus, upland forest	
northern two-lined salamander*	*Eurycea bislineata*	small forested stream	
spotted salamander*	*Ambystoma maculatum*	vernal pool, upland forest	

Continued

Appendix Table C-6, Amphibians and reptiles, continued.

TOADS & FROGS

Common name	Scientific name	Habitat	Statewide status[1]
American toad*	*Bufo americanus*	everywhere	
bullfrog*	*Rana catesbeiana*	forest, meadow	
Fowler's toad*	*Bufo fowleri*	sandy or rocky forest	SGCN
Atlantic coast leopard frog*	*Lithobates kauffeldi*	pond, marsh, meadow	SGCN[HP], S1S2
gray treefrog*	*Hyla versicolor*	shallow pool, upland forest	
green frog*	*Rana clamitans*	pond, marsh	
northern leopard frog*	*Rana pipiens*	grassy areas near marshes, ponds & streams	
pickerel frog*	*Rana palustris*	meadow, forest, wetland	
southern leopard frog*	*Rana sphenocephala utricularius*	moist meadow, weedy wetland	SPCN
spring peeper*	*Pseudacris crucifer*	upland forest, wetland	
wood frog*	*Rana sylvatica*	vernal pool, upland forest	

TURTLES

Common name	Scientific name	Habitat	Statewide status[1]
eastern box turtle*	*Terrapene carolina*	upland forest, meadow	SC
painted turtle*	*Chrysemys picta*	pond, marsh, stream	
red-eared slider* (non-native)	*Trachemys scripta*	pond, marsh, stream	
snapping turtle	*Chelydra serpentina*	pond, lake, wetland, meadow	SGCN

Continued

Appendix Table C-6, Amphibians and reptiles, continued.

TURTLES, cont.			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
spotted turtle*	*Clemmys guttata*	wetland, upland forest	SC
musk turtle (stinkpot)*	*Sternotherus odoratum*	stream, lake	SGCN^{HP}
wood turtle	*Glyptemys insculpta*	perennial stream, upland forest, meadow	

SNAKES			
Common name	**Scientific name**	**Habitat**	**Statewide status[1]**
common garter snake*	*Thamnophis sirtalis*	everywhere	
copperhead[2]	*Agkistrodon contortrix*	forest, ledge, meadow	SGCN
Dekay's brown snake*	*Storeria dekayi*	forest, meadow, wetland, yard	
eastern hognose snake*	*Heterodon platirhinos*	forest, forest edge, oldfield	SC
eastern racer*	*Coluber constrictor*	forest, upland meadow, ledge	
eastern rat snake*	*Elaphe alleghaniensis*	forest, ledge, talus	SGCN
milksnake*	*Lampropeltis triangulum*	meadow, forest, barnyard	
northern watersnake*	*Nerodia sipedon*	pond, lake, wetland, stream	
ring-necked snake*	*Diadophis punctatus*	forest, forest opening	

* *An asterisk denotes a species listed by Bill Buck and Beth Herr in the Kent biodiversity surveys.*

[1] *New York State ranks:*

E = Endangered; T = Threatened; SC = Special Concern (Environmental Conservation Law 6NYCRR Part 182.[g])
SGCN = Species of Greatest Conservation Need
SGCN^{HP} = Highest Priority Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)
SPCN = Species of Potential Conservation Need

[2] *Jefferson salamander and blue-spotted salamander have not been documented in Kent, but are known to occur nearby and are likely to occur here. Copperhead presence is uncertain.*

Appendix Table C-7. Breeding birds of Kent.

Data are from the New York State Breeding Bird Atlas, 1980-1985 and 2000-2005.

Group	Species	NYS rank[1]	NYNHP rank[2]
WATERFOWL	duck, American black*	SGCN[HP]	S3B
	duck, wood*		
	goose, Canada*		
	mallard*		
	swan, mute*		
GALLINACEOUS BIRDS	grouse, ruffed*	SGCN	
	turkey, wild*		
DOVES	dove, mourning*		
	pigeon, rock*		
CUCKOOS	cuckoo, black-billed*	SGCN	
	cuckoo, yellow-billed*		
NIGHTJARS	whip-poor-will*	SC, SGCN[HP]	S3B
SWIFTS & HUMMINGBIRDS	hummingbird, ruby-throated*		
	swift, chimney*		
SHOREBIRDS	killdeer*		
	sandpiper, spotted*		
	woodcock, American*	SGCN	
WADING BIRDS	heron, great blue*		
	heron, green*		
VULTURES	vulture, turkey*		

Continued

Appendix Table C-7, Birds, continued.

Group	Species	NYS rank[1]	NYNHP rank[2]
RAPTORS	goshawk, northern*		
	hawk, broad-winged*		
	hawk, red-shouldered*	SC, SGCN	
	hawk, red-tailed*		
	hawk, sharp-shinned*	SC	
	owl, barred*		
	owl, great horned*		
	screech-owl, eastern*		
KINGFISHERS	kingfisher, belted*		
WOODPECKERS	flicker, northern*		
	woodpecker, downy*		
	woodpecker, hairy*		
	woodpecker, pileated*		
	woodpecker, red-bellied*		
FALCONS	kestrel, American*	SGCN	
PASSERINES	blackbird, red-winged*		
	bluebird, eastern*		
	bunting, indigo*		
	cardinal, northern*		
	catbird, gray*		
	chickadee, black-capped*		
	cowbird, brown-headed*		

Continued

Appendix Table C-7, Birds, continued.

Group	Species	NYS rank[1]	NYNHP rank[2]
PASSERINES, cont.	creeper, brown*		
	crow, American*		
	crow, fish		
	finch, house*		
	finch, purple*		
	flycatcher, Acadian		S3B
	flycatcher, alder		
	flycatcher, great-crested*		
	flycatcher, least*		
	flycatcher, willow*		
	gnatcatcher, blue-gray*		
	goldfinch, American*		
	grackle, common*		
	grosbeak, rose-breasted*		
	jay, blue*		
	kingbird, eastern*		
	mockingbird, northern*		
	nuthatch, white-breasted*		
	oriole, Baltimore*		
	oriole, orchard		
	ovenbird*		
	phoebe, eastern*		

Continued

Appendix Table C-7, Birds, continued.

Group	Species	NYS rank[1]	NYNHP rank[2]
PASSERINES, cont.	redstart, American*		
	robin, American*		
	sparrow, chipping*		
	sparrow, field*		
	sparrow, house*		
	sparrow, song*		
	sparrow, swamp*		
	starling, European*		
	swallow, bank		
	swallow, barn*		
	swallow, cliff*		
	swallow, northern rough-winged*		
	swallow, tree*		
	tanager, scarlet*	SGCN	
	thrasher, brown*	SGCN[HP]	
	thrush, hermit*		
	thrush, wood*	SGCN	
	titmouse, tufted*		
	towhee, eastern*		
	veery*		

Continued

Appendix Table C-7, Birds, continued.

Group	Species	NYS rank[1]	NYNHP rank[2]
PASSERINES, cont.	vireo, blue-headed		
	vireo, red-eyed		
	vireo, warbling		
	vireo, white-eyed		
	vireo, yellow-throated		
	warbler, black-and-white*		
	warbler, blackburnian*		
	warbler, black-throated blue*	SGCN	
	warbler, black-throated green*		
	warbler, blue-winged*	SGCN	
	warbler, Canada*	SGCN[HP]	
	warbler, chestnut-sided*		
	warbler, golden-winged	SGCN[HP]	S3B
	warbler, hooded*		
	warbler, pine*		
	warbler, prairie*	SGCN	
	warbler, worm-eating*	SGCN	
	warbler, yellow*		
	warbler, yellow-rumped*		
	waterthrush, Louisiana*	SGCN	
	waterthrush, northern		

Continued

Appendix Table C-7, Birds, continued.

Group	Species	NYS rank[1]	NYNHP rank[2]
PASSERINES, cont.	waxwing, cedar*		
	wood-pewee, eastern*		
	wren, Carolina*		
	wren, house*		
	wren, winter*		
	yellowthroat, common*		

* *An asterisk denotes a species listed by Bill Buck and Beth Herr in the Kent biodiversity surveys.*
[1] *New York State ranks*
SC = Special Concern (Environmental Conservation Law 6NYCRR Part 182.[g])
SGCN = Species of Greatest Conservation Need
$SGCN^{HP}$ = Highest Priority Species of Greatest Conservation Need
[2] *New York Natural Heritage Program ranks are explained in Appendix D.*

Appendix Table C-8. Mammal species known or likely to occur in the Town of Kent.

Occurrence data are from Whitaker (in prep), the Kent Habitat Summary (Nardi-Cyrus 2021), and the Kent biodiversity surveys of Buck and Herr, 2011-2023.

Type of Mammal	Common name	Scientific name	Statewide Status[1]
MARSUPIALS	Virginia opossum*	*Didelphis virginiana*	
INSECT-EATERS	masked shrew*	*Sorex cinereus*	
	northern short-tailed shrew*	*Blarina brevicauda*	
	smoky shrew	*Sorex fumeus*	
	water shrew[2]	*Sorex palustris*	
	eastern mole	*Scalopus aquaticus*	
	star-nosed mole*	*Condylura cristata*	
BATS	big brown bat*	*Eptesicus fuscus*	
	eastern red bat*	*Lasiurus borealis*	SGCN
	eastern small-footed bat*	*Myotis leibii*	SC, SGCN
	hoary bat*	*Lasiurus cinereus*	SGCN
	Indiana bat*	*Myotis sodalis*	E, SGCN[HP]
	little brown bat*	*Myotis lucifugus*	SGCN[HP]
	northern long-eared bat*	*Myotis septentrionalis*	E, SGCN[HP]
	silver-haired bat[2]*	*Lasionycteris noctivagans*	SGCN
	tri-colored bat (eastern pipis-trelle)*	*Perimyotis subflavus*	SGCN[HP]
CARNIVORES	black bear*	*Ursus amercanus*	
	raccoon*	*Procyon lotor*	
	ermine	*Mustela ermine*	

Continued

Appendix Table C-8, Mammals, continued.

Type of Mammal	Common name	Scientific name	Statewide Status[1]
CARNIVORES cont.	fisher*	*Martes pennant*	
	long-tailed weasel*	*Mustela frenata*	
	American mink*	*Mustela vison*	
	river otter	*Lutra canadensis*	
	fisher*	*Martes pennanti*	
	striped skunk*	*Mephitis mephitis*	
	eastern coyote*	*Canis latrans*	
	gray fox*	*Urocyon cinereoargenteus*	
	red fox*	*Vulpes vulpes*	
	bobcat*	*Lynx rufus*	
RODENTS	eastern gray squirrel*	*Sciurus carolinensis*	
	woodchuck*	*Marmota monax*	
	southern flying squirrel*	*Glaucomys volans*	
	red squirrel*	*Tamiasciurus hudsonicus*	
	eastern chipmunk*	*Tamias striatus*	
	American beaver*	*Castor canadensis*	
	deer mouse*	*Peromyscus maniculatus gracilis*	
	white-footed mouse*	*Peromyscus leucopus*	
	southern bog lemming*	*Synaptomys cooperi*	
	meadow vole*	*Microtus pennsylvanicus*	
	southern red-backed vole*	*Clethrionomys gapperi*	

Continued

Appendix Table C-8, Mammals, continued.

Type of Mammal	Common name	Scientific name	Statewide Status[1]
RODENTS, cont.	woodland vole*	*Microtus pinetorum*	
	muskrat*	*Ondatra zibethicus*	
	Norway rat*	*Rattus norvegicus*	
	house mouse*	*Mus musculus*	
	meadow jumping mouse*	*Zapus hudsonius*	
	woodland jumping mouse*	*Napaeozapus insignis*	
	common porcupine*	*Erethizon dorsatum*	
RABBITS	eastern cottontail*	*Sylvilagus floridanus*	
	New England cottontail*	*Sylvilagus transitionalis*	SC, SGCN[HP]
HOOFED MAMMALS	white-tailed deer*	*Odocoileus virginianus*	
	moose*	*Alces alces*	

* *An asterisk indicates a species listed by Bill Buck and Beth Herr in the Kent biodiversity surveys.*

[1] *New York State ranks*

E = Endangered; T = Threatened; SC = Special Concern (Environmental Conservation Law 6NYCRR Part 182.[g])
SGCN = Species of Greatest Conservation Need
SGCN[HP] = Highest Priority Species of Greatest Conservation Need

[2] *Occurence in Kent is uncertain.*

Nardi-Cyrus, N. 2021. Natural areas and wildlife in your community: A habitat summary prepared for Kent. Hudson River Estuary Program, New York State Department of Environmental Conservation, Albany. 25 p.

Whitaker, J.O. (In prep). Mammals of New York. Cornell University Press, Ithaca.

APPENDIX D
EXPLANATION OF RARITY RANKS

A. Animals

The explanation below is from the New York Natural Heritage Program Rare Animal Status List (Schlesinger 2017). Explanation of all NYNHP ranks are given here, but the *NRI* lists none of the global (G) ranks and considers only the ranks of S1, S2, and S3 to denote species of conservation concern. State & Federal Listings NY Natural Heritage tracks a selected subset of New York's animals. The species tracked are chosen based on their degree of rarity or imperilment within the state, and as new information comes in, new species are sometimes added while others are discontinued. Information on the species and communities tracked by NY Natural Heritage are used for conservation, research, and regulatory purposes.

Many of the species tracked by NY Natural Heritage are listed as "endangered" or "threatened" under the state Environmental Conservation Law (ECL). Listing is a legal process that is conducted by the state agency with authority over the species in question, and for animals confers important protection requirements. See http://www.dec.ny.gov/animals/7494.html for all state-listed animals.

The NYSDEC Division of Fish, Wildlife, and Marine Resources has jurisdiction over rare animal species listed as "endangered," "threatened," or of "special concern" under ECL §11-0535. Animals listed as endangered or threatened receive notable legal protection, as it is illegal to take or possess any of these species or their parts without a permit from NYSDEC. Species of special concern warrant attention and consideration but current information does not justify listing them as either endangered or threatened.

A subset of the animal species listed under New York state law is also recognized under federal law. These species are so seriously imperiled across their entire range that they face the very real prospect of extinction. Species are listed as federally endangered or threatened by the US Fish and Wildlife Service in consultation with state agencies and other experts, and the Service works closely with NYSDEC on the protection of federally listed species in New York.

Ultimately, protection of New York's biodiversity lies with landowners and land managers regardless of state or federal listings. How private and public landowners manage their properties will determine what species and natural communities persist into the future. This situation is both a great opportunity and a serious challenge.

State legal listings are identified with the following codes:

- **E** endangered
- **T** threatened
- **SC** special concern

Federal legal listings are identified with the following codes:

- **E** listed endangered
- **T** listed threatened
- **SC** candidate

The New York Natural Heritage Program tracks all species listed as endangered and threatened. While they track many of the species listed as being of special concern, a subset of special concern species are currently not rare or imperiled enough to merit tracking at our precise scale. In addition, they track many species that are biologically rare and imperiled but that have not gone through the review process necessary for state listing.

NYNHP Active Inventory and Watch List

The NY Natural Heritage Program keeps two lists of rare animal species: the Active Inventory List and the Watch List. Species on the Active Inventory List are ones they currently track in our database; for the most part these are the most rare or most imperiled species in the state. Species on the Watch List are those that could become imperiled enough in the future to warrant being actively inventoried, or are ones for which the Heritage Program does not have enough data to determine whether they should be actively inventoried. Species are moved between lists, or off the lists entirely, as available information warrants.

NYNHP Global and State Status Ranks

NY Natural Heritage's statewide inventory efforts revolve around lists of rare species and all types of natural communities known to occur, or to have historically occurred, in the state. These lists are based on a variety of sources including museum collections, scientific literature, information from state and local government agencies, regional and local experts, and data from neighboring states.

Each rare species is assigned a rank based on its rarity, population trends, and threats. Like those in all state Natural Heritage Programs, NY Natural Heritage's ranking system assesses rarity at two geographic scales: global and state. The global rank (G-rank) reflects the status of a species or community throughout its range, whereas the state rank (S-rank) indicates its status within New York. Global ranks are maintained and updated by NatureServe, which coordinates the network of Natural Heritage programs. Both global and state ranks are usually based on the range of the species or community, the number of occurrences, the viability of the occurrences, and the vulnerability of the species or community around the globe or across the state. As new data become available, the ranks may be revised to reflect the most current information. Subspecific taxa are also assigned a taxon rank which indicates the subspecies' rarity rank throughout its range.

For the most part, global and state ranks follow a straightforward scale of 1 (rarest/most imperiled) to 5 (common/secure). The Town of Kent *NRI* refers only to the three ranks—S1, S2, S3—that indicate rarity or limited occurrence in the state, as follows:

- **S1** Critically imperiled in New York State because of rarity (5 or fewer occurrences, or few remaining acres or miles of stream) or factors making it especially vulnerable to extinction rangewide (global) or in the state;

- **S2** Imperiled in New York State because of rarity (6-20 occurrences, or few remaining acres or miles of stream) or factors demonstrably making it very vulnerable to extinction (global) or extirpation from New York (state);

- **S3** Either uncommon or local in New York State, typically with 21 to 100 occurrences, limited acreage, or miles of stream rangewide (global) or in New York (state).

Additional species lists and codes are at https://www.acris.nynhp.org/. Codes sometimes have qualifiers attached:

- **T1, T2**, etc. These ranks, which like global and state ranks run from 1 (rarest/most imperiled) to 5 (common/secure), are attached to global ranks to indicate the status of a subspecies or variety.
- **Q** Indicates that the species, subspecies, or variety is in taxonomic dispute.
- **?** Indicates that the state or global rank is uncertain and more information is needed. N Indicates the migratory status of a migratory species when it is not breeding in NY (for example, populations that are overwintering in the state).
- **B** Indicates the state status of a migratory species when it has breeding populations in NY.

Species of Greatest Conservation Need

The list of Species of Greatest Conservation Need was developed for the New York State Wildlife Action Plan (NYSDEC 2015).

High-Priority Species of Greatest Conservation Need

The status of these species is known, and conservation action is needed in the next ten years. These species 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

The status of these species is known and conservation action is needed. These species 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

The status of these species are 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.

Hudson Valley Priority Bird List

Audubon New York maintains a list of "priority birds" of conservation concern in this region based on information from continental, national, and regional bird planning initiatives and state and federal lists of threatened and endangered species. 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: state-listed 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; or Mid-Atlantic, New England, Maritime Waterbird Working Group - High Concern, Moderate Concern.

B. Plants

New York State Legal Status

The following categories are defined in regulation 6NYCRR part 193.3 and apply to New York State Environmental Conservation Law section 9-1503. Part (f) of the law reads as follows: "It is a violation for any person, anywhere in the state to pick, pluck, sever, remove, damage by the application of herbicides or defoliants, or carry away, without the consent of the owner, any protected plant. Each protected plant so picked, plucked, severed, removed, damaged or carried away shall constitute a separate violation." Violators of the regulation are subject to fines of $25 per plant illegally taken. The list and contact information for questions about the list may be accessed at the DEC Protected Plants website. This list is updated only every 10 years so legal status ranks may not reflect the current Heritage rank.

E = Endangered Species: listed species are those with

1. 5 or fewer extant sites, or
2. fewer than 1,000 individuals, or
3. restricted to fewer than 4 U.S.G.S. 7 1/2 minute topographical maps, or
4. species listed as endangered by the U. S. Department of Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

T = Threatened: listed species are those with

1. 1) 6 to fewer than 20 extant sites, or 2) 1,000 to fewer than 3,000 individuals, or
2. 3) restricted to not less than 4 or more than 7 U.S.G.S. 7 1/2 minute topographical maps, or
3. 4) listed as threatened by the U. S. Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

R = Rare: listed species have 1) 20 to 35 extant sites, or 2) 3,000 to 5,000 individuals statewide.

New York Natural Heritage Program Ranks

The explanation below is from the New York Natural Heritage Program Rare Plant Status Lists (Young 2022). The Town of Kent *NRI* refers only to the three ranks —S1, S2, S3—that indicate rarity or limited occurrence in the state, as follows:

- **S1** — Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological or human factors.
- **S2** — Imperiled in New York State because of rarity (6 - 20 sites or few remaining individuals) or highly vulnerable to extirpation from New York State due to biological or human factors.
- **S3** — Vulnerable in New York State. At moderate risk of extinction or elimination due to very restricted range, very few populations (usually 21 - 35 extant sites), steep declines, or other factors.

Double Ranks (S1S2, S2S3, S1S3)

The first rank indicates rarity based upon current documentation. The second rank indicates the probable rarity after all historical records and likely habitat have been checked. Double ranks denote species that need additional field surveys. Codes sometimes have qualifiers attached, such as “Q” or “?”:

- **Q** indicates a question exists whether or not the taxon is a good taxonomic entity.
- **?** indicates that an identification question exits about known occurrences. It also indicates the rank presumably corresponds to actual occurrences even though the information has not yet been documented in heritage files or historical records. It serves to flag species that need more field studies or specimen identification.

INDEX

To come

ABBREVIATIONS

ACOE	United States Army Corps of Engineers
asl	above mean sea level
ATV	all-terrain vehicle
CAC	Conservation Advisory Committee
CEA	Critical Environmental Area
CWA	federal Clean Water Act
dbh	diameter at breast height —a standard measure of tree size
ECL	New York StateEnvironmental Conservation Law
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency
ft	feet
GHG	greenhouse gas
HAB	Harmful Algal Bloom
HHLT	Hudson Highlands Land Trust
LED	light-emitting diode
m	meter(s)
mcl	micrograms per liter
mi	mile(s)
mm	millimeter(s)
MUA	Multiple Use Area
NAACC	North Atlantic Aquatic Connectivity Collaborative
NGO	non-governmental organization
NRCS	Natural Resource Conservation Service
NRI	Natural Resources Inventory
NWI	National Wetland Inventory
NYC	New York City
NYGS	New York Geological Survey
NYNHP	New York Natural Heritage Program
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYCDEP	New York City Department of Environmental Protection
NYSDOS	New York State Department of State
PCLT	Putnam County Land Trust
PFAS	per-and polyfluoroalkyl substances
ppt	parts per thousand
SBA	Significant Biodiversity Area
SEQR	New York State Environmental Quality Review
SGCN	New York State Species of Greatest Conservation Need
TNC	The Nature Conservancy
US	United States
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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