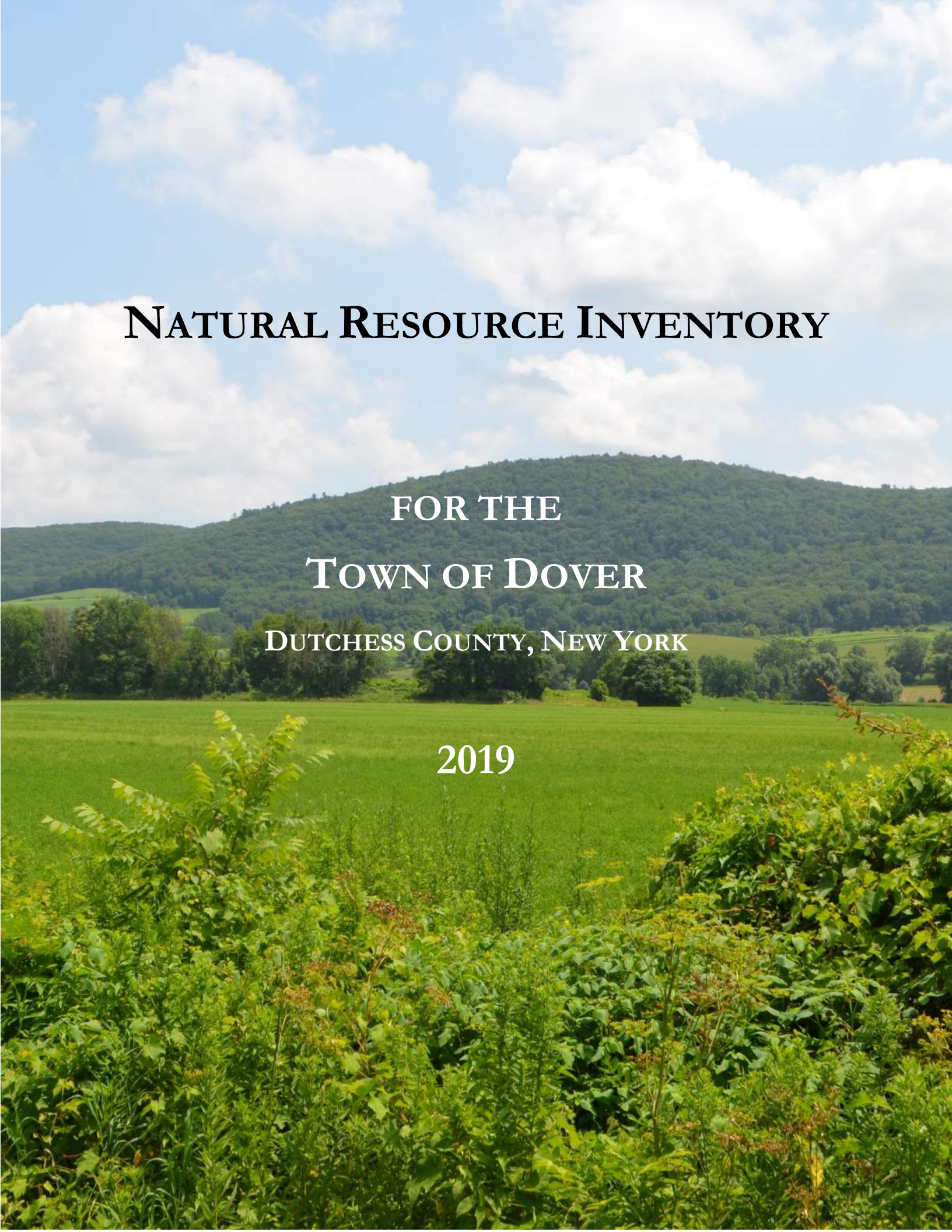

NATURAL RESOURCE INVENTORY

FOR THE

TOWN OF DOVER

DUTCHESS COUNTY, NEW YORK

2019

This *Natural Resource Inventory* was prepared by

Hudsonia Ltd.

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in collaboration with the

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Hudsonia Ltd.

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from the Dover Conservation Advisory Council and the Climate Smart Dover Task Force

The labor and dedication that contributed to this publication and its bounty of insight and information about Dover's natural ecology are acknowledged below with heartfelt appreciation.

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- We commend our fellow members of the Town of Dover Conservation Advisory Council and the Climate Smart Dover Task Force who lovingly shepherded this effort with integrity and mindfulness of its ecological and archival significance from inception to completion.

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(see over)

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The *NRI* is presented in abiding recognition of all Town of Dover residents—past, present, and future—who have or will come to know that sublime natural beauty is not only found from mountaintops and at wonders of the world, but right before our eyes in our own backyards.

"Look deep into nature and then you will understand everything better."
-Albert Einstein

THE TOWN OF DOVER
CONSERVATION ADVISORY COUNCIL
and the
CLIMATE SMART DOVER TASK FORCE

Evan van Hook, Chair
Constance DuHamel
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CONTENTS

CONTENTS

FIGURES

TABLES

APPENDIX TABLES

Summary

This Natural Resource Inventory (NRI) is intended as a practical reference for residents, landowners, developers, businesses, municipal agencies, conservation organizations, and others interested in understanding, using, and caring for Dover's land and water.

The maps and narrative illustrate and describe many of the resources that support the Dover community both directly and indirectly: geology, landforms, groundwater, streams, farmland soils, habitats, plants, and animals, and places of scenic and recreational value. The *NRI* describes some of our past and present uses of natural resources and present-day threats to resources of concern, and offers ideas for identifying conservation priorities and planning the best uses and conservation of important resources.

Dover's bedrock and glacial history are reflected in the landforms, habitats, and water of today, and have shaped human uses of the land for thousands of years. In the 1700s and 1800s, dams for water-powered saw mills and grist mills dotted small and large streams, and forests were cleared for agriculture even high into the hills. Iron ore was mined up and down the Harlem Valley along the contact between the schist of the uplands and the marble of the lowlands. Large additional areas of forest were cleared for charcoal-making to feed iron smelters and other industrial processes. Marble mining was also prominent, and peat was mined from some of Dover's wetlands.

But in the 21st century much of our lumber, grains, and food come from elsewhere, and the livelihoods of most residents are not so closely tied to Dover's natural resources as they were in the past. Mining has shifted to other regions where materials are more accessible or more suitable for present-day uses. Since the decline of water power in the early 20th century with the advent of rural electrical power, many of the dams along streams have crumbled and decayed. While farming is still important to Dover's culture and economy, the farmed land area is much reduced since the peak of agriculture in the 1800s, and forest has taken over many of the former pastures and cropland.

Today the beauty of the open and forested landscapes throughout the town, the quality and abundance of the water resources, the quiet and splendor of the wildlands, and the many opportunities for outdoor recreation may be the natural resources most appreciated in the daily lives of Dover residents. The forested hills, the open pastures, hayfields, and historic farmsteads, the deep ravines, the rocky hillside streams, the meandering lowland streams, the wetland complexes of the Great Swamp, and the high overlooks at the Stone Church Preserve and on Schaghticoke Mountain also support the local economy by attracting visitors that patronize Dover's businesses during their stays. The Stone Church grotto and ravine have been destinations for artists and others since the early 1800s, and the Stone Church Preserve remains a popular site for hiking, picnicking, birdwatching, and photography. The Appalachian Trail attracts day hikers, through hikers, and campers, and the Great Swamp draws paddlers, anglers, and birdwatchers. Trails at Nellie Hill and the Roger Perry Preserve bring the public close to some of Dover's signature habitats: marble knolls,

fens, springs, red cedar barrens, red cedar woodlands, calcareous ledges, and the "white sands of Dover"—white sand from weathered and eroded marble.

West Mountain and East Mountain are part of large contiguous forest areas that extend into Connecticut and beyond. Both the hills and the Harlem Valley are part of the Harlem Valley Wetlands Significant Biodiversity Area designated by the NYS Department of Environmental Conservation because of the high concentrations of unusual ecological communities and rare species of plants and animals. Indeed, Dover is famous among biologists as a hotspot for native biological diversity.

Pink lady's slipper is a native orchid of Dover's upland hardwood forests.

The deep marble bedrock underlying the Harlem Valley explains the presence of some habitats of the lowlands such as marble knolls, fens, and calcareous ledges, while the more acidic bedrock of the hills is associated with oak-heath barrens and cool ravines. Dover has numerous coolwater streams—a declining resource in the region—that support wild populations of brook trout and other sensitive aquatic organisms that do not survive in streams subject to thermal pollution, toxic contamination, siltation, and other abuses. The large upland and wetland forests in the Dover landscape help to maintain the water quality and habitat quality of these streams.

Two Critical Environmental Areas (CEAs)—Deuel Hollow and the Great Swamp—have been designated by the town and county because of their exceptional natural attributes. The Great Swamp is recognized for its high-quality fish and wildlife habitat, its important contributions to open space, scenic, recreation, and education resources, and its ecological, geological, and hydrogeological sensitivity. Audubon New York has identified the Great Swamp as an Important Bird Area, and the US Department of the Interior has named it a National Historic Landmark. The Deuel Hollow CEA is recognized for its diverse, high-quality upland, wetland, and stream habitats, its known support of rare and sensitive species of plants and animals, and its importance to the community for passive recreation. The CEA designation imparts no legal protections to these areas, but is intended to raise awareness of the unusual resource values that deserve special attention during master planning, environmental reviews, and land use decisions.

Still, many of the important and vulnerable resources that occur throughout the town are unprotected by state and local laws and regulations—including small wetlands, small streams, all

kinds of upland habitats, and scenic vistas. While landowners have much autonomy in the uses and care of their own land, the town has authority to enact local legislation to protect resources deemed important to the public welfare.

This *NRI* can be incorporated by reference into the Master Plan, zoning ordinance, and subdivision regulations to help ensure that impacts to important resources are fully considered when new land uses are proposed anywhere in the town. Local laws can be enacted or amended, for example, to protect the many wetlands and streams that are unprotected by the state or federal governments. The Planning Board could adopt environmental review procedures that ensure thorough and accurate assessment of resources prior to decisions about land development projects.

When reviewing land development applications, the Planning Board, Zoning Board of Appeals, and Conservation Advisory Council can use the *NRI* to see if there are known features of conservation concern on or near the development parcel. The *NRI* is not a substitute for onsite observations, however, but can alert users to some of the features that deserve special attention in the project review.

Developers and other land use applicants can use the *NRI* to understand some of the natural features of local concern so that the siting and design of new development projects can accommodate those features. Landowners can discover new aspects of their land, learn about the relationship of their property to the larger landscape, and consider land management that is compatible with and takes advantage of the natural assets while protecting sensitive areas. Land trusts can use the *NRI* information to help identify conservation priorities in the town for their own strategic planning, and in their work with landowners to design conservation easements.

A prominent message of the *NRI* is that careful use and conservation of natural resources is a responsibility shared by everyone, and can happen everywhere—on a half-acre residential lot, a ten-acre woodlot, and a 200-acre farm. Small measures such as maintaining undisturbed buffers along streams, wetlands, and ponds, or reducing use of pesticides and fertilizers on lawns, gardens, and cropland can be employed by individual landowners, and other townwide measures can be incorporated into town policy and the local code.

The NRI outlines conservation principles and measures that can be applied anywhere; for example:

- Maintain forests wherever possible. This may be the best means of maintaining groundwater supplies, ample water in lakes and ponds, and cool, clean streams with stable banks, and providing many other ecological services such as moderation of local air temperatures and carbon sequestration.
- Manage stormwater in ways that facilitate infiltration of rainwater and snowmelt to the soils to help replenish groundwater and maintain the water quality and habitat quality of streams.
- Install new culverts and retrofit old ones in ways that maintain the stream habitat continuity that allows fish and other organisms that move up and down the stream to fulfill their life needs.
- Consider the 500-year flood zone in all land use planning and decisions, so that new uses will be resilient to the larger storms predicted for coming decades.

- Educate landowners in the valley bottom aquifer area about the special vulnerability of groundwater to contamination in that zone.
- Protect large contiguous habitat areas well-connected across the landscape where possible, and especially areas that encompass broad south-to-north and low-to-high elevations, to maintain safe movement corridors for plants and wildlife in response to climate change.
- Avoid fragmenting large areas of forest or meadow with new roads, driveways, utility corridors, and other such developed features, so that interior habitats for sensitive species are maintained.
- In deciding on the location and design of any new structures, consider the impacts on the entire viewshed of the structure.
- Consider adopting Complete Streets principles for town roads, to improve and expand opportunities for walking and bicycling, and improve the safety of roads for all users, including motorists.

These are just a few examples of the many small and large measures set forth in the *NRI* that can help to protect the resources that make Dover a wonderful place to live.

This *Natural Resource Inventory* is part of a larger effort by the Town of Dover to promote community resilience to the effects of climate change. In pursuit of a Bronze-level certification as a "Climate Smart Community" the town is assessing Dover's landscape, infrastructure, and operations, and finding ways to reduce energy use, increase uses of renewable energy, reduce greenhouse gas emissions, improve efficiency, and "commit to an evolving process of climate action."

We hope the *NRI* will help the town make the best uses of Dover's rich endowment of land, water, and habitats. Finding ways to protect the areas of greatest vulnerability and importance, and maintain intact many of the natural areas that sequester carbon, moderate local temperatures, purify and conserve water, and provide a host of other ecological services will improve the resiliency of the people, the wildlife, and the natural landscape to the effects of climate change.

Introduction

This *Natural Resource Inventory* (*NRI*) describes important natural resources throughout the Town of Dover and some of the implications for resource use and conservation. The purpose of the inventory is to inform citizens, town agencies, and others about the land and water that supports the people, farms, businesses, and natural areas of the town.

The Dover Town Board perceived the need for the town to have good information about natural resources for decisions about land use planning, land development, and resource uses. Farmers, other landowners, and developers make plans and decisions every day about land management or new land uses; the Dover Planning Board routinely reviews land development proposals; and the Town Board periodically undertakes revisions to the master plan and zoning ordinance. This document can inform all of those efforts so that valuable natural resources can be put to their best uses, and resources of conservation concern can be better protected.

An understanding of the array of local resources, their vulnerabilities to human activities, their potential resilience to the effects of climate change and other stresses, and their importance to the human community will help the people of Dover consider which areas are best suited for land development or other uses, and which are best left alone. In addition to their importance for ecosystems, the town's rich natural resources, including our large and small streams, the Great Swamp, the Stone Church Preserve, the Appalachian Trail, large forests, farmlands, and other open spaces can be the foundation for substantial and sustainable economic activity through hospitality,

Hobblebush is an uncommon plant of Dover's cool ravines.
Nava Tabak © 2019.

The caterpillar of the hickory tussock moth feeds on leaves of hickories, oaks, elms, ashes, maples, and other hardwoods. Nava Tabak © 2019.

equestrian activities, agritourism, farm-to-table restaurants, and fishing and hiking guides, for example. This *NRI* identifies resources that might be particularly suited to supporting sustainable local economic development.

Promoting and maintaining clean air to breathe; ample and clean groundwater to feed our drinking water wells; abundant, clean water in our streams and lakes; high-quality farmland; wild landscapes for wildlife habitats, scenic beauty, and recreation; and the historic places and landscapes that bind us to our natural and cultural heritage will help to preserve the parts of Dover that make this a wonderful place to live.

The *NRI* was prepared by Hudsonia Ltd. in collaboration with and under the direction of the Town of Dover Town Board and the Climate Smart Dover Task Force as part of the town's larger effort to become certified as a "Climate Smart Community." The program involves assessing Dover's landscape, infrastructure, and operations, and finding ways to reduce energy use, increase uses of renewable energy, reduce greenhouse gas emissions, improve efficiency, and follow an evolving process of climate action. The *NRI* project was funded by the New York State Environmental Protection Fund through a Climate Smart Communities grant to the town from the New York State Department of Environmental Conservation.

Throughout the *NRI*, terms in blue type are defined in the Glossary (Appendix A). Plants and animals that are listed by New York State as Endangered, Threatened, Rare, or Special Concern, or listed by the New York Natural Heritage Program as S1, S2, or S3, or listed by the New York Department of Environmental Conservation as New York State Species of Greatest Conservation Need are given a dagger (†) superscript.

Physical Setting

Dover is a rural town of 36,024 acres (56.3 square miles) in the eastern rank of towns in Dutchess County, New York. It is bordered on the north by the towns of Amenia and Washington, on the west by the towns of Union Vale and Beekman, on the south by the Town of Pawling (all in New York), and on the east by the towns of Kent and Sherman, Connecticut.

The Dover population was approximately 8,699 at the time of the 2010 US Census, not including part-time and weekend residents. Residences are somewhat clustered in the seven hamlets—Chestnut Ridge, Dogtail Corners, Dover Furnace, Dover Plains, South Dover, Webatuck, and Wingdale (Figure 1)—and also widely distributed along roads throughout the town. The overall population density is approximately 155 people per square mile.

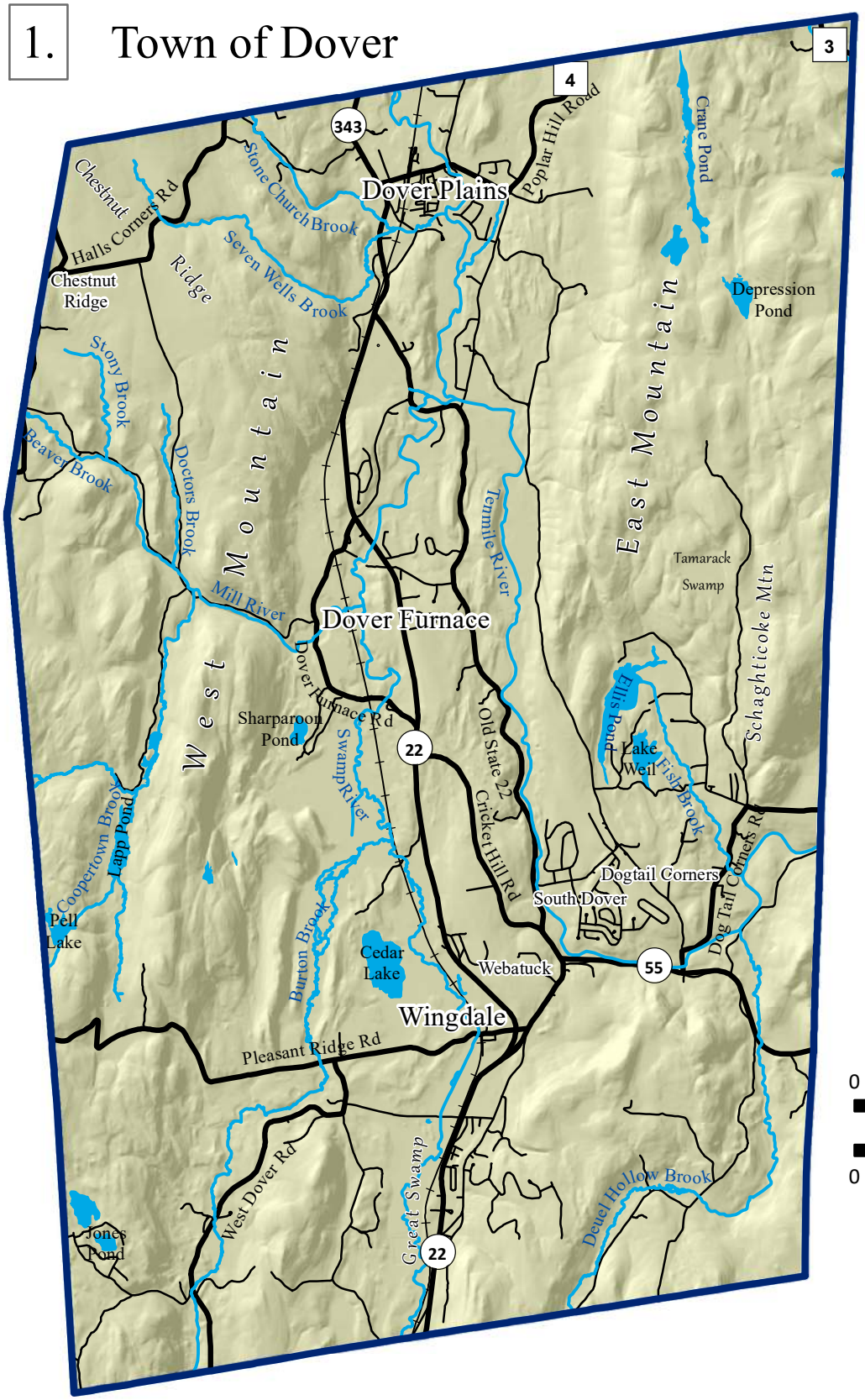
Climate

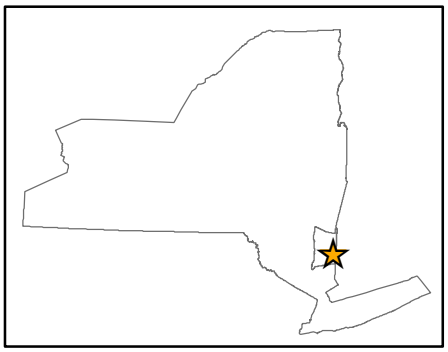
The "humid continental" climate type prevails in Dutchess County and throughout the northeastern US. The county receives masses of cold, dry air in winter from central Canada or the Hudson Bay, and warm, humid air from the Gulf of Mexico and adjacent subtropical areas in summer. Air masses from the North Atlantic Ocean produces cool, cloudy, and damp weather conditions from time to time. Storm systems moving northward along the Atlantic coast also have an important influence on the weather and climate of the county. The prevailing wind is generally from the west in this region, southwesterly during the warmer months and northwesterly in the colder half of the year (NCDC no date). Within Dover, differences in elevation and aspect from one place to another make for noticeable differences in the local climate.

Summer daytime temperatures usually range from the lower to mid-80s°F in Dutchess County (Cary Institute of Ecosystem Studies 2019). On a few days from late May to mid-September, highs are only in the 60s°F or reach into the 90s°F. The average length of the frost-free season is approximately 152 days (CliMOD2 2018), with the first frost typically in early October and the last frost in mid-May (Cary Institute of Ecosystem Studies 2019), but actual dates can vary greatly from year-to-year and by latitude, elevation, and aspect. The average annual minimum temperatures range from -5 to -10°F, putting Dover in the USDA Plant Hardiness Zone 6a (www.plantmaps.com).

Precipitation in Dutchess County is fairly uniformly distributed throughout the year—there are no distinctly dry or wet seasons on a regular annual basis. The least precipitation is typically in winter, but any month has the potential for the lightest or heaviest monthly precipitation within a calendar year at a given location (NCDC no date). Average monthly precipitation in summer is circa (ca.) four inches in Dutchess County, but the amount can vary widely from one place to another. Table 1 gives the normal monthly precipitation and temperatures for the Millbrook weather station, the closest station to Dover in the National Centers for Environmental Information (NCEI) system.

1. Town of Dover





Main road
Local road
Railroad
Perennial stream
Waterbody
Town Boundary

0 1 2 Miles

0 2 4 Kilometers

Data Sources:
Political boundaries and roads from New York State GIS Clearinghouse; streams and waterbodies from Graham et al. (2019). Relief-shaded topographic map generated from digital elevation models by the US Geological Survey (downloaded at Cornell University Geospatial Information Repository). Map created by Hudsonia Ltd., Annandale, NY.

Figure 1. Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Table 1. Climate normals (30-year averages) for the Town of Dover for temperature (1988-2017) and precipitation (1988-2018). Data are from the Cary Institute of Ecosystem Studies, Millbrook, NY, the closest NCEI weather station to Dover. Note that these are monthly averages over a 30-year period and do not show the extremes that occur in most years at these locations.

Month	Precipitation (in)	Mean Daily Minimum Temperature (°F)	Mean Monthly Temperature (°F)	Mean Daily Maximum Temperature (°F)
Jan	2.99	16	26	36
Feb	2.83	18	29	39
Mar	3.46	25	37	48
Apr	3.19	35	48	61
May	3.94	46	59	72
Jun	4.09	54	67	80
Jul	4.33	59	72	85
Aug	4.06	58	70	83
Sep	4.21	50	62	75
Oct	4.02	39	51	63
Nov	3.35	30	41	51
Dec	3.62	22	31	40
Year	44.09 (total)	38 (mean)	50 (mean)	61 (mean)

Rainfall is usually adequate during the growing season for commercial crops, lawns, gardens, and natural habitats. Severe droughts are rare, but minor droughts are not uncommon, and can deplete well water supplies, cause moisture stress for crops and natural vegetation, and increase the possibility of wildfires.

Over the last 20 years, many winters have seen limited snow cover and prolonged periods of bare ground.

In the past, New York State and Dutchess County have had abundant snowfall, with more-or-less continuous snow cover from about mid-December to mid-March. Nor'easter storms occur in most winters, and snow yields of 12-24 inches or more from such storms are not uncommon (NCDC no date). Snowfall patterns have been changing noticeably over the last 20 years, however, when many winters have seen limited snow cover and prolonged periods of bare ground. Topography and elevation produce great variations of snowfall from one location to another.

Major floods can happen in any season and, although they have been relatively infrequent in the past, we have seen several in the last decade associated with large storms. The greatest potential and frequency for floods is typically in the early spring when substantial rains combine with rapid snowmelt to produce large volumes of runoff. Recent hurricanes and tropical storms (Irene, Lee, and Sandy), however, have produced record-making floods in the late summer and fall.

Thunderstorms are common in Dover in spring, summer, and fall, and are often accompanied by heavy rain and strong wind. Hail events are less common but occur somewhere in Dutchess County in most years. Tornados occur occasionally in the region. Since 1978 there have been four Category F-0 tornadoes and seven Category F-1 tornadoes in Dutchess County. None were in Dover, but an F-1 tornado occurred in Pawling in 2002. (http://www.tornadohistoryproject.com/tornado/New-York/Dutchess/table) (On the Fujita scale, an F-0 tornado has wind speeds of 40-72 miles per hour, and an F-1 has wind speeds of 73-112 miles per hour.) Hurricanes and tropical storms are also rare, but several have swept through here in the last decade bringing torrential rains, high winds, and local flooding.

Physiography

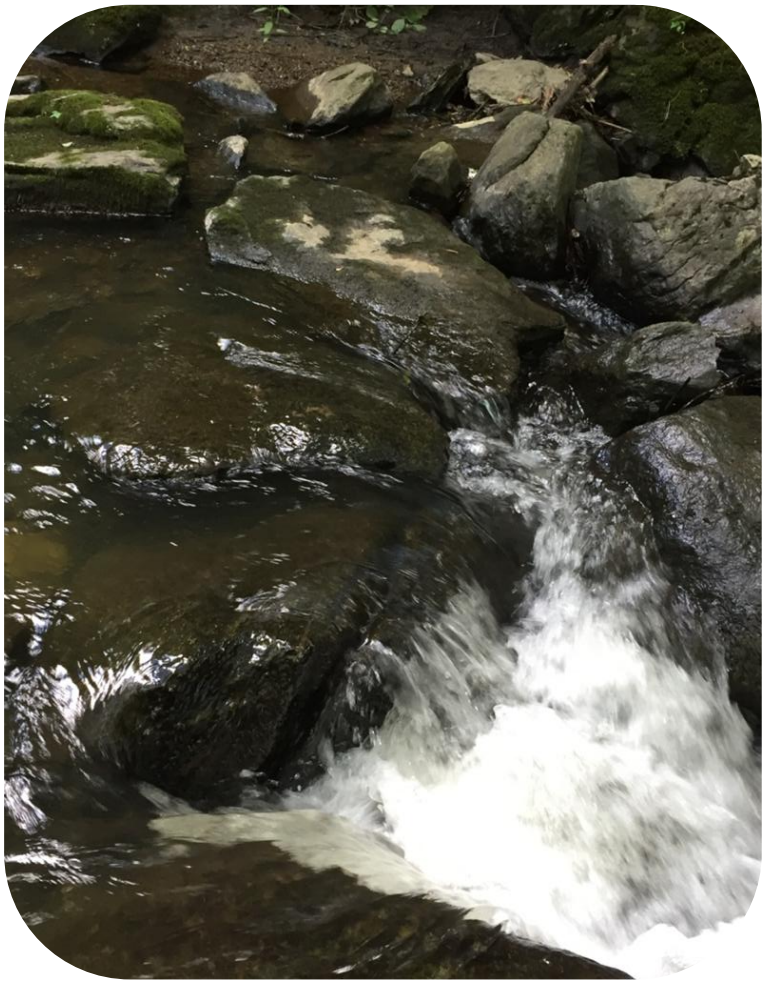
The Town of Dover is located in the New England Province physiographic region of the Appalachian Mountain range. The Dover hills are part of the "Housatonic Highlands," the hilly region straddling the New York-Connecticut boundary at the intersection of the Hudson Highlands and the Taconic Mountains. Dover is dominated by the two north-south-oriented ridges of West Mountain and East Mountain flanking the broad valleys of the Swamp River and Ten Mile River. The river corridor is a segment of the Harlem Valley—an unusual landform extending from mid-Columbia County into Westchester County and characterized by a deep bed of marble bedrock that is responsible for many of the unusual ecological communities, habitats, plants, and animals that biologically set this region apart from surrounding areas.

Elevations in Dover range from 290 ft above sea level (asl) where the Ten Mile River crosses the eastern town boundary to 1440 ft asl on Preston Hill, one of the East Mountain summits. There are several other high summits on East Mountain (1425 ft, 1414 ft and 1400 ft); Dennis Hill has the highest elevation summit elsewhere in Dover (1360 ft.). Much of the Harlem Valley floor in Dover is at elevations of 350-450 ft asl (Figure 2).

East Mountain and West Mountain are largely underlain by "hard," acidic bedrocks—gneiss, quartzite, schist—that are resistant to weathering and erosion. By contrast, the marble underlying the Harlem Valley is alkaline and relatively "soft" or easily weathered due to the water-soluble carbonate minerals. Bedrock is much exposed on the slopes and summits of the Dover hills, but is elsewhere covered by shallow and deep deposits of glacial till in the hills, and glacial outwash and alluvium in the lowlands. Dover's bedrock and surficial geology are described below in the **Natural Resources** section.

Water

The entire town is in the watershed of the Housatonic River which rises in the Berkshire Mountains of Massachusetts and flows generally south through Massachusetts and Connecticut to Long Island Sound at Stratford and Milford. The Ten Mile River, which drains most of Dover, is a major tributary to the Housatonic. Smaller Housatonic drainages in Dover are Furnace Brook, Great Brook, Macedonia Brook, and Webatuck Creek. The Swamp River—a large tributary to the Ten Mile—drains much of the western half of Dover. The broad valley of the Swamp River in the southern part of town holds a portion of the Great Swamp, one of the largest freshwater wetlands in New York State.



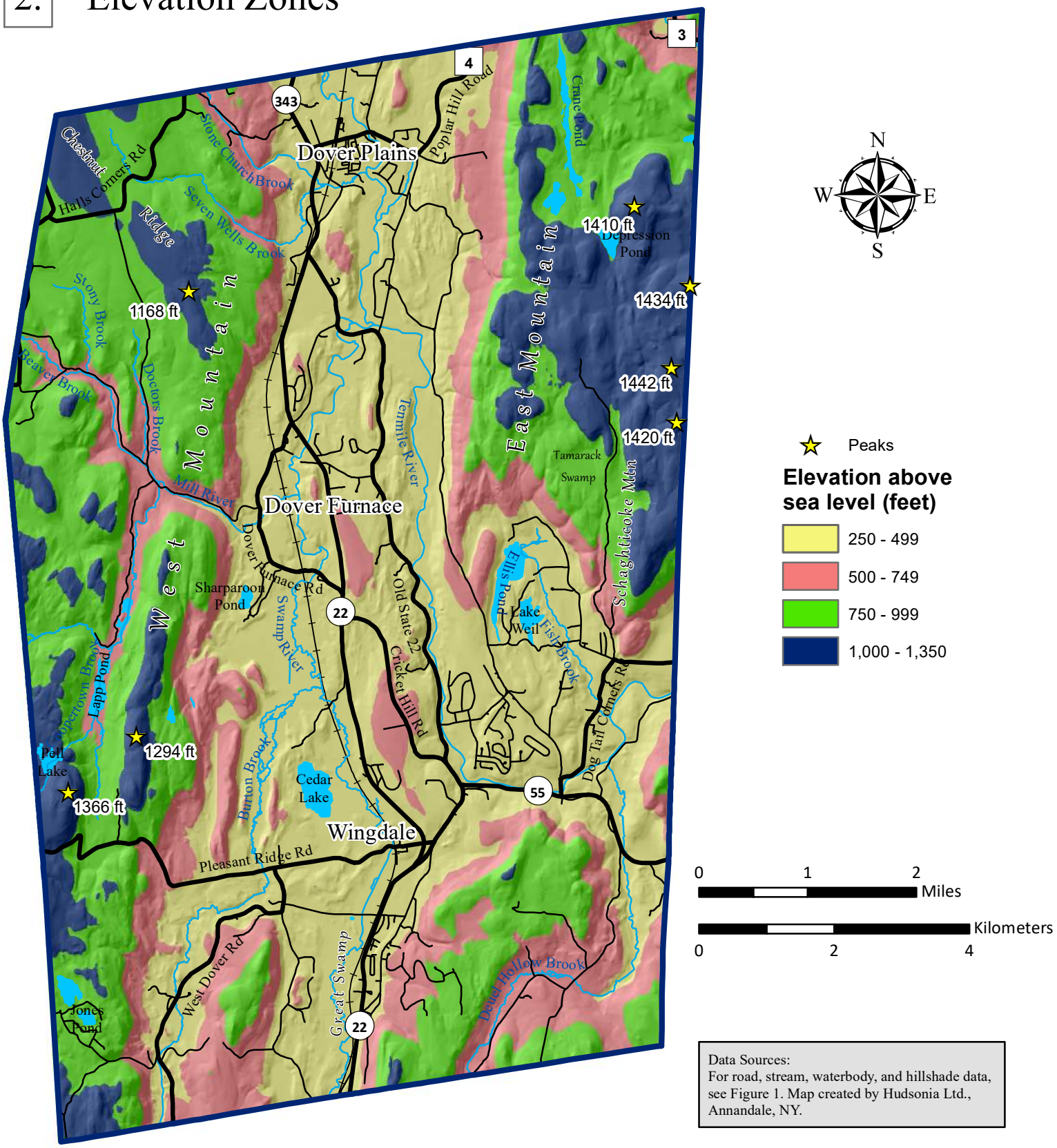
Deuel Hollow Brook

Many smaller streams—both perennial and intermittent—occur throughout the town (Figure 7). Rocky streams on steep gradients—such as Stone Church Brook and Seven Wells Brook—have carved deep ravines in some places, and low-gradient streams such as Burton Brook meander through broad wetlands on nearly flat terrain.

Dover has many large and small ponds and lakes; some are in naturally-formed basins, some were created by beaver, some were incidental to iron or marble mining, but most were constructed for other purposes by damming a stream or excavating in a wetland or upland area. Many are backyard ponds created for fire protection, recreation, or ornament, or farm ponds for watering livestock or other agricultural uses. Graham et al. (2019) mapped 316 ponds and lakes in Dover. The largest is Cedar Lake (74 ac), and some of the other large ponds are Crane Pond, Ellis Pond, Depression Pond, Jones Pond, Lapp Pond, Pell Lake, Sharparoon Pond, and Lake Weil (Figure 7).

The valley bottom aquifer—a large source of readily-accessible groundwater—lies in the glacial outwash deposits and in fractures, fissures, and solution cavities of the marble bedrock of the Swamp River and Ten Mile River corridors.

2. Elevation Zones



Data Sources:
For road, stream, waterbody, and hillshade data, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Figure 2. Relief-shaded elevation zones in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Resource Uses

Early History

Dover's forested mountains and fertile valleys have been used by humans for over 10,000 years. The last glacier retreated from Dover around 16,000 years ago, and by around 12,000 years ago the ice-age tundra had been gradually replaced by mixed conifer-hardwood forests that supported large mammals such as mastodons, mammoths, giant beavers, giant ground sloths, and musk-oxen. Climatic changes and perhaps the arrival of the first humans led to the extinction of many large mammals and changes in vegetation (Balter 2014). With the adoption of small-scale, shifting cultivation of maize and other crops, eastern forests included small, cleared settlements in the fertile floodplains beside streams and rivers, and shrubby regenerating patches where these were abandoned.

Prior to 8,000 years ago, small, temporary settlements of indigenous people were often located next to large, inland wetlands on glacial lakes. During the next 3,000 years, a warmer, drier climate resulted in loss of wetlands, expansion of grasslands and nut-bearing trees (oaks, hickories), and the establishment of settlements along large river valleys. Between 5,000 and 4,000 years ago, continued climate warming caused expansions of plant and animal diversity and the human population (Lavin 2013).

Maize was first cultivated in this region about 1000 AD, when the climate warmed sufficiently to permit its growth in the Northeast. Other plant domesticates, such as gourds and squash, had been cultivated earlier, but the reliance on crop cultivation expanded greatly with the introduction of maize and, later, beans and sunflowers. Apparently, when and where wild foods were abundant enough, Native Americans did not cultivate maize but, by the 1300s, with increasing population densities at least along major rivers, maize cultivation was in wide practice. Agricultural fields were cleared by girdling, cutting, and/or burning forest along fertile floodplains and terraces. Fields were cultivated and left fallow in rotation to preserve fertility, and then abandoned when fertility was exhausted (Thomas 1976). Fallow and abandoned fields were still used as food sources, as berries, grapes, and ground nuts, as well as game, thrived in these early-successional habitats. Silvicultural practices included the use of fire to clear the understory for hunting, and planting of orchards or management of forests to favor nut- and fruit-bearing trees and shrubs (Munoz et al. 2014).

Wild nuts and fruits as well as crops were gathered, dried, and stored in fall. Dried maize, fish, and other foods were stored in underground pits. "Bush-burning" occurred annually in the fall, to provide lush herbaceous regrowth as food for game, to make hunting easier by opening the understory, and to provide edge habitat which favored game, seed-bearing plants, and berries. (Thomas 1976, Sellers 2016).

When the first European colonies were established in the early 1600s, Algonquin-speaking peoples of various groups inhabited the general area. It is unknown which group occupied Dover, but probably members of the Mahican tribe, which resided in much of southeastern New York and may

have extended into western Connecticut (Lavin 2013). Trading relationships between Native American tribes and first the Dutch and then English colonists were sometimes mutually beneficial, but also intensified inter-tribal conflict. European diseases soon decimated indigenous populations, and European land acquisition and farming practices began to diminish subsistence resources.

The Schaghticoke tribe was formed sometime prior to 1699, and inhabited the Ten Mile and Housatonic river valleys. It was composed of Mahican, Pequot, Pootatuck, Oweantinock, and Tunxis peoples. The name Schaghticoke, derived from the Algonquian word *Pishgachtigok* meaning "gathered waters," may refer to the confluence of the Ten Mile and Housatonic rivers. In 1736, the colonial Connecticut government granted the Schaghticoke tribe a reservation on the west side of the Housatonic, and also stated that they were allowed to remain "on the sweep of the Ten Mile River around the Dover Hove Out" (www.schaghticoke.com). In the 1700s, Mahican and Schaghticoke villages in northwestern Connecticut annually moved from a winter-spring village to a summer-fall village (Lavin 2013), and the Schaghticoke people "continued their annual rounds through Dover well into the mid-1800s" (Hearn 2008). They visited swamps for basket materials, streams and ponds for fish, and specifically hunted and cooked frogs and turtles around Allis' Pond [Ellis Pond]: "The small speckled turtles [spotted turtles?], so numerous about the swamp in early spring, were held by them in great esteem." "Indian orchards" were also mentioned on two Dover farms by Smith (1877).

The name Schaghticoke, from an Algonquian word meaning "gathered waters," may refer to the confluence of the Ten Mile and Housatonic rivers.

The first Europeans probably settled Dover in the early 1700s (Maher 1909). The Beekman land grant, including Dover, had 92 residents in 1737. Apart from the Hudson River corridor, Dover was one of the earliest places settled in Dutchess County because it lay on a route between the Hudson Valley and Connecticut. In the 1730s there were two roads through mountain passes from Dover to Poughkeepsie and one (today's NYS Route 343) to Rhinebeck (McDermott 1986).

The flat land including present-day Dover Plains was "nothing but a scrub oak plain" (that is, probably regenerating indigenous farmland). Early settlers reportedly preferred to buy mountain land, even though it was more expensive. Wild turkeys were abundant, deer less so, and wolves, bears, and mountain lions were present but uncommon (Smith 1877). New York State passed laws in 1726, 1728, and 1741"to encourage the destroying of wolves and panthers in Dutchess County" (Hasbrouck 1909). By 1800 there were virtually no deer or wild turkeys, bears, wolves, or mountain lions in Connecticut (Lavin 2013). Sawmills were among the first buildings constructed and, to promote land clearing, timber from undeveloped land was freely available according to Dutch and then English law (Sellers 2016). Wetlands were commonly ditched or drained to convert them to farmland, starting in the 1700s (Sellers 2016).

Most of the first colonial farms were established on the sites of abandoned Native American fields, and settlers adopted and relied heavily on many of the crops and methods of indigenous agriculture. Early land sales often contained provisions allowing the continued use of the noncultivated areas by Native Americans for hunting, fishing, and gathering wild foods. Colonization, however, brought rats, weeds, crop diseases, free-ranging livestock, rapid and extensive land-clearing, damming of streams, and draining of wetlands. These changes diminished resources and altered indigenous subsistence patterns, leading to conflict, impoverishment, and displacement of Native Americans, some of whom became laborers on European farms (Sellers 2016).

Although colonial agriculture was much more intensive than the indigenous farming that went before, colonists did practice the traditions of "husbandry" that had evolved to sustain fertility and resources on small farms in Europe. Their methods relied on an integrated system of crops, livestock, pasture, woods, and water. For example, hay grown in naturally fertilized floodplains and marshes was harvested to feed livestock through winter, and then their manure was carefully applied to fertilize cropland. Woodlands were managed to provide a steady supply of wood for building, fuel, and a variety of essential products, while also providing forage for livestock (Donahue 2004). Fields were often left fallow every second or third year (Smith 1877).

Farms from colonial times through the mid-1800s were small, diversified family businesses, largely self-sufficient but also dependent on market income. Early settlers grew maize, wheat, flax, oats, barley, apples, and garden vegetables; and raised cattle, horses, sheep, pigs, poultry, and honey bees (Smith 1877, Thomas 1976). As examples of the integrated local economy, sheep were kept, and wool was washed, carded, spun, woven into cloth, and fulled on the farm (later there were mills for carding, weaving, and fulling), and then sewn into clothing at home or by a tailor. When a cow was butchered, the farmer brought the hide to the local tanner to be made into leather, and then to the local shoemaker to be made into shoes.

In the 1700s, a main route for stagecoaches and drovers from Vermont to New York City led through Dover.

The first prominent income-producing crop for export was wheat, which was profitable until the end of the 1700s (Reed 1875). A main route for stagecoaches and drovers from Vermont to New York City led through Dover (Hearn 2008). Drovers bought cattle and sheep for later sale in the city, and they had to stop every few miles to feed the livestock; in Dover there were taverns at Dover Plains and at South Dover that hosted drovers (Hasbrouck 1909). In 1780, a French officer stayed at a tavern in Wingdale with 13 farmers who were driving 250 cattle from New Hampshire to supply the Revolutionary Army.

When wheat crops began to fail due to disease, maize, barley, and then oats were each briefly grown for sale. Then in the early 1800s, farmers began to use lime to improve pastures and hayfields, and raised cattle and sheep for meat (Reed 1875). In the early 1800s mills for carding, spinning, fulling, knitting, and weaving proliferated throughout Dutchess County. Woolen cloth was briefly profitable (1809-1815). Then in 1824, tariffs on imported wool and wool cloth raised the price of domestic

wool and led to an explosion of sheep farming in much of the Northeast. The expansion of sheep pastures, even on steep hillsides and summits, led to the maximum deforestation of the region until the price of wool (and number of sheep) dropped rapidly after 1850. Sheep farming had severely declined by 1875.

When the Harlem Railroad was built through Dover in 1849, farms began to shift from diversified, self-sustaining homesteads to more commodity-led production. Dairy farming became profitable, because fresh milk could now be transported quickly to the city. Ice was harvested from a bend in the Swamp River and stored in a huge ice barn at the Borden Condensed Milk Company in Wingdale to refrigerate milk overnight until morning delivery to the city (Hearn 2008). In 1908, the McDermott Milk Company had a large factory that handled about 100 cans of milk per day. Fresh fruit and vegetables could also be shipped profitably by rail to the city. In 1908, Dover Plains and Wingdale each had a cider mill, and there was a large cold-storage plant, with a capacity of 15,000 barrels of fruit (Maher 1909).

The market revolution's shift from manure-based, mixed husbandry to intensive production of animal-based products (wool, milk, beef) resulted in increased productivity, but also accelerated environmental degradation. After sheep (for wool) and cattle (for beef and dairy) began to be raised on a larger scale, deforestation rapidly accelerated, until most land was cleared by 1850 (Donahue 2004). Although we do not know the decade when agricultural land-clearing peaked in Dover, it was likely in the mid-1800s. Dover's forests probably followed the regional trend of increased forest age (hence tree size) from 1950 to the present, along with a shift in relative abundance (compared to before 1800) favoring shorter-lived, rapidly growing trees such as red maple and black birch at the expense of long-lived, mature forest species such as American beech and eastern hemlock (Hall et al. 2002). Kiviat (1988) noted a few small groves of large, old trees on the east- and west-facing slopes and top of East Mountain, near the lakes. Some of the trees on rocky crests, ledges, and barrens, though not large, may also be very old, and some steep-sided ravines may retain groves of hemlock that have never been cut.

Technological and transportation advances in the 1940s dramatically influenced the sizes of dairy farms. Rural electrification in the 1940s enabled artificial refrigeration and the spread of electric and mechanical milking technology. Milking machines enabled individual farms to manage much larger herds. The introduction of refrigerated tank trucks for hauling milk to dairy processing plants relieved the farmers of the need to haul their milk to milk stations daily, but required that each farm install a refrigerated bulk tank. The financial cost of these transitions drove many small farms out of business, so that after World War II, the trend has been toward fewer but larger dairy farms in the region (Stott 2007).

Dover's farmers are owners and managers of some of the largest land areas in the town, and are important stewards of land and resources.

Dover's subsistence and commercial economy for the first 150 years after European arrival was almost entirely based on uses of local natural resources—hunting, fishing, trapping; production of livestock and crops; mining of iron and marble; charcoal production from forests; water power for forges, woolen mills, grist mills, marble finishing, and early electrification; and related industries such as lime production, and creameries. Today, although farming and associated businesses are still important to the town's economy and culture, the livelihoods of most residents and businesses are not directly dependent on local natural resources. Only a small percentage of the population is employed in farming, logging, or mining or in businesses supporting those industries. Even so, farmers are owners and managers of some of the largest land areas in the town, and are important stewards of land and resources. Currently, Dover has approximately 12,908 acres in active agriculture. The largest acreage is devoted to pasture for beef and other livestock, and to hay, corn, and other field crops.

Dover's large and small streams served many water-powered mills and factories in the 18th and 19th centuries.

Mills

Because water power was a free and ubiquitous energy source, there were numerous water-powered mills on streams in this region in the 18th and 19th centuries. Mill abundance peaked around the mid-to-late 1800s, but water-powered mills persisted until around 1940. Several Dover place names reflect this history, including Saw Mill Hill, Mill River, and Reagans Mill Road. Ebenezer Preston, one of the earliest settlers in the town, established three grist mills on the Ten Mile River. By 1877, two of these still had working mills at the same sites—possibly the mill sites on the 1867 map in Dover Plains (labeled S. Mill, G. Mill, and Marble Saw Mill) and Webatuck (Prestons Marble Mill)—and the third was previously a sawmill at Old Forge, near the state line (Smith 1877). There was also a sawmill on Deuel Hollow Brook in the late 1800s (Hearn 2008). In addition to grist mills and sawmills, fulling and marble finishing mills were mentioned by Smith (1877). In 1908, Dover Plains businesses included a feed mill and a cider mill, and one of each was listed at Wingdale, as well as a grist mill at South Dover (Maher 1909). Dover Plains also had a mill generating electricity starting in 1895 (Hearn 2008). Dover Furnace Dam on the Swamp River was built as part of the ironworks.

Numerous dams interrupted fish migrations, and often led to the decline and disappearance of fisheries.

Before all the extensive damming of streams for water power in the 1700s and 1800s, many or most low-gradient streams in the eastern US had branching channels meandering through open, shrubby, or forested spring-fed wetlands that extended the width of the valley, similar to Swamp River today. After dam construction, millponds gradually filled with sediment (hastened by deforestation and agriculture in the watershed) and eventually supported meadows and forests; when dams were breached, the streams carved deeply into the deposited sediment, leading to single channels with high, eroding streambanks, inset flood-plains, and dry upper terraces (at the previous millpond level). High sediment and nutrient loads in some of our modern streams may be largely due to this history (Walter and Merritts 2008). In addition to the extensive destruction of these valley wetlands, dam construction interrupted fish migrations and hydrology critical for other organisms, and often led to disappearance of fisheries.

Iron Mines and Furnaces

Production of iron before 1840 depended on four elements: iron ore, water power, forests for charcoal production, and limestone or marble for flux. Dover had all four, making it an ideal site for this industry. Limonite and siderite are iron ores present in the Harlem Valley, found in small to large deposits along the contact between marble and schist (Newland 1919).

Iron ore was smelted in blast furnaces to create crude iron ingots—pig iron—that were the feedstock for iron foundries. Early blast furnaces were stoked with a mix of charcoal, limestone, and ore, and blasted with air from water-powered bellows to make the high temperatures needed to melt the iron from the ore.

In 1889 there were 24 working iron mines up and down the Harlem Valley.

Charcoal was a primary industrial fuel in the 1800s, used especially for iron smelting, but also for blacksmithing and metal manufacturing (Stott 2007, Leff 2016). Charcoal was made by slowly heating logs in an outdoor earthen kiln—a pile of logs covered with soil and green vegetation. This created a low-oxygen environment in which a smoldering fire would vaporize the moisture in the logs, and leave only charcoal, which burns longer and hotter than firewood. Large quantities of charcoal were needed for iron production, and large areas of forests around the charcoal pits (kilns) were cut for charcoal production.

There were 24 working iron mines up and down the Harlem Valley in 1889, nearly all open pit mines up to 100 ft deep; ore was sorted by hand (Smock 1889). Dover Mine (also called the Foss Ore Bed, or the White Ore Bed) was first an open pit mine and later an underground mine. The nearby Dover Furnace was a busy iron-producing village with, at one time, a total of four blast furnaces that produced pig iron from ore received from the Dover Mine and the Deuel Hollow Mine (Hearn 2008). The dam, water wheel, and other structures associated with one of the furnaces are still visible where Dover Furnace Road crosses the Swamp River. In 1941 the dam was modified to provide power for electric generation.

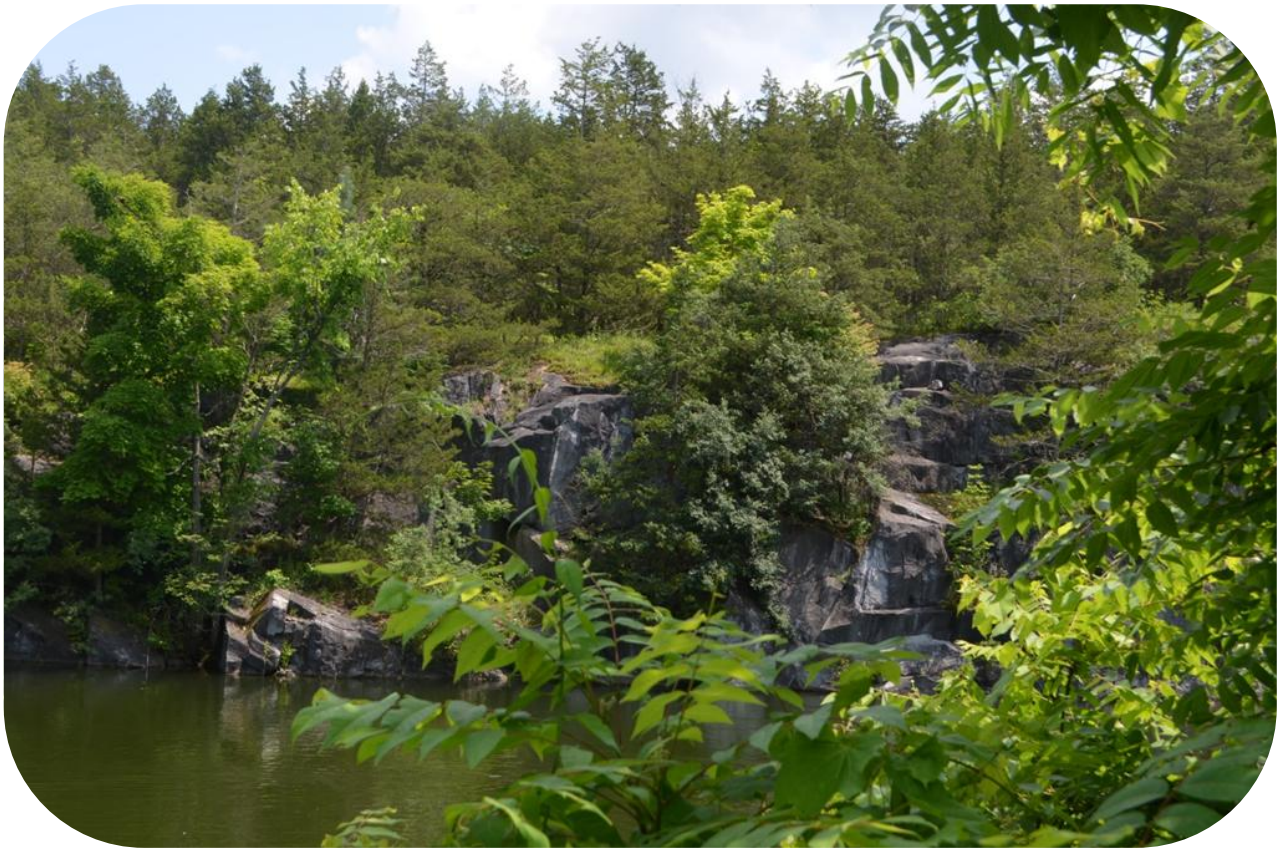
In 1886, the Dover Mine produced 9,000 tons of ore, with approximately 38% iron content. Based on these figures, the furnace could produce approximately 3,400 tons of pig iron per year, which would necessitate cutting about 600 acres of forest for charcoal annually. A furnace this size would likely manage approximately 12,000 acres of forest for charcoal production (equal to the western, mountainous third of the Town of Dover) with rotational cutting, using 20-year cycles, to sustain this level of production (Straka 2014). Dover Mine was actually in intermittent production (Smith 1877, Smock 1889), and may have cut fewer acres of forest. But there were several furnaces operating in Dover at roughly the same time as the peak of agricultural land-clearing in the region, so the mid-to-late 19th century Dover landscape would have been quite open.

Quarries

Dover's broad central valley is underlain by a deep bed of Stockbridge marble, which varies in composition from dolomitic to calcitic, and in texture from fine to coarse. The varieties of marble found in Dover are suitable for use in building (fine-textured, dolomitic), for flux in iron production to remove impurities in the metal, and for lime (calcitic) (Dale 1923). Lime, produced by heating

marble in a kiln, was used for fertilizer, whitewash, and later for the production of concrete and many other industrial products.

Marble was first mined in Dover for local building and iron production, but after the arrival of the railroad in 1849, marble was mined on a larger scale for export. An 1867 map lists a dealer in lime, and shows "marble mills" (water-powered mills for finishing marble) on the Ten Mile River in Dover Plains and Webatuck. The Dover Plains Marble Works was in business since 1867 (Maher 1909). By the late 1890s, South Dover Marble Company was operating a large marble quarry between Ellis Lake and the Ten Mile River. This high-quality building marble ("uniform white marble of fine compact texture" Newland 1919) was used in public buildings from New York City to Washington, DC. By 1906 there was a third company, Dover White Marble Company; and the South Dover Marble Company employed 100 men (Maher 1909). In 1919, there were "extensive cutting and polishing works at Wingdale Station" (Newland 1919) and a small rail line connecting the quarry and the station (Hearn 2008).



Callahan quarry.

Shortly thereafter, the adoption of concrete and steel for construction led to the decline of the marble industry in the region. This led, however, to a high demand for lime, which could also be produced from Dover marble (Hearn 2008). In the first decades of the 20th century, coarse-textured marble was being quarried for lime production by Dutchess County Lime Company (for building and agricultural lime) and Kelley Island Lime & Transport Company from several small quarries near Dover Plains (Newland 1919, Dale 1923). There was a lime kiln in Dover Plains at the confluence of Seven Wells Brook and Ten Mile River, and presumably one or more kilns along Lime Kiln Road. During World War II, Dover marble was mined to recover magnesium for use in metal alloys for airplane body construction, and for use in incendiary bombs, flares, and ammunition (Hearn 2008, Budnik et al. 2010).

Smith (1877) reported that "[s]ome peat beds have been opened near the line of the Harlem Railroad." It is unclear whether this peat was mined for bog iron, fuel, fertilizer, or stock feed, or how extensive the mining was.

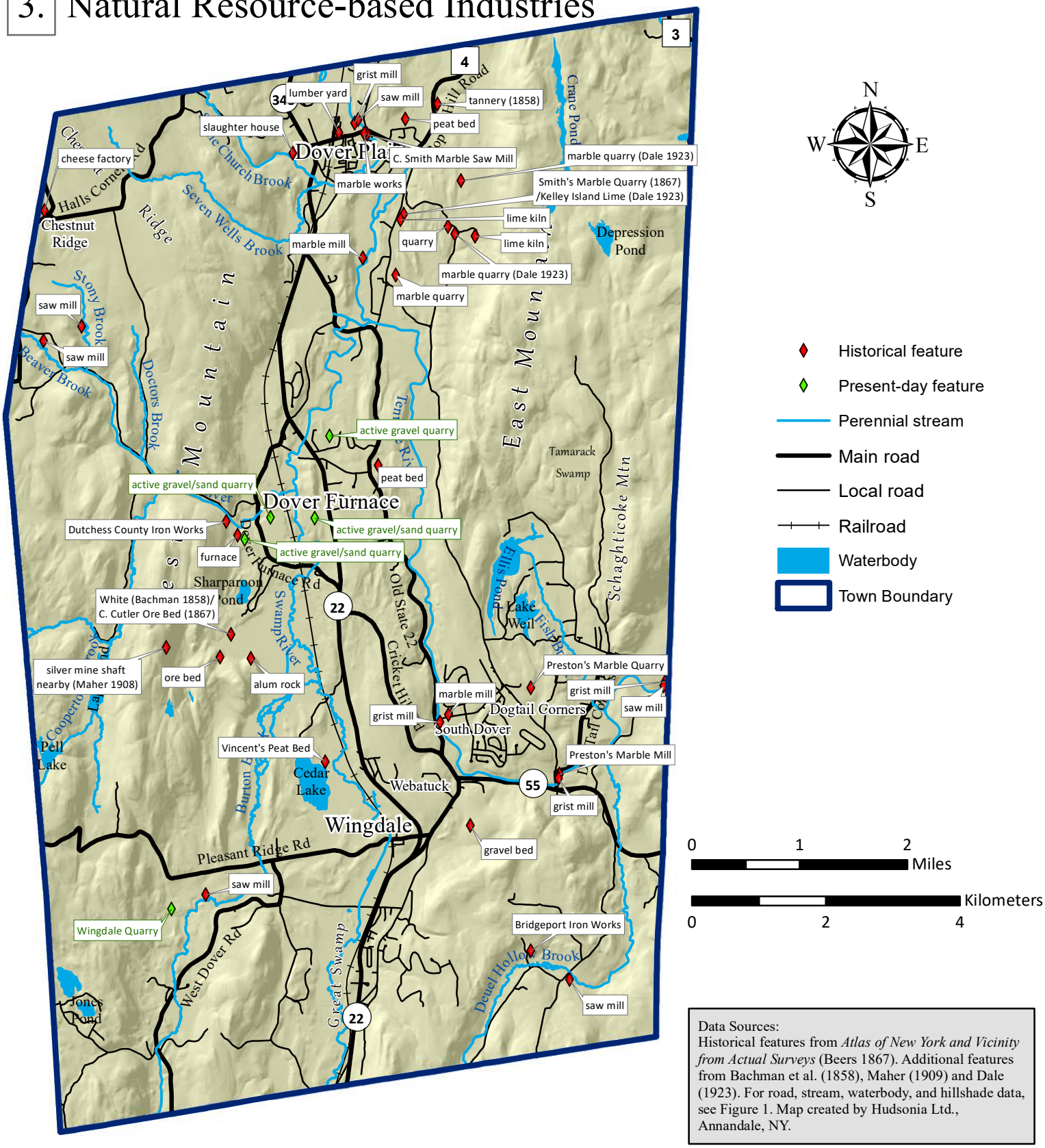
Figure 3 shows the locations of some of the old mines, quarries, mills, and other natural resource-based industries.

Present-Day Uses

Today the remaining extractive land uses in Dover are for sand, gravel, schist, and aggregate. Agriculture is still important, but is confined to much smaller areas of the town than in the 1800s. Dairy, beef, sheep, horses, poultry, bees, hay, corn, soybeans, vegetables, fruits, herbs, flowers, trees, and shrubs, maple syrup, and honey are produced commercially. The first solar farm in town—a three3 megawatt installation—is now under construction. Many other natural resources still support Dover's economy by attracting hikers, picnickers, equestrians, paddlers, anglers, bird-watchers, and other recreationists drawn to all the wild and beautiful places that are accessible to the public.

View from Hall's Corner Road.

3. Natural Resource-based Industries



Historical feature

Present-day feature

Perennial stream

Main road

Local road

Railroad

Waterbody

Town Boundary

0 1 2 Miles

0 2 4 Kilometers

Data Sources:
Historical features from *Atlas of New York and Vicinity from Actual Surveys* (Beers 1867). Additional features from Bachman et al. (1858), Maher (1909) and Dale (1923). For road, stream, waterbody, and hillshade data, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Figure 3. Historical and present-day locations of natural-resource-based industrial operations in the Town of Dover, Dutchess County, New York. All historical features are from an 1867 map unless labeled otherwise. The map is incomplete but provides a sense of the array of local resources that have contributed to Dover's culture and economy. Dover Natural Resource Inventory, 2019.

Natural Resources

Dover's natural resource are much influenced by this setting in the Housatonic Highlands and Harlem Valley, the local topography, the varied textures and chemistries of the bedrock and surficial geology, along with the influence of human land uses—especially mining, charcoaling, agriculture—since European settlement. The natural resources have long supported the subsistence and commercial economies of the town, and today provide the scenic backdrop and recreational sites much loved by Dover residents and visitors. This Natural Resources section describes the array of resources—landforms, minerals, water, habitats, and farmland—that constitute the Dover landscape, and some of the uses and values of the resources to the human community. Later sections describe threats to these resources and measures that can help to protect them.

Enduring Features

The term "enduring features" refers to features such as bedrock, hills, and valleys that are substantially unaffected by human land uses and ordinary natural events such as floods, wildfires, hurricanes, and even climate change. These are the foundations upon which our streams, ponds, marshes, forests, meadows, and other habitats have developed. For conservation planning, and in the absence of more detailed information, planners can use enduring features as "surrogates" for the species, communities, and processes that sustain our ecosystems (Austin et al. 2013).

Protecting representative intact (i.e., undeveloped) areas of these features connected across the landscape will help preserve a host of natural communities, interactions, and ecological services. Three kinds of enduring features are especially significant for conservation:

- **landforms**—mountaintops, hillsides, and valleys;
- **bedrock**—the variety of bedrock types throughout the town; and
- **surficial materials**—the gravel, sand, silt, clay, and peat that sits on top of the bedrock.

Certain ecological communities or rare species occur only in certain landscape and geological settings—such as a north-facing slope, or a ravine, or a marble valley, or on sandy soils. We may not know all the places where that community or species occurs in the town, but protecting representative, intact (undeveloped) areas with varying topography, bedrock, and surficial material will help to ensure that those species or communities can continue to persist here.

The major landforms in Dover are represented by West Mountain, East Mountain, Schaghticoke Mountain, and the major valleys of Deuel Hollow Brook, Burton Brook, the Swamp River, and the Ten Mile River. The bedrocks of Dover's hills are predominantly gneiss, quartzite, and schist (with some conglomerate) in hills to the east, and slate, phyllite, and schist to the west. Marble underlies the areas below ca. 250 ft elevation in the major valleys. Very small areas of graywacke, shale, and

mélange occur on West Mountain. Deep ravines are along Stone Church Brook, Seven Wells Brook, and a tributary to Deuel Hollow Brook.

Surficial deposits are the loose materials over bedrock that have been deposited by glaciers or running water, or the organic materials that developed in place. These are the glacial till, which covers much of the town, the glacial outwash and kame deposits in lowland areas, and the alluvial materials along stream corridors. Deep layers of organic peat and muck have accumulated where prolonged inundation or saturation has led to the very slow decay of plant and animal remains in the oldest and wettest wetlands. The soils that support our forests, meadows, wetlands, and wildlife, as well as our croplands, pastures, and lawns have developed over millennia through the interaction of these surficial materials with plants, animals, water, and weather.

Air

Clean air, like clean water, is fundamental to human health and well-being, and is equally important to our livestock and pets and to plants and wildlife in the natural habitats all around us. We also consider clean air to be one of the many perquisites of rural life.

> The major air pollutants in Dutchess County are ground-level ozone, particulate matter, and acidic deposition.

A rural, substantially forested town such as Dover, located far from urban areas, high-traffic roadways, intensive industrial areas, or coal- or oil-fired utility plants would be expected to have good quality air but, although better than that of New York counties to the south, the air quality in Dover and much of Dutchess County is not high. The major air pollutants in the county are ground-level ozone, particulate matter, and acidic deposition. Some pollutants originate here or nearby, and others are from distant places (Bernhardt et al. 2010).

Ozone is a gas formed by chemical reactions between volatile organic compounds (VOCs) and nitrogen oxides (NO_x) in the presence of sunlight. The reactions are stimulated by high temperatures, so peak ozone levels occur on warm days in summer. VOCs and NO_x are produced from many sources, including fossil fuel-burning industries and power plants, vehicle exhaust, paints, and solvents, evaporation of stored fuels, and even evaporation from vegetation (Bernhardt et al. 2010, Kinney et al. 2011). Ground-level ozone is the most harmful component of smog. Breathing ozone can cause lung inflammation and can exacerbate asthma conditions and other lung-related ailments. Because ozone formation increases with greater sunlight and higher temperatures, ground-level ozone is expected to increase with the warming climate (Kinney et al. 2011).

Particulate matter includes dust, dirt, soot, pollen, smoke, and liquid droplets suspended in the air. Fine particulate matter (less than 2.5 microns) causes reduced lung function, with serious consequences for those with asthma and other lung impairments. The typical sources for fine particulates are emissions from combustion processes and transformations of gases such as sulfur dioxide, NO_x, and VOCs. Other common sources are smoke from wildfires and airborne pollens, molds, and dust. The prolonged droughts, the increased incidence of wildfires, and the increases in molds that are predicted by climate scientists are expected to increase the levels of airborne particulates in the region (Kinney et al. 2011). Particulate matter is not currently monitored in Dutchess County (Bernhardt et al. 2010).

Acidic pollutants arrive here in rain, snow, and ice (acid precipitation), in gaseous form, or attached to airborne particulates (dry deposition). Sulfuric acid and nitric acid—the primary compounds in airborne acidic pollutants— originate from sulfur dioxide and nitrous oxides from car exhaust and industrial processes, and from coal-burning power plants in the Midwest. Acidic deposition over the last 60+ years has significantly altered the terrestrial and aquatic communities of the Northeast. The ecological effects include acidification of soils and water, mobilization of toxic mercury and aluminum in aquatic and terrestrial ecosystems, fish mortality, reduced growth and increased susceptibility of trees to stress, and reduction of overall ecosystem productivity (Driscoll et al. 2001). Due to federal Clean Air Act regulations governing emissions from fossil fuel-burning plants, the acidity of precipitation in the Dutchess County has declined dramatically since 1970 and even more since adoption of additional Clean Air Act regulations in 1990, but is still far above that of uncontaminated precipitation (Bernhardt et al. 2010). The buffering actions of Dover's carbonate-rich bedrock and soils helps to reduce the acidification of Dover habitats and thus somewhat protects the plants and animals.

The air quality index (AQI) is a number used to characterize the quality of the air at a given location based on the levels of six pollutants: carbon monoxide, lead, nitrogen oxides, ozone, particulate matter, and sulfur dioxide. A higher AQI means poorer air quality. AQI values are divided into ranges, and each range is assigned a descriptor and a color code. Standardized public health advisories are associated with each AQI range. In 2014-2016 there were eight days when the ground-level ozone level in Dutchess County was coded "orange"—indicating that the air was unhealthful for sensitive groups such as those with asthma, bronchitis, or other respiratory diseases. In the period January – August 2018 there were two days when the average ozone level exceeded the 2015 federal standard of 0.070 ppm. According to a report of the American Lung Association (April 2018), the county's air quality received a "D" grade (on a scale of A-F) for the 2014-2016 period due to high levels of ground-level ozone.

The county's air quality received a "D" grade (on a scale of A-F) for 2014-16 due to high levels of ground-level ozone.

Figure 4 shows data for particulate matter (PM), ground-level ozone (O_3), and nitrogen dioxide (NO_2) collected at the air quality monitoring station at the Dover High School, operating since late 2017. In the period November 2017 - February 2019, particulate matter exceeded the 35 μg/m³ federal standard just once (in May 2018), but there were frequent readings over the recommended annual mean of 15 μg/m³. Ground-level ozone levels have exceeded the federal standard of 0.070 ppm on many days in 2018. In the period July 2018 through February 2019, however, NO_2 levels stayed well below the federal standard of 0.053 ppm. The air quality monitoring station at the Dover High School was funded by the Cricket Valley Energy electric generating facility at the request of the town because of concerns over the potential for local air quality degradation due to emissions from the plant.

View from Berkshire Road in Dover Plains.

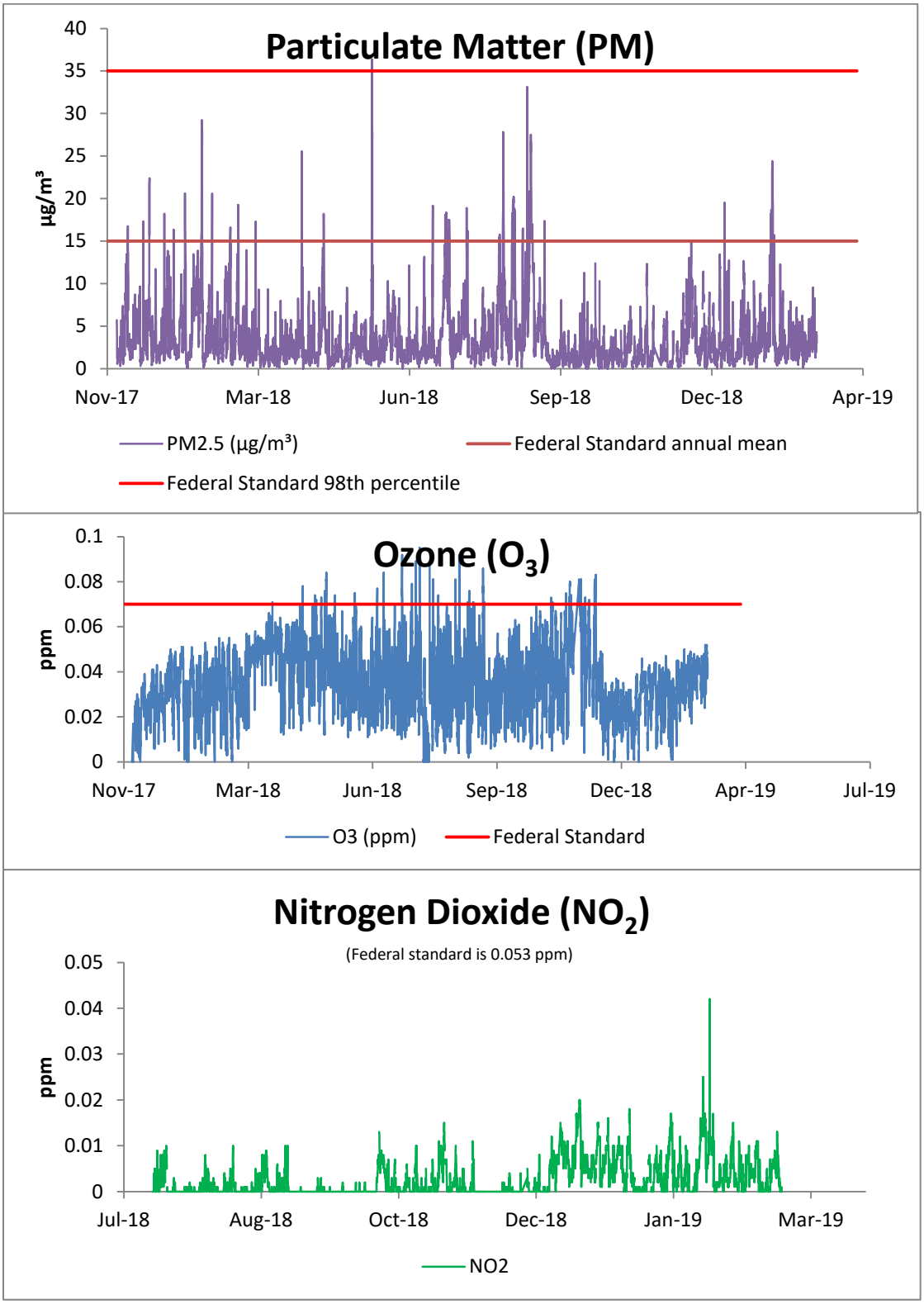


Figure 4. Air quality data from the Dover High School monitoring station. Federal air quality standards are at https://www.epa.gov/criteria-air-pollutants/naaqs-table.

Mineral Resources

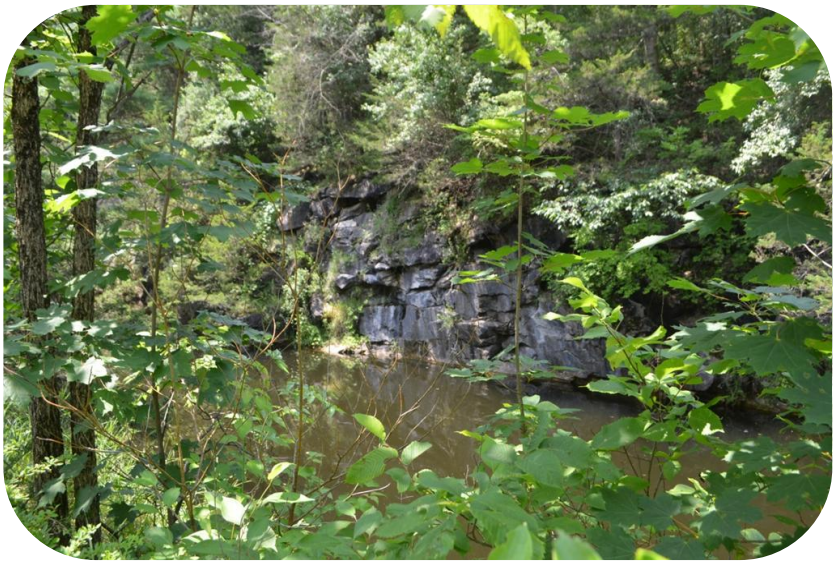
Bedrock

The generalized bedrock geology map prepared by Fisher et al. (1971) shows five major bedrock formations in Dover (Figure 5):

- gneiss and other metasedimentary rock on East Mountain;
- Poughquag quartzite at the foot of East Mountain;
- calcitic and dolomitic marble of the Stockbridge formation in the Harlem Valley;
- Everett schist with graywacke lenses on the eastern ridge and escarpment of West Mountain; and
- slate, phyllite, schist, and metagraywacke of the Walloomsac formation on the western and southeastern parts of West Mountain.

The contact zone between schist and marble at the edge of the Harlem Valley held rich veins of iron ore that were mined in the 1700s and 1800s, contributing much to early industry and settlement of the town (Budnik et al. 2010). Bog iron, which develops in wetlands where iron-rich groundwater interacts with the oxygen-rich surface environments, was also mined in Dover and nearby towns in New York and Connecticut (Ripley and Dana 1873, Budnik et al. 2010).

Marble was mined for construction material, for flux in iron smelting, for aggregate, and for fertilizer. No marble mines are active today, but Wingdale Materials continues to mine schist for aggregate. Aggregate is raw mineral material of different sizes—sand, gravel, crushed stone—used mainly for road construction, concrete, water filtration, and sewage treatment.



Quarry at Sand Hill

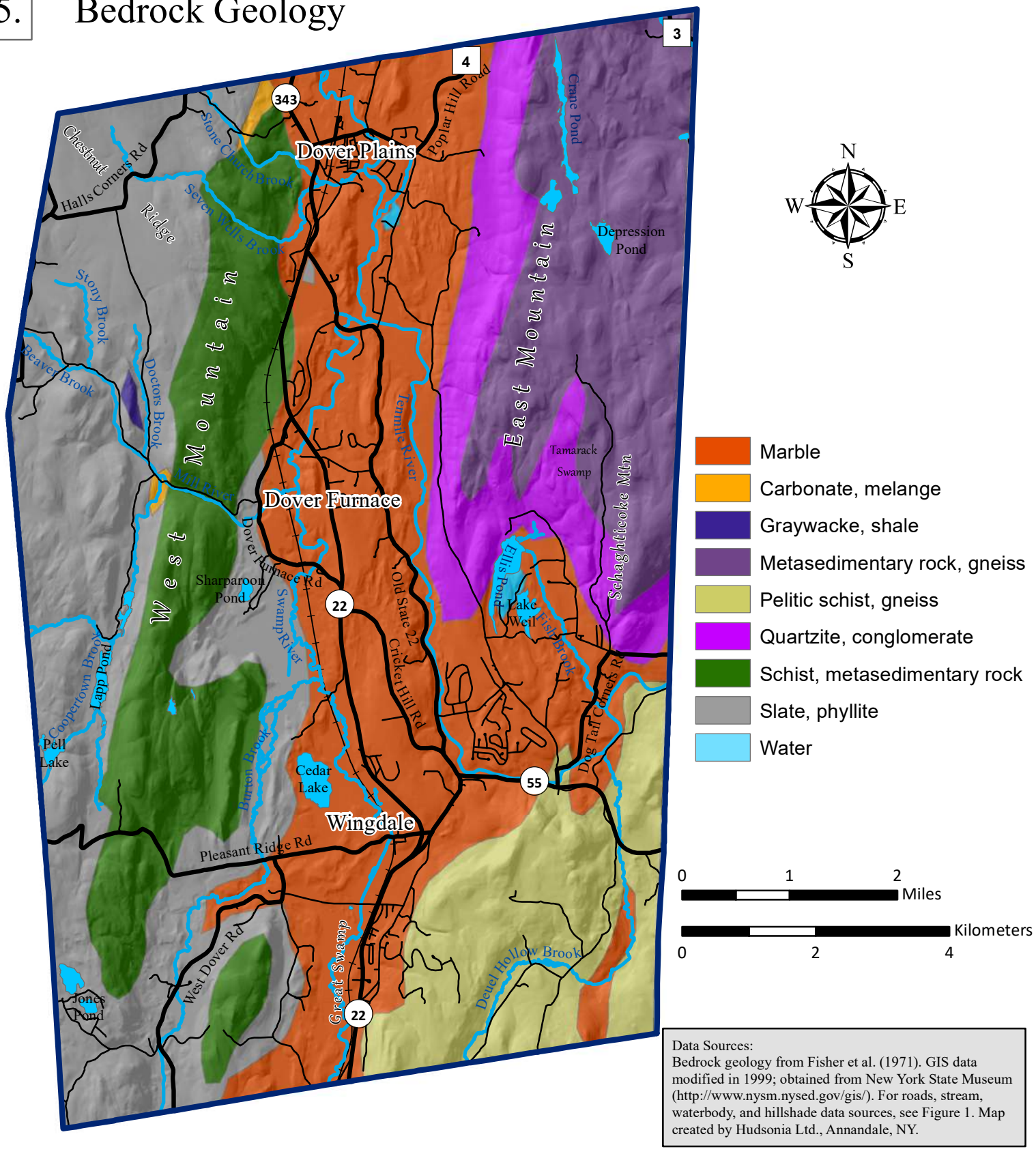
Garnet—a very hard mineral used as an industrial abrasive—is found in schists in the uplands adjacent to the Harlem Valley. (It is visible in some of the rocks along Stone Church Brook below the main grotto.) Garnet has been recovered as a by-product of aggregate production at the Wingdale Materials mine (Budnik et al. 2010).

The contrasting structures, textures, and chemistries of the Dover bedrock partially account for the very diverse ecological communities in close proximity to each other throughout the town. Some of these are described in the **Biological Resources** section below.

ROCKS AND MINERALS

dolostone	A durable sedimentary rock composed primarily of ***dolomite*** (calcium magnesium carbonate); slightly harder than limestone, but otherwise similar in appearance, solubility, and human uses.
gneiss	A metamorphic rock with a bands, streaks, or speckles of light and dark minerals. The rock is usually transformed from the sequential metamorphosis of shale into slate, slate into phyllite, phyllite into schist, and schist into gneiss.
graywacke	An impure, gray sandstone.
limestone	A fine-grained sedimentary rock composed of calcium carbonate.
marble	A medium-grained metamorphic rock of interlocking calcite crystals derived from limestone.
metagraywacke	A partially metamorphosed graywacke.
metasedimentary rock	A sedimentary rock that recrystalized upon subjection to intense heat and pressure; for example, marble is the metasedimentary equivalent of limestone, and slate is the metasedimentary equivalent of shale.
phyllite	A fine-grained metamorphic rock intermediate in grade between slate and schist.
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.
shale	A fine-grained thinly layered sedimentary rock derived from silt and clay.
slate	A fine-grained metamorphic rock derived from shale.

5. Bedrock Geology



Data Sources:
Bedrock geology from Fisher et al. (1971). GIS data modified in 1999; obtained from New York State Museum (http://www.nysm.nysed.gov/gis/). For roads, stream, waterbody, and hillshade data sources, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Figure 5. Generalized bedrock geology of the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Surficial Deposits

One hundred thousand years ago, great ice sheets covered the region with ice up to one mile thick in places. As the glaciers advanced and receded several times over the next 60,000 years, they transported and deposited large amounts of rock and other unconsolidated material. The most recent ice sheet—called the Wisconsin—receded from this region approximately 16,000 years ago (Fisher 2006), leaving behind much loose mineral material overlying the bedrock and sorted by texture—the glacial till, glacial outwash, and glacial lacustrine deposits (sidebar and Figure 6). These are the mineral and structural bases for most of our soils which formed over the ensuing thousands of years in interactions with plants, animals, water, weather, and biological processes on a thin layer of material at the Earth's surface.

Glacial outwash—composed primarily of sand and gravel—is mostly in the Ten Mile and Swamp River stream corridors. Alluvium — deposited by running water—is also found along those stream corridors. It can be of any texture, fine clays to coarse gravel, but is typically sorted by particle size and weight. Glacial till—unsorted mineral material—is prominent throughout Dover, and is the parent material for most of our upland soils. Basins, depressions, and other areas where water has been held at the ground surface for long periods (hundreds or thousands of years) have developed a deep layer of organic material—plant and animal matter in various stages of decay. The organic material—peat and muck—may be several to many meters deep in some of the oldest wetlands (Cadwell et al. 1986) (Figure 6).

Sand and gravel excavated from glacial outwash and kame deposits are widely used in construction and other industries but expensive to transport long distances, so maintaining local sources is important to local and regional economic interests. When sources are paved or built upon or otherwise lost to land development, they are rendered inaccessible to mining and the local demand for these materials must be met by importing from elsewhere.

SURFICIAL DEPOSITS

(Loose material over bedrock.)

Glacial till 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 kame A low mound-like hill of sand and gravel deposited by a slowly melting glacier.

Glacial lacustrine deposits Fine silts, clays, and sands that settled in glacial lakes and ponds. (No lacustrine deposits are mapped in Dover.)

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.

Organic material Decaying plant and animal matter that has accumulated as "peat" and "muck" in areas of prolonged water saturation.

6. Surficial Geology

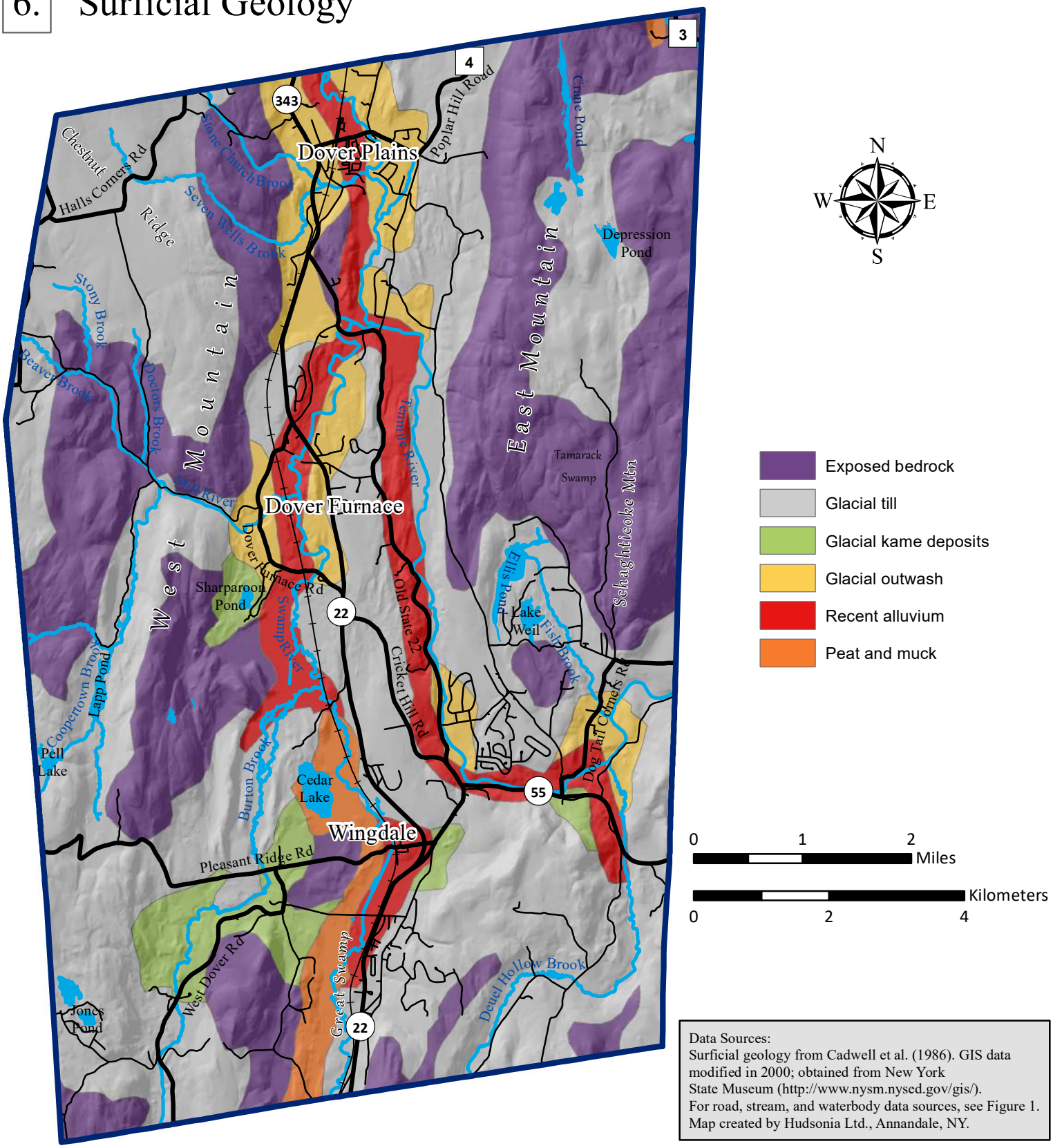


Figure 6. Generalized surficial geology of the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

In addition to their commercial value, gravel mines have significant habitat value for native plants and animals. Inactive areas and abandoned mines are used by many kinds of wildlife (e.g., nesting turtles, snakes, and songbirds) and sometimes support communities of pioneering plant species that include rarities (see **Biological Resources**, below).

In 1999 Dover established a Soil Mining Overlay District (Chapter 145 Section 17) that specifies the places where new commercial mines may be permitted and existing commercial mines can renew their permits for continuing operations. The purpose is to reduce conflicts between mining and residential uses while supporting the needs for farmers to supplement their income.

Soils

The soils that have formed in the surficial deposits are a natural resource with immeasurable value to the human community. They are responsible for the presence of most of our vegetation (trees, shrubs, forbs, graminoids, mosses, etc.), for successful agriculture, for the purification of water, and for immense amounts of carbon storage. Soils are the foundation of our forests, meadows, and wetlands, as well as our farmland, lawns, gardens, and golf courses. The biological diversity of plants and animals depends on the structure, chemistry, and biology of the soils. Without soils, humans would not occupy this land.

The largest reservoir of carbon in most ecosystems is in the soils, both in the soil organic matter—composed of decomposing plant and animal matter and microbes—and the carbon in the soil mineral material (Mitsch 2016). Where soils remain substantially undisturbed, the carbon can remain sequestered for thousands of years. But disturbance such as soil erosion, drying, removal of vegetation, or other direct disturbance such as plowing or excavation can lead to rapid releases of carbon to the atmosphere.

SOILS

"Soils" are composed of organic materials and unconsolidated mineral materials that have been acted on by weathering and organic 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., bedrock, sand, silt, clay, peat), and by topography, climate, vegetation, hydrology, and age.

The Soil Survey of Dutchess County, New York (Faber 2002) describes and illustrates the occurrences of soil types throughout Dover and the rest of the county. Soil maps and descriptions for any particular location can be viewed online at https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

The county soils have been identified and mapped by soil scientists through interpretation of field observations, landscape settings, bedrock and surficial geology, 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, and most of the mapping was done remotely. Any map unit (polygon) for a particular soil type may contain up to two acres of

other soil types. For this reason 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 soil at any site.

The largest reservoir of carbon in most ecosystems is in the soils, both in the soil organic matter and in the mineral material.

The Natural Resource Conservation Service of the US Department of Agriculture has identified the soils best suited to agriculture, and classified them as Prime Farmland Soils and Farmland Soils of Statewide Importance. Prime Farmland Soils are those that have the best combination of physical and chemical characteristics for producing crops. Typically they are deep soils on level or nearly-level land, and are well-drained, fertile (e.g., with high pH and high base cations), and stable. 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. Farmlands soils are described further in the **Farmland Resources** section below.

Soils formed in glacial till predominate in Dover. The typical soils of East Mountain, Schaghticoke, and West Mountain are somewhat acidic fine sandy loams in the Charlton, Chatfield, and Hollis series. Those prominent in the Swamp River/ Ten Mile River corridor north of Wingdale are the gravelly loams and gravelly silt loams in the Hoosic and Copake series, formed in glacial outwash, and Wayland silt loam formed in alluvium. Major soils in the lower Swamp River corridor and extending to Lake Weil are till-derived neutral-to-alkaline silt loams in the Stockbridge and Georgia groups. Large areas of the Great Swamp are underlain by Carlisle muck--a deep organic soil—and Wayland silt loam.

Soils develop slowly over thousands of years and will not recover quickly or reestablish once severely damaged or lost.

Soils can be damaged by poor farming practices, compaction, toxic contamination, and other disturbances, and can be easily lost to erosion where unvegetated roadways, trails, construction sites, and cropfields are exposed to large rainstorms or snowmelt events, or to the forces of floodwaters. Soils develop slowly over thousands of years and, once they are lost to erosion or severely damaged, they will not recover or reestablish quickly. For these reasons, soil conservation is a key element of responsible stewardship of the land.

Water Resources

The term "water resources" refers both to surface water— i.e., streams, springs, lakes, ponds, and wetlands—and to groundwater, the water that resides beneath the soil surface in spaces between sediment particles and in rock fissures and seams. The quantity and quality of water available to humans and natural habitats from surface water and groundwater depends in part on the conditions in the land areas that drain to those resources.

Groundwater is fed and replenished by rainwater, snowmelt, and other surface water that seeps through surficial material and rock fissures, and can be depleted or degraded by inadequate or contaminated seepage. Our surface waters (streams, lakes, ponds) are fed in part by rain and snow, but many are also fed by groundwater.

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 and quality of organic duff at the soil surface, the kinds of vegetation, the extent of impervious surfaces (e.g., roads, 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.

Deuel Hollow Brook at the Appalachian Trail

Clean and abundant water is critical both to ecosystems and the human community of Dover, so protection and conservation of surface water and groundwater resources is of paramount importance to the town.

Watersheds

A watershed is the entire land area that drains to a particular feature, such as a stream, pond, or wetland. The major watersheds of Dover are shown in Figure 7. The entire town is in the watershed of the Housatonic River, which rises in Massachusetts and flows ultimately into Long Island Sound. Most of the town is in the sub-watershed of the Ten Mile River, a major tributary of the Housatonic. The sub-basins in Dover include those of the Swamp River, draining much of the western half of Dover, the Ten Mile River, draining much of the eastern half, and small portions of the Macedonia Brook, Furnace Brook, Great Brook, and Webatuck Creek sub-basins (Figure 7). Within each sub-basin, a large network of perennial and intermittent 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, encourages floods, and reduces the recharge of groundwater unless special efforts are made to mitigate the pavement effects.

The Town of Dover participates in the Ten Mile River Watershed Collaborative—a group of municipal officials, non-profit organizations, and environmental and planning professionals—which has recently received funding from the Long Island Sound Futures Fund of the National Fish and Wildlife Foundation to begin the development of a comprehensive watershed management plan for the Ten Mile River. The plan is expected to address issues related to water quality, flood damage prevention, wildlife and habitat conservation, and recreation and economic enhancement.

Groundwater

Groundwater wells supply most of the water for residents, farms, businesses, and industry in Dover. Groundwater also feeds our upland habitats, springs, ponds, and wetlands, and is the source of the base flow for our 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.

Drinking water wells throughout Dover tap into groundwater from a variety of shallow and deep sources. Most of the deep wells—tens to hundreds of feet deep—are in the fine and mixed glacial till material and in fractures and seams in underlying bedrock. Most of the shallow wells—tens of feet deep—are in coarse glacial outwash deposits (sand and gravel), and in the solution cavities of carbonate rock. Carbonate rocks are susceptible to dissolution by groundwater, creating channels

7. Watersheds

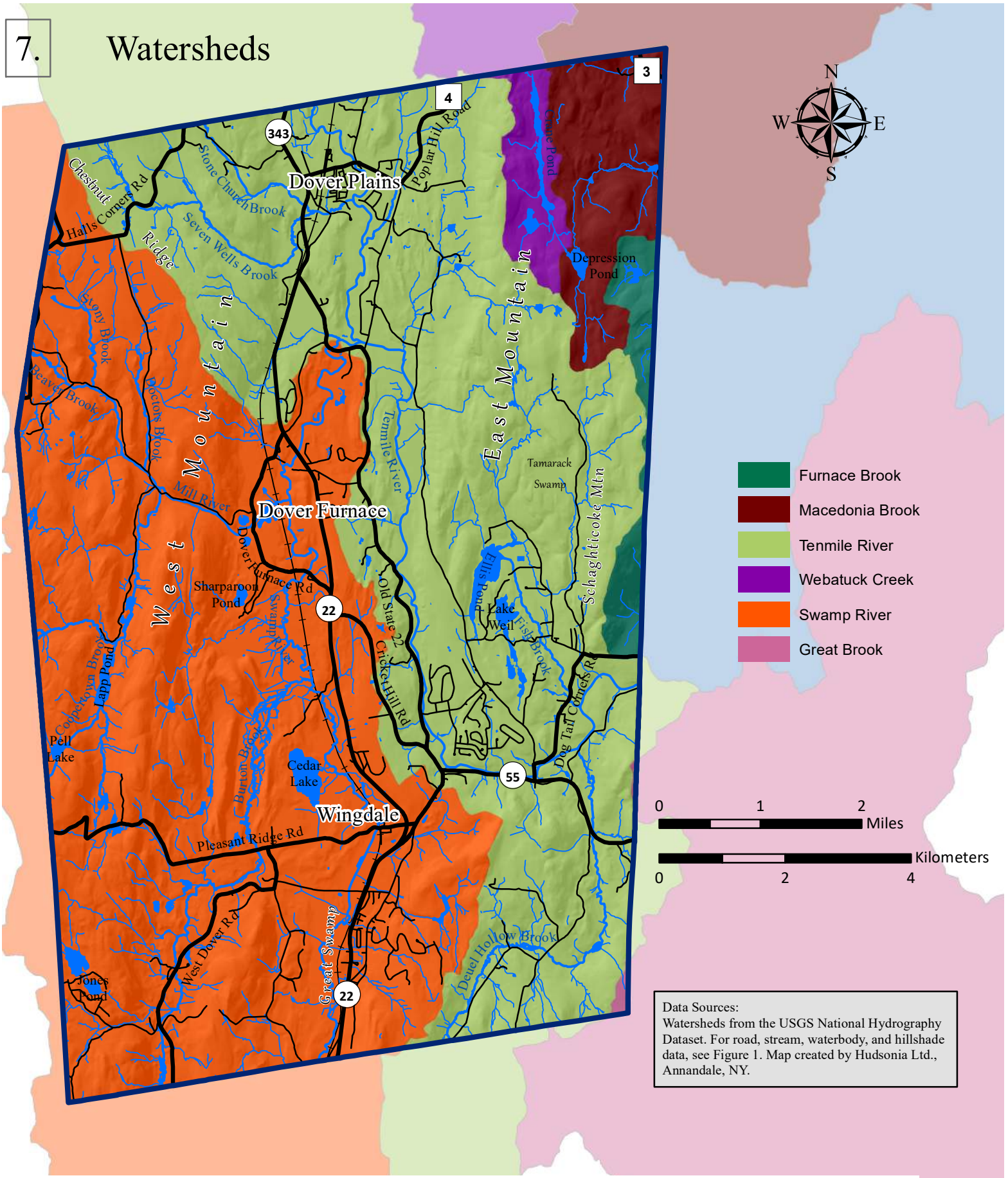


Figure 7. Major watersheds in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

and voids that provide storage areas for groundwater. Figure 8 illustrates the location of the valley bottom aquifer (Urban-Mead 1997) in the areas of carbonate bedrock and glacial outwash along the Swamp River and Ten Mile River corridors (figures 5 and 6).

The valley bottom aquifer represents the largest and most accessible potential water source for shallow wells, but is also the most vulnerable to contamination due to the permeability of the bedrock and the overlying material (sand and gravel) that can be an efficient conduit for contaminants introduced by above-ground human activities. In 1999 the town established Aquifer Overlay Districts (Figure 8) to protect groundwater supplies for public and private wells; the districts are described in the **Legislative Protections** section, below.

Dover's Aquifer Overlay Districts were established to protect groundwater supplies for public and private wells.

Recent water testing has shown no significant contamination of public water supplies in Dover. The public water supply serving the Dover Plains hamlet is from two shallow wells tapping the valley bottom aquifer in the NYS Route 22 corridor. In 2017 (the most recent data available) the Dover Plains system served fewer than 1000 people through 225 service connections. Of the five contaminants tested for in the required annual water quality assessment—arsenic, barium, copper, lead, nitrate, and trihalomethanes—all were present at levels far below the regulatory limits (Dover Plains Water Company 2017).

The same aquifer is tapped for the public water supply serving the Schreiber Water District in Wingdale, which served 70 residents in 2017. Because of the proximity of the wells to (permitted) industrial/commercial discharge facilities and residential and agricultural land uses, the water is deemed to be susceptible to microbial and nitrate contamination. Also, the soils overlying the water source in fractured bedrock may provide inadequate protection from potential contamination. All of the contaminants tested for in the required annual water quality assessment, however, were at levels below—mostly far below—the regulatory limits. Lead was detected at one house, apparently leaching from the interior plumbing.

Other centralized water systems (serving 25 or more people) include those of the Country Mill and Woodwinds developments in Wingdale, the High Meadows Mobile Home Cooperative on Holsapple Road, and the Olivet University campus at the former Harlem Valley Psychiatric Center in Wingdale.

Springs are places where groundwater discharges to the ground surface under gravitational pressure. Springs occur in a variety of settings in Dover, emerging unseen into wetlands, streams, and waterbodies, but also more visibly into upland habitats. Many of our streams are fed in part by springs. Springs that originate from deep underground emerge at a fairly constant temperature, usually in the range of 45-55°F year-round, so they help to maintain cool stream temperatures in

summer—an important characteristics for many aquatic organisms—and a warmer environment in winter compared to the surrounding landscape. The habitat values of springs and seeps are discussed in the **Biological Resources** section below. In addition to their ecological importance, springs can be important drinking water sources for humans and livestock, and some have been modified with constructed or excavated basins and spring houses.

Swamp River at Pleasant Ridge.

Streams, ponds, lakes, floodplains

Dover's abundant streams, lakes, and ponds (Figure 7) have influenced the locations and character of indigenous human settlements since the last glaciation, and European settlements, industry, and commerce since the 17th century. These water features are also integral to the natural habitats of the town, and the wildlife, plants, and communities that depend on their proximity to surface water.

The major streams in Dover are the Ten Mile River and its largest tributary, the Swamp River. Other notable streams are Burton Brook, Deuel Hollow Brook, Mill Brook, Seven Wells Brook, and Stone Church Brook, but many more streams occur throughout the town. Figure 7 shows all the streams identified by Hudsonia in Dover, including many of the intermittent and small perennial streams that do not appear on other maps in the public domain (Graham et al. 2019).

Small constructed ponds are numerous in Dover. Some are farm ponds built for watering livestock, crop irrigation, or fire control. Many are backyard ponds built for fire control, for recreation, or as aesthetic landscaping features. The site of the former Harlem Valley Psychiatric Center—now Olivet University—has a drinking water reservoir that serves the campus. Some of the larger ponds and

lakes are remnants of old mines. Others were originally created for or used as millponds and/or water sources for industrial processes. And some are naturally-formed ponds in glacial kettles or other natural depressions.

In the 1600s –1800s our streams were intensely exploited for waterpower and industrial processes, with mills of all kinds established at waterfalls, cascades, and other abrupt change in elevation, often with several mills strung out on a single stream. These uses of streams have greatly diminished over the last century; the sawmills, grist mills, forges, foundries, paper mills, textile mills, and other industrial plants that once lined the streams are gone, even though some of the dams and millponds remain. Those past uses, however, followed by the 20th century introduction of paved roads and petroleum-powered vehicles have all affected the water quality, habitats, and biological communities of our streams and lakes.

Today our streams are used mostly for recreational fishing, occasional trapping, and swimming, and some are tapped for irrigating crops or watering livestock, but present-day uses are minor compared to those of the past centuries (see the **Land Uses** section, below).

Dover has many high quality streams that retain the cool, clear, high-oxygen conditions that are essential to some of our most sensitive aquatic organisms.

The widespread abandonment of water power, and the regional reforestation of agricultural land over the last 80-100 years, together with environmental protection laws since the 1960s, have helped to restore some of the former water quality and habitats of streams and lakes. Some of these waterbodies are still subject to disruption from dams and culverts, pollution from agricultural lands, roads, residences throughout the rural areas, and stormwater runoff from roads and the more densely-settled hamlets.

Still, Dover is blessed with many high quality streams that retain the cool, clear, high-oxygen conditions that are essential to some of our most sensitive aquatic organisms. Figure 9 shows the streams classified by NYSDEC as suitable for trout and trout spawning; these include Beaver Brook, Burton Brook, Deuel Hollow Brook, Fish Brook, Stone Church Brook, Stony Brook, Ten Mile River, and Swamp River (for supporting trout), and many of the tributaries and sub-tributaries to Burton Brook, Fish Brook, Swamp River, and Ten Mile River (for trout spawning). Trout have also been found in Wells Brook, but it is not yet classified by NYSDEC as a trout stream.

Woody vegetation stabilizes streambanks and provides shade to instream habitats.

Water Use Classification

NYSDEC has classified many of the perennial streams and other waterbodies in the state according to the "existing or expected best usage of each water or waterway segment." The classes range from AA to D, and may be modified by a T or TS to indicate suitability for supporting trout or trout spawning (see sidebar). These classifications are based on limited information, and do not necessarily reflect up-to-date or site-specific habitat conditions. NYSDEC also has water quality standards for pollutants and other factors such as dissolved oxygen and turbidity, to protect the uses associated with the waterbody classifications. Waterbodies that do not meet the standards for their "best uses" may be listed as "impaired" on the Priority Waterbody List (explained below).

NYSDEC Waterbody Classes

Class	Best Use
AA	drinking (with disinfection), bathing, fishing
A	drinking (with disinfection and treatment), bathing, fishing
B	bathing, fishing
C	fishing (reproduction and survival)
D	fishing (survival)
Modifiers	
T	sufficient dissolved oxygen to support trout
TS	suitable for trout spawning

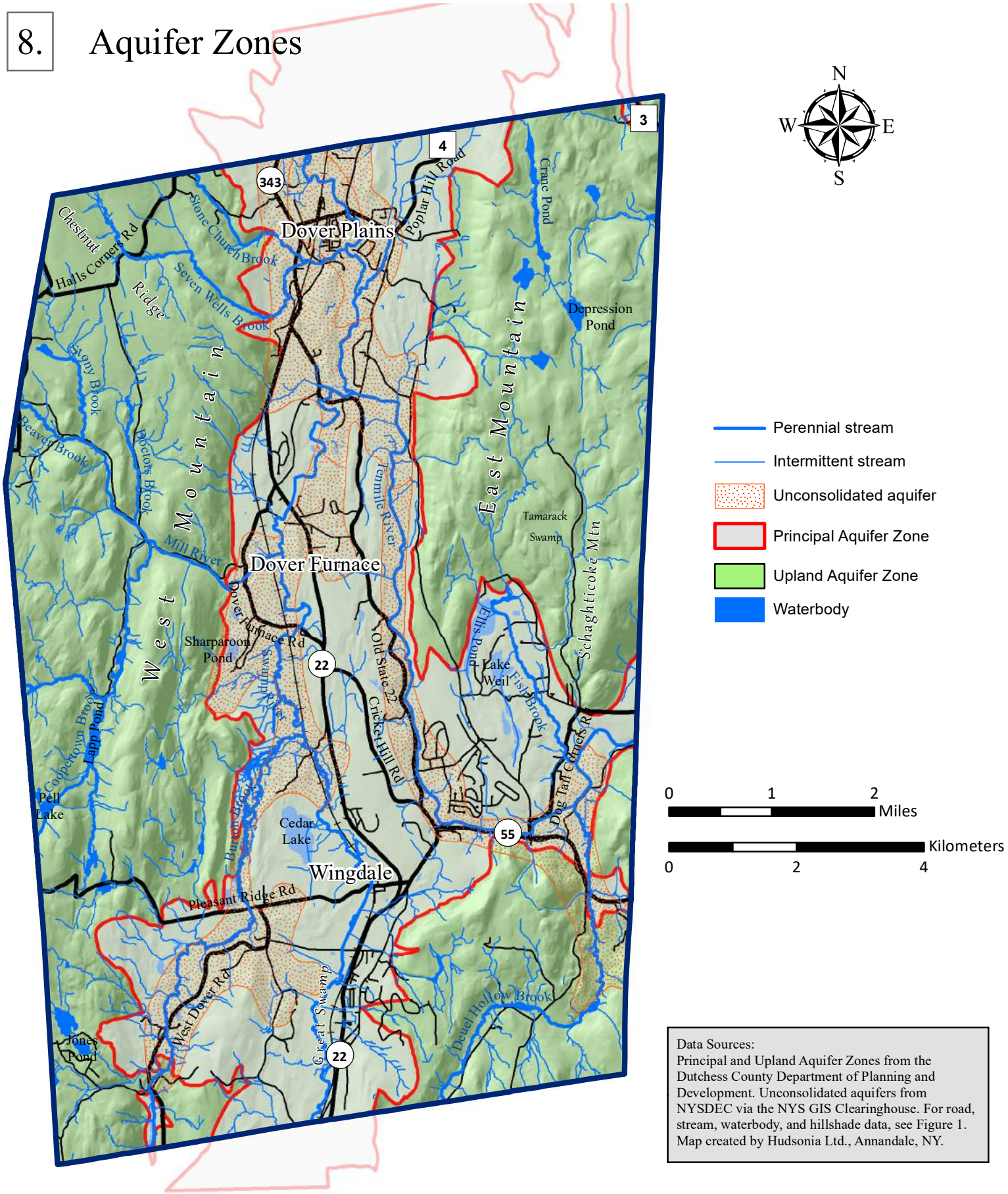
Streams classified as AA, A, B, C(TS) or C(T) are "protected streams" subject to additional regulations to protect the associated uses. State permits are also required for disturbance of the bed or banks of those streams. Any perennial streams that have not been classified by the DEC share the classification of the larger stream that they flow into. Intermittent streams are considered to be Class D *(*Article 15 of the ECL, 6NYCRR Part 608).

Figure 9 shows the streams and lakes coded by water use classifications. Stream size, gradient, substrate conditions, water temperature, water chemistry, and clarity all influence the occurrence and survival of fish species and aquatic communities. Obstructions in streams, such as dams or culverts, also strongly affect the aquatic communities above and below those features.

Most of Dover's streams are classified as C (suitable for fishing) (Figure 9). The Seven Wells Brook and the southern portion of the Swamp River are classified as A (suitable for drinking [with disinfection], bathing, and fishing), and the eastern-most reach of the Ten Mile River is classified as B (suitable for bathing and fishing). More than ten years have passed, however, since NYSDEC has sampled and classified these streams, and their condition may have since changed due to improvements or new hazards imposed by nearby land uses.

The cool temperatures and rocky substrates of the Mill River offer suitable habitat for trout.

8. Aquifer Zones



Data Sources:
Principal and Upland Aquifer Zones from the Dutchess County Department of Planning and Development. Unconsolidated aquifers from NYSDEC via the NYS GIS Clearinghouse. For road, stream, waterbody, and hillshade data, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Figure 8. Aquifer zones of the Dover Aquifer Overlay District, and the unconsolidated aquifer delineated by NYSDEC in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

9. Surface Water Classification

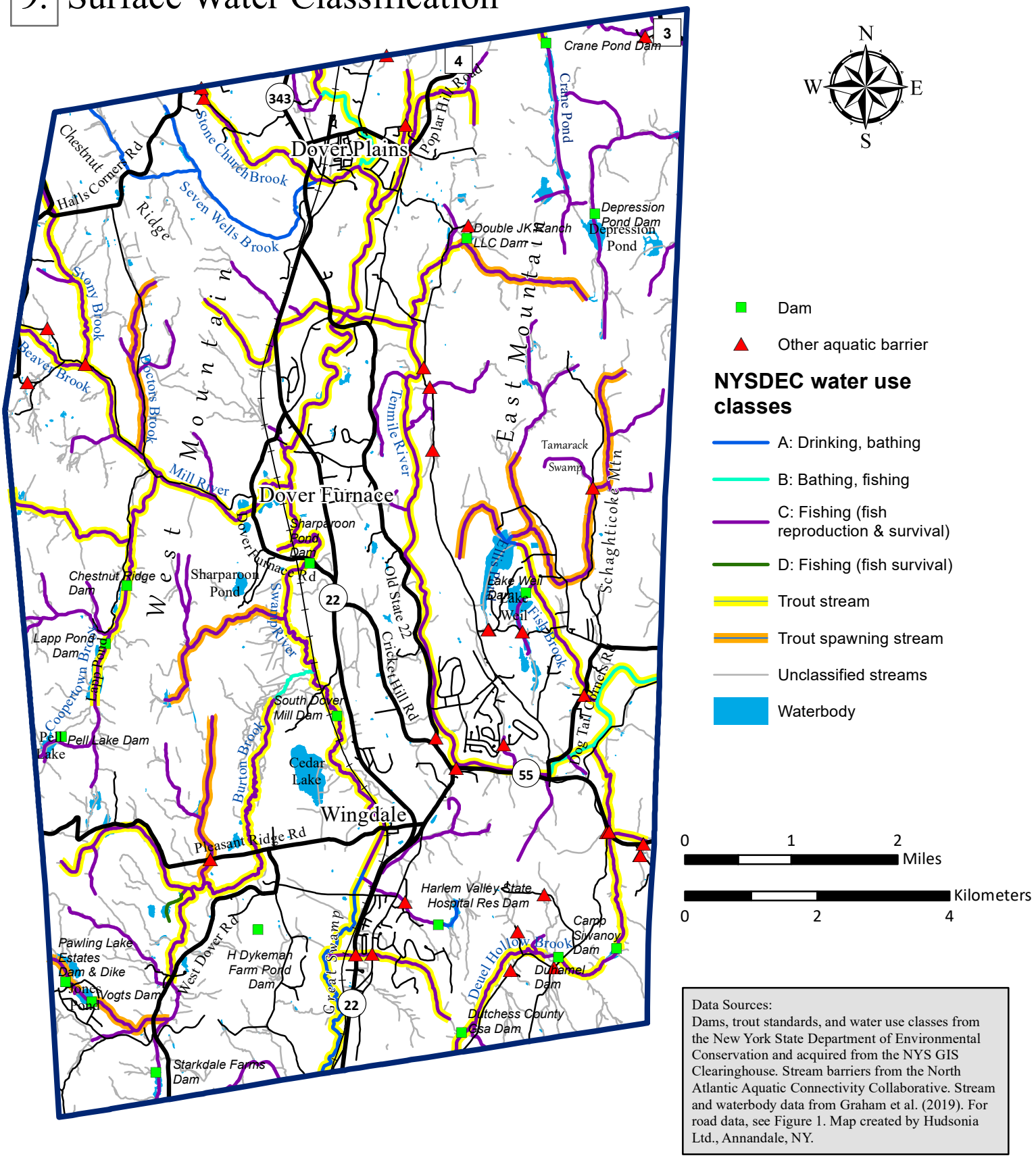


Figure 9. Surface water classifications, dams, and other aquatic barriers in the Town of Dover, Dutchess County, New York. (Aquatic barrier data are incomplete.) Dover Natural Resource Inventory, 2019.

Priority Waterbodies List

A NYSDEC waterbody inventory program was conducted in the Housatonic watershed through 2008 to monitor water quality and trends throughout the state, and identify impaired streams, lakes, and ponds most in need of improvement (NYSDEC 2008). Streams were assessed for invertebrates, water and sediment chemistry, and sediment toxicity, and 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 are apparent, but 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 were evaluated to assess the ability of each waterbody to support specific water uses (e.g., water supply, swimming, aquatic life, or secondary recreation). The program covered the entire state, but only a few stream segments and lakes were sampled in the Town of Dover. Figure 10 shows the sampled and unsampled areas, and the impairment classifications that resulted. Appendix B has the assessment data for the Swamp River (lower reach and minor tributaries), which was deemed in 2008 to have "minor impacts." The upper and minor tributaries of the Ten Mile River were identified as having "no known impacts." The lakes, ponds, and most streams in Dover were not assessed.

Agriculture was the only cited source of pollution in the affected waterbodies in the region in the NYSDEC study. However, the amount of pollutants in the Swamp River and Ten Mile River were low enough to fall within the NYS Department of Health fish region advisory to permit four fish meals per month (NYSDOH 2017).

The Swamp River was reported to suffer from nutrient enrichment, likely from agricultural sources. The upper (southern) reaches, however, were suspected to have pollution from wastewater point sources and landfill runoff. The report cautioned that the health of the Swamp River deteriorated from 1992 to 2002 and that there is a risk of protozoan contamination from surrounding agriculture activities, and increased by wastewater discharge. While the lower reaches of the Swamp River are known to have "minor impacts," the upper reaches were awaiting verification when the report was published.

At Dover Furnace the Swamp River is a class C trout stream with "minor impacts" according to the NYSDEC study

The lower reaches of the Ten Mile River experienced occasional high coliform levels, but had overall indicators of good health, such as a diverse macroinvertebrate community with species indicative of clean water (mayflies, stoneflies, caddisflies, and hellgrammites). The sources of the coliform spikes are unknown but could pose risks to recreational users of the river. While the upper reaches of the Ten Mile had "no known impact," the lower reaches were awaiting verification.

The Housatonic Valley Association (HVA) conducted water quality sampling at five stations—three in Pawling and two in Dover—on the Swamp River and its tributaries in 2010, and found highest concentrations of nutrient and chloride pollution nearest the upstream urban areas in Pawling (Cunnick et al. 2013). Dissolved oxygen (DO) was generally within acceptable ranges for good fish habitat, but was consistently low at the Appalachian Trail crossing in Pawling. DO levels were highest at Old Post Road in Dover, just before the Swamp River joins the Ten Mile. At the Wheeler Road sample station, phosphate-phosphorus was high on three of four sampling dates, and ammonium was high on one of four dates.

In general, water quality decreased with proximity to impervious ground cover and urbanization, and was poorest at stations in and near the Village of Pawling. Cunnick et al. predicted that future land development along the NYS Route 22 corridor will further reduce water quality in the Swamp River.

10. Waterbody Impairment Classification

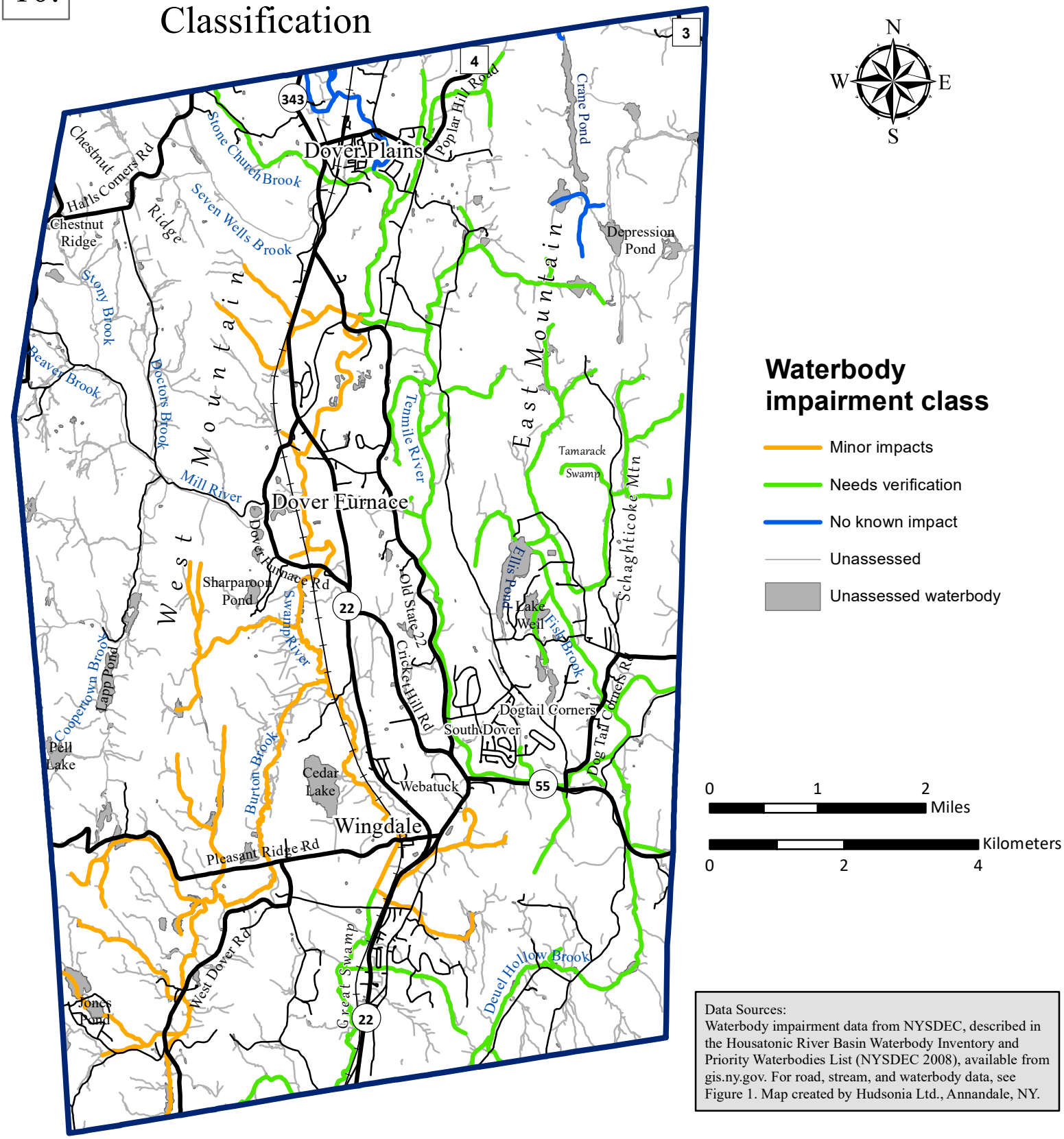


Figure 10. Impairment classes of streams and other waterbodies in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Floodplains

A floodplain is the area bordering a stream that is subject to flooding at frequent or infrequent intervals. Some streamside areas flood annually or more frequently, and some flood only in the largest storms or snowmelt events. Floodplains at some locations are just a few feet wide, and elsewhere are a half-mile wide or wider, depending on the local topography and the water volumes.

Based on historical flood records, the Federal Emergency Management Agency (FEMA) has mapped the areas along larger streams that are expected to flood at statistical intervals. Figure 11a shows the extent of the 100-year and 500-year flood zones identified by FEMA; these are the zones estimated to have a 1% (for the 100-year) and 0.2% (for the 500-year) chance of flooding in any given year. Those chances may seem remote, but a more practical way for a landowner to understand the likelihood of flooding is this: 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 those 30 years (Holmes and Dinicola 2010).

Two cautions: 1) FEMA has identified flood zones only on the larger streams, even though small streams can also have significant floodplains. 2) The mapping of Dutchess County flood zones was updated in 2012 but does not reflect the predicted occurrence of more frequent and more severe large storms in the future.

Riparian areas, which include the floodplains and other areas adjacent to streams, ponds, wetlands, and other waterbodies, are the transition zones between land and water and are vital to the physical processes, habitats, and water quality of those waterbodies.

In addition to the 100-yr and 500-yr flood zones, Figure 11a also shows a "riparian buffer zone" which encompasses a 50-year flood zone delineated by the New York Natural Heritage Program (NYNHP) based on elevation data, and adjacent wetlands (Conley et al. 2018). The NYNHP identified the riparian zones along many of the smaller streams that were not included in the FEMA mapping. The mapped areas overlap partially with the FEMA flood zones on the larger streams and may indicate additional flood-prone areas but are not a substitute for the FEMA flood insurance rate maps. The riparian buffer zones were developed through modeling and have not been field verified, but can provide a starting point to inform land use and stream protection efforts.

Floodplains serve critical roles in the ecology and flow dynamics of streams. A well-vegetated floodplain helps to stabilize the streambank and reduce stream channel erosion, moderate stream water temperatures, attenuate flooding, and trap and remove sediment and 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. Well-vegetated floodplains also provide important habitat for terrestrial plants and animals, and travel corridors for wildlife, and contribute woody debris and other organic detritus to the habitat structure and food base for stream organisms (Wenger 1999).

The Dover zoning code includes a Floodplain Overlay District (Section 145-13) that coincides with the "100-year floodplain." The law prohibits the building of any new houses, or installation of septic systems or sewage systems within the zone, although repair and replacement of existing structures and facilities is permitted.

The ecological values of floodplains are described below in the **Biological Resources** section.

Wetlands

Small and large wetlands occur throughout Dover at all elevations, and include hardwood swamps, shrub swamps, kettle shrub pools, buttonbush pools, intermittent woodland pools, acidic bogs, marshes, wet meadows, and fens (Graham et al. 2019). The largest wetlands are the Great Swamp wetland complex that borders the Swamp River and Burton Brook, Tamarack Swamp, and a wetland adjacent to Ellis Pond. Other large wetlands are along Stony Brook, Deuel Hollow Brook, and other streams. Small wetlands, including hardwood swamps, marshes, and intermittent woodland pools, occur throughout the town.

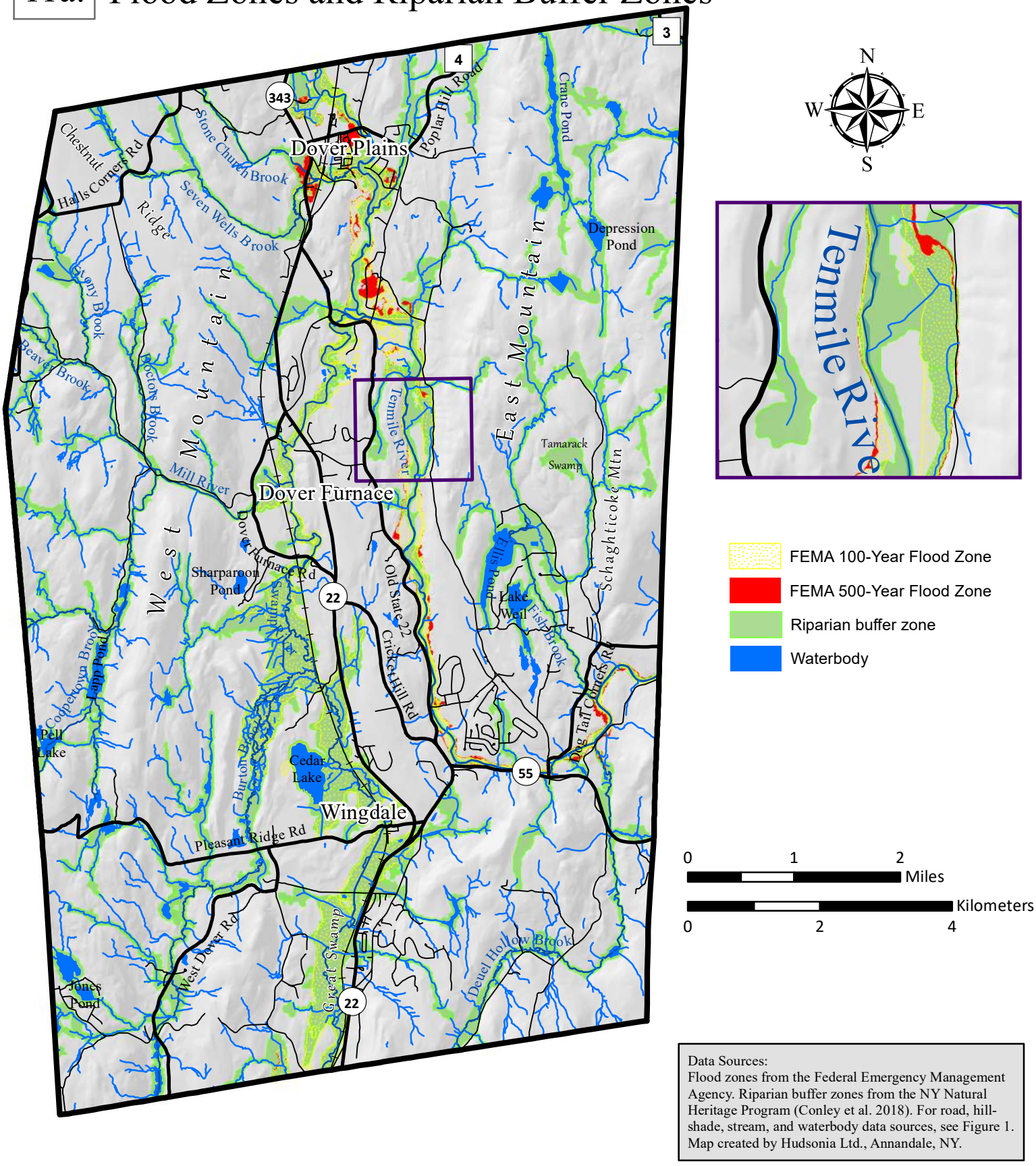
Wetlands of all sizes have great value for ecosystems and for groundwater and surface water supplies. They capture and process rainwater, snowmelt, and overland runoff, take up nutrients, break down contaminants, intercept sediments, make water slowly available to groundwater, streams, and ponds, and reduce the volumes of floodwater reaching downgradient areas. The cumulative contribution of wetlands to reducing floodflows can be huge (Kadykalo and Findlay 2016). The ecological values of wetlands are described below in the **Biological Resources** section.

The Great Swamp is a wetland complex of 6000+ acres—one of the three largest freshwater wetlands in the state—stretching 20 miles through Dover, Pawling, Patterson, and Southeast. The wetland straddles the divide between two watersheds: it drains south from Pawling to the Croton River system, where it feeds New York City drinking water reservoirs on its way to the Hudson, and it drains north from Pawling via the Swamp River to the Ten Mile River and ultimately to the Housatonic. Part of the north section overlies the valley bottom aquifer that runs north and south through Dover and is the significant well-water source for residences and businesses of Dover's Harlem Valley.

The Great Swamp has been named a National Historic Landmark by the US Department of the Interior, and a Critical Environmental Area by Dutchess and Putnam counties.

The Great Swamp has been named a National Historic Landmark by the US Department of the Interior, and a Critical Environmental Area by Dutchess and Putnam counties. The New York State Open Space Plan (NYSDEC 2016) identified Great Swamp as one of the Regional Conservation Priority Projects. Some of its ecological, scenic, and recreational values are described in sections below.

11a. Flood Zones and Riparian Buffer Zones



Data Sources:
Flood zones from the Federal Emergency Management Agency. Riparian buffer zones from the NY Natural Heritage Program (Conley et al. 2018). For road, hill-shade, stream, and waterbody data sources, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Figure 11a. FEMA flood zones and NYNHP riparian buffer zones in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

11b. Active River Areas

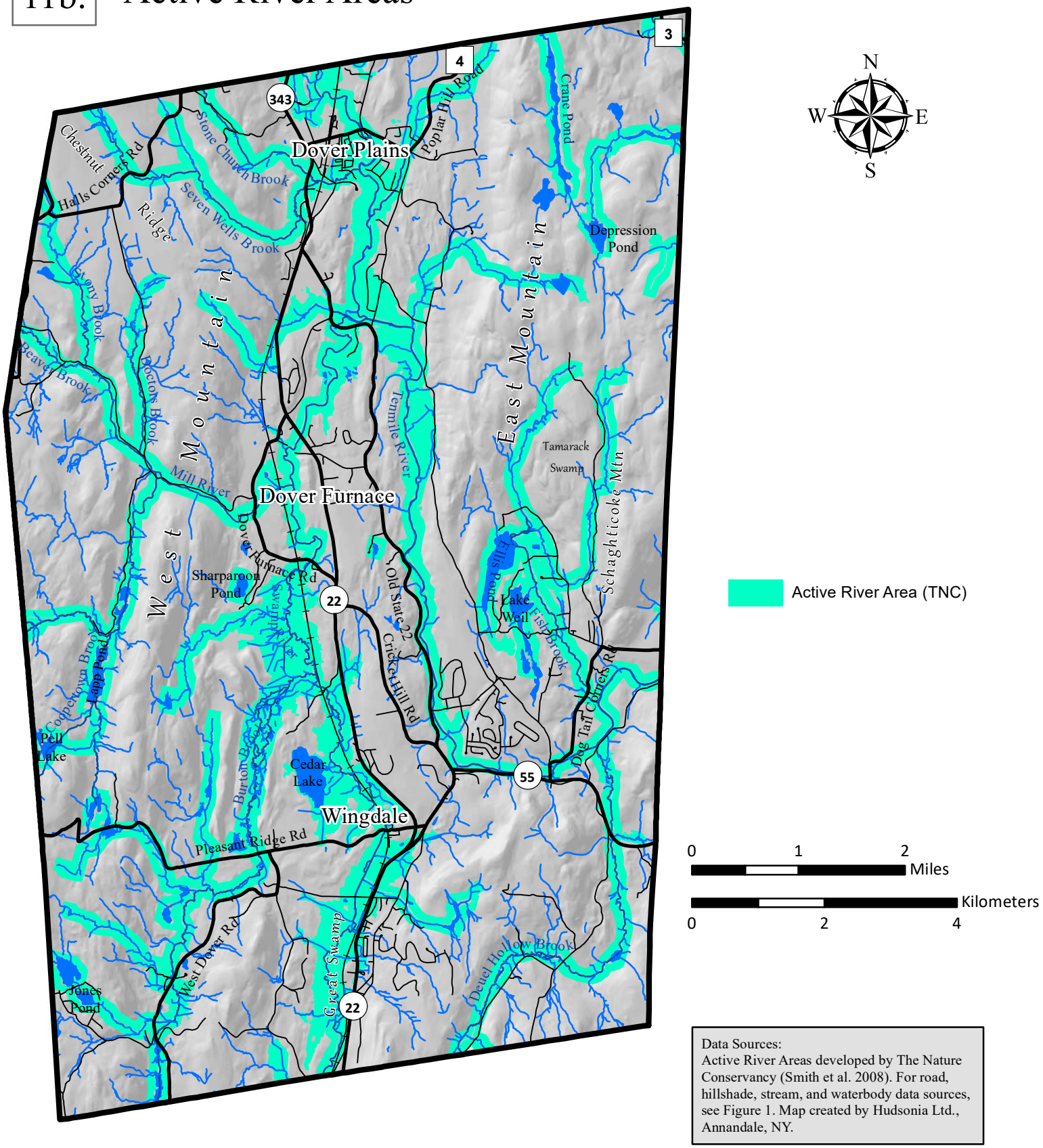


Figure 11b. Active River Areas (ARAs) in the Town of Dover, Dutchess County, New York. See text for explanation. Dover Natural Resource Inventory, 2019.

Biological Resources

Biological resources include plants, animals, biological communities, and the habitats they depend on. They occupy the land all around us, and are responsible for the air we breathe, the abundance and quality of our water in our streams, lakes, and ponds, and the beauty of our landscapes.

The Town of Dover is famous among biologists as a hotspot for native biological diversity and especially for rare species of plants and animals. Some of these resources are described below and their general locations are illustrated in Figures 12-17 and in the photographs throughout this *NRI*.

The Town of Dover is famous among biologists as a hotspot for native biological diversity.

Habitats/Ecological Communities

The Town of Dover is extraordinarily endowed with native biological diversity, including many habitats, plant species, and wildlife that are uncommon or rare in other parts of the region or the state. In fact, Dover may have the greatest concentration of rarities of any town in the southeastern New York.

A "habitat" is simply the place or environment where an organism lives for all or parts 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. Graham et al. (2019) identified and mapped 36 different types of ecologically significant habitats in Dover (Figure 12). These include 11 kinds of wetland habitats and 22 kinds of upland habitats, as well as streams, lakes, and ponds.

Below are descriptions of some of Dover's habitats, where they occur, and some of the plants and animals of conservation concern that use them. More detailed descriptions of these habitats and their values for biodiversity are in Graham et al. (2019). We use common names of plants in this narrative but Appendix Table C-1 gives the scientific names of all plants mentioned in the *NRI*.

UPLAND HABITATS

Rose twisted-stalk is a plant of Dover's cool, upland and mixed forests. Nava Tabak © 2019

Upland Forests

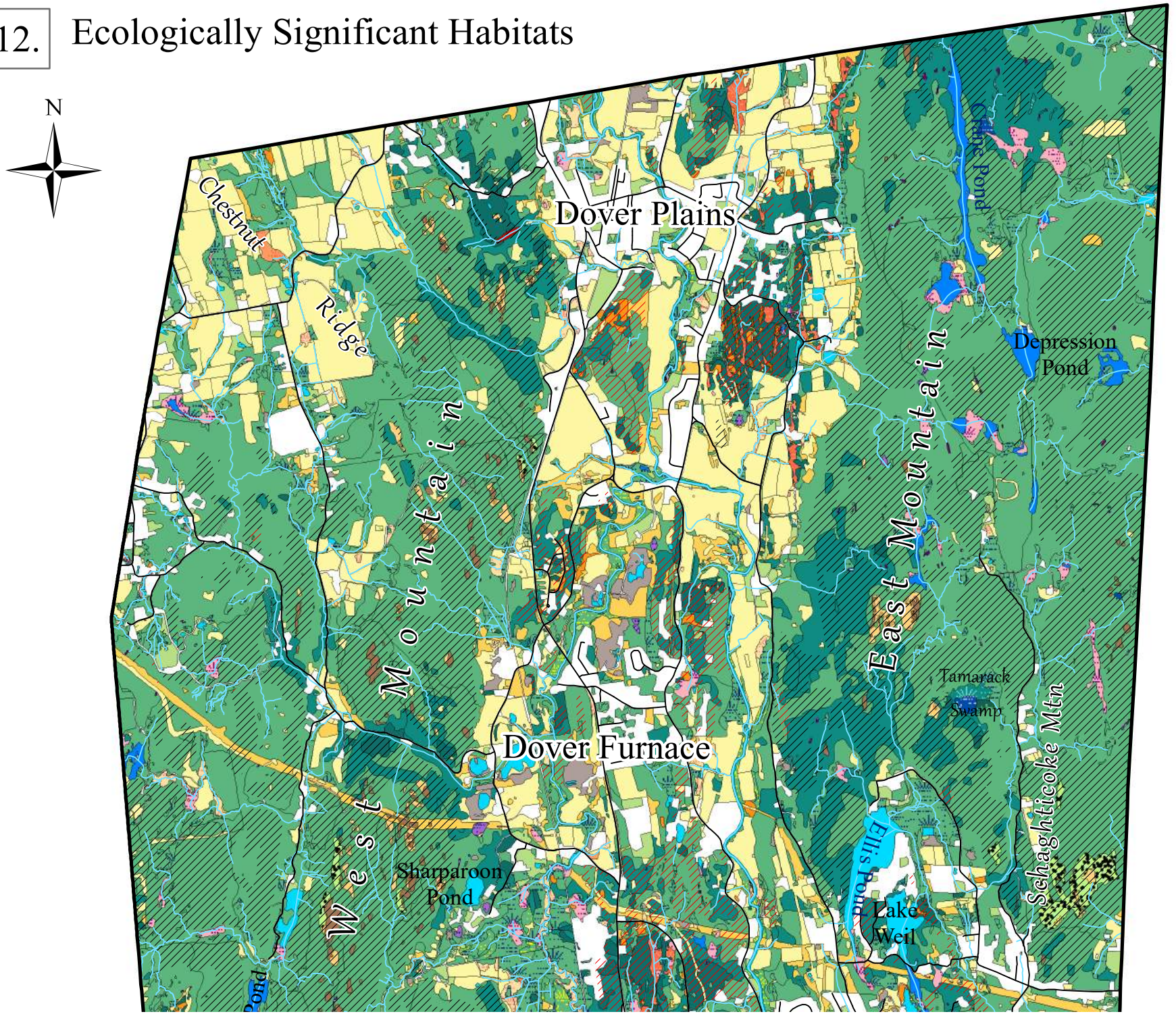
Much of Dover outside the Harlem Valley and the Chestnut Ridge area is in forested upland habitats (figures 12 and 13). These include hardwood, conifer, and mixed forests, mostly populated by tree species typical of the region: sugar maple, red maple, American beech, oaks (red, black, white, scarlet), hickories (pignut, shagbark, bitternut), black cherry, white ash, American and slippery elms, birches (white, gray, yellow, black), eastern hemlock, eastern white pine, and eastern red cedar, among others. Forests of eastern red cedar occur on calcareous soils. Other trees of calcareous soils included American basswood, mockernut hickory, bur oak, chinquapin oak, and American hackberry. Hackberry occurs on floodplains as well as in ledgy rich forests.

Dover's upland forests contain other habitats, such as intermittent woodland pools, crests, ledges, talus slopes, hardwood swamps, and streams that are closely tied to the forest ecosystem.

Forests provide important habitats for a wide array of plants and wildlife—turtles, snakes, salamanders, songbirds, raptors, large and small mammals, and invertebrates that inhabit above-ground live and dead vegetation, and the organic duff, rocks, and soils of the forest floor. Large forests are especially important for "area-sensitive" wildlife species that have large territories or large home ranges, and for wildlife and plants that do best in the special habitat conditions of deep forest interiors. Large forests may also be especially valuable for wildlife (and plants) that are seeking new microhabitats or cooler areas in response to climate change.

A ferny slope in hemlock forest at the Stone Church Preserve. Gretchen Stevens © 2019

12. Ecologically Significant Habitats



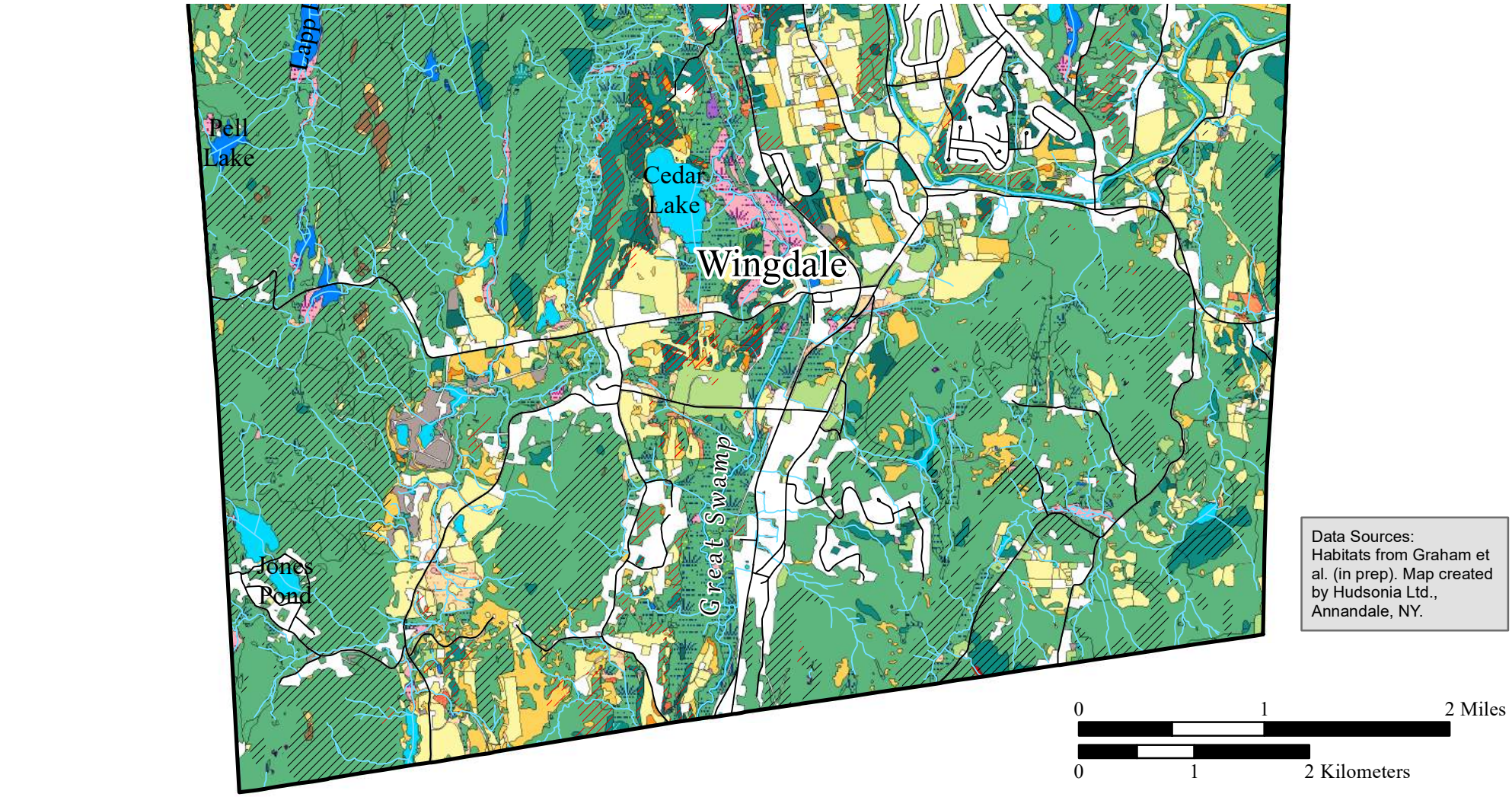


Figure 12. Ecologically significant habitats of the Town of Dover, Dutchess County, NY. Dover Natural Resource Inventory, 2019.

In addition to their great value for wildlife, forests are the most effective types 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 forest floors promote infiltration of precipitation to the organic duff and soils (Bormann et al. 1969, Likens et al. 1970, Bormann et al. 1974, Wilder and Kiviat 2008), 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 are also great repositories of stored carbon in the vegetation, the duff, and the soils. Forests bordering streams help to keep the streams cool, and supply them with organic material for the aquatic food web and structural material (downed logs and branches) to diversify the instream habitats.

Figure 12 shows the forests in relation to other habitats in Dover, and Figure 13 shows the large forests classified by size. The forests of East Mountain, Schaghticoke Mountain, and Gardiner Hill are part of the large (>15,000 acres) forest complex of the Housatonic Highlands and the Taconic Mountains. This area has been identified by The Nature Conservancy (TNC) and the New York Natural Heritage Program (NYNHP) as one of the "matrix forest" areas of the Northeast. 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 forests of West Mountain and Waldo Hill are part of forests of 1000+ and 5000+ acres, and have been identified by the TNC and NYNHP as "linkage zones" 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. Some of these zones are "stepping stone" patches or stream corridors, and others are broad areas of undeveloped land (NYNHP 2017). 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.

Forested talus slope at the Stone Church Preserve. Gretchen Stevens © 2019

Pitch pine and scrub oak in an oak-heath barren at the Stone Church Preserve.
Gretchen Stevens © 2019

Crest, Ledge, and Talus

In this *NRI* we use the term "ledge" for steep or vertical exposures of bedrock; "crest" for gently-sloped or near-level bedrock exposures, often on summits or shoulders of hills or knolls; and "talus" for the fields of loose rock that often accumulate below steep ledges and cliffs. Crests, ledges, and talus often occur together. Some of these rocky habitats support well-developed forests, while others have only sparse, patchy, and stunted vegetation. "Rocky barrens" are a special group of crest and ledge habitats with sometimes sparse and often stunted vegetation. These include oak-heath barrens and red cedar barrens described in Graham et al. (2019). Crest hickory woodland and crest oak woodland are closely related to barrens habitats, with much exposed bedrock but often with more trees (widely-spaced) and more understory and ground vegetation.

Despite their harsh appearance, these habitats can support an extraordinary diversity of uncommon and rare plants and animals. Some species, such as wall-rue, smooth cliffbrake, purple-stemmed cliffbrake, and northern slimy salamander are found only in and near such 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, aspect, exposure, slope, elevation, biotic influences, and kinds and intensity of human disturbance.

13. Large Forests

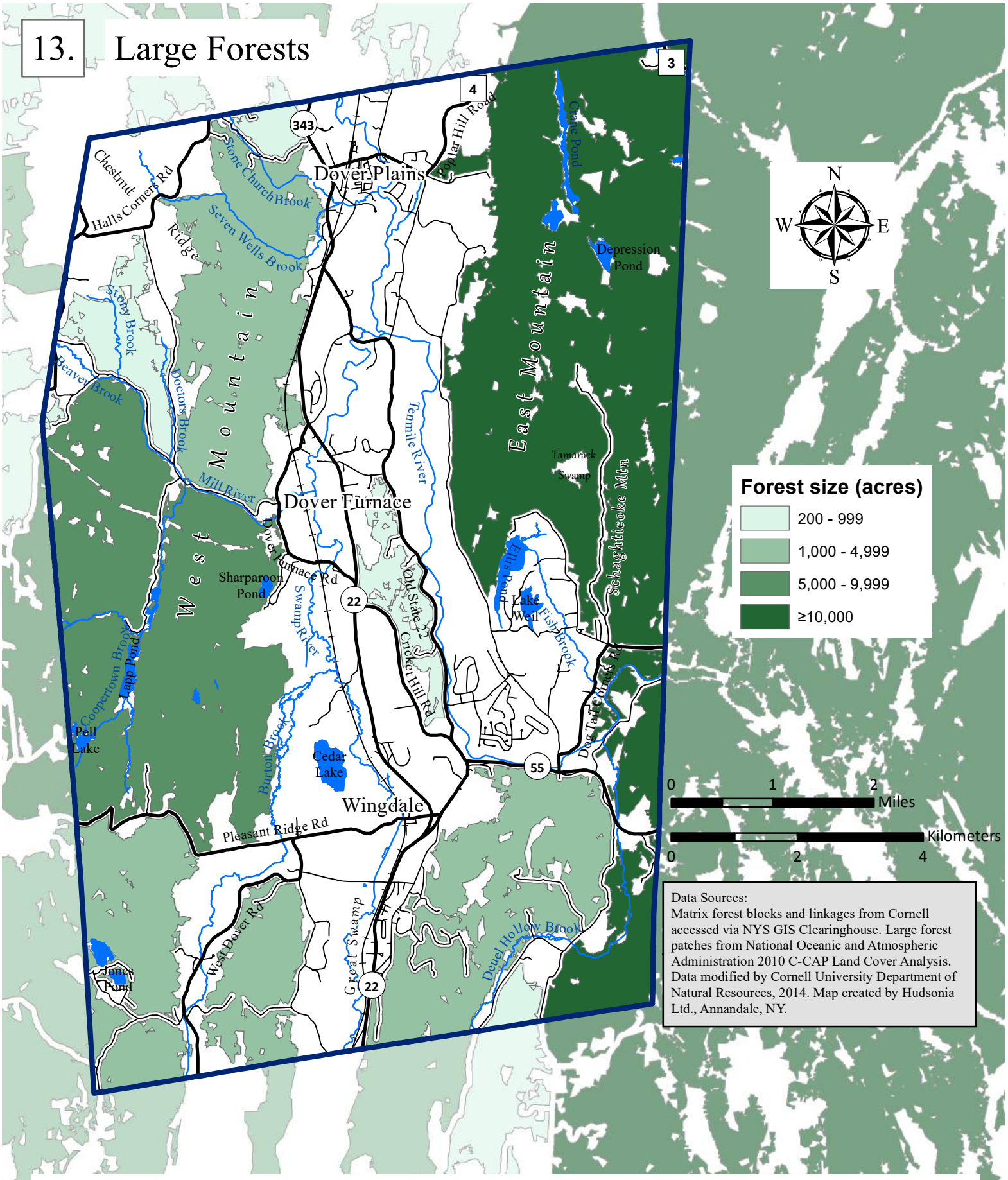


Figure 13. Large forest patches, forest matrix blocks, and forest linkage zones. Forest within 164 ft (50 m) of roads was excluded to minimally account for human development and disturbance at forest edges. Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

The rock chemistry helps to determine the kinds of biological communities that develop in these habitats. For example, outcrops and talus of calcareous (calcium-rich) rock may have trees such as American basswood and butternut; shrubs such as bladdernut and American prickly-ash; and herbs such as wild columbine, ebony spleenwort, maidenhair spleenwort, maidenhair fern, and fragile fern. They can support diverse and abundant land snails and numerous rare plant species, such as walking fern, pale corydalis, and American ginseng. Bedrock and talus with more acidic chemistry may have trees such as red oak, chestnut oak, eastern hemlock; shrubs such as lowbush blueberries, chokeberries, and scrub oak; and herbs such as Pennsylvania sedge, little bluestem, common hairgrass, bristly sarsaparilla, and rock polypody.

Several rare butterfly species use ledgy habitats that support their larval host plants, and reptiles of conservation concern such as five-lined skink, timber rattlesnake, black rat snake, and black racer use certain ledges for basking, breeding, and denning. Northern slimy salamander is found in wooded ledge and talus areas, porcupine and bobcat use ledge and talus for denning, and eastern small-footed bat† uses talus habitats for summer roosts. Other animals and plants of conservation concern that use these habitats are listed by Graham et al. (2019).

Crest, ledge, and talus habitats are abundant in Dover's forested hills (Figure 12), and the town may have more and larger rocky barrens, including oak-heath barrens, than any other Dutchess County town. Most of the rocky habitats are on acidic bedrock; those on calcareous bedrock are in and near the Harlem Valley.

Cool Ravine

There are many ravines in Dover, but a "cool ravine" is a very deep, narrow ravine with steep-sided rocky walls, and a rocky stream at the bottom. The deepness, narrowness, and rocky walls create a deeply-shaded, cool, moist microhabitat that is distinctly different from the surrounding landscape. These places often support plants and animals that are ordinarily found at more northern latitudes or at higher elevations. Several rare species are

Cascade in a Dover cool ravine. Nava Tabak © 2019.

known from cool ravines in the region. The cool conditions may make these areas an important refuge for animals and plants that are stressed by the warming climate. Graham et al. (2019) found just three cool ravines in Dover—on Stone Church Brook, Seven Wells Brook and on a tributary to Deuel Hollow Brook—but there could be others.

Shrubland

Upland shrubland is a common habitat on abandoned farmland, in utility corridors, in cleared, burned, or blowdown forest areas, and in rocky areas with shallow soils. It is often a transitional habitat stage between upland meadow and young forest. Shrubland plant communities vary according to soils, age, past land uses, and recent management, but they often share many of the plant species of oldfields (see below), with plants such as Kentucky bluegrass, sweet vernal grass, timothy, bentgrass, pointed broom sedge, clovers, wild madder, common milkweed, spotted knapweed, goldenrods (early, wrinkle-leaved, grass-leaved), and yarrow, along with shrubs such as gray dogwood, meadowsweet, steeplebush, multiflora rose, and autumn-olive.

Shrublands are used by many kinds of wildlife, including butterflies, bees, dragonflies, songbirds, turtles, snakes, small mammals, and their larger mammal predators such as fox and coyote. The complex habitat and microhabitat structure and diverse herbaceous (non-woody) communities of shrubland often support diverse and abundant spiders, ground beetles, ants, and other invertebrates.

Many species of conservation concern are known to use shrubland habitats in the region, including butterflies such as dusted skipper,† Leonard's skipper, and cobweb skipper (all regionally rare or scarce), nesting songbirds such as golden-winged warbler,† blue-winged warbler,† and American woodcock,† and mammals such as the New England cottontail† (NEC). The last species—very similar in appearance to the eastern cottontail (the common non-native species)—is our only native cottontail, but its populations have declined dramatically in the Northeast in recent decades. It seems to prefer large areas of shrubland with dense shrub thickets that provide protection from predators. The New England cottontail is known to occur in Dover. NYSDEC is attempting to locate extant populations in the region and works with landowners in southeastern New York to develop and enhance shrubland habitats for the NEC. For landowners interested in supporting the NEC, the NYSDEC website has information on managing shrublands especially for this rare and vulnerable species.

Many species of conservation concern, such as Leonard's skipper, golden-winged warbler, American woodcock, and New England cottontail, use shrubland habitats in the region.

Shrubland habitats have been declining in the Northeast, along with many animal species that depend on them, such as New England cottontail, prairie warbler, blue-winged warbler, field sparrow, American woodcock, and brown thrasher. See discussion of the Great Thicket National Wildlife Refuge in the **Animals** subsection below.

14. Large Meadow Complexes

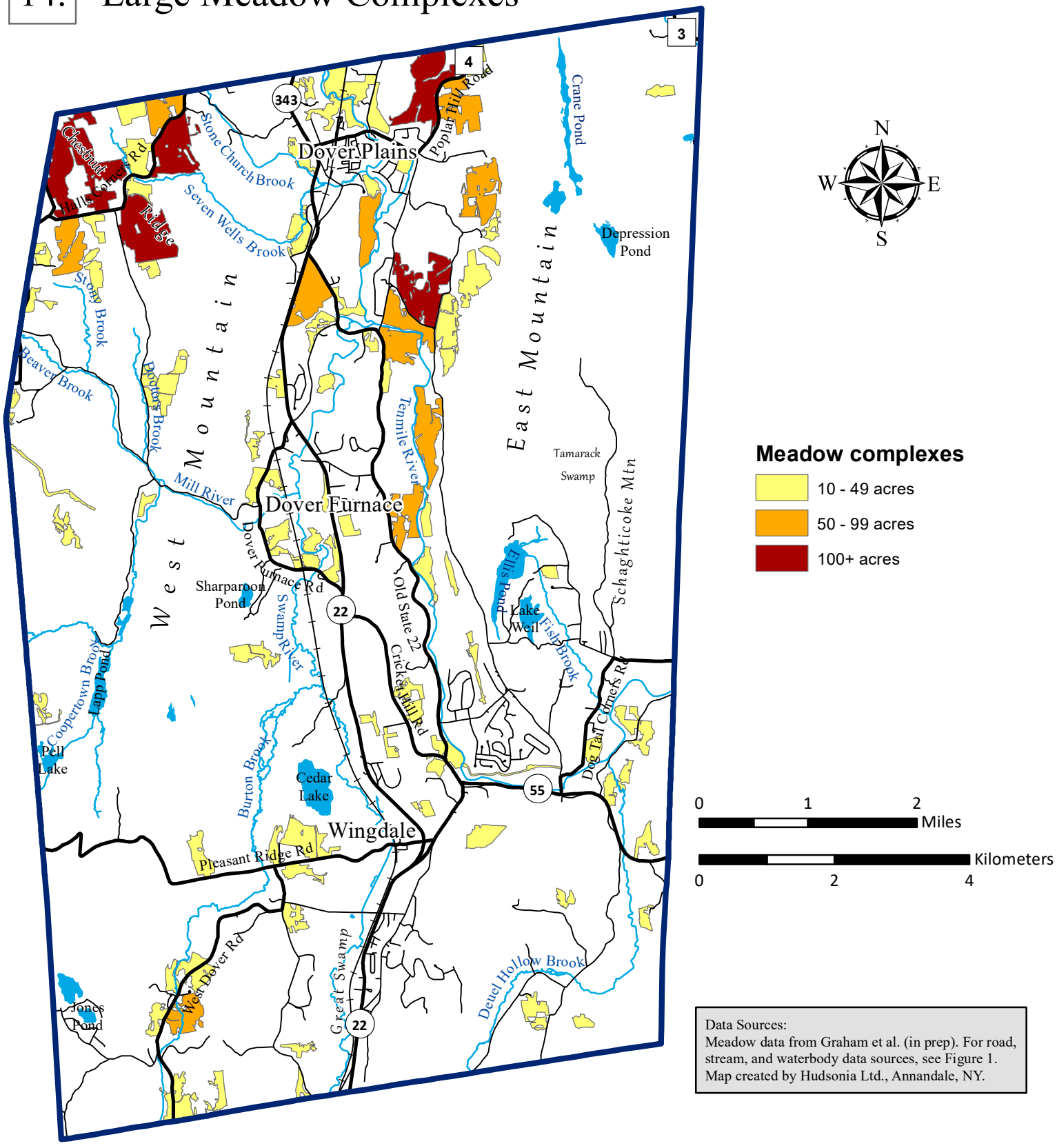


Figure 14. Meadow complexes in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Upland Meadow

The term "upland meadow" covers cropfields, pastures, oldfields, and other open non-wetland areas dominated by herbaceous (non-woody) vegetation. Most of the upland meadows in Dover occur in the Route 22/Old Route 22 corridor and on Chestnut Ridge (Figure 12). Most of the large meadows are in current (or recent) agriculture use—hayfields, cropfields, pastures, and equestrian fields; hayfields were the most common. Some of the smaller meadows are now oldfields—meadows that have been unmowed for awhile and have developed a diverse plant community of graminoids and forbs.

Meadows of all kinds can be valuable to wildlife, but the kinds of vegetation and intensity of uses (tilling, mowing, grazing, pesticide applications) help to determine their habitat value. Intensively cultivated cropfields have perhaps the least habitat value for native plants and animals, but even they are used by rodents, nesting turtles, foraging snakes, songbirds, wild turkey, nesting killdeer, pollinating insects and other invertebrates, and a host of other kinds of wildlife. Cropfields can act as ecological traps however, attracting animals that are then harmed or killed by farm equipment, pesticides, and other hazards. Hayfields, pastures, and oldfields, because of less frequent and less intensive disturbance, are more likely to support plants and animals of conservation concern.

Undisturbed, unmowed meadows develop diverse plant communities of grasses, forbs, and shrubs and support an array of wildlife, including invertebrates, frogs, reptiles, mammals, and birds. Meadows with shallow, nutrient-poor soils often support a higher abundance and diversity of native grasses and other native plants. Several species of rare butterflies, such as Aphrodite fritillary, meadow fritillary, dusted skipper,† Leonard's skipper, swarthy skipper, and striped hairstreak use upland meadows that support their particular host plants. Upland meadows can be used for nesting

by wood turtle,† spotted turtle,† box turtle,† painted turtle, and snapping turtle.† Wild turkeys forage on invertebrates and seeds in upland and wet meadows. Upland meadows often have large populations of small mammals (e.g., meadow vole) and can be important hunting grounds for their predators—raptors, foxes, and eastern coyote.

Large (e.g., 10+ acres) hayfields or pastures dominated by grasses, for example, may support grassland-breeding birds and many other kinds of wildlife. Grassland breeding birds are a special group of birds that nest and forage in grassy meadows; these include species such as grasshopper sparrow,† vesper sparrow,† savannah sparrow, eastern meadowlark,† and bobolink.† Populations of these birds have been declining in the Northeast for several decades, due primarily to loss of suitable habitat. The size of the meadow, kinds of meadow vegetation, and the kinds of management (e.g., mowing schedule, grazing intensity, etc.) will determine the actual value of any particular meadow for species of grassland birds. Although bobolink or eastern meadowlark can nest successfully in a ten-acre meadow, other grassland species require meadows of 25, 50, or 100+ acres to maintain longterm breeding populations. Each species has its own requirements and preferences for vegetation type and structure (e.g., grasses vs. forbs, short or tall, dense or sparse, tolerance for shrubs, etc.), and sensitivity to the surrounding landscape. The grassland bird species nest on or near the ground and are sensitive to nest predators and nest parasites, but the deep interior areas of large meadows provide some protection from those disturbances. Mowing or heavy grazing in spring or early summer is also likely to destroy nests or nestlings. Most of the largest meadows in Dover occur in the northern Harlem Valley area and on Chestnut Ridge (Figure 14).

Marble Knoll and Red Cedar Barren

A marble knoll is a low hill in the marble terrain of the Harlem Valley, usually with sandy or gravelly soils and outcrops of marble bedrock. This is a rare landscape feature that occurs only in the eastern tier of towns in Dutchess County. Many of these hills have been used in the past for pasture or hayfield, but have since developed into oldfields or red cedar woodlands—habitats with widely-spaced red cedar trees and meadow-like areas between the trees. Unusual features on some knolls are the white sands formed from weathering and erosion of the marble bedrock, and "red cedar barrens"—sparsely-vegetated habitats on marble bedrock or marble sand.

Red cedar barren on a Dover marble knoll. Chris Graham © 2019.

Marble knolls are hotspots for rare plants and animals, known to support at least 19 state-listed rare plant species in Dover, and several animal species of conservation concern such as eastern

hognose snake and eastern wormsnake. Graham et al. (2019) found 36 marble knolls in Dover concentrated in the vicinity of Dover Plains and an area north and south of Pleasant Ridge Road.

WETLAND HABITATS

A wetland is a vegetated area that has saturated soils in the rooting zone of plants for a prolonged period during the growing season. Some wetlands (e.g., marshes) have permanent standing water, and some (e.g., wet meadows) have little or no standing water, and may appear to be quite dry for a significant part of the year. Wetlands can occur at any elevation, from the valley bottom along the Ten Mile River to high on the East Mountain ridge—any vegetated place where:

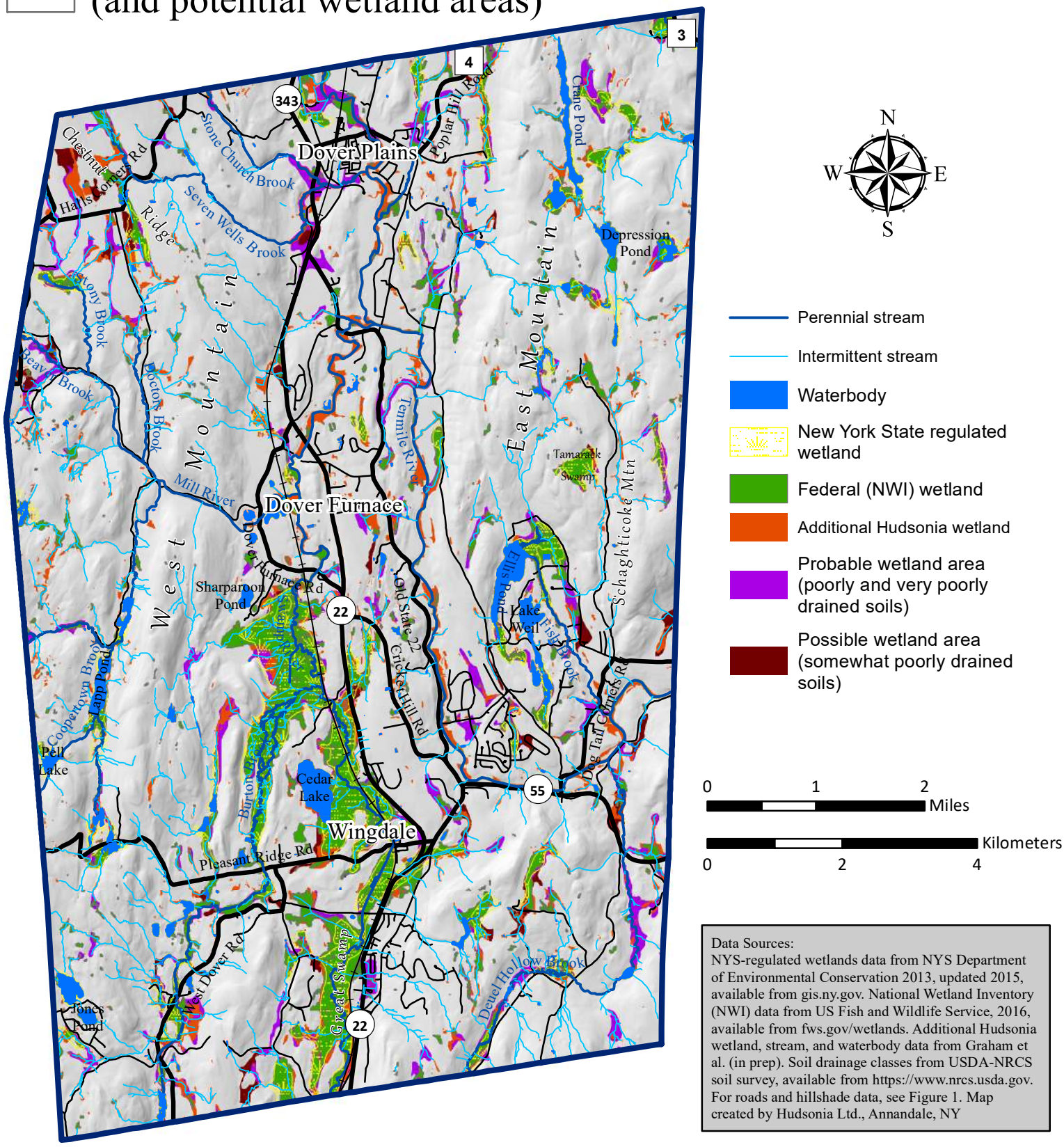
- the water table is at or near the ground surface for prolonged periods, or
- groundwater seepage emerges under gravitational pressure for prolonged periods, or
- a confining layer (e.g., bedrock or a compacted soil layer) holds water perched near the ground surface for prolonged periods.

Wetlands in general provide important habitat to a wide array of wildlife and plants, and provide important ecological services to the human community. They capture and hold large volumes of rainwater, snowmelt, and surface water runoff, and release it slowly to soils, vegetation, and evaporation. Maintaining wetlands and well-vegetated uplands are our best means of preventing large floods and their consequences to infrastructure and human safety. Wetlands with more-or-less continuously saturated soils also accumulate and store large amounts of carbon in the peat and muck soils, and thus reduce carbon emissions to the atmosphere, a primary driver of climate change.

Tiger swallowtail visiting swamp milkweed. Chris Graham © 2019.

Wetlands are one of the few parts of the landscape that receive some regular protections from the state and federal governments, but many wetlands are excluded from those protections. Wetlands have been mapped by New York State and the US Fish and Wildlife Service, but those maps show inaccurate wetland boundaries, and omit many small wetlands and even some large ones. Graham et al. (2019) conducted additional mapping of wetlands on the basis of more detailed remote sensing and field work. Figure 15 shows the wetlands mapped by all three entities, and additional areas mapped as "probable" or "possible" wetlands on the basis of soil drainage as indicated in the Dutchess County soil survey (Faber 2002). Further discussion of state and federal wetland maps and wetland regulatory programs is in the **Legislative Protections** section.

15. Wetlands (and potential wetland areas)



Data Sources:
NYS-regulated wetlands data from NYS Department of Environmental Conservation 2013, updated 2015, available from gis.ny.gov. National Wetland Inventory (NWI) data from US Fish and Wildlife Service, 2016, available from fws.gov/wetlands. Additional Hudsonia wetland, stream, and waterbody data from Graham et al. (in prep). Soil drainage classes from USDA-NRCS soil survey, available from https://www.nrcs.usda.gov. For roads and hillshade data, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY

Figure 15. Wetlands and potential wetland areas in the Town of Dover, Dutchess County, New York. See explanations in text. All wetland jurisdictional determinations should be made on the basis of field observations. Dover Natural Resource Inventory, 2019.

The eleven kinds of wetlands identified and mapped by Graham et al. (2019) are briefly described below.

Swamp

"Swamp" is a technical term for a wetland dominated by woody vegetation (trees or shrubs). Swamp habitats can be extremely variable in their hydrology, appearance, and plant species composition. Some have more-or-less permanent standing water, with much of the vegetation on raised woody hummocks, and others have little or no standing water for much of the year, and a densely-vegetated swamp floor.

The habitat values of a swamp are enhanced when the swamp is surrounded by large areas of other intact habitats.

The hardwood swamps in Dover typically have red maple and green ash in the overstory, along with any combination of other trees such as black ash, American elm, slippery elm, yellow birch, or swamp white oak. Shrubs often include species such as silky dogwood, winterberry holly, swamp azalea, northern arrowwood, and highbush blueberry, and herbaceous species may include tussock sedge, skunk-cabbage, marsh-marigold, sensitive fern, and cinnamon fern (among many others). Conifer swamps in Dover are dominated by eastern red cedar or eastern hemlock, sometimes with eastern white pine as a co-dominant. The shrub and herbaceous layers are typically sparse and low in species diversity, but *Sphagnum* and other mosses are sometimes abundant.

Marsh skullcap is a wildflower of Dover's forested and shrub swamps. Nava Tabak © 2019

Swamps occur at all elevations—in basins, on seepy hillsides, as part of larger complexes with other kinds of wetlands or ponds, or along streams, or entirely isolated from other wetlands, streams, or waterbodies. Hardwood swamps are the most common and extensive wetland type in Dover. The largest in Dover are in the Great Swamp, but large swamps also occur along Deuel Hollow Brook and Stony Brook, and in Tamarack Swamp, adjacent to Ellis Pond, and other places. Smaller swamps are widely distributed throughout the town.

Blue-spotted salamander breeds in swamps but spends the rest of the year in upland forests. Chris Graham © 2019

Swamps are important to a wide variety of plants and wildlife, including songbirds, raptors, amphibians, reptiles, fishes, and invertebrates. The habitat values are enhanced when the swamp is contiguous with other wetlands or surrounded by large areas of upland forest or other intact habitat.

The Great Swamp is a 6000+-acre complex of calcareous swamps, marshes, beaver ponds, fens, and small and large streams that support diverse biological communities, including numerous state-listed rare species of plants and animals. It is recognized as an important stopover area for migrating birds, and may be an important south-to-north corridor for wildlife seeking cooler areas in a warming climate. Due to the great value of the Great Swamp for biodiversity and water resources, much of its 63,000-acre watershed has been identified by the USDA Forest Service as one of several Highlands Conservation Focal Areas where three conditions coincide: a major cluster of (undeveloped) land; a high-priority composite conservation value; and an absence of permanent protection (NYS Open Space Plan 2016).

Acidic Bog

An acidic bog is a wetland habitat that is principally fed by rainwater (instead of groundwater) and has a distinctive plant community typically dominated by shrubs of the heath family and extensive carpets or floating mats of peat mosses (*Sphagnum*). Leatherleaf, sheep-laurel, swamp azalea, highbush blueberry, and black chokeberry are typical bog plants in this region, but bogs also have uncommon plants such as pitcher-plant, sundews, cranberries, and green-keeled cottongrass. Several rare butterflies, moths, and dragonflies are known to occur in these

Round-leaved sundew among *Sphagnum* mosses. Sundew is one of several insectivorous plant species of Dover's bogs. Chris Graham © 2019.

habitats, and several birds of conservation concern sometimes nest in or at the edges of bogs.

This is a rare habitat in the region. The plant communities of bogs are very sensitive to direct disturbance (such as trampling) and indirect disturbance that would alter the cool microclimate or the quantity or chemistry of the water entering the bog. Graham et al. (2019) documented five acidic bogs in Dover. The largest was a black spruce-tamarack bog in Tamarack Swamp.

Intermittent Woodland Pool

An intermittent woodland pool is a small pool-like wetland that is surrounded by forest, is hydrologically isolated from other wetlands or streams, and holds standing water in the winter and spring but dries up at some time during the summer. This is a "vernal pool" in a forested setting. The hydrologic isolation and the seasonal drying help to ensure that the pools are fish-free, an essential characteristic for some of the woodland pool animals. These habitats are the critical breeding habitat for a special group of pool-breeding amphibians—Jefferson salamander,† spotted salamander, marbled salamander,† and wood frog—that use the pools for breeding and early development, but otherwise inhabit the surrounding forest. The pools often have rich invertebrate communities of species that are well-adapted to the seasonal drying. Many other animals, including turtles, snakes, songbirds, waterfowl, wading birds, and mammals use the pools intermittently. Several rare plant species are known to occur in woodland pools of southeastern New York. Graham et al. (201) found false hop sedge† in two woodland pools in Dover.

Graham et al. (2019) mapped 172 intermittent woodland pools and "pool-like swamps"—isolate hardwood swamps that seem to share many of the ecological functions of woodland pools. Most were on East Mountain and West Mountain and surrounded by large forests—an important component of the intermittent woodland pool habitat complex.

Kettle Shrub Pool

A glacial "kettle" is a depression created by a stranded block of ice left behind in the outwash plain by the retreating glacier. Some kettle holes fill with water and vegetation and, over time, decaying organic sediments develop into deep layers of peat. Kettle wetlands are often hydrologically isolated from streams or other wetlands or waterbodies. One of these is a kettle shrub pool. A kettle shrub pool in a forested setting can be ecologically similar to an intermittent woodland pools (see above), supporting a similar array of plants and animals. But these wetlands have other characteristics that set them apart, including the deep peat that forms due to prolonged soil saturation. In some pools the peat is underlain by marl—a mud or mudstone rich in calcium carbonate formed from decaying plants and animals. Kettle shrub pools are often characterized by a stand of shrubs—typically buttonbush—in the center of the pool partially or entirely surrounded by an open-water moat or, conversely, the shrub stand may occupy the pool perimeter, with open water in the middle. Hudsonia has found several species of rare plants and animals in these pools elsewhere in the region. Graham et al. (2019) found six kettle shrub pools in Dover. A habitat that we call a "buttonbush pool" is similar in appearance and plant species to a kettle shrub pool, but occurs in glacial till terrain instead of an outwash plain.

Marsh

A marsh is a wetland that has standing water for most or all of the growing season and is dominated by herbaceous (non-woody) vegetation. Typical plants of marshes include cattails, tussock sedge, common reed, rice cutgrass, bur-reed, broad-leaved arrowhead, water-plantain, and pond-lilies. Marshes sometimes stand alone, but often occur at the edges of ponds, lakes, or streams, or are part of larger wetland complexes.

Marshes are used by many kinds of wildlife—amphibians, reptiles, fish, waterfowl, wading birds, raptors, songbirds, and mammals, as well as mollusks, dragonflies, damselflies, other aquatic insects, butterflies, moths, and a host of other invertebrates. Several rare plant species are known from marshes, and those adjacent to ponds or lakes can be important stopover habitats for migrating waterfowl.

Dover has large marshes—up to 36 acres—in the Great Swamp and on East Mountain east of Crane Pond, and other sizable marshes within or adjacent to several of Dover's ponds and lakes. Some, including the large marshes in the Great Swamp, are in beaver impoundments; marsh is a typical but ephemeral stage in the life of a beaver pond. Small marshes occur here and there throughout the town, as isolated wetlands, within wetland complexes, and along streams.

Wet Meadow

A wet meadow is a wetland with predominantly herbaceous (non-woody) vegetation, and which has little or no standing water during most of the growing season. Wet meadows are typically vegetated with graminoids and forbs such as reed canary-grass, soft rush, fox sedge, blue flag, purple loosestrife, and spotted Joe-Pye-weed. Wet meadows on calcareous soils often have plants such as sweetflag, lakeside sedge, yellow sedge, New York ironweed, rough-leaved goldenrod, and blue vervain. Wet meadows are often at the edges of other kinds of wetlands, but are sometimes isolated in the middle of agricultural fields or other managed or unmanaged upland habitat. Fens (see below) often grade into calcareous wet meadows, which sometimes have plant species typical of fens.

New York ironweed is a forb of calcareous wet meadows. Nava Tabak © 2019

Wet meadows with diverse plants often have diverse invertebrate communities, and many other animals use these habitats for foraging, resting, or nesting. Calcareous wet meadows that are adjacent to fens may be used by bog turtles† for summer foraging and nesting.

Wet meadows are common and widespread in Dover, mostly occurring in small patches of less than 1 acre, although large ones are off West Dover Road (32 ac), off Halls Corner Road (11 ac), and off Route 55 (5 ac) (Graham et al. 2019). Most of the calcareous wet meadows are in the Harlem Valley.

Fen

As used in this document, the term "fen" refers to an open (unforested) wetland fed by calcareous groundwater seepage. Fens are found in areas influenced by carbonate bedrock (e.g., limestone or marble), and are characterized by seepage rivulets, low-stature vegetation, and a distinctive plant community. Some typical plants of fens include shrubby cinquefoil, red-osier dogwood, autumn willow, sage-leaved willow, Kalm's lobelia, grass-of-Parnassus, bog goldenrod, spike-muhly, porcupine sedge, yellow sedge, and woolly-fruited sedge.

Shrubby cinquefoil is a characteristic plant of fens.
Nava Tabak © 2019

The Harlem Valley is the main locus of fens in southeastern New York, although some also occur westward in Dutchess County and in Orange and Ulster counties. The biological communities of fens are very sensitive to water chemistry, and many historical fens have been degraded or destroyed by polluted runoff from agricultural fields, lawns, and roads.

Graham et al. (2019) found 78 fens in Dover, and believe there may be others that were missed. Fens occur through-out Dover's Harlem Valley and a few other places, but are concentrated in places off Cricket Hill Road, in and near the Roger Perry Preserve, and off Poplar Hill Road. Many are small, but the two largest are six acres and nine acres (Graham et al. 2019).

Fens are famous for supporting rare species of plants and animals, some of which are found almost exclusively in these habitats. At least twelve state-listed rare plants are closely tied to fens in this region, and several rare butterflies and dragonflies. Fens are the core habitat for the bog turtle† in southeastern New York. The bog turtle is listed as Endangered on the state and federal rare species lists.

Spring and Seep

Springs and seeps are places where groundwater discharges to the ground surface, either at a single point (a spring) or diffusely (a seep). Some springs and seeps are ephemeral, appearing only during or after large rainfall events, and others are perennial or nearly so. Those that originate from deep groundwater sources emerge at a fairly constant temperature, creating an above-ground environment

that is cooler in summer and warmer in winter than the surroundings. They sometimes support species of plants or animals that are ordinarily found at more northern or southern latitudes.

Springs and seeps are water sources for many streams, lakes, ponds, and wetlands where they help maintain the cool summertime conditions that are beneficial to certain rare and declining fishes, amphibians, and other aquatic organisms. Those with more-or-less perennial flow can serve as water sources for terrestrial animals during droughts and in winter when other water sources are frozen. The quality and quantity of water emerging at seeps and springs can be much altered by nearby land uses and by excessive extraction of groundwater.

Springs and seeps are common and widespread in Dover, occurring at high and low elevations and in many different landscape settings. Most are small (e.g., 100s of square feet) but Graham et al. (2019) found several of five acres each, and one as large as 16 acres.

Open Water

"Open water" habitats are unvegetated areas of ponds and lakes, and large unvegetated pools within marshes and swamps. (Constructed ponds that are surrounded by manicured landscapes are described separately, below.) Open water areas are used by many common and uncommon species of invertebrates, fishes, frogs, turtles, waterfowl, muskrat, beaver, river otter, and bats. They can serve as important rest areas for migrating waterfowl.

Dover has numerous lakes, ponds, and pools in this "open water" category. Some developed spontaneously in natural basins, some were created by human- or beaver-constructed dams, and some were created in former quarries. Cedar Lake, Crane Pond, Depression Pond, and Lapp Pond

James Pond. Nava Tabak © 2019.

are the largest examples. Because these open waterbodies are often less-intensively managed or disturbed by humans, they often have greater habitat value for native plants and animals than "constructed ponds" that are managed for weeds, fish, and aesthetics. Open water habitats can be adversely affected by developed shorelines, herbicides, polluted runoff, and septic leachate, and by noise, mechanical disturbance, or leaked fuel from motorized watercraft.

Constructed Pond

Constructed ponds are water bodies that have been excavated or impounded by humans. Many of these ponds are created for fishing, watering livestock, irrigation, swimming, boating, or aesthetics. Some are constructed near houses or other structures to serve as an aesthetic landscaping feature or as a source of water in the event of a fire, while others were excavated during mining. Those that are not intensively managed or regularly disturbed by humans can be important habitats for many of the common and rare species associated with naturally formed open water habitats (see above). They can serve as drought refuges and foraging areas for turtles, waterfowl, and wading birds and, if not stocked with non-native fish, can support native fish species.

Habitat values for native plants and animals are greater in ponds with marshy edges and unmanicured shorelines.

Constructed ponds are abundant in Dover; Graham et al. (2019) mapped nearly 280. Most are small backyard ponds or farm ponds of less than an acre, but a few are large, such as Ellis Pond (67 ac), and Lake Weil (31 ac).

In general the habitat values for native plants and animals are greater in ponds with well-vegetated (i.e., marshy) edges and unmanicured shorelines, and in those that are less-managed and less-disturbed by human activities. The native communities of ponds are adversely affected by polluted runoff from lawns, gardens, agricultural fields, or roads, septic leachate, treatments with herbicides and other pesticides, and introduction of non-native fish.

Stream and Riparian Corridor

A "perennial stream" flows continuously throughout the year, and an "intermittent stream" flows only part of the year—a few days, a few weeks, or many months. A "riparian corridor" is the zone along a stream that includes the stream banks, the floodplain, and adjacent areas.

Perennial streams and their intact (undeveloped) riparian areas often have diverse habitats and are used by many species of stream-associated and terrestrial animals and plants. Wood turtle,† for example, uses perennial streams with certain habitat characteristics, and is known to use parts of the Swamp River and Ten Mile and their tributaries. Muskrat, river otter, and

American mink are regular users of streams and riparian areas. Bats often forage over streams. Louisiana waterthrush† nests along forested streams, and bank swallow and belted kingfisher sometimes nest in the high vertical banks of streams. Intermittent streams are the headwaters of most perennial streams, and are significant water sources for lakes, ponds, and wetlands. They also provide important habitats in their own right for mollusks, insects, other invertebrates, fish, and salamanders.

Stone Church Brook. Nava Tabak © 2019

Dover's numerous small and large streams are shown in figures 7 and 16; the largest are the Swamp River and the Ten Mile River.

The Ten Mile River acquires its name at the confluence of Wassaic Creek and Webatuck Creek in Amenia. Those two feeder streams rise in the Town of North East, and the entire watershed of the Ten Mile encompasses 210 square miles in parts of fourteen New York and Connecticut towns. The watershed is a rural landscape of farmland and forest with rural residences, villages, and hamlets. The Ten Mile drains most of the Town of Dover, fed by large and small streams including the Swamp River, Stone Church Brook, Fish Creek, and Deuel Hollow Brook.

The Ten Mile itself is a lowland meandering stream that winds southward through Dover, turns abruptly east at Webatuck, and ultimately joins the Housatonic River about 3000 ft east of the Dover town boundary. The Ten Mile stream bed is mostly sand, gravel, and cobbles (Shoumatoff and Reagan (2006). Water quality of the Ten Mile is discussed in the **Water Resources** section, above.

The Swamp River—the largest tributary to the Ten Mile—coalesces in the Great Swamp in the Town of Pawling, and flows north approximately 13 miles to meet the Ten Mile River in Dover Plains. The Swamp River drains a watershed of over 62,000 acres (97 square miles). It is a low-gradient, lowland stream bordered by the Great Swamp for much of its length. A 2010 study fou

Ten Mile River at Webatuck.

nd that the Swamp River water quality was affected by urban runoff in the vicinity of the Village of Pawling, and by elevated nutrients and coliform bacteria, and low dissolved oxygen at downstream locations (Cunnick et al. 2013). The suspected sources of impairment were agricultural runoff and failing septic systems. Water quality data gathered previously by NYSDEC are reported in the **Water Resources** section, above.

The Ten Mile River and Swamp River are classified by NYSDEC as "trout streams" for their entire lengths in Dover. Many of their tributaries are also classified as trout streams, and a few as "trout spawning streams" (Figure 9). These designations are given to streams that have the clear, clean, cool water required by brown trout, brook trout,† slimy sculpin, and other coldwater fishes that do not thrive in warmer, more turbid, or more polluted streams. A "trout spawning" designation indicates that the streams also have the coarse-textured, unsilted substrates needed for trout spawning and nursery habitat.

The Ten Mile River and Swamp River are classified by NYSDEC as "trout streams" for their entire lengths in Dover.

Trout streams are a declining resource in the region due to water pollution, stream-bed siltation, removal of forest canopies in the stream corridors, altered stream flows, and other consequences of human activities. The degradation of streams coincides with the decline of wild-reproducing populations of brook trout† and other organisms of high-quality coldwater streams. Brown trout (non-native) are stocked annually by NYSDEC in the Ten Mile and Swamp River. They compete

with brook trout for habitat and food resources, and may interfere with the growth of slimy sculpin, another fish of coldwater streams (Zimmerman and Vondracek 2007).

Figure 16 shows the larger streams in Dover classified by size, gradient, and temperature. These classifications can help predict the kinds of aquatic communities that are likely to occur in those streams. For example, a high-gradient (swift) coldwater stream is likely to support wild brook trout,† stoneflies, and other aquatic organisms of coldwater habitats. A "warm medium river" is more likely to support warmwater fish such as smallmouth bass, largemouth bass, and chain pickerel. If stocked trout are present, they are unlikely to survive year-round in a warm stream.

Maintaining intact floodplains, wetlands, and well-vegetated uplands are the best means of reducing or preventing large floods.

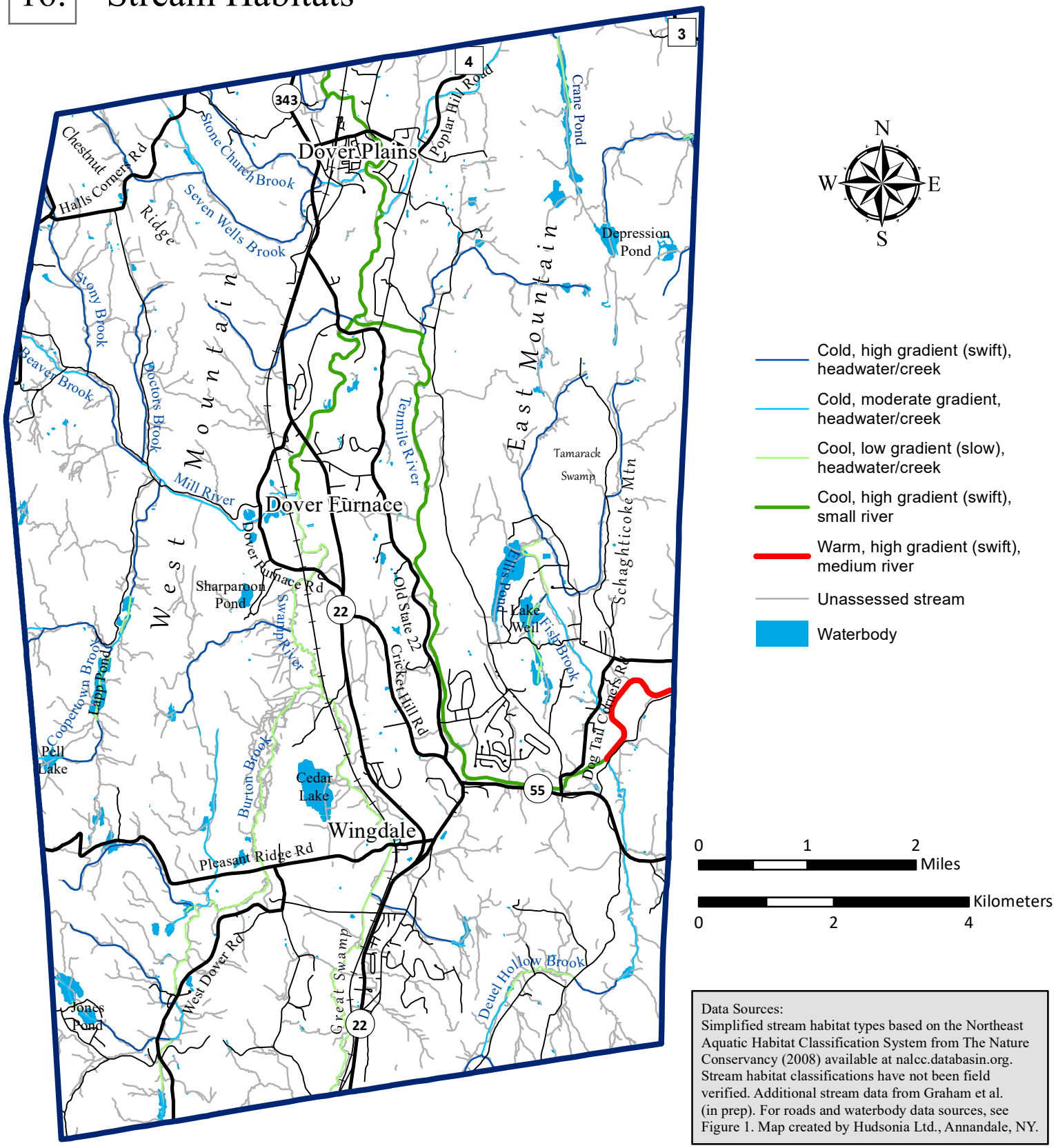
Floodplains of streams—the streamside areas that flood at frequent or infrequent intervals—are integral to the stream ecosystem. Intact (undeveloped) and well-vegetated floodplains help to stabilize streambanks, moderate floodflows, regulate stream temperatures, trap sediments, and remove pollutants. They also provide important habitat for plants and animals, and contribute organic materials to the stream (Wenger 1999). Many rare plants, such as cattail sedge, Davis' sedge, and goldenseal, occur on streambanks and floodplains in the region,
The Nature Conservancy developed the concept of the Active River Area (ARA) to help describe the physical and ecological processes that drive and sustain a stream, and can inform stream protection strategies. Active River Areas include the stream itself and the present and past floodplains and adjacent areas that protect, nourish, and accommodate the stream during normal flow conditions as well as during droughts and floods.

The Active River Area includes five components:

- *material contribution zones*, which regularly contribute organic and inorganic (e.g., sediments, water) material to streams;
- *meander belts*, the lateral areas within which the channel migrates over time;
- *floodplains*, the streamside areas that flood regularly or episodically;
- *riparian wetlands*; and
- *terraces*, former floodplains that may still flood in the largest flood events.

The contributions of these five components support the major processes influencing the stream—system hydrology, sediment transport, processing and transport of organic materials, and key biotic interactions (Smith et al. 2008)—useful concepts when considering effective measures for stream conservation. Figure 11b shows the Active River Areas for the larger streams of Dover. (The ARA zones are based on coarse elevation data, and have not been field-verified.) Sections below offer ideas for protecting the habitats of streams, floodplains, riparian corridors, and Active River Areas.

16. Stream Habitats



Data Sources:
Simplified stream habitat types based on the Northeast Aquatic Habitat Classification System from The Nature Conservancy (2008) available at nalcc.databasin.org. Stream habitat classifications have not been field verified. Additional stream data from Graham et al. (in prep). For roads and waterbody data sources, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Figure 16. Stream habitats defined by size, gradient and temperature in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Non-Native Invasive Species

Non-native species are those that were introduced to the region in the last 350+ years (i.e., since European arrival), mostly from other parts of North America or from Eurasia. Many were brought here intentionally, such the non-native grasses and forbs of pastures and hayfields that were planted to carry on European-style agriculture. Many other non-native plants were brought here as ornamentals and have since spread into forests, shrublands, meadows, wetlands, and roadsides. Others were brought here unintentionally as hitchhikers on ships, with imported goods, or in travelers' luggage. Non-native animals have similar histories of introductions; some (such as certain game fish) were introduced to expand recreational opportunities or to combat previous introductions, but many were unintentional. Non-native species that spread into natural areas are of concern to ecologists and others because they often lack significant consumers or diseases in their new environments, allowing their populations to expand rapidly and outcompete native species for limited resources or space, resulting in the decline of native biological diversity.

Non-native Plants

Some of the non-native plants that establish and persist outside of lawns, gardens, and cultivated land 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, preventing erosion 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 changing habitat characteristics (i.e., by altering soil chemistry, soil microbiota, nutrient cycling, vegetation structure, or plant community composition) (Travis and Kiviat 2016). In many cases where a non-native invasive plant 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.

Some examples of non-native invasive plants in Dover are Japanese barberry, oriental bittersweet, multiflora rose, mile-a-minute, purple loosestrife, sticky sage, garlic-mustard, common reed, and Japanese stiltgrass. Appendix Table C-3 lists many of the non-native invasive plants known to occur in Dutchess County and that do or may occur in Dover. Unfortunately, some of these species are still offered 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. Information about the ecology and management of some of Dover's non-native invasive plants species can be found at https://www.lhprism.org/document/best-management-practices-common-invasive-plants-lower-hudson-valley or at https://www.invasive.org/gist/products/handbook/methods-handbook.pdf.

Non-native Animals

Non-native invasive animals in Dover include species of earthworms, mollusks, crustaceans, insects, fishes, birds, and mammals, and other groups. Many of the non-natives have far-reaching effects on biological communities. Just a few examples are described below.

Only four species of earthworms are known to be native to the Northeast (McCay et al. 2017). Most of the earthworms we see in our lawns, gardens, meadows, and forests were imported, intentionally and unintentionally, from other places. 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 and microbes of the forest floor, and helps to prevent soil erosion, and maintain soil moisture and nutrient sources for woody and herbaceous plants. When earthworms are introduced to forest soils, they rapidly consume the organic duff, leaving bare soil that is no longer suitable for many forest wildflowers, tree seedlings, ferns, fungi, ground-nesting or foraging birds, and amphibians (Bohlen et al. 2004). 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 dessication (Bal et al. 2017). A recent arrival in New York, the snake worm (*Amynthas agrestis*), is especially large and voracious 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 (Raver 2007).

Most of our land snails are native to the region, but a few non-natives have become pests to farmers and gardeners. For example, the slugs most familiar to many of us are the several non-native species that are often pests in gardens and crop fields.

The rusty crayfish (*Orconectes rusticus*)—native to the central and midwestern US—is large and aggressive, allowing it to escape predation, and displace native crayfish. It has been found to reduce the populations of other important aquatic invertebrates, compete for food with native fish, and feed on fish eggs, especially trout (Conard et al. 2015). It may have arrived in New York streams in fishermen's bait buckets, which can also carry other non-native animals, pathogens, and parasites. The virile crayfish (O*rconectes virilis*) occurs in the Stone Church Brook and perhaps in other Dover streams. In streams of the US West, virile crayfish have been found to prey on brook trout eggs and stream invertebrates, and reduce populations of fishes, native crayfish, mollusks, and others (USFWS 2015a), and could have similar impacts here.

Non-native forest pests such as the hemlock woolly adelgid and the emerald ash borer are likely to transform our forest communities with wide-ranging ecosystem consequences. The hemlock woolly adelgid is a tiny aphid-like insect, native to Asia and the US Pacific Northwest that first appeared in

New York State on Long Island in the early 1980s and has been slowly moving northward. It is present in Dover, and has infested and killed significant areas of hemlock forest in the region. The insects deplete the host trees by feeding on plant fluids. Eastern hemlocks create cool, moist, deeply-shaded microclimates that are important to many plants and animals and to stream habitats. Loss of hemlocks leads to many changes to the forest ecology, warming stream temperatures, and an increase in nitrogen leaching into streams from forest soils (Lovett et al. 2013). Biological control agents—a predatory beetle and two species of silver fly—are being studied at Cornell, but have not yet been approved for widespread release in New York.

The emerald ash borer (EAB) is a wood-boring beetle native to Asia that was first detected in New York in 2009. EAB larvae feed under the bark of ash trees, cutting off the transport of nutrients. Trees usually die within several years of initial infestation. The EAB attacks all three species of ash that occur in Dover—white ash, green ash, and black ash. USDA scientists are currently evaluating four parasitoid wasps from the native range of the EAB for biological control of EAB in the US but, to our knowledge, none have yet been approved for release in New York.

The Asian longhorned beetle (*Anoplophora glabripennis*) is a wood-boring insect, native to Asia, first detected in New York in 1996. To date it has not been detected north of New York City and Long Island. It attacks maples and other hardwood trees.

Native coldwater fishes such as brook trout† and slimy sculpin are sensitive to water temperature increases and sedimentation of stream habitats, and are also threatened by the introduction of exotic fish species such as smallmouth bass and non-native trout, which are better adapted to warm water temperatures. Wild-reproducing brook trout are increasingly confined to small headwater streams, due to degraded water quality and stream habitat quality in lower reaches, and competition from brown trout, a non-native species that is stocked by NYSDEC each spring in the Ten Mile River and the Swamp River, and many other New York streams.

The European starling, native to Europe, was introduced to New York in 1890 and has since spread to all US states. They inflict much damage on fruit and grain crops, and may compete with native birds for nest sites and other resources. They may also contribute significantly to the spread of certain non-native plants—e.g., autumn-olive and oriental bittersweet—by improving the germination potential of the seeds that pass through the birds' digestive systems (LaFleur et al. 2009).

Once these non-native animals become established in natural areas, their populations are difficult or impossible to remove, except in very localized situations such as a small stream or pond. Often the best we can do is to prevent additional introductions, and maintain natural habitats in ways that support native species and discourage non-natives. For example, maintaining large forest areas undisturbed and unfragmented by driveways, yards, and utility corridors will help to prevent incursions by non-native plants, non-native earthworms, non-native slugs, and European starlings, and may postpone or stave off infestations by non-native forest pests such as the hemlock woolly adelgid and the emerald ash borer.

Special Biological Resources

PLANTS AND ANIMALS OF CONSERVATION CONCERN

Every plant species is adapted to particular kinds of environments. Some are tolerant of shade and some need full sunlight. Some do well in dry, rocky places, others occur only in permanent standing water, and some need the running water of a stream or seep. Some are found mainly in neutral or alkaline environments, and others are found only in acidic soils or water. Thus, you find most grass species in meadows and shrublands but not in deeply-shaded hemlock forests; you find pond-lilies in marshes and ponds but not in wet meadows that lack standing water; and you find chestnut oak in dryish upland 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 occurs only in the vicinity of beech trees because it obtains nutrients solely from the roots of beech. Lady's slippers and other orchids require certain soil fungi for successful germination. Even the effects of long-ago land uses (e.g., pasture, plowing) and catastrophic events (hurricanes, tornadoes, floods) can be detected in plant communities of today. Climate gradients—e.g., west-to-east, low-to-high-elevation, north-facing-to-south-facing—can have noticeable influence on the occurrence of certain plant species and plant communities.

False hop sedge (NYS Threatened) is found in intermittent woodland pools and isolated hardwood swamps.
Chris Graham © 2019

Native plants and animals of all kinds are important components of Dover's ecosystems, but rare species are a particular concern because they are in the greatest danger of disappearing from our landscapes. Some are at or near the edge of their range and are living close to the limits of their environmental tolerances. Some are surviving at locations disjunct from their main populations, and may have limited resilience due to a depleted gene pool. Some are in rare habitats, or in habitats that have been stressed by habitat fragmentation, pollution, or extreme weather events. Loss of rare species often

indicates a degraded environment, and can alert us to needs for protection and restoration before other species or communities are lost.

Dover is extraordinarily endowed with rare species, due in part to the topography, the complex geology, and the land use history. Just a few are discussed below.

Rare Plants

Many of Dover's rare plants occur in either a rare habitat or an unusual microhabitat. For example, the very rare habitat that we call a "marble knoll" supports at least 19 state-listed rare plant species. In southeastern New York, marble knolls occur only in the Harlem Valley. Yellow wild-flax and green milkweed (both NYS Threatened) occur on marble knolls and in red cedar woodlands. Canada yew is common in the Adirondacks but regionally-rare in southeastern New York, where it is found mainly in cool ravines—a very rare habitat. Hidden spikemoss and bristly sedge (both NYS Endangered) occur in some of Dover's fens, and false hop sedge (NYS Threatened) has been found in some of Dover's intermittent woodland pools.

Knowing what habitats are present will help you predict what kinds of rare species could occur there. For that reason, a habitat assessment (e.g., see Appendix E) by a knowledgeable biologist conducted in the early stages of planning for a land development project can help the developer and the Planning Board know whether any rare species of plants or animals might be put at risk.

Appendix Table C-2 lists the plant species of conservation concern that are known to occur or may occur in Dover. Most parts of the town have never been surveyed for rare plants, however, so there is no comprehensive list of rarities for the town.

Rare Animals

Like plants, most animal species are closely associated with particular kinds of habitats and habitat conditions. Some (gray squirrel, black-capped chickadee, Canada goose) are tolerant of or even thrive around human settlements and agriculture, and some stay far away from humans if possible. Some require very large habitat areas (red-shouldered hawk), and some need only small areas of suitable habitat (meadow vole, some native bees, and ground beetles). Some are habitat generalists, able to use a variety of habitats and tolerate a wide range of conditions, but many of the rarest animals are habitat specialists, requiring very specific kinds of habitats to meet their needs for food, shelter, and reproduction. Understanding the habitats present at any location will help you understand the kinds of rare species that might occur there. The brief profiles below of just a few of Dover's rare animals illustrate the range of habitats and landscape settings that support the unusual biological diversity of the town.

Bog turtle

The bog turtle† is New York's smallest and rarest freshwater turtle (NYS Endangered). Its critical habitat in southeastern New York is a fen, an uncommon kind of wetland characterized by calcareous (calcium-rich) groundwater seepage, low herbaceous and shrubby vegetation, and a distinctive plant community with species such as shrubby cinquefoil, grass-of-Parnassus, and bog goldenrod. The turtles typically spend the entire year in the fen and adjacent wetlands, but sometimes need to move overland to reach other fens. The Harlem Valley is the main locus of the bog turtle population in this region.

Many of the fens in the region are in agricultural areas where they are subject to nutrient-laden runoff from cropfields, trampling and overgrazing by livestock, or habitat conversion to other uses by excavation, filling, or draining. Excessive nutrients tend to alter the unusual plant community and structure, rendering the habitat no longer suitable for the bog turtle.

Timber rattlesnake

The timber rattlesnake† overwinters in deep crevices in ledges. During the warm months it uses open rocky crests for basking and breeding, and forests, shrublands, and meadows for foraging, often travelling long distances (sometimes over two miles) from the core ledge habitat. Those migrations expose the snake to the hazards of automobiles, construction equipment, and mowing equipment, and to direct encounters with humans.

Timber rattlesnake uses ledges for overwintering, basking, and breeding, and forages widely in surrounding forests, shrublands, and meadows. Nava Tabak © 2019.

Venomous snakes are often harassed or intentionally killed, and are sometimes (illegally) collected for the sale on the black market. Once numerous in the rocky hills of southeastern New York, the timber rattlesnake has been locally extirpated from many places over the last 80-100 years, due apparently to intentional killing and collecting, and mortality from vehicles. The snake still occurs in Dover and a few other towns. Keeping human use areas distant from known and potential rattlesnake use areas will help to preserve the local snake populations.

Louisiana waterthrush

Louisiana waterthrush† (NYS Species of Greatest Conservation Need) is a bird of clear, unpolluted, swift, perennial streams. It nests along the streambank among tree roots or logs, and feeds on a wide array of aquatic invertebrates, and even larvae of amphibians. It occurs more often along unsilted streams with good water quality, so its presence may be a useful indicator of overall stream integrity. Although it spends most of its time near the stream, Louisiana waterthrush seems to prefer streams in large forest areas (McCracken 1991).

Bats

At least nine species of bats are known to occur or are likely to occur in Dover in spring, summer, and fall (Appendix Table C-10), and most of these are listed as NYS Species of Greatest Conservation Need. Six of the nine overwinter in caves in New York, and three migrate south for the winter. All of these bats roost in trees in the warm months, and some use the interiors or exteriors of human-made structures for summer roosts. The small-footed bat† also uses crevices of ledge and talus areas. Bats forage in a variety of habitats, including open glades and meadows, over ponds, and along stream corridors. The northern long-eared bat† also forages in mature forests.

The Indiana bat population in NY declined 71% in the period 2007-2015, and the northern long-eared bat has declined by 99% due to the white-nose syndrome.

The white-nose syndrome, a fungal disease first identified in 2006, has devastated the populations of most of our cave-dwelling bat species in the Northeast. Already on the NYS and federal Endangered list before the arrival of white-nose syndrome, the Indiana bat† population in the state declined 71% during the period 2007–2015 (NYNHP 2019a), and the New York population of long-eared bat, now on the federal and NYS Threatened lists, has declined by 99% (NYNHP 2019b).

Our bat populations can be aided by preventing human disturbance of any known hibernation sites, maintaining mature trees and standing snags of forests and open areas for summer roosts, maintaining intact (undeveloped) foraging habitats such as ponds, meadows, and stream corridors, and reducing or eliminating use of insecticides on agricultural crops; insects are the primary food of bats.

Standing snags provide important habitat for summer roosting bats and many other animals—invertebrates, amphibians, small mammals, and birds. Gretchen Stevens © 2019.

New England cottontail

The New England cottontail† —once common in the Northeast—is a rare rabbit in Dutchess County and is listed as a Species of Special Concern in New York. It is the only cottontail rabbit native to New York and New England. In southeastern New York it occurs only east of the Hudson River. It is very similar in appearance to the non-native—and much more common—eastern cottontail, although the New England cottontail has shorter ears and has a black spot between the ears. The species' range has shrunk by 86% since 1960 (Fuller and Tur

2012). The New England cottontail is a habitat specialist, requiring dense shrub thickets and young forests with dense, shrubby understories (Litvaitis 2001). It is known to occur in Dover, which is within the area (towns east of the Hudson River and northwestern Connecticut) believed to be a very important part of the remaining range of this species (USFWS 2015b). The main reason for its decline appears to be loss of suitable shrubland habitat, but competition with eastern cottontail may also play a part. NYSDEC has been conducting surveys to identify places where the New England cottontail still occurs, and has been working with local landowners to create, restore, and maintain shrubland habitat suitable for this species.

To stem the losses of the New England cottontail and other shrubland-dependent species, the US Fish and Wildlife Service (USFWS) established the Great Thicket National Wildlife Refuge in 2016, with a goal to acquire conservation easements or in-fee lands from willing landowners in particular parts of six northeastern states—Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, and New York. Much of eastern Dover is within one of the focus areas for the Great Thicket, and the first property acquired for the NWR was the 144-acre parcel at Nellie Hill, donated by The Nature Conservancy to the USFWS.

SIGNIFICANT BIODIVERSITY AREAS

The NYSDEC has identified twenty-three "Significant Biodiversity Areas" (SBAs) throughout the ten counties of southeastern New York. Two of these occurs partially in the Town of Dover—the Harlem Valley Calcareous Wetlands SBA and the Hudson Highlands East SBA.

Dover has two "Significant Biodiversity Areas:" the Harlem Valley Calcareous Wetlands SBA and the Hudson Highlands East SBA.

The Harlem Valley Calcareous Wetlands SBA covers a large part of the Harlem Valley and nearby areas in Columbia, Dutchess, and Putnam counties, including not only wetlands but also surrounding upland areas and adjacent rocky hills. The SBA has been recognized for especially high concentrations of important, unusual, and vulnerable biological features (Penhollow et al. 2006). The carbonate bedrock underlying valley areas of the SBA is responsible for the carbonate ledges, the calcium-rich groundwater that feeds many of the wetlands, and the calcium-rich soils of both wetlands and uplands that support unusual ecological communities and many rare species of plants and animals (Figure 17a).

The Hudson Highlands East SBA, which covers hills and valleys in parts of Dutchess, Putnam, and Westchester counties, is recognized as a relatively undeveloped corridor of forests, wetlands, and grasslands of regional importance to breeding and migratory birds, resident amphibians and reptiles,

rare plants, and communities of special regional significance that are dependent on large, unfragmented habitat areas.

These two SBAs are by no means the only "significant" areas for biodiversity in Dover, but have been identified for their exceptional regional importance.

AREAS OF KNOWN IMPORTANCE

While the SBAs cover broad areas with multiple features significant for biodiversity, the New York Natural Heritage Program (NYNHP) has identified more localized *Areas of Known Importance* for biodiversity throughout the state. These are areas deemed to be important for the continued persistence of rare plants, rare animals, and significant ecosystems, identified through analysis of known occurrences of rare species, their life histories and habitats, and the physical and hydrological features of the landscape. The NYNHP has also identified several exemplary natural communities in Dover because of their rarity in the region or their especially high quality. These include red cedar barrens, oak-heath barrens, floodplain forests, red maple-hardwood swamps, and other significant wetland and other areas of high-quality wetland and upland habitats ("palustrine" and "terrestrial" communities) (Figure 17b).

The actual species of concern in each *Area of Known Importance* is not divulged here because of the sensitivity of the information. Rare species are vulnerable to illegal collecting, harassment, or removal, so the NYNHP and NYSDEC are careful to keep this information confidential unless there is an immediate threat or another important reason to make it known to a landowner or the public.

The NYNHP *Areas of Known Importance* and NYSDEC *Significant Biodiversity Areas* carry no legal weight, but the designations 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 intention is to 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.

When new land uses are contemplated within an *SBA* or an *Area of Known Importance*, people are encouraged to contact NYSDEC or 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 maps of *Areas of Known Importance* should never be used as a substitute for onsite habitat assessments or rare species surveys where such studies are warranted.

CRITICAL ENVIRONMENTAL AREAS

A Critical Environmental Area (CEA) is a geographical area formally designated by a municipality or county with exceptional character with respect to its natural attributes or sensitivities, agricultural importance, cultural importance, or benefit or threat to human health. 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. (CEAs are explained further in the **Legislative Protections** section, below.)

Dover has three Critical Environmental Areas: the Great Swamp CEA, the Deuel Hollow CEA, and the MICA Products CEA.

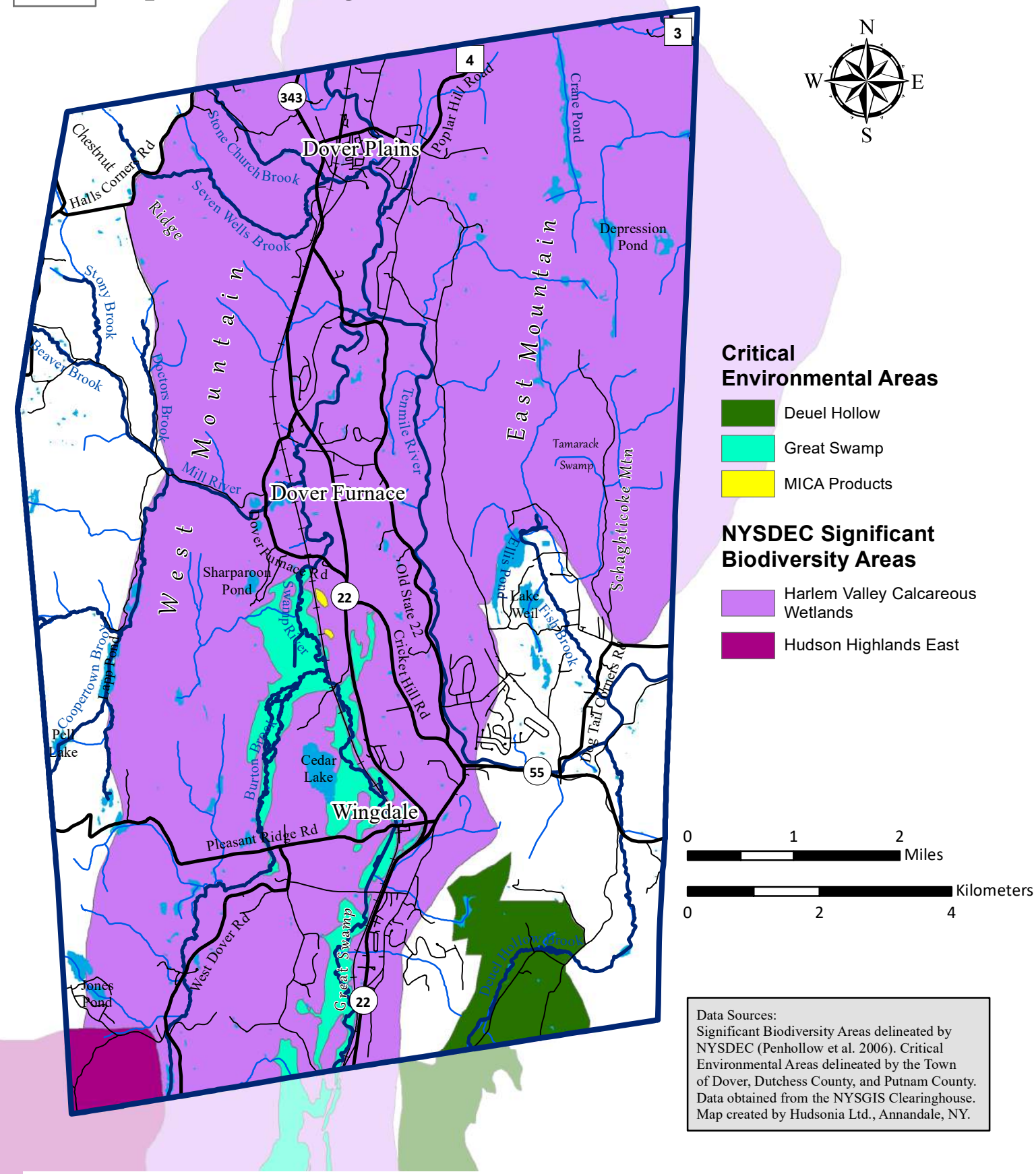
Dover has three existing CEAs—the Great Swamp CEA, the Deuel Hollow CEA, and the MICA Products CEA (Figure 17a). The first two were identified for their biological and water resource values, and the last for the potential environmental harms posed by hazardous wastes in an inactive landfill.

The Great Swamp CEA was established in 1992 by the Dutchess and Putnam county legislatures because of its benefits for human health, for its high-quality fish and wildlife habitat, for its important contributions to open space, scenic, recreational, and educational values, and for its ecological, geological, and hydrological sensitivity. Audubon New York has identified the Great Swamp as an Important Bird Area, and the US Department of the Interior has named it a National Historic Landmark.

The Deuel Hollow CEA was established by the Town of Dover in 1986 in recognition of its diverse, high-quality upland, wetland, and stream habitats, its known support of rare and sensitive species of plants and animals, its value for feeding (then) an institutional water supply reservoir, and its importance to the community for passive recreation. The Town of Pawling has designated an adjacent CEA to the south.

The Mica Industries CEA was established in 1985 by the Dutchess County legislature at the site of an inactive industrial landfill due to the potential for pollutants leaching to surrounding areas and the Ten Mile River. The Cricket Valley Energy electric generating facility, now under construction, is located at the site of the Mica CEA, and the project sponsors have committed to working with the Town of Dover and NYSDEC to clean up the contamination and return the land to productive use.

17a. Special Biological Resources



Data Sources:
Significant Biodiversity Areas delineated by NYSDEC (Penhollow et al. 2006). Critical Environmental Areas delineated by the Town of Dover, Dutchess County, and Putnam County. Data obtained from the NYSGIS Clearinghouse. Map created by Hudsonia Ltd., Annandale, NY.

Figure 17a. Special biological resources: Significant Biodiversity Areas and Critical Environmental Areas in the Town of Dover, Dutchess County, New York. Many other important biological resources occur throughout the town. Dover Natural Resource Inventory, 2019.

17b. Special Biological Resources

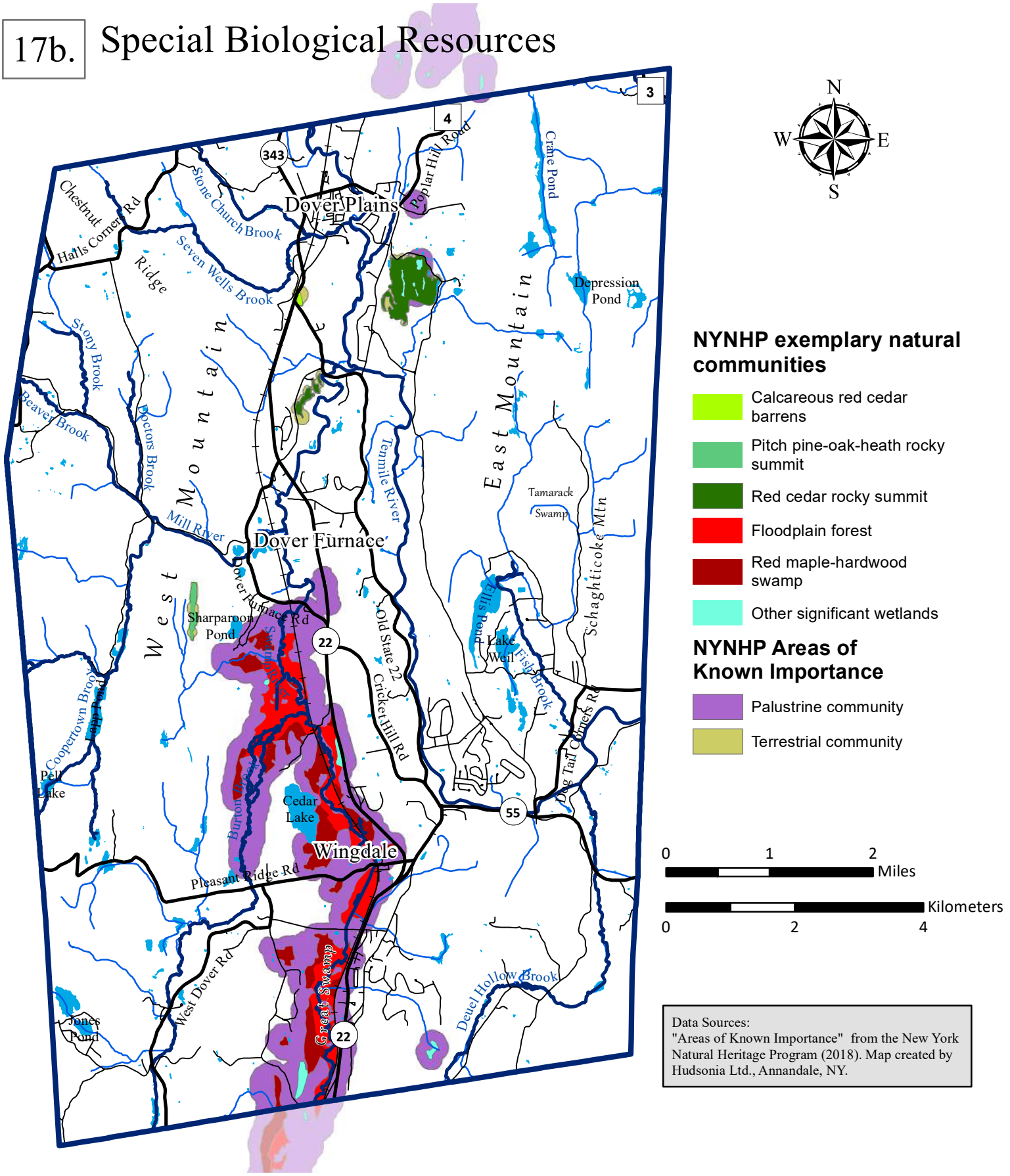


Figure 17b. Special biological resources: Areas of Known Importance for biodiversity, designated by the NY Natural Heritage Program in the Town of Dover, Dutchess County, New York. Many other important biological resources occur throughout the town. Dover Natural Resource Inventory, 2019.

CLIMATE RESILIENCE AND LANDSCAPE PERMEABILITY

Species of plants and animals need to move to adjust to new habitat conditions imposed by climate change. 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 of northeastern landscapes 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 (Anderson et al. 2012).

One assumption of the study is that unfragmented landscapes with complex landforms and topography, and high habitat diversity and wetland density are most likely to provide the array of habitats and microhabitats needed to support species in a changing climate. Anderson et al. use the term "resilience" to refer to "the capacity of a system to adapt to climate change while still maintaining diversity."

The investigators considered both 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 and thus lower landscape permeability. Permeability was assessed according to the hardness of barriers, the connectedness of natural cover, and the arrangement of land uses.

After identifying "resilient" sites and areas representing all geophysical settings, and then identifying networks of such sites in the larger landscape, Anderson et al. created maps showing areas with high or low predicted resilience. Figure 18 shows the results of that analysis of the Dover landscape for resilience, and Figure 19 the results for permeability.

Sweet white violet is a spring wildflower of upland hardwood and mixed forests. Nava Tabak © 2019.

The high-resilience areas shown in Figure 18 are those that are mostly forested and have a high degree of topographic complexity. The most permeable areas (Figure 19) share those characteristics and are the least fragmented by roads. The areas showing the lowest

permeability are concentrated in the Harlem Valley and on Chestnut Ridge where there is the most open land cover and the least forest (Figure 12).

The "local connectedness" measure reflects the number of barriers and the degree of fragmentation in an area, and is thus a measure of the ease and safety with which wildlife can move across the landscape. Figure 19 shows the areas identified by TNC as the most important for local connectedness in Dover—encompassing much of West Mountain and East Mountain, a section of the Route 22 corridor, and part of the Pawling Nature Preserve. In the scientific literature on building resilience to climate change, maintaining a connected landscape is most widely cited as the strategy with the greatest promise of success (Heller and Zavaleta 2009).

The TNC analysis provides only a coarse filter for conservation planning. The notions of permeability, resilience, and connectedness are not intended to supersede or outweigh other basic conservation principles or the protection of features of concern throughout the town—such as riparian corridors, rare or high-quality habitats, or known areas of importance for rare species. But the resilience and permeability maps provide additional perspectives on connectedness and landscape complexity, and add other layers for identifying local and regional conservation priorities. For example, these concepts and areas could be included in a revised Master Plan and zoning ordinance so that landscape connectedness through these areas could be better accommodated in planning, design, and review of new development projects.

Dutchman's breeches is a spring ephemeral wildflower of rich deciduous forests. Nava Tabak © 2019.

18. Landscape Resilience

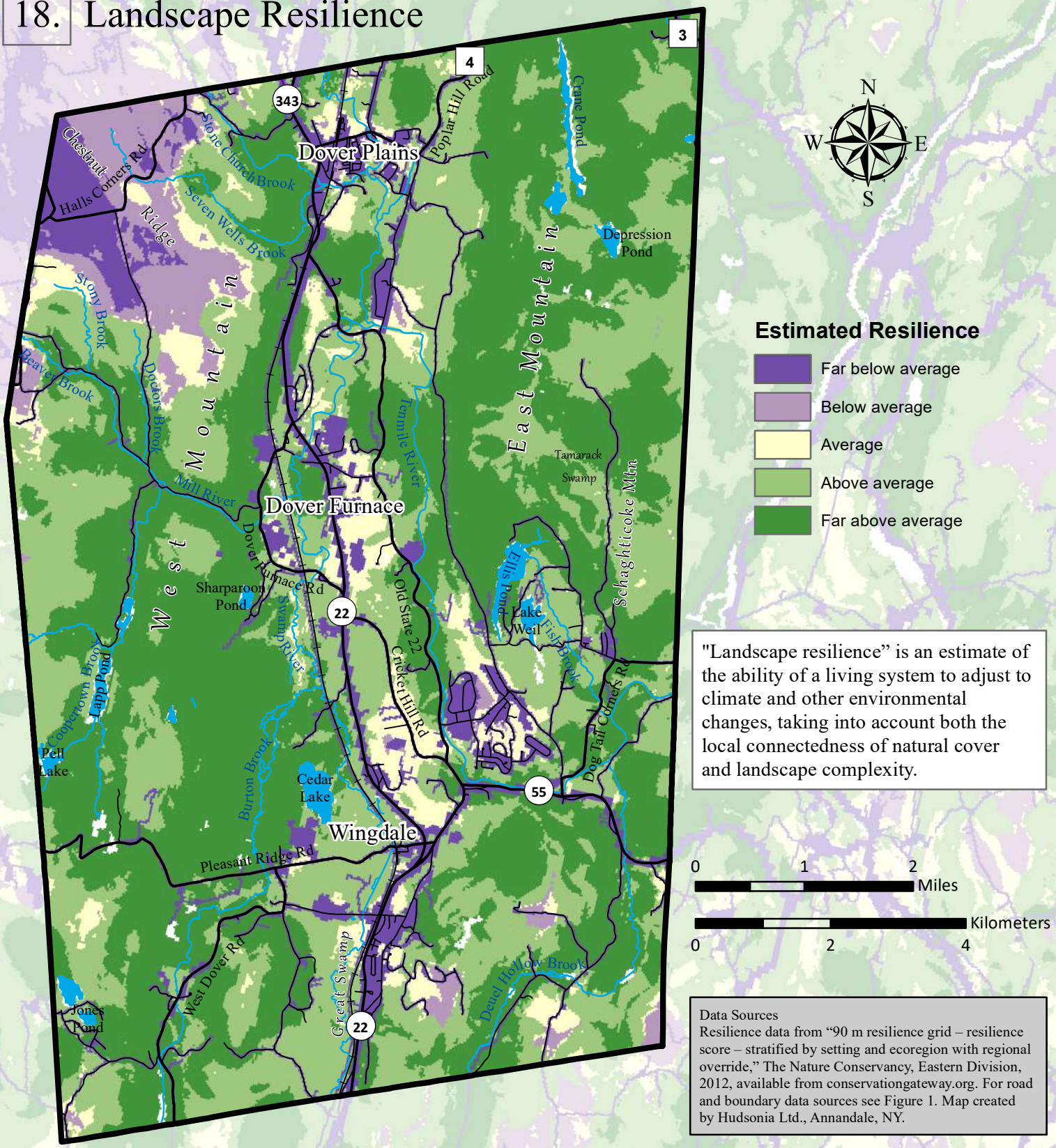


Figure 18. Local resilience of living systems, according to modeling by The Nature Conservancy. See text for explanation. Dover Natural Resource Inventory, 2019.

19. Landscape Permeability

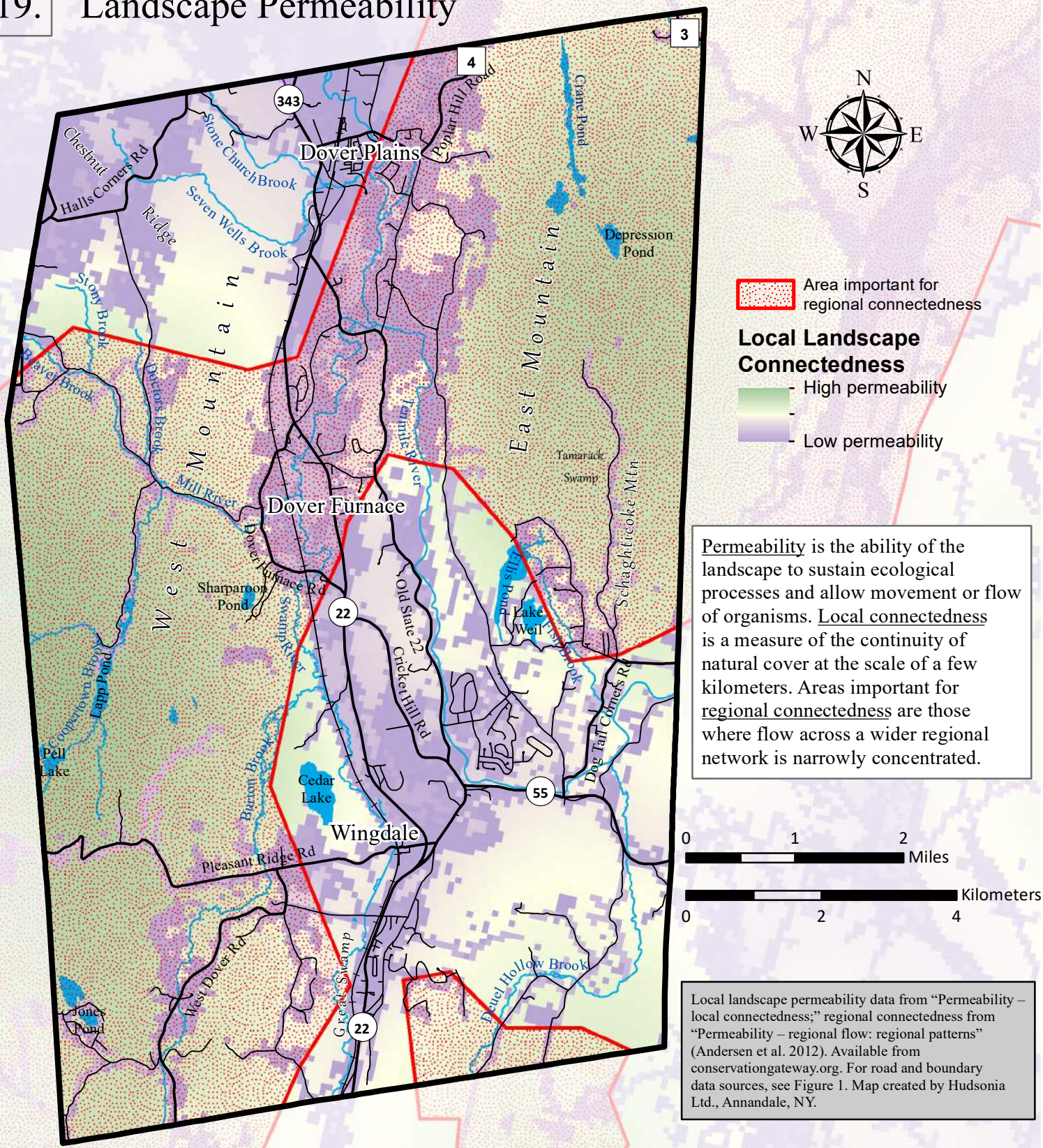


Figure 19. Landscape permeability according to modeling by The Nature Conservancy. See text for explanation. Dover Natural Resource Inventory, 2019.

FARMLAND RESOURCES

Dover is generously-endowed with good agricultural soils. Figure 20 shows the extent of Prime Farmland Soils and Farmland Soils of Statewide Importance in the town, based on the soils map in the *Soil Survey of Dutchess County, New York* (Faber 2002). The best farmland soils are concentrated on Chestnut Ridge and in the lowland areas of the Harlem Valley.

Prime Farmland Soils are those that have 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 nearly-level land, and are well-drained, fertile (e.g., with high pH and high base cations), 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" (Soil Survey Division Staff 1993). 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 (NRCS no date).

Prime farmland may be cultivated land, pasture, forest, or other land potentially available for growing crops, The soils identified as "prime farmland if drained" are too wet to meet the prime farmland criteria unless artificially drained.

Prime Farmland Soils

(Technical criteria established by the US Congress)

- Adequate natural moisture content
- Specific soil temperature range
- pH between 4.5 and 8.4 in the rooting zone
- low susceptibility to flooding
- low risk of erosion from wind or water
- minimum permeability rate
- low rock fragment content

As of 2015, there were 220 "farm parcels" in Dover—all the land parcels with an agricultural use; many of these had other uses in addition to agriculture. Farm enterprises include dairy, beef, sheep, horses, poultry, bees, hay, corn, soybeans, vegetables, fruits, herbs, flowers, trees, shrubs, maple syrup, and honey. Among the horse farms is a horse rescue sanctuary in Dover Plains. In 2017, the largest acreage (4310 acres) was in pasture for beef, and the next largest (4234 acres) was in hay, corn, and other field crops. Lesser areas were used for horses (460 acres) and dairy (235 acres). Most farms are small, producing less than $10,000 in gross annual sales (Cornell Cooperative Extension – Dutchess County 2017).

Several of the farms operate farm stores or seasonal farm stands. A weekly farmers' market has been held in the parking lot the Dover Elementary School. Several of Dover's farms operate on a Com-

munity Supported Agriculture model, where members pay an annual fee—or in some cases contribute labor—for a share of the anticipated harvest. Each member then receives shares of produce at intervals during the growing season and sometimes through the winter. In this way the members share some of the inherent risks of farming, and provide the farmer with up-front capital for purchasing seeds, feed, soil amendments, equipment, fuel, and other necessities long before realizing any income from farm products each year.

Protecting lands with the best farmland soils helps to preserve the ability to produce high-quality local food.

Agricultural Districts and Agricultural Assessments

The New York State Agricultural District Program exists to protect current and future farmland from nonagricultural development by reducing competition for limited land resources and helping to prevent local laws that would inhibit farming and raise farm taxes (AFPB 2015). The 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.

20. Farmland Soils

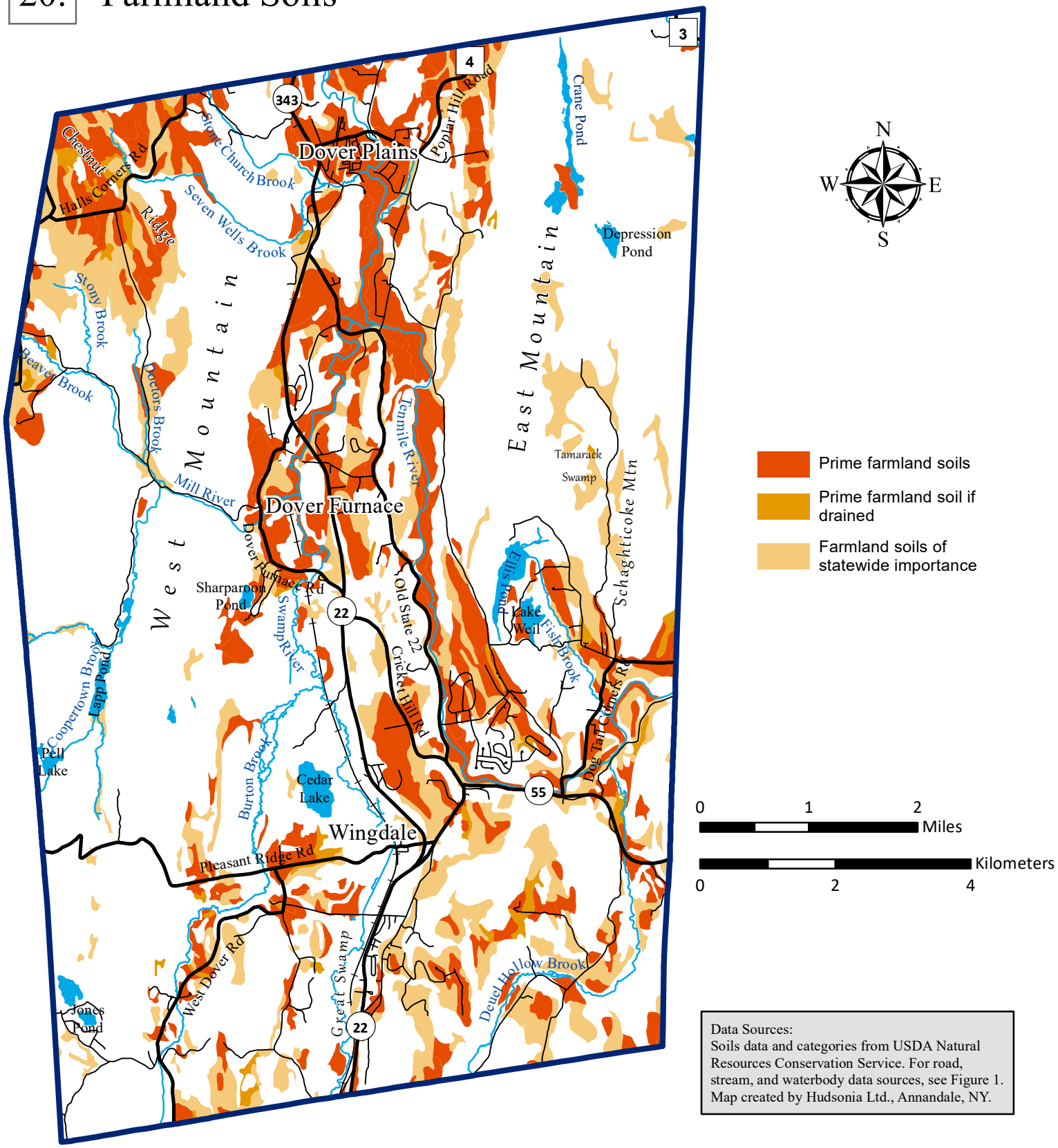


Figure 20. Farmland soils in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

The Agricultural Value Assessment Program provides property tax relief for landowners by requiring that eligible farmland is assessed based on actual agricultural production value rather than the full market value of the land. The reduced assessment for active farmland results in reduced property taxes for the landowner. From 2008 to 2017 Dover land in the agricultural district (District 23) increased 8.6 percent, and eighty-seven parcels totaling 7,690 acres received an agricultural exemption in the Dover tax assessment (see sidebar).

Farmland Assessments

Farmland that receives a reduced assessment for tax purposes under this program must be actively farmed, and the land generally 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 must average $10,000 or more for those two years. An enterprise on less than seven acres may quality if average annual gross sales were $50,000 or more. (There are some exceptions to these gross sales requirements.)

Protecting Dover lands with the best farmland soils will help to preserve the ability to produce high-quality local food, and support the local economy in numerous ways. Farm produce sold locally supports both farmers and local businesses, and availability of locally-grown farm products improves the quality of life for Dover residents. Active farmland is an important part of the town's scenic landscapes that attract visitors and businesses, and farm operations that purchase local supplies, equipment, and services further fuel the local economy.

In addition to all the direct and tangible benefits to the human community, agriculture creates open habitats—pastures, hayfields, row cropfields, fallow fields, and oldfields—that are used in various ways by native plants and animals. The ecological values of these habitats are described in the **Biological Resources** section, above.

RENEWABLE ENERGY RESOURCES

Renewable sources for power generation are undergoing a renaissance in New York due to technological advances, falling costs for components and installation, state and federal subsidies and incentives, and widespread concern over carbon emissions and other environmental damage associated with fossil fuels.

Although water power played a large role in Dover's past, supporting saw mills, grist mills and many other industrial operations in the 1700s and 1800s, today there are no commercial hydropower facilities in the town.

Wind Energy

Wind is a renewable source of energy that can provide economical electric power in locations with the right conditions. Wind turbines come in all sizes, from small, residential models generating 1-2 kilowatts (kW), to medium-sized commercial models in the 100-kW range, to large, utility wind turbines with megawatt (MW) energy production. "Wind farms" are utility sites with multiple large turbines that connect to the grid via high-voltage transmission lines. "Distributed wind" refers to single turbines for residential, farm, school, or community use that offset some or all grid power usage near the point of end use (a so-called "behind the meter" connection). Small wind turbines typically have towers 60-100 ft tall, whereas utility-scale turbines have towers 260 ft or taller. Although wind farms are best suited to the windiest locations, such as high-elevation ridges, distributed wind has potential in many more areas, including places in Dover.

What sites are appropriate for wind power generation? Wind power is proportional to the cube of wind speed, so a small increase in average annual wind speed translates into a large increase in power. Average wind speed also increases greatly with height above the ground. For a location to be feasible for commercial wind power production with today's technology, wind speeds must average at least 13.4-14.5 mph (6 to 6.5 m/second) (NYSERDA 2014, DWEA 2016) at 262 ft (80 m) above the ground (or the height of the turbine).

Figure 21 shows that most of Dover is ranked "poor" for commercial wind power, with small areas on hilltops and ridges ranked "marginal." As technologies improve, however, even places with lower average wind speeds may become good candidates for wind power (Hand et al. 2012; mapsnrel.gov).

Even now, however, small turbines for residential and on-farm energy production can be economically viable in many locations. Distributed wind uses smaller turbines and is practical at lower average wind speeds than those needed for commercial energy production. An average wind speed of at least 10 mph (4.5 m/s) is needed for distributed wind with today's technology. If the efficiency of small turbines improves, areas with lower wind speeds could become even more viable for power generation in the future.

Average wind speed and turbulence at any particular site is affected by topography, aspect, trees, and other obstacles, and is quite variable monthly and annually. Maps of modeled average annual wind speed only predict general areas with adequate wind speed. To accurately determine if a site has enough wind, onsite wind data needs to be collected for at least several months to one year—ideally at the height and location of a potential turbine—and then extrapolated for the longer-term using nearby weather station or airport wind data.

Distributed and community wind projects, sited appropriately, are probably a low risk to wildlife, especially compared to the risks to birds, bats, and the rest of life on earth posed by nonrenewable energy development. Bird collision deaths caused by turbines are currently estimated to be 100 to 10,000 times lower than those caused by other human-related sources of bird mortality, including feral and domestic cats, transmission lines, buildings and windows, and communication towers. As wind energy development continues, however, continued research on wildlife impacts and improvements in turbine design, siting, and operation will be important.

Solar Energy

Dutchess County receives an ample amount of solar radiation year-round to support photovoltaic (PV) solar electricity generation for both individual (e.g., residential) and utility scales. It is difficult to remotely measure the amount of solar radiation reaching the ground on a townwide basis, but estimated values for Dover range from approximately 4.1-4.4 kilowatt-hours (kWh) per m^2 per day for annual average daily irradiance (https://maps.nrel.gov). These values take into account estimates of cloud cover, water vapor, and aerosol optical depth (a measure of the density of dust and other particulates, air pollution, and smoke)—all of which reduce the irradiance reaching earth's surface via absorption or scattering.

Figure 22 shows the mean daily solar irradiance in Dover, calculated using the Area Solar Radiation tool in ArcMap 10 Spatial Analyst. This tool estimates the global (direct + diffuse, but not including reflected) radiation based on latitude and topography at a scale of 100 ft (30 m).

Many residences and businesses in Dover now have rooftop or ground-mounted solar panels that supply much of their electricity needs, and this trend is likely to continue as the technology improves and the costs to consumers continues to decline. Final site plan approval for a three megawatt solar energy installation, the first solar farm in the town, was issued in early 2018, and the facility is now under construction.

Criticisms of solar farm projects include conversion of high quality farmland; impacts on scenic resources, rural character, habitats, or wildlife; and safety concerns. Taking advantage of road verges, brownfields, capped landfills, and other disturbed and unused spaces can help avoid or minimize some of those potential conflicts.

21. Wind Speed

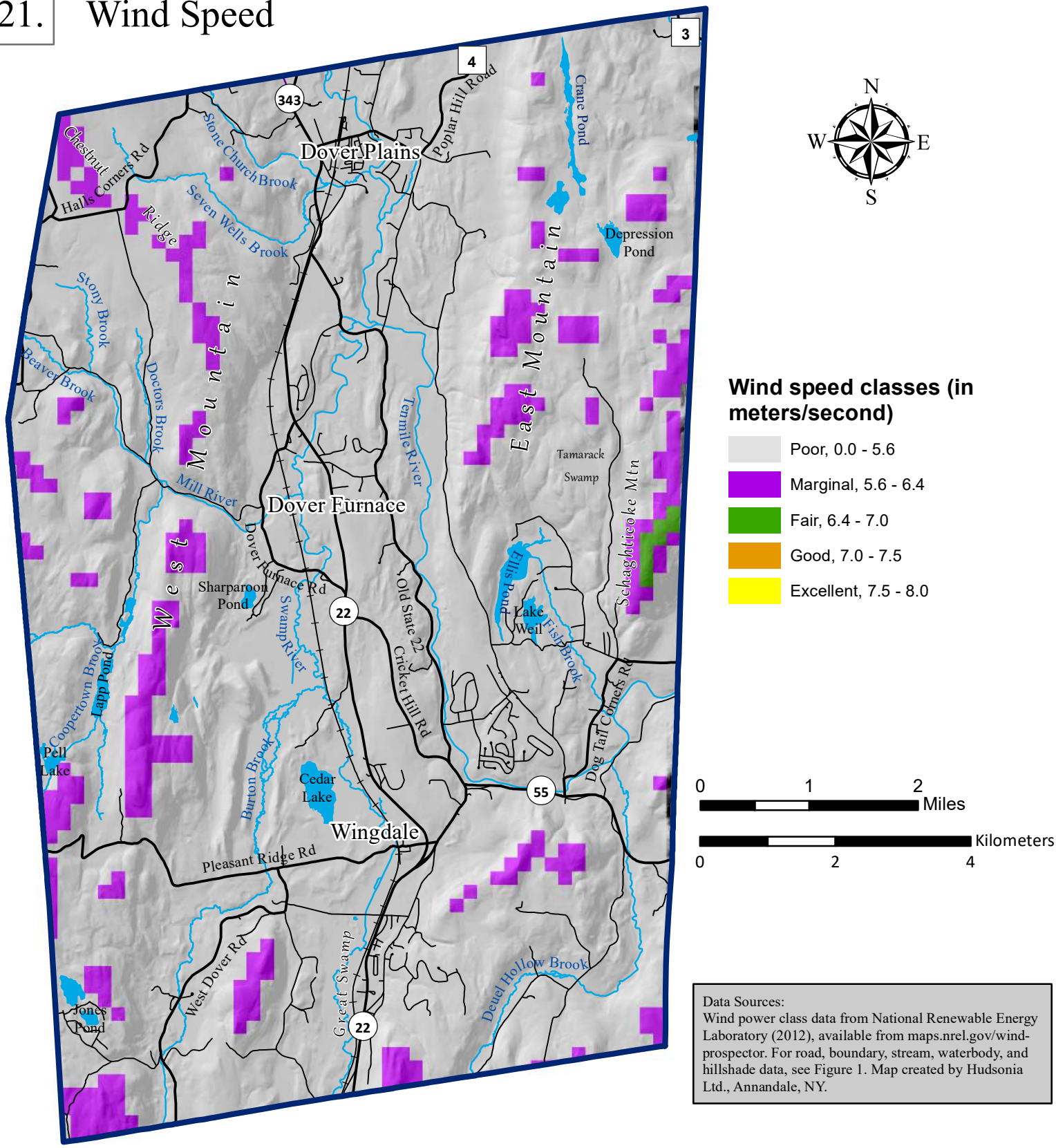
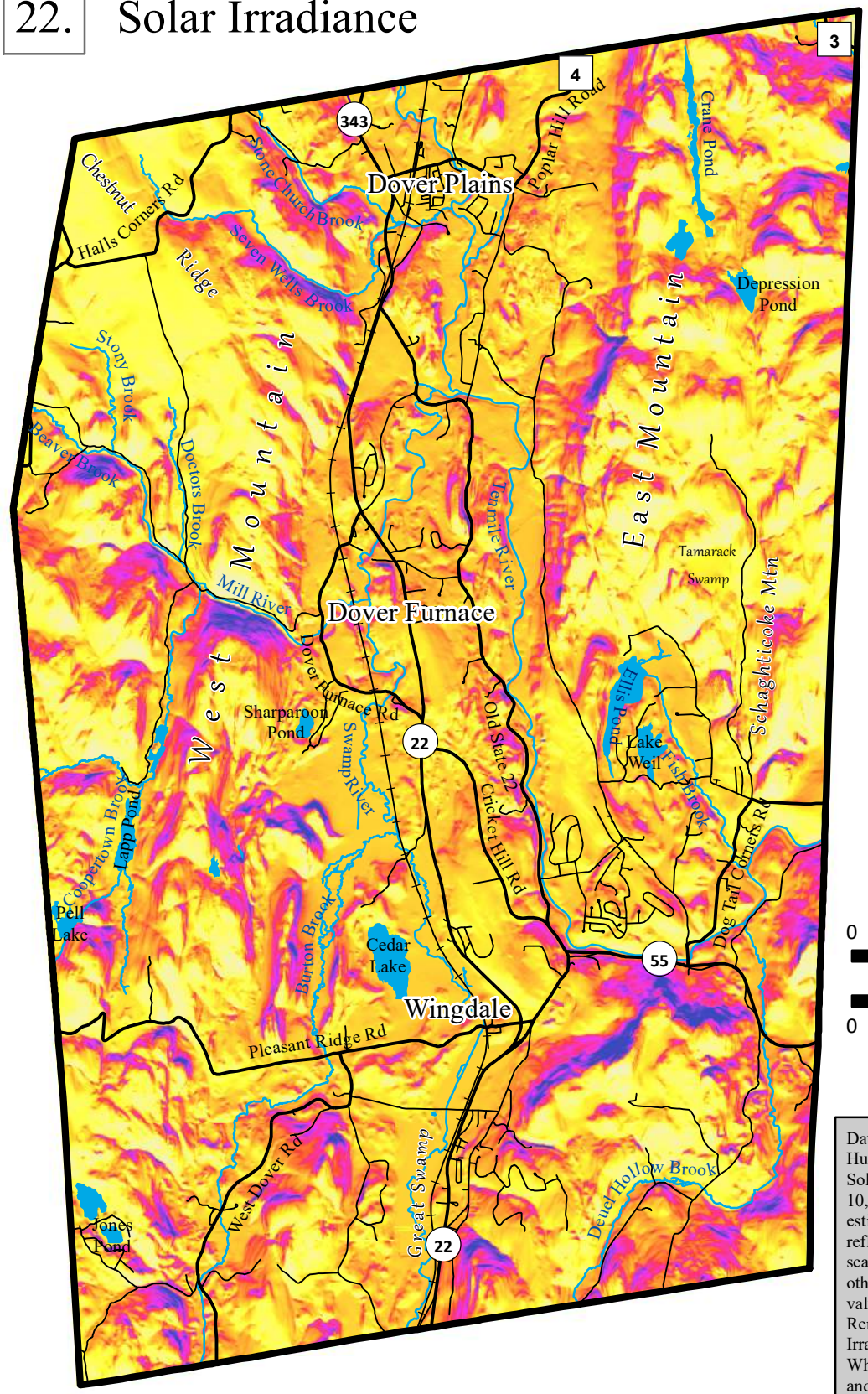


Figure 21. Modeled average annual wind speed for 50 meters (164 ft) above ground in the Town of Dover, Dutchess County, New York. Wind power classification is rated for economically viable commercial wind power. Actual wind conditions vary greatly over small areas and must be analyzed for suitability on-site. Dover Natural Resource Inventory, 2019.

22. Solar Irradiance

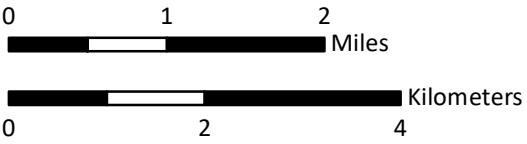


Average kWh/m²/day

4.951

4.180 (mean)

1.506



Data Sources:
Hudsonia created the solar irradiance raster with the Area Solar Radiation tool, Spatial Analyst Extension, in ArcMap 10, set to run for one year at monthly intervals. This tool estimates the global (direct + diffuse, but not including reflected) radiation based on latitude and topography at a scale of 30 m. We set the diffuse proportion to 0.2; all other inputs were left at default levels. The resulting raster values were adjusted upward to approximate National Renewable Energy Laboratory mean Direct Normal Irradiances for the town and transformed from Wh/m2/year to mean kWh/m2/day. For road, stream, and waterbody data, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Figure 22. Mean daily solar irradiance (kilowatt-hours per square meter per day) in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Scenic Resources

The scenic beauty of Dover is the natural resource that may be most appreciated in the daily lives of Dover residents: the forested hills, the open pastures and hayfields, the oldfields of goldenrods and asters in late summer, the rocky hillside streams and deep ravines, the meandering lowland streams, the silent expanses of ice-covered lakes in winter. These landscapes are inseparable from the enduring features, habitats, surface water, and farmland that are the other subjects of this *NRI*.

Now that most people's livelihoods are no longer directly dependent on farming, hunting, trapping, fishing, mining, and other natural resource-based occupations, the scenic qualities of the area provide the most immediate connection to the land that is shared by the people of Dover. The local concern for the visual landscape is reflected in many parts of the town's Master Plan and Zoning Ordinance.

> The town's scenic beauty is the natural resource that may be most universally appreciated in the daily lives of Dover residents.

The zoning ordinance mentions protection of scenic values in the overall statement of purpose, and requires consideration of scenic impacts in sections covering the Stream Corridor Overlay District, Steep Slopes, Architectural Design Review, Open Space Development, and in the Special Permits and Site Plan Review.

Large expanses of active and abandoned farmland in the Harlem Valley and on Chestnut Ridge, and the forested hillsides and summits of East Mountain and West Mountain visible from much of the NYS Route 22 corridor are part of the town's visual signatures. The Dover Stone Church itself and the Stone Church Brook ravine have been renowned scenic destinations since the 1800s. Other parts of the Stone Church Preserve have high-elevation viewpoints where the trails intersect open ledges. In addition to other overlooks along the Appalachian Trail, the Appalachian Trail Conservancy trail maps note two especially scenic viewpoints along the trail on Schaghticoke Mountain. Many locations accessible to paddlers along the Swamp River offer exceptional views of the streams, marshes, swamps, and backwater pools of the Great Swamp.

Dover's Master Plan acknowledges the great importance of the town's open spaces and scenic landscapes to the people of Dover, as aesthetic resources, recreational features, and economic assets, supporting both jobs in and revenues from hiking, equestrian activities, agriculture and agritourism, hospitality, and other enterprises that attract or benefit from visitors.

The Town of Dover could conduct a local survey to identify all the scenic places valued by and accessible to the public.

Figure 23 shows some of the especially scenic places around the town. The large green areas are the areas above 750 ft elevation on the forested hills and summits--the areas most visible from public-

access locations. The figure also shows the areas within Dover's Stream Corridor Overlay District, where "preserving the scenic character" is among the purposes of the legislation. The figure shows a few notable viewpoints on public-access lands, but these are only a small sample of the scenic places and viewpoints in the town. A local survey could be conducted by the town to identify all the other scenic places valued by and accessible to the public.

Eastern view from summit of the Blue Trail at the Stone Church Preserve.
Gretchen Stevens © 2019.

23. Scenic Resources

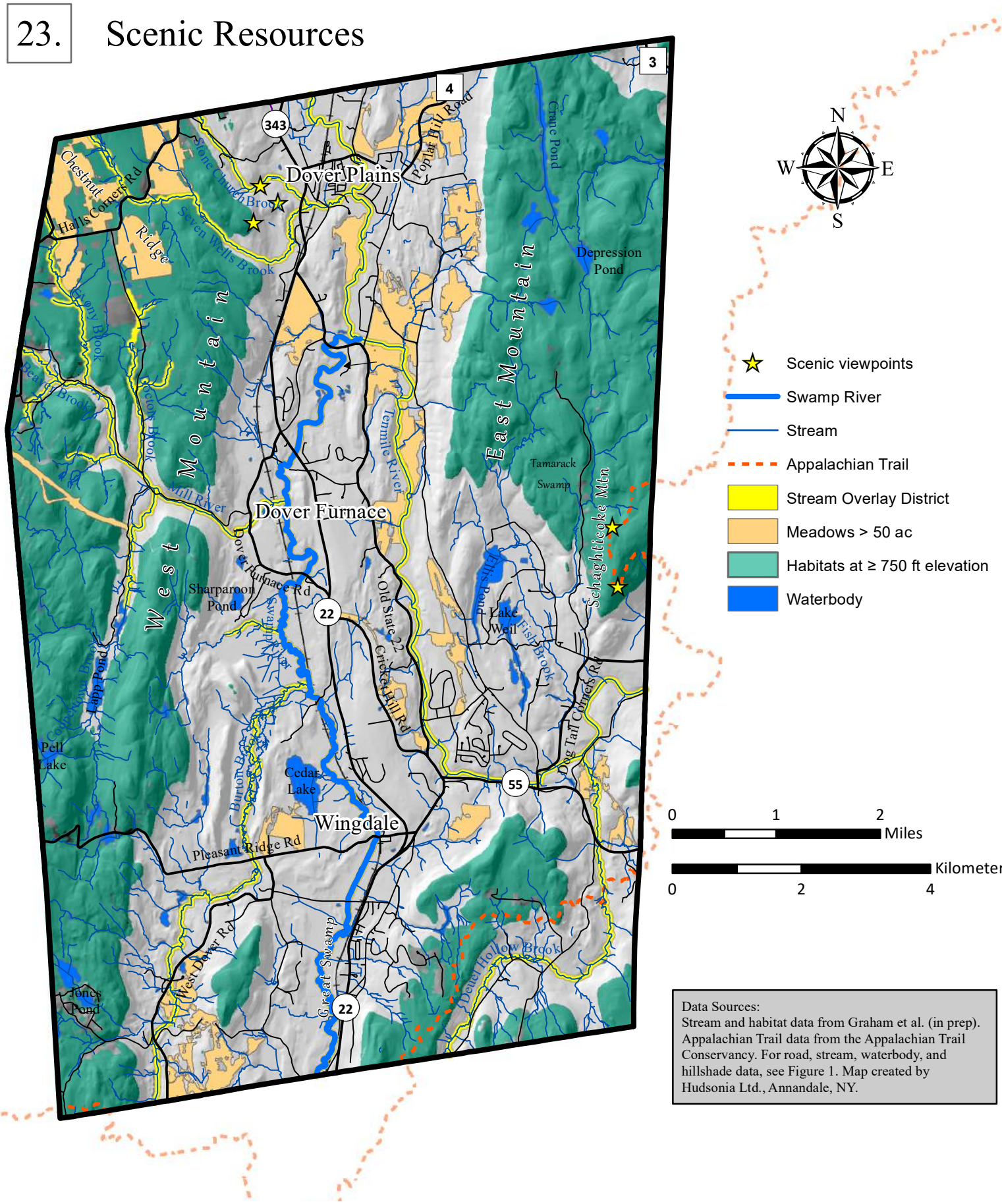


Figure 23. A few of the scenic resources in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Recreation Resources

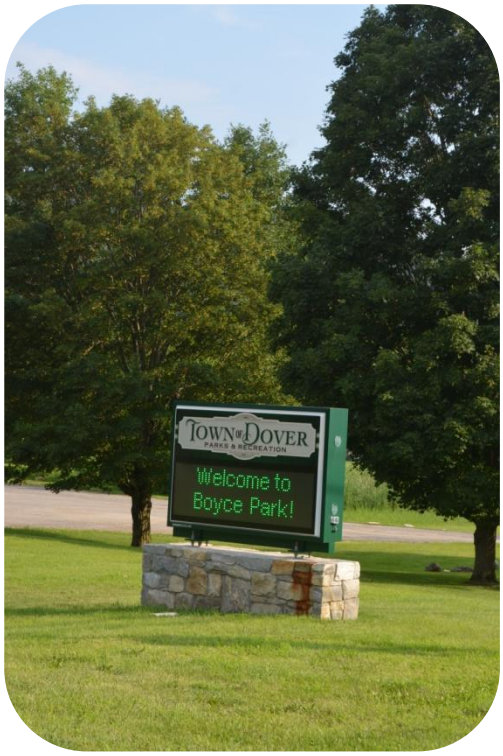
Local recreation opportunities improve the daily lives of residents, attract visitors, and benefit local businesses, and can strengthen people's connections to and appreciation for the land. Public recreational opportunities tied to the natural landscape can help to spur economic development and, if designed carefully, have relatively low environmental impacts. The kinds of public outdoor recreation best suited to Dover are those that take advantage of natural landscapes and cultural features while protecting intact the resources of conservation concern.

Many of the large and small land parcels in Dover are posted against trespassing, so most private lands are inaccessible for walking, hiking, biking, skiing, motor sports, hunting, or other recreational uses without landowner permission. Some of the public-access recreation areas in the town are briefly described below, and their locations are shown in Figure 24.

Appalachian Trail

The Appalachian Trail is a ca. 2,190-mile-long trail between Springer Mountain in Georgia and Mt. Katahdin in Maine. The trail is managed by the National Park Service, the US Forest Service, and the Appalachian Trail Conservancy. The trail runs through the extreme southwestern corner of Dover, then dips south into Pawling before re-entering Dover in the Pawling Nature Reserve, winding northeastward and exiting into Connecticut, and then looping back into Dover on Schaghticoke Mountain. The land along the trail is variously owned by public and private entities.

Appalachian Trail bridge over Deuel Hollow Brook.



Boyce Park
Boyce Park is a 199-acre town-owned park, developed with athletic fields, basketball courts, tennis courts, a playground, hiking trails, equestrian trails, and other facilities for public use.

Great Swamp
The Great Swamp has long been a destination for canoeing, kayaking, birdwatching, hiking, fishing, and photography. There are numerous hiking trails and 14 miles of navigable waters for paddlers (http://frogs-ny.org). The Great Swamp has been identified as an Important Bird Area by Audubon New York, and designated a Critical Environmental Area by Dutchess and Putnam counties.

Swamp River at Webatuck.

Nellie Hill / Great Thicket National Wildlife Refuge

After managing the property for 25 years, in 2017 The Nature Conservancy donated the 144-acre Nellie Hill Preserve to the US Fish and Wildlife Service to be the first piece of the Great Thicket National Wildlife Refuge, a project that will incorporate land in six northeastern states for purposes of restoring and maintaining shrubland and young forest habitat for species of conservation concern. The Nellie Hill site is managed both for rare species conservation and for passive public recreation—wildlife observation, photography, environmental education, and interpretation.

Pawling Nature Reserve

The Pawling Nature Reserve is a ca. 1000-acre property in Dover and Pawling owned by The Nature Conservancy (TNC) and managed jointly by TNC and local volunteers for conservation, research, education, and passive recreation.

Public Fishing Rights

Throughout New York State, NYSDEC has purchased easements from willing landowners at specific locations along streams to allow public access for fishing. In most cases these are ca. 33-ft-wide strips along one or both banks of the stream. The land remains in private ownership, and public access is for fishing only, not for other uses. There is one such location in Dover—along the Swamp River north and south of the Wheeler Road bridge. Another public-access site for fishing on the Swamp River is off Old Route 22 just below the junction with the Ten Mile River.

Roger Perry Memorial Preserve
This is a 120-acre site owned and managed by The Nature Conservancy. It contains numerous unusual features and habitats, such as marble knolls, fens, springs, red cedar barrens, red cedar woodlands, calcareous ledges, and the "white sands of Dover"—white sand from weathered and eroded marble bedrock. A loop trail takes visitors through several habitats and an overlook for viewing fens.

Slocum-Mostachetti Preserve
This is a ca. 106-acre property owned and managed (with assistance from local volunteers) by the Oblong Land Conservancy for conservation of unusual habitats and rare species, and for public education and enjoyment.

Stone Church Preserve

The Stone Church Preserve is named for the Stone Church, a natural grotto of metamorphic rock along the Stone Church Brook that has attracted visitors, artists, and writers since the 1800s. Trails guide hikers through forests and meadows, oak-heath barrens, and wooded talus slopes. The preserve is owned by the Town of Dover and managed jointly by the town and the Dutchess Land Conservancy (DLC) for public recreation and conservation. The DLC holds a conservation easement on the 168-acre preserve property and an adjacent property that holds the Stone Church access right-of-way, pictured below, but is not otherwise open to the public.

The maple-lined allée leading to the Stone Church Preserve.

West Mountain State Forest

This is an 830-acre state-owned parcel straddling the boundary between the towns of Dover and Beekman. It has no marked trails but several unmarked trails open for non-motorized recreation, including hiking, skiing, hunting, fishing, and primitive camping.

24. Public Recreation Resources

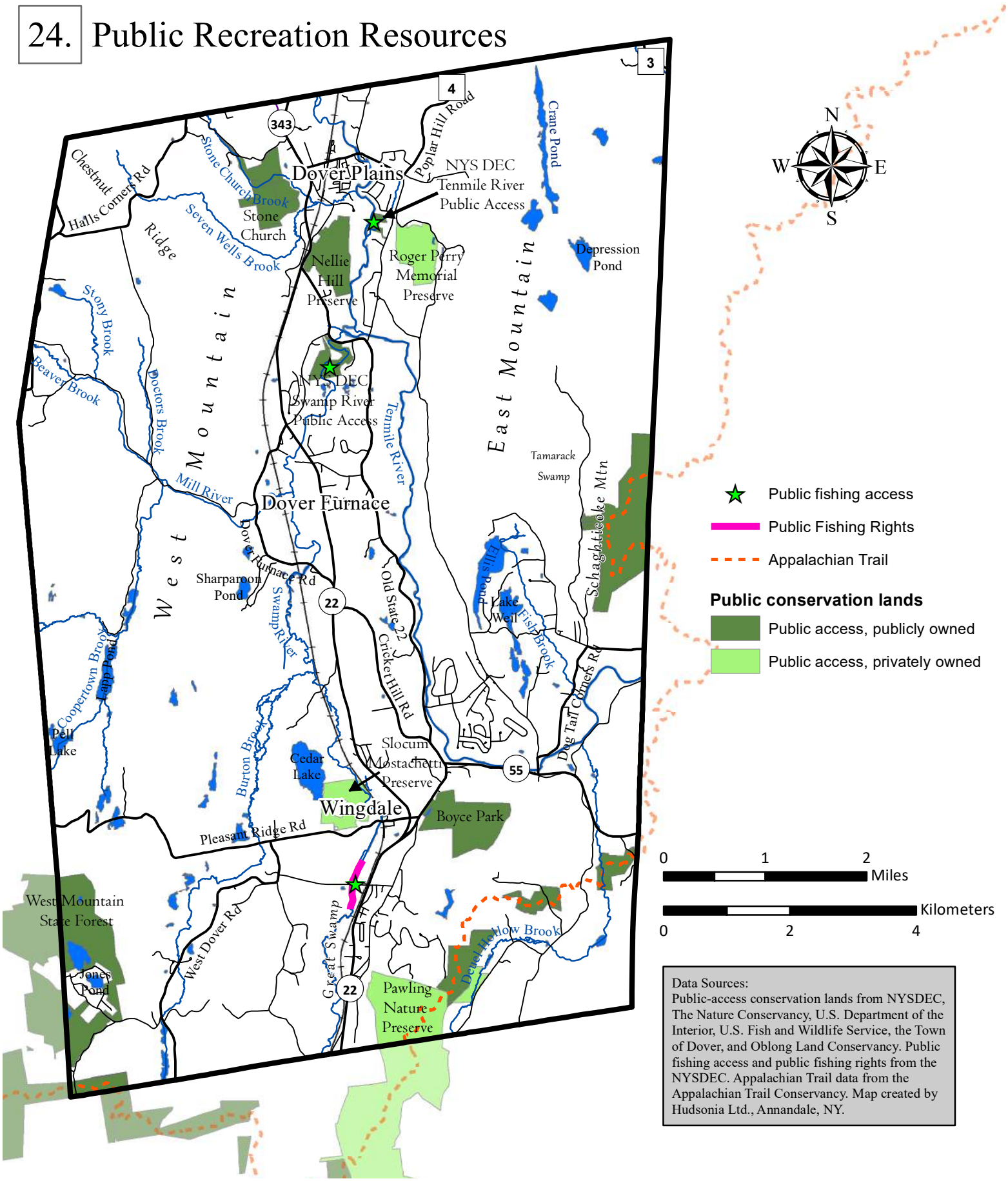


Figure 24. Public recreation resources in the Town of Dover, Dutchess County, New York. Dover Natural Resource Inventory, 2019.

Threats to Resources of Conservation Concern

Streams, ponds, wetlands, upland habitats, wildlife, and farmland are subject to numerous direct and indirect threats from human activities that include obvious threats such as polluted discharges to streams, or less obvious ones such as leachate from failing septic systems 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 insecticides. Climate change poses over-arching and wide-ranging threats to water supplies, agriculture, wildlife, and human health. A few of these threats are described below, and ways to reduce them or improve ecosystem resiliency are presented in the **Conservation Principles and Measures** section.

Climate Change

Global air temperatures have been increasing for the last century (Horton et al. 2011). Here in Dutchess County, springs arrive sooner, summers are hotter, fall frosts begin later, spring frosts end earlier, winters are warmer, and depth and duration of snow cover are reduced from those of past decades. The effects of climate change are likely to be felt more acutely in the coming years—larger and more frequent floods, higher temperatures, droughts, wildfires, and severe storms, as well as some less dramatic symptoms such as increases in invasive pests, and pathogens affecting humans, livestock, and wildlife, and depletion of native biological diversity (Rosenzweig et al. 2011).

Climate change is 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. The increased emissions are largely due to human activities such as production, transport, and burning of fossil fuels in power plants and automobiles, and by the cumulative effects of many other activities, such as burning of wood and other organic materials, and emissions from agriculture and industry. 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 increase at the current rate, these changes are likely to increase dramatically over the coming decades.

Recognizing the threats of climate change to infrastructure, farms, ecological communities, drinking water supplies, recreational opportunities, public health, the town economy, and livelihoods of town residents, the Dover Town Board signed the Climate Smart Communities Pledge in 2016, asserting the town's commitment to taking multiple actions to combat climate change and promote community resilience to climate change effects. The town established the Climate Smart Dover Task Force to take the lead in moving the town toward certification as a Climate Smart Community and

achieving eligibility for state-funded grants for projects to improve the town's climate resiliency. This *NRI* is part of that effort. More information about the Climate Smart Communities program is at https://www.dec.ny.gov/energy/50845.html, and updates on the work of the Task Force are at http://townofdoverny.us/ClimateSmart.cfm.

Much of the climate data in the discussion below is from the publication *Responding to Climate Change in New York State* (Rosenzweig et al. 2011)—called the ClimAID report, published by the NYS Energy Research and Development Agency (NYSERDA). 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) Fifth Assessment Report. Dutchess County is in the part of the state called ClimAID Region 5 that encompasses the Mohawk Valley region and towns east of the Hudson River in southeastern New York.

The Changing Local Climate

Large rainstorms and snowstorms, ice storms, heat waves, and droughts have long been characteristic of the Northeast, but overall climate patterns remained fairly consistent since European settlement until the latter part of the 20th century (Union of Concerned Scientists 2006). 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.

Rising Air Temperatures

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 increased 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 Dutchess County is projected to increase approximately 4-6°F by mid-century and as much as 11 degrees by the end of the century (Table 2).

Table 2. Air temperature projections for ClimAID Region 5 (includes Dutchess County), summarized by Zemaitis (2017) from the 2014 ClimAID report (Horton et al. 2014).

	Actual 1971-2000	Projected 2020s	Projected 2050s	Projected 2080s	Projected 2100
Annual average air temperature	50°F	52.3 – 53.2°F	54.5 – 56.2°F	55.6 – 59.7°F	56.1 – 61.4°F
Increase in annual average	-	2.3 – 3.2°F	4.5 – 5.2°F	5.6 – 9.7°F	6.1 – 11.4°F

Summer heat waves are expected to be more frequent, more intense, and lengthier. By 2100 the number of days with temperatures exceeding 90°F degrees in the county may be similar to those in South Carolina today. Even at the lowest projected rate of carbon emissions, Dutchess County summers by 2100 could be similar to those of northern North Carolina today. Severe heat waves pose problems for humans, livestock, food crops, and wildlife, and can be especially dangerous for the elderly, the sick, infants, and the poor who have no access to air conditioning or other means of staying cool.

Changing precipitation patterns

In the northeastern US, the total precipitation amount has increased only slightly in recent decades, but has become much more variable and more extreme. The amount of rain falling in heavy storm events increased 74% from 1958 to 2011. Precipitation patterns are difficult to predict, and the climate models are being continually refined on the basis of up-to-date regional data, but the current models predict that total annual precipitation could increase as much as 12% by 2050 and 21% by 2100 (Table 3). The models project more droughts, heavier rains in the intervening periods, and reduced snow cover in winter (Horton et al. 2011).

Table 3. Precipitation projections for the ClimAID Region 5 (includes Dutchess County), summarized by Zemaitis (2017) from the 2014 ClimAID report (Horton et al. 2014).

	Actual 1971-2000	Projected 2020s	Projected 2050s	Projected 2080s	Projected 2100
Total annual precipitation (inches)	51	52-54.5	53-57	53.5-58.5	53.5-61.5
Increase in annual precipitation	-	2-7%	4-12%	5-15%	5-21%
Number of days with precipitation >1 inch	10	14-15	14-16	15-17	*
Number of days with precipitation > 2 inches	1	3-4	4	4-5	*

* Projections not available

Drought

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, and plants and wildlife in natural upland and wetland habitats. Droughts can extend the low-flow period of streams, and further stress the fish and other organisms that are already suffering from pollution, warmer stream temperatures, and stream barriers. Drought may become a long-term concern for agriculture in Dover, and could threaten drinking water supplies. In the higher-emissions scenario, long-term droughts (longer than three months) that now occur every 20-30 years could occur every 6-10 years (Union of Concerned Scientists 2006).

Drought may become a long-term concern for agriculture in Dover, and could threaten local drinking water supplies.

Wetlands that have perennially saturated soils develop deep layers of peat—decaying organic matter—that continues to accumulate over hundreds and thousands of years if the wetland hydrology and vegetation remains intact. Due to this capability for peat accumulation, wetlands have the greatest capacity of any ecosystem for longterm carbon storage, and are believed to hold 20-30% or more of the total stored organic carbon in the Earth's soils (Mitsch 2016). 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.

Although intact (undisturbed) 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 (Mitsch 2016).

Below is a brief discussion of expected effects of climate change on human health; effects on water resources, ecosystems and agriculture are embedded in following sections.

Climate Change and Human Health

Climate-related health risks stem from heat events, extreme storms, disruptions of water supply and water quality, degraded air quality, changes in timing and intensity of pollen and mold seasons, and increased prevalence of infectious disease vectors and organisms. Expected health effects include increases in heat-related illness and death, respiratory disorders from exposure to increased air-borne allergens and air pollution, physical injuries from large flood events, and a range of infectious diseases (Kinney et al. 2011). The actual extent of these health effects is difficult to predict, as are the magnitudes of the various changing climate factors. People with pre-existing disease or otherwise compromised health may be among the most vulnerable to the impacts of climate change. Those with diseases such as asthma, cardiovascular diseases, or infectious diseases may be especially sensitive (Kinney et al. 2011).

Heat

Heat-related health effects may disproportionately affect the elderly, the poor, the sick, those with limited mobility and social contact, and those lacking access to public facilities and public transportation or otherwise lacking air conditioning. The combined effects of extreme temperature and air pollution are likely to increase the incidence of illness and death during heat waves (Cheng 2008). Cardiovascular disease—already the single greatest killer of New York State residents (Kinney et al. 2011)—can reduce a person's ability to regulate temperature in response to heat stress, so the predicted increases in summer temperatures and heat waves may pose particular risks to those with compromised cardiovascular systems.

Extreme temperatures and air pollution may increase the incidence of illness and death during heat waves.

Air pollution

Increasing temperatures and increasing frequency of stagnant air events are likely to produce more days with high ozone levels—a risk factor for respiratory irritation and damage. The risks are greater for people who work or exercise outdoors, for children, and for those with respiratory disease (Kinney et al. 2011). Breathing ozone can cause lung inflammation and decrease lung function, and has been found to increase asthma episodes and cause respiratory failure leading to death.

Airborne particulate matter originates from a variety of sources, but some of the most important sources are combustion of fuels by motor vehicles, furnaces and power plants, wildfires, and windblown dust. Particulates have been associated with premature deaths related to heart and lung diseases, and increased hospital visits for respiratory problems. The risk of wildfires increases with higher temperatures, reduced soil moisture, and extended periods of drought, and the fire-prone rocky hills of Dover could be especially vulnerable. Wildfires produce fine airborne particulates that can be carried long distances from the fire where they originate.

Changing patterns and timing of temperature and precipitation can alter the timing and intensity of allergy triggers such as pollens and molds. Warming temperatures and higher CO_2 levels may create extended pollen seasons, and spur greater pollen production and allergen potency in plants such as common ragweed (Ziska and Runion 2003). Warm temperatures and rising air moisture, especially after extreme storms, may also spur the growth of indoor and outdoor molds.

Pathogens

A warming climate and accompanying large rainstorms are likely to increase mosquito and tick populations along with the risk of diseases carried by those organisms. Many pathogens—such as those for Lyme disease, ehrlichiosis, West Nile virus, and malaria—have increased their geographic range in recent decades in part due to warming winter temperatures (Quarles 2017). Other infectious pathogens may also be climate-sensitive, including those spread by contaminated food and water (Kinney et al. 2011).

A warming climate and predicted large rainstorms may increase mosquito and tick populations, along with the risks of diseases carried by those organisms.

Even small increases in average temperatures can increase rates of population growth and average population densities of mosquitoes (Kinney et al. 2011). In addition, the biting rates of mosquitoes and the replication rates of the parasites and pathogens they transmit has been found to increase with increasing temperatures (Harvell et al. 2002).

Droughts may provide new breeding sites for mosquito larvae, and warmer temperatures will spur mosquito reproduction and the growth of mosquito-borne pathogens (Quarles 2017). These conditions may help to explain instances of malaria and expansion of the West Nile virus in New York. West Nile is carried by certain species of *Culex* mosquitoes and spread by birds and humans.

Droughts act to bring birds and mosquitoes together at reduced water sources, and also to reduce populations of dragonflies and other predators of mosquitoes (Epstein 2000, 2001). These phenomena together may hasten the spread of the virus. Warmer temperatures may also make this region hospitable to the *Aedes* mosquitoes that spread the Zika virus.

Ticks do not survive prolonged periods of very cold temperatures. Warming temperatures have been a significant factor in the northward spread of Lyme disease (Leighton et al. 2012) and the increased numbers of Lyme-infected ticks in the Northeast (Levi et al. 2015). Climate models predict that tick populations will continue to expand northward into areas now considered to be too cold to support them (Brownstein et al. 2005, Ogden et al. 2005). The flourishing populations of wood ticks and Lyme-infected black-legged ticks in Dutchess County have been aided by the warmer winter temperatures.

Mill River

Threats to Water Resources

Human activities on the land pose multiple threats to streams, lakes, ponds, wetlands, and groundwater through stream channelization, changes in surface water runoff, soil erosion, reduced groundwater infiltration, excessive withdrawals from surface or ground sources, and water contamination. Climate change is exacerbating some of these stresses and adding new ones.

Groundwater

Groundwater can be depleted by the expansion of impervious surfaces preventing groundwater replenishment, and by excessive groundwater withdrawals, e.g., for industrial processes, commercial products, or from spatially crowded wells in residential areas. Groundwater depletion could become a more common problem in Dover with the increasing frequency and severity of droughts predicted by climate scientists.

Groundwater is vulnerable to point and non-point source pollution from fertilizers and pesticides applied to farm fields and lawns, nitrates, phosphate, and bacteria from septic systems, deicing salts from roads and driveways, and volatile 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) or carbonate bedrock (limestone, dolostone, marble) as in Dover's Harlem Valley.

A small volume of a harmful substance can contaminate a large volume of groundwater, and can be very difficult and costly to clean up.

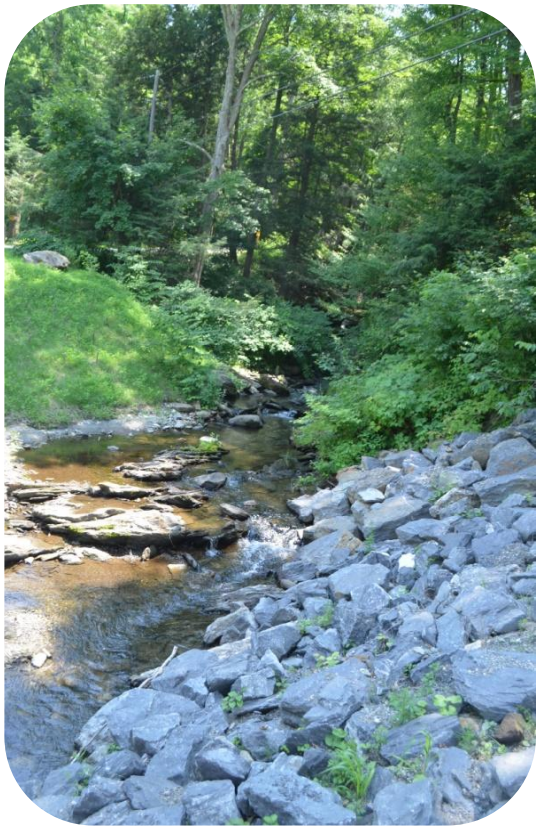
The most significant potential sources of groundwater contamination in Dover are from wastewater discharges (e.g., from crowded, failing, or institutional septic systems), agricultural applications of fertilizers and pesticides, de-icing salts applied to roads and driveways, and leaking fuel storage tanks (Urban-Mead 1997, Winkley 2009). 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. For these reasons, and because most Dover residents and businesses obtain their drinking water from groundwater wells, the quality and quantity of groundwater should be of paramount concern to residents and town agencies. Recent (2017) water testing of the major public water systems in Dover has shown no significant contamination (see discussion the **Water Resources** section). There is no public record, however, of the water quality of individual drinking water wells, which are tested only on the initiatives of individual landowners.

Surface Water

Increasing impervious surfaces (roads, driveways, parking lots, and roofs) usually increases surface runoff of rainwater and snowmelt unless special measures are taken to promote onsite infiltration to the soils. Excessive surface runoff leads to erosion of stream banks, siltation of stream bottoms, and degradation of stream habitat quality and water quality. Impervious surfaces also reduce groundwater infiltration which then reduces the groundwater available to support the base flows of streams. Runoff from impervious surfaces can also raise the water temperature of streams, leading to reduced 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 increases the surface runoff with similar consequences. Stormwater management measures 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. Recognizing this problem, the Dover town code requires that, for any project undergoing site plan review, the peak rate of surface water runoff not exceed that of predevelopment conditions.

Fertilizers and pesticides applied to farm fields, golf courses, lawns, and gardens can degrade the water quality of groundwater, streams, and ponds.

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, golf courses, 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 the water chemistry, biota, and whole aquatic ecosystem. Cunningham et al. (2009) found that the amount of nutrients and sediments entering a stream is especially affected by amount of development within 300 ft of the stream. 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 Mid-West, and nitrogen compounds from distant agriculture (Driscoll et al. 2001).



Riprap along a Dover stream.

Removal of shade-providing vegetation along a stream or pond-shore for landscaping or other purposes can lead to elevated water temperatures and 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. Although the incremental harm from each new development site may seem minor, the cumulative effects of multiple such sites in a watershed can be significant (NYSDEC 2008).

Forested land is very effective at facilitating the infiltration of rainwater and snowmelt to the soils, thus making it available for uptake by vegetation, for recharging the groundwater, and for slowly feeding streams, lakes, and ponds. Clearing of forests can greatly reduce the infiltration to the soils, and greatly 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.

Although large wetlands and those connected to perennial streams receive some legal protection from the state or federal government, many of the town's small streams and hydrologically-isolated wetlands lack legal protection, and are subject to filling, draining, or excavation (e.g., for ponds). Wetlands are also sensitive to many of the same threats as streams, such as changes in surface water runoff from the expansion of impervious surfaces, and contamination carried by runoff. Adoption of local wetland and watercourse legislation may be the only way to extend legal protection to these important and vulnerable habitats. (See the **Legislative Protections** section below for more discussion.)

> Adoption of local wetland legislation may be the only way to extend legal protection to the many wetlands and streams that remain unprotected by state and federal laws.

A warming climate is expected to affect both the quantity and quality of Dover's groundwater and surface water resources. Both total annual rainfall and rainstorm intensity are predicted to increase in the coming years, with multiple consequences to the land, water resources, and agriculture. More extended and more frequent droughts are also predicted, and are likely to affect agricultural crops, farm ponds for watering livestock, public water supplies, and private drinking water wells (Shaw et al. 2011), as well as streams, other natural habitats, and native plants and animals.

Flooding hazards may increase due to the increased intensity and frequency of large rainstorms. The areas within the 100-year and 500-year flood zones illustrated in Figure 11a will be particularly at risk, but additional areas may also be affected. 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 floodflows.

The FEMA flood maps for this region were updated in 2012, but may underestimate the flood zones of future large storms. Large floods can damage roads, bridges, and other infrastructure, destroy agricultural crops, wash away farmland soil, carry pollutants and large volumes of sediments into streams, and damage or destroy buildings and other structures in the flood zone.

The Dutchess County Hazard Mitigation Plan (February 2016) lists several facilities in Dover that are within the FEMA-designated 100-year or 500-year flood zones: the Harlem Valley Wastewater Pump station, the Wingdale Rail Station, and the Regan's Mill Wastewater Treatment Plant (in the 100-year flood zone), and the Crystal House Manor, the Dover Plains Post Office, and the NDP St. 3 fire station (in the 500-year flood zone.)

Threats to Biological Resources

Plants, animals, habitats, and ecosystems are highly dependent on streams, lakes, ponds, wetlands, and groundwater, so are also vulnerable to many of the threats to water resources outlined above. Other threats include loss and degradation of habitats, over-harvesting, non-native pests, and new diseases, along with the multiple and complex effects of climate change.

Loss of habitat occurs when new residential, commercial, or industrial development eliminates former meadow or forest habitat, for example, or unprotected wetlands are drained, filled, or converted to ornamental ponds. Although local, state, and federal laws provide limited protection to certain wetlands and streams and the habitats of listed rare animal species, most upland habitats and many small wetlands lack legal protection and are susceptible 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 extinction of particular species or habitats are unknown, but each organism plays a particular role in maintaining its biological community. The maintenance of each community at the regional scale enables ecosystems to withstand stresses and adapt to changing environmental conditions.

Less obvious but more insidious than habitat *loss* is the problem of habitat *degradation*, which can occur by many mechanisms with consequences that are often invisible in the near term. A ubiquitous form of degradation is habitat fragmentation.

Habitat Fragmentation

Habitat fragmentation occurs when an intact habitat area is cut by a road, driveway, utility corridor, or other feature that divides the habitat patch into smaller segments. The subdivision of a large meadow or a large forest into building lots, for example, creates smaller habitat blocks that may be unsuitable for area-sensitive wildlife that require large habitat areas, are sensitive to the altered environmental conditions at habitat edges, or sensitive to human contact or disturbances.

Fragmentation of forests into smaller blocks, for example, increases the area of forest "edge" habitat with higher light and noise levels, and often facilitates incursion by non-native plant species and by predators such as raccoons and domestic cats. Fragmentation makes the (formerly) deep interior forest areas newly accessible to nest 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.

> Forest "edge" habitat has higher light and noise levels, and often facilitates incursions by non-native invasive plants and by nest-predators and brood parasites.

The "edge effects" of human disturbance (from roads, residential areas, and other development) can reach well over 300 feet into forest patches (Glennon and Kretser 2005). 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 habitats inhibits the ability of wildlife to move across the landscape, and may render critical parts of their habitats inaccessible, or expose the animals to mortality

This style of development with long driveways to single houses in a forested setting is emblematic of rural sprawl and forest fragmentation.

from vehicles, predation, or dessication. Similarly, a dam or a suspended culvert fragments the stream such that the movement of stream organisms is obstructed and the aquatic communities upstream and downstream of the obstruction are profoundly altered.

On a longer time scale, maintaining habitat connectivity is critical for maintaining genetic exchange among distant populations and facilitating the migration of species under deteriorating environmental conditions. Many species that *are* able to cross human-created barriers (such as roads) then face greater mortality risk from vehicles and predators. Populations of species that are unable to cross barriers such as roads, walls, or culverts, and thus become restricted to fragmented habitat patches, may become genetically isolated and face local extinction. 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.

Maintaining broad connections between habitat areas can help ensure that the habitat and migration needs of many native plants and wildlife are protected.

The brown-headed cowbird is a particular threat to some of our forest songbirds. The cowbird is a native blackbird that 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 landscapes and forest edges, and the new edges created in previously forested areas by roads, driveways, yards, and utility corridors allows the cowbird to gain access to bird nests in forest areas that were previously inaccessible. The cowbird has been implicated in the decline of many songbird species in the Northeast.

These days, the primary threat of habitat fragmentation in Dover comes from rural sprawl—unplanned, low-density development that occurs outside of population centers such as hamlets or villages. In recent years, new development has been mainly in the form of new houses on single lots instead of large residential subdivisions of 10, 20, or more lots. The fragmentation of habitats is most severe when a lot is designed with the house located at the end of a long driveway that fragments a large forest or meadow. Utility corridors, roads, and even walking trails can have a similar fragmenting effect when located in an otherwise intact habitat area.

Breaking up forests and meadows into smaller units also reduces the potential for forestry or agricultural uses, and might then increase the likelihood of further land subdivision, once the opportunity for economic gain from the working landscape is lost.

Other Threats to Habitats

Forest habitats can be degraded in many ways besides fragmentation. Clearing the forest understory destroys habitat for birds such as wood thrush,† which nests in dense understory vegetation, and black-and-white warbler† and ovenbird,† which nest on the forest floor. Removal of mature and especially overmature (large) trees eliminates habitat for lichens, fungi, and bryophytes, as well as the many kinds of animals that use cavities or forage in and around large and decaying trees.

Clearing the forest understory destroys habitat for birds that nest in dense understory vegetation or on the forest floor.

Logging can damage the forest understory and cause erosion, compaction, and rutting of soils, and siltation 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.

Soil compaction and removal of dead and downed wood and debris eliminates habitat for mosses, lichens, fungi, birds, amphibians, reptiles, small mammals, and insects. Human habitation in fire-prone forests leads to the suppression of the naturally occurring wildfires, which can be important for some forest species and the forest ecosystem as a whole.

Crest, ledge, and talus habitats are threatened by recreational uses, and construction of houses, communication towers, and other structures. The reptiles of conservation concern that use some of these habitats are also threatened by destruction of surrounding forests, and construction of houses, roads, and driveways nearby. Rare plants may be trampled or collected; rare snakes may be harassed, killed, or collected; and nesting of rare birds may be disrupted. Fire suppression around rocky barrens can lead to the loss of special barrens communities that are especially adapted to episodic wildfires.

Fens are especially sensitive to water quality degradation in the springs, seeps, and overland runoff feeding the fen. Water contaminated with excessive nutrients (as from fertilizer-laden runoff) can spur the growth of tall, lush vegetation which may displace the rare plants and animals of fens. Although fens are resilient to light grazing by livestock, they are sensitive to overgrazing and trampling, which can destroy rare plants, harm the delicate soil structure, and make the habitat unsuitable and unsafe for some of the fen animals of conservation concern.

Removal of trees or other shade-producing vegetation along a stream can lead to elevated water termperatures that adversely affect aquatic invertebrate and fish communities. Clearing of vegetation in and near floodplains can reduce the important exchange of nutrients and organic materials between the stream and the floodplain, and reduce the amount and quality of organic detritus available to support the aquatic food web. It can also diminish the floodplain's capacity for flood attenuation, leading to increased flooding downstream, scouring and bank erosion, and

siltation of downstream reaches. Hardening of the stream banks with concrete, riprap, gabions, or other materials reduces the biological and physical interactions between the stream and floodplain, and tends to be harmful to both stream and floodplain habitats. Removal of snags (fallen trees or logs) from the streambed degrades habitat for fishes, turtles, snakes, birds, muskrats, and stream invertebrates.

Wetlands of all kinds can be damaged by direct disturbance and by alterations of the quality or volumes of water feeding them from overland or groundwater sources. Excessive nutrients can alter the plant community and vegetation structure of a wetland, which can profoundly affect the suitability for plants and for wildlife. Disruptions to the surrounding upland habitats can also be harmful if they introduce barriers or hazards for migrating wildlife or interfere with the exchange of organisms or organic material between upland and wetland areas.

Red efts, the juvenile stage of the eastern newt, live in upland forests for two or more years before moving into permanent water as an adult. Extended droughts can be harmful to these and other animals of the forest floor. Chris Graham © 2019

Climate Change and Ecosystems

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 experienced during the most recent ice age (Wolfe et al. 2011). The widespread fragmentation of today's landscape by roads and land development poses additional obstacles to adaption and migration.

While floods and droughts are normal and expected events in this region, extreme floods and droughts can add to the multiple stresses on ecosystems from human activities. The predicted extreme floods and severe droughts as well as increases in water temperatures with climate change are likely to adversely impact populations of trout and other sensitive stream organisms that rely on cool, clear streams and unsilted stream substrates. 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 overharvesting, climate change may have synergistic effects that magnify the stresses and hazards to wildlife (Hannah et al. 2005).

Goslings at the Great Swamp. Ken Luhman © 2019

Already, many plant species now bloom 4-8 days earlier on average than in the early 1970s (Union of Concerned Scientists 2006), and 2-3 weeks earlier than they did a century ago (Ellwood et al. 2013)—an effect that may have far-reaching ecological consequences. For example, insect pollinators whose activity periods are closely tied to the particular 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 and the native plants and agricultural crops that they benefit.

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 (Wolfe et al. 2011). Reduced snow cover will harm small mammals and other animals that depend on snow for insulation and protection from predators, but may favor white-tailed deer—already over-abundant—whose intense browsing and grazing pressure has been transforming our forests for several 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 (Wolfe et al. 2011).

Non-native Invasive Species, Insect Pests, and New Diseases

Disturbances to soils from forest clearing, mining, and 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, mile-a-minute, Japanese knotweed, purple loosestrife, multiflora rose, Bell's honeysuckle, Japanese barberry, and tree-of-heaven are now widespread in Dover, but are concentrated in areas in and near human land development and disturbance. Sticky sage (*Salvia glutinosa*), an uncommon invasive, has spread along the Dover segment of the Appalachian Trail. These non-native plants often lack significant predators or diseases that might keep them in check in their new environments, and can often outcompete native species for limited nutrients, sunlight, or space, resulting in the decline of native biodiversity, including the many rare plant species for which Dover is renowned. 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. Elevated atmospheric levels of carbon dioxide associated with climate change is also expected to favor many of the non-native invasive plants in this region (Wolfe et al. 2011).

Shorter, warmer winters and longer, hotter summers have been aiding the spread of pathogens and invasive non-native species, and this is expected to continue with the warming climate. Forest pests such as the hemlock woolly adelgid and the emerald ash borer—both are present in Dover—are likely to transform our forest communities with wide-ranging ecosystem consequences. Pathogens that are encouraged by less-severe winters will also take advantage of the weakened condition of trees and other plants stressed by rising temperatures and droughts. The advance of the hemlock woolly adelgid and emerald ash borer, apparently hastened by the warming climate, promises to

decimate our eastern hemlock and white, green, and black ash trees, greatly altering the forest communities of Dover and other parts of southeastern New York. The pear thrip, an insect native to Europe, attacks domestic (pear, apple, plum, cherry) and native (serviceberry, black cherry) fruit trees, and also native forest trees such as sugar maple, red maple, and American beech. A large outbreak can defoliate thousands of acres of forest, and can be triggered by warm, dry springs associated with climate change (Natural Resources Canada 2015). These are just a few of the climate-related stresses that may transform Dover forests in the coming decades.

Most of the worms in our lawns, gardens, meadows, and forests are non-native species imported intentionally and accidentally 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 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.

Although non-native earthworms are highly valued by farmers and gardeners because of their ability to aerate soils and speed up nutrient cycling, those worms can damage the soils, soil life, and plant communities of forests. Earthworm infestations can remove the forest duff, alter the soil structure and chemistry, and create conditions inviting to non-native plants and harmful to native trees, shrubs, and wildflowers (see discussion in the **Biological Resources/Habitats** section, above).

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 provide "resource subsidies" unintentionally 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, barns, and other structures), as well as intentionally by our feeding of 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, and can have negative effects on other animals and humans.

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 agricultural, 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 reduce populations of bobcat and red fox,

and sometimes prey on livestock. They are valuable as the only non-human predator that regularly preys on deer, and they help control deer populations where winter weather is severe (Ray 2000).

Among the important ecological roles of the eastern coyote is its assistance with controlling white-tailed deer populations.

Raccoon populations have expanded rapidly in the Northeast since the 1930s, and often achieve the highest densities in urban and suburban areas, but raccoons also thrive in rural residential and agricultural settings. They cause considerable agricultural damage, and are a commonly-reported nuisance in residential areas; they also 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. These three species are among the "human-subsidized predators" that thrive around human settlements and have large ecological influences on populations of their prey species and of other carnivores (Ray 2000).

Many of the wildlife that become abundant in our residential and agricultural landscapes are "generalist scavengers" that are also predators of songbird nests. These include 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 (Rodewald et al. 2011).

Raccoons, skunks, and domestic and feral cats and dogs are among the "human-subsidized predators" that pose serious threats to wildlife.

Domestic cats and dogs, whether feral or pets with access to the outdoors, pose serious threats to wildlife. Cats kill up to 4 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 (Twardek et al. 2017).

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 bears leads to more frequent aggressive encounters and the need to remove problem individuals (Cox and Gaston 2018).

Permanent loss of the wolf and cougar has had devastating effects on the ecology of Northeastern landscapes.

The white-tailed deer is native to this region and 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 causes of the over-population are many: extirpation of major predators—eastern wolf and eastern cougar; abundant food sources in our cropfields, roadsides, lawns, and gardens; decline of recreational and subsistence deer hunting; and expansion of human-settled areas where deer are relatively safe 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 (Rawinski 2008). Deer herbivory on native understory herbs and shrubs (and perhaps other 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 (Eschtruth and Battles 2009; Blossey and Gorchov 2017).

Selective browsing by deer prevents the regeneration of many native trees, shrubs, and wildflowers of our forests.

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 (Waller and Alverson 1997). 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 (Jirinec et al. 2017). Deer also cause agricultural losses ($59 million in New York in 2002), collisions with vehicles (over 70,000 in New York in 2011), and damage to home gardens and landscaping (NYSDEC 2011).

Today the population of white-tailed deer is at a pestilential level in Dutchess County and much of southeastern New York, 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.

Overharvesting

The region has a long history of overfishing, overhunting, and over-gathering which, at times, has imperiled or extinguished populations of certain species, and has dramatically altered the ecology of the region. Beaver were trapped to extinction in southeastern New York 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 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—even to pestilential levels. Some of the wild turkeys from Pennsylvania that later repopulated areas of western New York, were captured and transplanted in the 1950s-60s by the NYSDEC to restore populations throughout the state. The wild turkey population in Dutchess County is now large and apparently thriving. Beaver have since returned and the regional population may be secure for the time being. But 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.

Overcollecting of certain wildflowers led to statewide restrictions on collecting "Exploitably Vulnerable" plants without landowner permission. Overharvesting of ramps (wild leek) and American ginseng continues to deplete local populations in the region, however, and overharvesting of edible mushrooms and fiddleheads may have similar local effects.

Collecting of rare species of plants and animals has long been of concern to the NYSDEC and the New York Natural Heritage Program. It is illegal to collect 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 survive.

Threats to Particular Species of Conservation Concern

Dover is home to an extraordinary array of rare plants and animals due to the unusual confluence of geology, topography, climate, and land use history. Most of these rare species have highly-specialized habitat requirements, and disturbances to those habitats can lead to the decline or local disappearance of the species.

For example, the critical habitat of the bog turtle† (NYS Endangered) is a fen—an unusual kind of wetland with calcareous groundwater seepage and a distinctive plant community. Excessive nutrients, as from fertilizer-laden runoff, or alterations of the groundwater quality or quantity, can alter the species composition and structure of the plant community to the degree that the fen can no longer support the turtle. These disturbances along with overgrazing or trampling by livestock may have contributed to the rarity of the bog turtle today.

The timber rattlesnake† (NYS Threatened) uses rocky crest and ledge habitats for basking, breeding, and overwintering, and travels widely from those places to forage in forests and meadows. The

snake is vulnerable to mortality from vehicles and equipment on roads, construction sites, golf courses, and lawns, as well as harassment, intentional killing, and collection by humans. The best way to keep a rattlesnake population safe is to keep its habitat areas separated from human activity as much as possible.

The New England cottontail† (NYS Species of Special Concern) requires dense shrub thickets and young forests with dense, shrubby understories. Its habitat requirements are much more specialized than those of the eastern cottontail—the more common species. The decline of the New England cottontail has been attributed to loss of suitable habitat and perhaps competition with the eastern cottontail. Shrublands are typically an ephemeral habitat, on their way to becoming forests unless human management or natural events such as fire intervene.

Bats are threatened by the white-nose syndrome, declining insect populations, and loss of summer roosting habitats.

Of the nine species of bats known or likely to occur in Dover, seven are listed as NYS Species of Greatest Conservation Need. The populations of many of the cave-dwelling bats have been devastated by the white-nose syndrome, and they are further threatened by human disturbance of their winter caves. In the warm months, most of our bat species roost in dead or live trees under loose bark, and in or on buildings or other built structures, and forage in a variety of habitats, especially over meadows, over open water, and along forested stream corridors. In summer they are threatened by loss of roosting habitat, degradation of foraging habitat, and applications of pesticides that affect the populations of flying insects—the bats' primary food.

Many of Dover's streams are still cool and clean enough to support trout (figures 9, 16, 17b), but trout streams are a disappearing resource in the region due to water pollution, streambed siltation, removal of forest canopies in the stream corridors, altered stream flows, suspended culverts, and other effects of human activities. The degradation of streams coincides with the decline of wild-reproducing populations of brook trout† and other organisms of high-quality coldwater streams. The Floodplain Overlay and Stream Corridor Overlay districts in Dover's zoning ordinance, which restrict certain kinds of construction in the floodplain and require site plan reviews for other development proposals, can help to protect the ecological integrity of streams.

Many of Dover's rare plants are in calcareous upland and wetland habitats, but some are elsewhere in the forests, ledges, and woodland pools of the eastern and western hills. Some are on land open to public uses, and others on private lands remote from intensive human activity. Rare plants are threatened by trampling by humans or livestock, grazing by livestock or white-tailed deer, competition from non-native plants, destruction by mowing, logging, or construction equipment, and collecting by humans. Some may also be harmed by weather extremes, pollinator asynchrony, and other effects of climate change.

Threats to Farmland and Agriculture

Loss of Farmland and Active Farms

Farmland is sometimes abandoned by farmers 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 re-clearing a shrubland or forest is labor-intensive. Farmland is lost permanently, however, if the soils are excavated or if the land is fragmented and developed with structures, pavement, roads, and driveways. Protecting the areas with good farmland soils is a fundamental requirement for maintaining the potential for viable local agriculture and its benefits for Dover's economy, food security, and scenic vistas, and human connection to the land.

Agricultural land is often lost to developed uses both because of the financial needs of struggling or retiring farmers, and because the land is easy to convert to non-agricultural uses because it is often flat or gently sloped, well-drained, and cleared of woody vegetation.

Subdivision of large farmland parcels into smaller lots poses another threat to the viability of land for farming. Small parcels create too many inefficiencies for practical farm operations for certain kinds of agriculture.

Even where conservation organizations have succeeded in acquiring conserva-tion easements or development rights on important farmland parcels, keeping farms in active agriculture can be a major challenge. Farmland protection must go beyond open space protection to address access and affordability of farmland, and maintenance of opportu-nities for farming on protected agricultural lands. Some initiatives of the Dutchess Land Conservancy and partner organizations in the region to address this problem are described in the **Conservation Principles and Measures** section.

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 their resistance to herbicides (Ziska and Runion 2003). 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 (Klinedinst et al. 1993).

Warmer temperatures will be harmful to many crops and livestock that are adapted to cool climates.

Increased frequency of summer droughts will stress many crops, and increased frequency of large rainstorms and flood events will lead to direct losses of crops, soils, and nutrients, and to 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 (Wolfe et al. 2011). 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.

Rising winter temperatures are already allowing the northward expansion of agricultural pests that reduce crop production.

Perennial fruit crops are affected by the climate year-round, and the stresses experienced in one growing season can affect growth and productivity for two or more years afterward. While apple trees may benefit from longer growing seasons and increased atmospheric CO_2, 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. 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.

Although longer growing seasons may increase overall forest productivity (Kareiva and Ruckelshaus 2013), increases in pests and pathogens may cancel out the potential benefits to the timber industry. 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 (Wolfe et al. 2011).

Impacts of Recreation

Outdoor recreation is of great value to the residents, visitors, and businesses of Dover, and maintaining and expanding opportunities for public recreation is a goal shared by many. Outdoor recreation can increase our understanding and appreciation of the natural world; improve our physical and mental health; promote family and community bonding; and contribute in many ways to the local economy.

The goals of land management for recreation and for biodiversity conservation are sometimes but not always compatible, however, and the use of natural areas for recreation inevitably comes with environmental costs. Many of these can be anticipated by land managers, however, and mitigated by appropriate planning, design, and management techniques.

Trails for biking, ATVs, snowmobiling, 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 (e.g., for grassland and forest birds near heavily used trails), eventually skewing natural communities in favor of disturbance-tolerant species (Marion et al. 2015). Trampling and vehicle use cause damage to vegetation, reduced organic duff, and 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 nest parasites into the forest interior. Walking trails located near the forest edge instead of the interior cause 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. Artificial night lighting can disorient, repel, attract, entrap, or kill a wide range of organisms including moths, other insects, birds, frogs, and fish, and can also reduce reproductive success (birds, amphibians) and disrupt communication (fireflies, eastern coyote), bird migration, and predator-prey relationships (Longcore and Rich 2004). 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 (well

below ATV/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 (Shannon et al. 2016).

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 (e.g., acidic bogs) or easily-disturbed species of conservation concern (e.g., nesting raptors or great blue heron). In general, a trail represents a linear corridor of disturbance. The "area of influence" in the vicinity of the trail may extend 300-1000 ft or more from trails in open areas, and shorter distances in forest (Taylor and Knight 2003). 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. For some animals such as raptors, however, 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. Lead-free bullets and fishing tackle are available but still not widely used in most parts of the US. (Haig et al. 2014).

Lead bullets fragment on impact, resulting in an average of 235 fragments in an animal carcass and 170 in the viscera.

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 and declines in aquatic plant richness. 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) (Venohr et al. 2018).

Motorized watercraft use and shoreline development cause by far the greatest problems for the water quality and ecological integrity of rivers and lakes. Engine noise, wave action, suspension of sediment, spilled and leaked fuel and engine oil, and destruction of aquatic vegetation can pollute water, change behavior and communication in fishes, kill fishes and turtles, disrupt bird nesting, and disperse invasive species—resulting in the disruption of food webs and a decline in diversity of plants and animals (Venohr et al. 2018). Land development or other significant disturbance to the riparian or shoreline buffer 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 and agricultural fields often lead to overabundant algae and aquatic weeds in lakes and ponds, which can be nuisances for recreation and harmful to the pond ecology.

Motorized watercraft and shoreline development cause the greatest problems for water quality and ecological integrity of lakes.

Opportunities for public recreation are among the natural resource assets most highly valued by Dover residents and visitors. The conservation challenge is how to protect habitats, natural communities, wildlife, and water quality while maintaining, improving, and expanding the recreation opportunities. While the risks are serious, careful planning, monitoring, and remediation can help to manage them.

Stewardship efforts can be aided by planning for economic development that is dependent on natural resources and ties local livelihoods directly to the health of the ecosystem. Planned revisions to Dover's Master Plan seek to concentrate non-resource-based economic development in dense development corridors, and enhance protections of sensitive areas. In these ways economic development that is tied to intact resources can be promoted in the right areas—and in the right ways. (Some ideas for expanding recreation opportunities while protecting the resources are described in the **Conservation Principles and Measures** section.)

All actions to reduce greenhouse gas emissions will help to slow the warming of the planet.

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. The following section outlines some of the basic conservation principles that can be applied throughout Dover, and specific measures that can be employed by individual landowners, land developers, and municipal agencies.

Conservation Principles and Measures

Many of the factors associated with stewardship of natural resources are closely interrelated. This section outlines some of the basic principles and measures 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 or small—in private or public ownership, and others relate to townwide or regionwide land use planning and policy.

Examples of policies, procedures, and legislation to implement these measures are in the **Legislative Protections** section, and a recommended Action Plan for town agencies and commissions is in the **Achieving Conservation Goals** section, below.

Conservation of Enduring Features

The enduring features of the Town of Dover—the bedrock, surficial materials, hills, and valleys—are the foundations upon which our streams, ponds, marshes, forests, meadows, and other habitats have developed. They help to define the character of the soils, the water, the habitats, and the natural communities of the town, and constitute some of the extractable resources such as marble, schist, sand, and gravel.

Protecting representative intact (undeveloped) areas of these features connected across the landscape will help preserve a host of natural communities, interactions, and ecological services. In the course of planning for conservation and sustainable uses of other natural resources (habitats, water, farmland, scenic areas, etc.), enduring features can be layered with other factors to help identify areas of greatest conservation importance. For example, Dover has only small areas of bedrock mapped as graywacke or mélange (Figure 5), and limited areas of kame deposits. When helping an applicant plan a residential subdivision, or helping a landowner design a conservation easement in those areas, those features could be considered along with other constraints such as significant habitats, aquifers, wetlands, and offsite habitat connectivity to decide where to locate new developed features, and which areas to leave alone.

General Measures for Conservation of Enduring Features

- Protect enduring features that are unusual or in especially good condition.
- Confer formal conservation status on lands representing the full range of elevations in the town, including areas in the Harlem Valley and on the slopes and summits of East, West, and Schaghticoke mountains.
- Protect areas representing all the types of bedrock and surficial geology in the town; for example, the quartzite, conglomerate, gneiss, and metasedimentary rock of East Mountain, the schist, slate, and phyllite of West Mountain, and the marble of the Harlem Valley.
- Protect representatives of intact (undeveloped) areas of all the significant landforms in the town—mountains, hillsides, valleys, ravines, caves.
- Protect broad landscape connections between protected areas wherever possible.

Conservation of Water Resources

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 may be the best insurance for maintaining flow volumes, temperatures, water quality, bank stability, and habitat quality in streams and ponds. Springs and seeps in the watershed are also key to maintaining the cool stream temperatures that are critical to sensitive stream invertebrates, fishes, and amphibians.

A storm of a severity that was once considered to be a 1 in 100 years event is now likely to occur almost twice as often—i.e., once every 50 years.

Groundwater

While groundwater throughout the town is of conservation concern, the valley bottom aquifer deserves particular attention as it is the largest and most accessible potential water source for well withdrawals, and is also the most vulnerable to contamination. The aquifer is located in permeable glacial deposits (sands and gravels) and fractured carbonate rock that can be efficient conduits for contaminants introduced by above-ground human activities. Ensuring ample surface water infiltration to the soils, and avoiding contamination in these most vulnerable land areas overlying the aquifer is of particular importance for the residents and businesses of the routes 22 and 55 corridor.

Quantity and quality of groundwater will best be protected by maintaining forested landscapes wherever possible, using agricultural fertilizers judiciously, reducing or avoiding use of pesticides and other toxins as much as possible, and carefully designing stormwater management systems to reduce surface runoff and ensure that ample volumes of precipitation and snowmelt infiltrate the soils. To protect the groundwater quality, land uses with higher risk for soil or water contamination should be steered away from the aquifer areas wherever possible.

In anticipation of prolonged droughts, the town could establish water conservation programs to harvest rainwater for domestic, agricultural, and business uses, and increase water usage efficiency. The programs could include acquisition of key land parcels in the vicinity of the valley bottom aquifer, use of green infrastructure where appropriate, minimization of impervious surfaces, and stormwater management policies that require onsite infiltration of rainwater and snowmelt to match pre-development conditions. Urban-Mead (1997) recommended establishing a program for long-

term monitoring of groundwater and surface water quality to provide baseline data on long-term quality trends, and to alert the town to emerging contaminants.

Streams and Floodplains

We have experienced increasing frequency and intensity of extreme storm events in this region, and climate scientists predict the trend to continue in response to a warming climate. A storm of a severity 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. Likewise, 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 (NRCC and NRCS 2015). 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 revetment) and full connectivity between streams and their floodplains allows floodwaters to spread out and thus dampens downstream floodflows, and reduces downstream bank erosion and potential flood damage to property and infrastructure. It also allows movement of animals between stream and floodplain habitats, and allows 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 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 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.

Insurance premium discounts are available to communities with floodplain management programs that exceed FEMA standards.

Dover's local code designates a Stream Corridor Overlay District that covers the area within 150 ft of NYS-classified streams. An erosion and sediment control permit is required for any projects requiring a special permit, site plan review, or subdivision approval and involving more than 10,000 square feet of disturbance that is partially within the Stream Corridor zone. Within that zone, the code requires that measures for erosion and sedimentation controls be installed and maintained, and that site preparation and construction not adversely affect the free flow of water by encroaching on, blocking, or restricting watercourses. The code also requires that construction of any structure within the overlay district with a footprint of 500 square feet or larger undergo site plan review. Site plan approval requires that "[d]rainage of the site shall recharge groundwater to the extent practical" and that "[t]he peak rate of surface water flowing off site shall not increase above predevelopment conditions and shall not adversely affect drainage on adjacent properties or public roads" (Sect. 145-65/D/5(c). The Stream Corridor Overlay District, however, includes only state-classified streams, so many of Dover's streams are still unprotected.

The Flood Damage Prevention section of the Dover zoning ordinance (Chapter 81) regulates activities within the "areas of special flood hazard" which is equivalent to the FEMA-designated 100-year flood zone. Within these areas, any new construction, excavation, or filling, or alterations to existing structures, must comply with certain specifications designed to keep structures safe from flood damage, and prevent obstruction or alteration of flood flows.

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 and marble bedrock, 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.
- 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.
- 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 and toxins.
- 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.
- 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; 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 uses to ensure that water withdrawals from groundwater or surface water sources are at sustainable levels.

Conservation of Biological Resources

Protecting large intact habitat areas will help to protect the habitats of area-sensitive wildlife species that require large habitat patches to fulfill their life history needs, and will also protect the array of natural communities in each area, even those of which we are yet unaware. Protecting high-quality representatives of all ecologically significant habitats or communities (such as rocky barrens, calcareous and acidic 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.

> Protecting large contiguous areas representing all elevational gradients and significant landforms may be the best way to ensure resiliency to the effects of climate change.

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 seek to maximize the connectivity of intact habitat areas. This approach will help to maintain and protect important biodiversity elements in the present, and will provide the greatest opportunities for adaptations and safe migration of wildlife and plants to suitable habitats in a rapidly changing environment.

Protecting habitats and habitat complexes critical to particular plant and animal species of conservation concern will provide 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 (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 the timber rattlesnake,† contiguous habitats within a two-mile radius around rocky barrens habitats and high elevation 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 within that zone, siting and design of new development with an eye to the rattlesnake's needs will help to protect the snakes and minimize human/snake encounters which are often fatal to the snakes. Other ledge-associated snakes of conservation concern would also benefit from protected habitat areas within that zone.
- 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.
- 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 Dover'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.

Graham et al. (2019) describe other specific conservation measures for Dover habitats and species.

Different organisms have different sensitivities and responses to effects of climate change; some 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.

Landscape ecologists 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 Dover.
- 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 wetlands with deep organic soil, are less common in the region than young 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.

The Housatonic Valley Association (HVA) has undertaken a watershed management planning project for the entire Housatonic drainage (which includes all of Dover), looking especially at the forested corridors and their connections to the larger landscape of the US Northeast. With the help of municipalities, organizations, landowners, and others, the HVA aims to identify and protect the areas of greatest importance for maintaining high-quality water resources, native biological diversity, and the ecosystem services provided by those features to the human community. Their Follow the Forest initiative and other projects are described at https://hvatoday.org/our-solutions/.

General Measures for Biological Resource Conservation

- Protect areas representing all significant landforms and the full array of elevations, bedrock geology, and surficial geology that occur in the town.
- 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 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.
- Promote wildlife-friendly agricultural practices, such as late mowing to accommodate ground-nesting grassland birds, leaving unmowed strips and fallow rotations to support pollinators and other beneficial invertebrates, and minimizing applications of pesticides and fertilizers.
- 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; discourage construction of new roads or long driveways in undeveloped areas.
- Employ sustainable forestry practices in working forests that promote biological and structural diversity.
- Employ sustainable agricultural practices that build living soils, conserve water, and minimize uses of fertilizers and toxic pest controls.
- Maintain natural disturbances, such as fires, 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.

Conservation of Farmland Resources

Maintaining viable local agriculture has obvious large 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 vicinity 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 difficulties of withstanding the ups and downs of weather and markets pose significant threats to local agriculture. The continuing viability of farming in Dover will require other measures to foster the economic success of existing and new farm operations and to pair farmers with available farmland.

The Dutchess Land Conservancy (DLC) has programs to support farmers, promote farmland access, and in other ways promote the viability and success of Dutchess County farms. The DLC has partnered with the Columbia Land Conservancy and the Hudson Valley Farmlink Network to operate the Farmer-Landowner Match Program which facilitates farm leases and helps farmers and private landowners find solutions to overcome some of the challenges to leasing farmland, including building equity in a farm business, having security of land tenure, and farmer housing.

The American Farmland Trust published *Planning for Agriculture in New York: A Toolkit for Towns and Counties* (Haight and Held 2011) 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.

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 breakfasts, 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 hayfields, cropland, orchards, and pastures 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.

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 ponds, marshes, and farmland. Protection of many of those features will help to protect the scenic areas of the town, but some areas deserve special conservation attention because of their exceptional scenic importance to the human community.

The "rural character" of the town that is prized by Dover 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 these working landscapes and land-dependent uses will allow landowners to keep the land undeveloped while maintaining Dover's rural traditions.

General Measures for Scenic Resource Conservation

- Conduct a formal survey of scenic areas viewable from public-access locations, identify the most important areas, and develop policies and plans for protection.
- Consider the impacts on the entire viewshed in the siting and design of any new structure or new land use in the town.
- 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.
- Minimize outdoor lighting, and design any necessary outdoor lighting to minimize visibility of lights in nearby habitat areas and offsite areas throughout the viewshed.
- Develop town policies that support the working landscapes and land-dependent uses that help to keep Dover lands productive.

Conservation of Recreation Resources

Dover has many places for public recreation that provide access to some of the beautiful, unusual, and rare natural features of the town, and provide a range of active and passive recreation uses (Figure 24).

A few measures can help protect natural features from the kinds of damage sometimes caused by recreational uses. For example, locate 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 (Miller 1998). Thus, a spatially extensive network of "social" trails and campsites has adverse effects than a few clearly-marked and well-maintained formal trails and campsites, even with more annual visitors (Marion et al. 2015). 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 (https://lnt.org)—can be very helpful because many impacts are unintentional and avoidable. Signs are not very effective, but being talked to by a ranger or volunteer often changes visitor behavior (Taylor and Knight 2003).

Visitor education about outdoor etiquette can be very helpful, because many impacts are unintentional and avoidable.

The different goals of recreation and resource protection should not be confused; they are sometimes but not always compatible. The most ecologically sensitive sites may be inappropriate for public uses, due to the sensitivity of habitats, plants, wildlife, or other resources to human disturbance, while other sites may be more resilient. 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 so widely valued in Dover.

Dover could expand opportunities for cycling and walking by upgrading certain roads to a Complete Streets standard.

Walking and bicycling opportunities can also be improved and expanded if Dover adopts the "Complete Streets" principles for public roads. The Complete Streets program uses sidewalks, paved shoulders, lane striping, bicycle lanes, "share the road" signage, crosswalks, pedestrian control signals, curb cuts, and traffic calming measures to improve the suitability and safety of roads for all users, including bicyclists, pedestrians, and people with disabilities, as well as motorists. Dover could greatly expand the opportunities for cycling and walking by upgrading certain roads to a Complete Streets standard (http://www.dot.ny.gov/programs/completestreets).

MEASURES FOR CONSERVATION AND ENHANCEMENT OF OUTDOOR RECREATION RESOURCES FOR THE PUBLIC

- Design new trails and access areas with the area of influence (e.g., 330 ft from trails) in mind and, when 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 levels.
- In existing recreation areas, prohibit lead-containing bullets and fishing tackle and live bait.
- 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 resource health, such as bed and breakfasts near hiking trails, small businesses relating to hiking, fishing and equestrian equipment and services, or eco-sensitive infrastructure such as composting toilets.
- Adopt the Complete Streets approach to enhancing the quality and safety of county and town roads for biking, walking, and other uses.
- Educate landowners about protection from liability under NYS General Obligations Law (to reduce the perceived need for No Trespassing signs).

Protected Lands

Approximately 3470 acres of land in Dover has some kind of protected status. This includes federal- and state-owned properties, a town preserve, several properties owned by conservation organizations, and privately-held lands with conservation easements (figures 24 and 25).

The Appalachian Trail runs through public and privately-owned land in southern Dover and on Schaghticoke Mountain, including lands of the National Park Service and the Pawling Nature Preserve.

The 144-acre Nellie Hill Preserve is part of the recently-established Great Thicket National Wildlife Refuge, a six-state project intended to restore and maintain shrubland and young forest habitat for species of conservation concern. The Nellie Hill site is managed both for rare species conservation and for passive public recreation—wildlife observation, photography, environmental education, and interpretation.

NYSDEC manages the 830-acre West Mountain State Forest in Dover and Beekman for forest products and public uses. It is open to the public for non-motorized recreation, including hiking, skiing, hunting, fishing, and primitive camping. NYSDEC also manages several public access sites for the Swamp River and the Ten Mile River.

The 168-acre Stone Church Preserve is owned by the Town of Dover and managed jointly by the town and the Dutchess Land Conservancy which holds a conservation easement on the property. The preserve has extensive hiking trails and is managed for public recreation and conservation. The town also owns Boyce Park, a recreation park that is not formally protected from further development but still has conservation value for the meadow, shrubland, stream, and forest habitats.

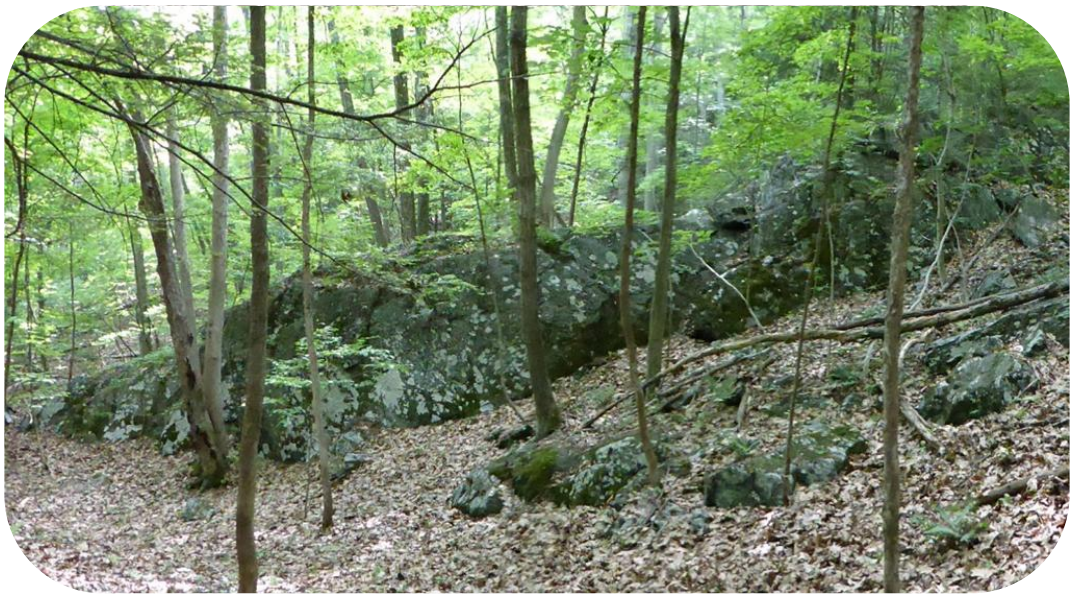
Several other preserves are owned and managed by land trusts for conservation and public uses. The Pawling Nature Reserve is a ca. 1000-acre property in Dover and Pawling owned by The Nature Conservancy (TNC) and managed jointly by TNC and local volunteers for conservation, research, education, and passive recreation. The Slocum-Mostachetti Preserve is a ca. 106-acre property owned and managed (with assistance from local volunteers) by the Oblong Land Conservancy for conservation of unusual habitats and rare species, and for public education and enjoyment. The Roger Perry Memorial Preserve is a 120-acre site on a marble knoll owned and managed by The Nature Conservancy for conservation of unusual natural features and for passive public uses.

The Dutchess Land Conservancy holds conservation easements on over 1200 acres in Dover. With the exception of the Stone Church Preserve, these are lands held by private landowners and are not open for public use. Conservation easements on other parcels are held by the Appalachian Trail Conservancy and the US Fish and Wildlife Service. A conservation easement is a voluntary legal

agreement drawn up by the landowner and a land trust or other authorized entity to ensure permanent protection of the land. The landowner retains ownership of the land, with all the rights and responsibilities of ownership (including property taxes), and can pass the land on to heirs or sell it, but the easement remains attached to the land in perpetuity. The easement is designed to serve the conservation goals of the landowner and land trust, and describes permissible and impermissible land uses and sometimes other restrictions on land management.

Figures 24 and 25 show the pattern of land protection in the county—Figure 24 shows the protected land areas open for public recreation, and Figure 25 shows the privately-held conservation easement lands that are not open to the public. Together these 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 isolated from each other, so finding ways to protect connecting corridors would expand the habitat options and help to secure safe travelways for wildlife.

Although there is much protected land in Dover, most of the fens, intermittent woodland pools, marble knolls, large forests, large meadows, other unusual habitat areas, and active farms are on privately-held lands without formal protection, so are vulnerable to future land development and other disturbances. The persistence of these special resources depends on land management decisions by individual landowners. Although many landowners recognize the value of their land for farming, timber production, or other income-producing enterprises, 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 landowners to special features on their land, and sections above and below on **Conservation Principles and Measures** and **Achieving Conservation Goals** describe some of the numerous ways that any landowner can voluntarily protect important natural resources.



Bedrock outcrop at the Stone Church Preserve. Chris Graham © 2019.

25. Private Conservation Lands

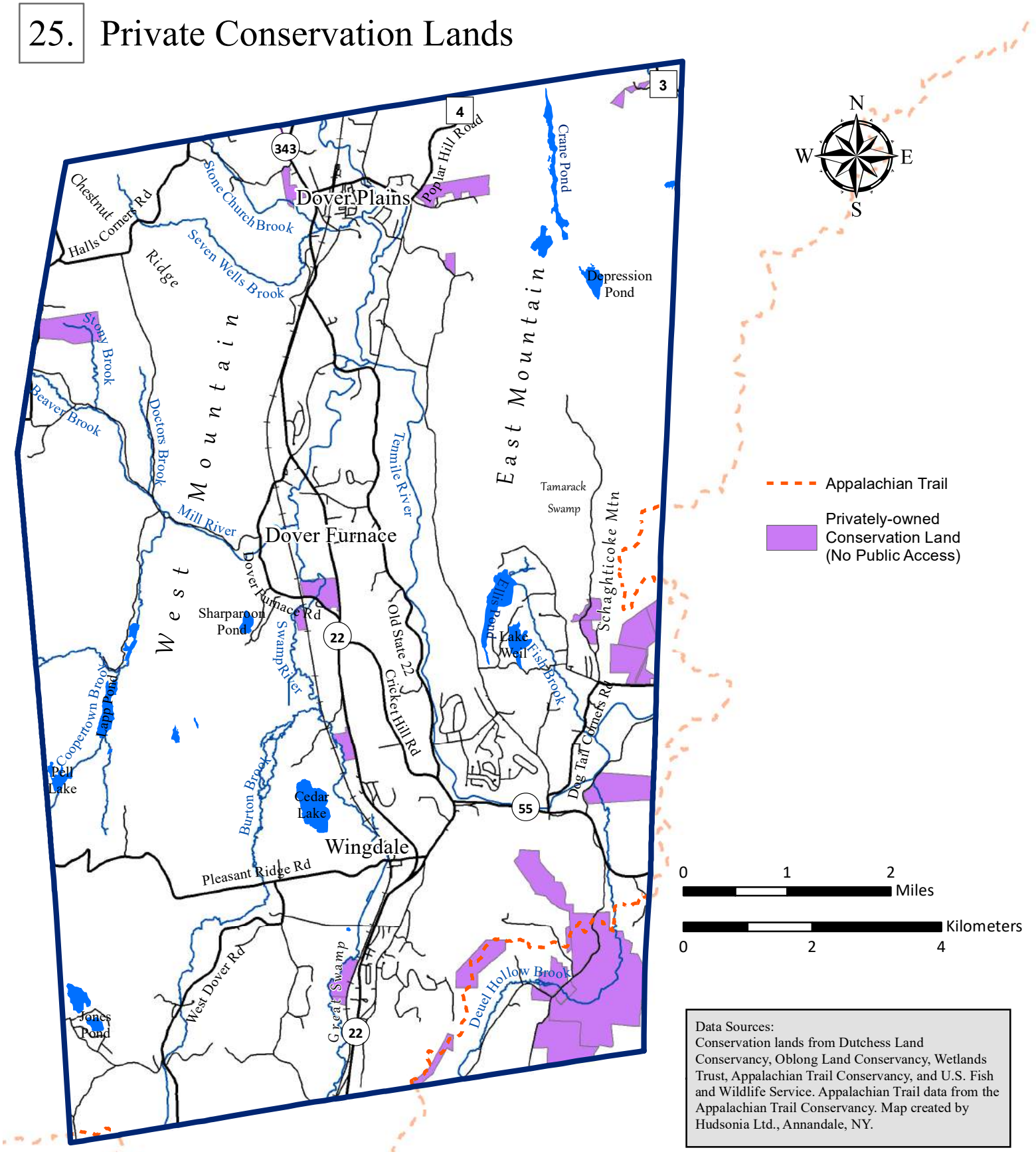


Figure 25. Privately-owned conservation lands in the Town of Dover, Dutchess County, New York. These lands are NOT open to the public. Dover Natural Resource Inventory, 2019.

Legislative Protections for Natural Resources

Federal and state laws provide some protections for certain kinds of resources, but many resources of great importance to communities have no protection except for those imposed by local legislation. Municipalities have considerable authority to establish land use policies and regulations through local zoning and other mechanisms in their local codes. Citizens can make their concerns known to municipal agencies by attending agency meetings and becoming involved in comprehensive planning, zoning revisions, open space planning, and the Conservation Advisory Council.

The municipal Master Plan sets forth the interests and intents of the community for land uses and conservation, and the municipal code establishes rules and procedures to carry out those intents. Good land use policies and decisions, however, depend on having good information. This *NRI* provides information on natural resources throughout the town, including resources of conservation concern and particular sensitivity, but does not show the precise locations of those resources on a parcel-by-parcel basis. On-the-ground observations are essential to identify the resources of concern on any site where new land development is proposed.

> The town has considerable authority to establish land use policies and regulations related to the public welfare.

Below are outlined some of the existing protections for species and land areas in federal and state laws, and some examples of provisions in the Dover zoning ordinance that extend protections to resources of local concern.

RARE SPECIES

The federal and New York State governments maintain lists of rare species, and have laws intended to prevent harm to individuals and populations of those species. Unfortunately, most places have never been surveyed for rare species, so no one knows all the other locations where they occur. Thus, most land disturbance and land development takes place without anyone knowing whether or not rare species occur in the vicinity and will be harmed by the new land uses.

Most species, however, are associated with particular kinds of habitats, so information on habitats can help us determine where particular species are likely to occur. For example, a spotted turtle[†] may

use a kettle wetland but is unlikely to be found on a high-elevation ledge. An eastern meadowlark† is likely to nest in a large meadow, but not in a marsh; and a blue-spotted salamander† is likely to spend most of the year in an upland forest but not in an upland meadow. Thus, understanding the kinds of habitats that a rare species uses will help to predict the places where the species might occur in Dover.

Understanding the kinds of habitats that a rare species uses will help to predict the places where the species might occur in Dover.

The report and map of ecologically significant habitats prepared by Graham et al. (2019) provides lots of information on Dover's habitats. Still, a habitat assessment based on onsite observations is recommended prior to any detailed planning for new development projects. This involves identification of habitat types and physical features (e.g., ledges, ravines, streams) on the site, an assessment of their condition or quality, connectivity with other (offsite) habitat areas, known or potential rare species, and likely impacts on habitats and species from the proposed project. (A template for habitat assessments is available at http://hudsonia.org/education/#2.) Such an assessment can help determine the likelihood of rare species occurrence at any site. Although many of the habitats in Dover are unprotected by federal, state, or local laws, town agencies still have the authority to guide new projects in ways that help protect habitats and other resources of concern.

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 establishes and revises the list of plant and animal species deemed to be rare nationwide, and assigns a rank of "Endangered" or "Threatened" to each. Only a few species in New York are on the federal list. In Dover, those are limited to Indiana bat† and bog turtle.† Land development projects that may interfere with known locations of federally-listed Threatened or Endangered species must be reviewed by the US Fish and Wildlife Service.

New York State Environmental Conservation Law

Animals ranked as Endangered, Threatened, and Special Concern are listed and regulated under 6 NYCRR Part 182 of the New York Environmental Conservation Law (ECL) 11-0535. The regulations prohibit the taking of (or engaging in any activity likely to result in the taking of) any species listed as Endangered or Threatened in New York. The regulations also prohibit importing, transporting, possessing, or selling "any endangered or threatened species of fish or wildlife, or any hide or part thereof..."

Plants ranked as Endangered, Threatened, Rare, or Exploitably Vulnerable in New York are listed and regulated under Environmental Conservation Law section 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 likely to be picked 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 plants on their own property, but others are not permitted to harm those plants without the landowner's permission.

WETLANDS

Federal Wetland Regulatory Program

Section 404 of the federal Clean Water Act 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 Environmental Protection Agency and other federal agencies. The federal government regulates activities in wetlands of any size as long as the wetland is functionally connected to "navigable waters." The law prohibits certain kinds of activities (especially filling) in jurisdictional wetlands without a permit. It imposes no regulated buffer zone around a wetland, but federal agencies may specify such a zone in permit conditions if they so choose.

Jurisdictional decisions (that is, decisions about whether or not a wetland comes under the federal purview) are made by the ACOE on a case-by-case basis. The criteria for federal jurisdiction have been in flux since US Supreme Court decisions in 2001 and 2006, a 2015 Wetland Rule issued by the USEPA, and a repeal of that rule in 2019. For the time being, a wetland adjacent to a perennial stream is usually considered jurisdictional under the federal program. An isolated wetland or a wetland adjacent to an intermittent stream that runs only a few days or a few weeks of the year is often non-jurisdictional. This removes protections from many small, isolated wetlands despite their demonstrated importance to the quality and quantity of groundwater and surface water supplies.

New York State Wetland Regulatory Program

The New York State Freshwater Wetlands Act (Article 24 of the New York Environmental Conservation Law) regulates the kinds of activities that can legally occur in and near large wetlands (12.4 acres and larger), and in 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 jurisdictional wetland. Most wetlands in New York do not fall under state jurisdiction, however, because they do not meet the size criterion or any of the criteria for "unusual local importance."

Thus, due to their small size or hydrologic isolation, most of our intermittent woodland pools, isolated swamps and isolated wet meadows receive no protection from the federal or state governments. These small and isolated wetlands can have great value for biodiversity and for water

management, however. Indeed it is often the very isolation that imparts their special value to certain plants or animals. In the case of intermittent woodland pools, for example, the isolation from streams and other wetlands helps to maintain the fish-free environment that is a critical characteristic for the pool-breeding amphibians of conservation concern (Jefferson salamander,† spotted salamander, marbled salamander,† wood frog). For the time being, local legislation or private conservation easements are the only means of formal protection for the many wetlands that do not fall under state or federal jurisdiction.

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ENVIRONMENTAL REVIEWS

State Environmental Quality Review (SEQR)

The New York State Environmental Quality Review Act sets forth a formal procedure for assessing potential environmental impacts of proposed projects, and integrating environmental concerns into planning and regulatory reviews at the state and local levels. Most projects proposed by a state agency or a municipality, and all permits from a state agency or unit of local government, require an environmental impact assessment (6 NYCRR Part 617 State Environmental Quality Review). The basic document for this assessment, to be completed in the early stages of a SEQR review, is the Environmental Assessment Form (EAF), designed to help the project applicant and the reviewing agencies gather and assess basic information about the proposed project, the natural and cultural features of the project site, and the potential impacts of the project on resources of concern. SEQR requires the sponsoring or permitting agency (such as a municipal planning board) to identify and ensure mitigation of the significant environmental impacts of any activity it is proposing or permitting.

If the lead agency insists on thorough and informative answers to EAF questions, the document can be a powerful tool for assessing impacts and creating better projects.

As with many such bureaucratic forms, however, the EAF is often completed in a perfunctory way by the applicant and the lead agency in the environmental review, providing only scant and superficial information about resources at risk and potential impacts to those resources. But if the lead agency insists on thorough and informative answers to the EAF questions, the document can be a powerful instrument for assessing impacts and creating better projects. Applicants, the planning board, and the town board are encouraged to use the EAF and the SEQR process to their fullest potential to identify resources

of concern and to help design projects in ways that protect important resources and cause least harm to the most sensitive areas.

DOVER LEGISLATION

Many provisions in the Dover municipal code are intended to protect important natural resources in the town. Among the stated purposes of the Code of the Town of Dover are:

- to conserve the natural resources and rural character of the town;
- to minimize negative environmental impacts of development, especially in visually and environmentally sensitive areas such as East and West Mountain, the Swamp River, along the Ten Mile River and its tributaries, in aquifer and aquifer recharge areas, and on steep slopes, erodible soils, wetlands and their buffers, floodplains, active farmlands, and other designated open space resources;
- to protect the integrity of scenic views, ridgelines, agricultural land, existing and potential recreation areas, waterways, ground and surface water supplies, ecological systems, wetlands, wildlife habitat, and natural vegetation, and to maintain environmentally significant open space in its predominantly undeveloped state, in order to preserve the open and rural character of the town; and
- to encourage the continuation of agriculture and the preservation of open space, and to avoid regulating agricultural uses in a manner that unreasonably restricts or regulates farm structures or farming practices.

A few of the especially relevant sections of the code are described below.

Flood Damage Prevention (Chapter 81)
The purposes of this chapter are to promote public health and safety, to minimize losses of property and infrastructure, to prevent increases in soil erosion, to prevent increases in the heights or velocities of floodwaters and flood heights, to reduce the need for flood rescue and relief efforts, and to help the town qualify for participation in the National Flood Insurance Program (81-2). The law requires that no approvals be given for new or substantially improved structures in the regulated areas that would act to raise the flood levels at all (for projects within the regulatory floodway) or more than one foot (for projects outside the regulatory floodway). The law also sets forth construction standards to ensure that new structures can withstand flood forces and other flood effects. This clause applies to the areas of special flood hazard areas identified by FEMA in 2012.

Floodplain Overlay District (Chapter 145, Section 13)
Among the purposes of the restrictions imposed in this overlay district are to minimize public and private losses due to flood conditions (Chapter 81-2 by reference). The zoning code prohibits the installation of new residential structures, septic tanks, leachfields, or other sanitary sewage systems within the district. The boundaries of the district coincide with the 100-year floodplain (the area with a 1 percent or greater chance of flooding within any given year) as delineated by the Federal Emergency Management Agency (FEMA).

Stream Corridor Overlay District (Chapter 145, Section 14)
The purposes of this overlay district are to preserve the scenic character and water quality of Dover's streams, and to reduce the risk of damage from flooding. The law prohibits the installation of any "principal structure" within 100 ft of the watercourse, or any accessory structure of 200 square feet or larger within 50 ft of the watercourse. The law also requires the Site Plan Approval process for certain projects that fall within those thresholds. Approvals are to be given only if the project will not result in degradation of the scenic character of the location, and will not cause erosion or stream pollution. The district includes all the land lying within 150 ft of the mean high water line of the Ten Mile River, the Swamp River, and all other streams classified by NYSDEC.

Aquifer Overlay District (Chapter 145, Section 15)
The purposes of this overlay district are to protect the quality of the public water supply and private drinking water wells. The district is divided into two zones—the Principal Aquifer Zone and the Upland Aquifer Zone. The Principal Aquifer Zone encompasses the Valley Bottom Aquifer, plus all other areas where the ground surface is 150 feet or less above the Wappinger Group bedrock, and existing and future wellhead protection areas around community water systems. The Upland Aquifer Zone includes the rest of the land area in the town, recognizing that it all drains to the Principal Aquifer Zone.

The law regulates:

--the use, storage, or discharge of hazardous materials or other pollutants;
--land uses and activities within wellhead protection areas;
--wastewater treatment systems, including residential septic systems;
--storage and stockpiling of animal waste, fertilizers, and pesticides; and
--applications of manure, other fertilizers, and pesticides

The law prohibits:

--point source discharges;
--open storage of fertilizers; and
--disposal of pesticides (unless authorized by state permit)

Soil Mining Overlay District (Chapter 145 Section 17)
The purpose of this overlay district is to provide appropriate locations for soil mining, reduce conflicts between mining and residential uses, balance the needs for soil mining to support local agriculture, and protect Dover's "rural peace and quiet." The district includes existing commercial farm operations with sufficient buffering from nearby residences.

Wetland and Watercourse Protection (Chapter 145, Section 35)
The purpose of this clause is to maintain water quality and the health of natural ecosystems, reduce flooding, erosion, and sedimentation, and protect important wildlife habitat areas. The law requires compliance with state and federal wetland delineation and regulation requirements, but has no requirements for delineating or protecting the additional wetlands that do not fall under state or federal jurisdiction.

Steep Slope Regulations (Chapter 145, Section 36)
The purposes of the steep slope regulations are to prevent soil erosion, sedimentation of streams and waterbodies, and landslides, and the degradation of scenic views. The regulations apply to areas with slopes exceeding 15 percent. The law requires that erosion and sedimentation be prevented during and after construction, that excessive road or driveway grades be avoided, and that constructed features be engineered and installed to prevent subsidence, road washouts, landslides, flooding, and avalanches.

Ten Mile River at Webatuck.

Identifying Conservation Priorities

Recognizing that all places with valuable natural resources cannot be protected from incompatible uses, municipalities, landowners, developers, and land trusts often need to identify the features and places that seem most important for conservation. Municipal comprehensive planning and zoning revisions and environmental reviews of land development projects, as well as landowner decisions about land use and management on their own properties can benefit from an exercise in identifying conservation priorities. This can help sort out the areas of greater or lesser importance, and allow new land use projects to proceed in the least vulnerable areas, while the most sensitive areas are protected from disturbance.

Local conservation priorities can be identified on the basis of a large array of factors associated with groundwater and surface water resources, good farmland soils and active farms, native biological diversity, and recreational and scenic resources. In addition, there may be other special features such as unusual land formations, caves, springs, waterfalls, or places of exceptional cultural or historical significance that have particular meaning for the community. Landscape features that contribute to the ability of plants, wildlife and people to respond to the effects of climate change can also be part of the calculation.

Below are listed some of the factors that may be relevant to local assessment of priorities. Information and maps for many of these factors are included in this *NRI*, and can be expanded by additional local knowledge of the land and resources. The Dover community is strongly encouraged to adapt and add to this basic list of factors and develop their own weighting values that reflect a hierarchy of local concerns.

Some of the types of resources that warrant consideration when identifying conservation priorities are listed below:

- 100-year and 500-year flood zones, riparian buffer zones, Active River Areas, and floodplain forests
- corridors along streams
- large forests
- large meadows (≥ 10 acres)
- known locations and habitats of rare species of plants or animals (from local knowledge, the New York Natural Heritage Program, and Figure 17b).
- Significant Biodiversity Areas (Figure 17a)
- exemplary and rare habitats (Figure 17b)

- wetlands and buffer zones, including wetlands already mapped (Figure 15) and others not yet mapped (from local knowledge)
- unusual landforms (caves, cliffs, ravines, etc., from local knowledge) or unusual bedrock types (Figure 5)
- Prime Farmland Soils and Farmland Soils of Statewide Importance (Figure 20)
- active farmland (from local knowledge)
- broad, intact corridors from low-to-high elevations
- broad, intact south-to-north corridors, and broad corridors connecting formally protected land parcels
- areas with high resilience to climate change effects (Figure 18) or high landscape permeability (Figure 19)
- scenic areas (from local knowledge, and also Figure 23)

The values and needs of the community (or organization or landowner) will determine the relative weight given each of those factors. Dover may prioritize a subset of those resources because of their importance in the regional landscape, their local or regional rarity, or their importance to the local economy, identity, or quality of life.

A second level of analysis could identify the above-listed resources that are located in higher-risk areas, such as:

- Around population centers
- Near quickly-growing commercial areas ("strips")
- In areas especially at risk for residential development such as recently abandoned farmland, high-elevation areas with good views, and land near large streams and waterbodies or in areas desirable for other reasons (access to schools, amenities, etc.)
- Near potential water pollutant sources such as industry, stormwater outfalls, dense residential or commercial areas, extensive paved or tilled areas, dumps, or landfills

Another, complementary approach would be to focus on general topics of importance to the community—perhaps those identified in the town's Master Plan, or in responses to a public survey, such as "protecting environmental features and natural beauty" or "protection of stream corridors," or "protection of scenic vistas." Some potential purposes, for example, are:

- Reducing flood intensity and flood damage
- Protecting drinking water quality/quantity
- Protecting or improving stream habitats
- Protecting wildlife habitat and/or overall biodiversity

- Preserving farmland
- Planning for ecosystem stability in the face of climate change
- Preserving rural character or scenic landscapes

The Housatonic Valley Association is undertaking a landscape analysis of the Housatonic River watershed, which includes all of the Town of Dover. The "Follow the Forest" project (https://hvatoday.org/connecting-forest-corridors/) is identifying the largest contiguous forest areas (250+ acres), and the other parts of the landscape that may provide the most effective corridors and stepping stones to facilitate movement of wildlife and plants between those large patches. Like the resiliency and permeability analyses of The Nature Conservancy, the Follow the Forest initiative hopes to find the areas that may be most important for conservation, now and with the changing climate in the coming decades. The results of the HVA analysis can help planners consider the role of Dover's habitat areas in the larger landscape.

Once some general priorities are identified, specific resource information from the *NRI* can be brought to bear. The conservation priorities can be incorporated into the Master Plan or zoning ordinance by means of overlay zones or regulatory setbacks, for example. They can contribute to designation of Critical Environmental Areas or decisions about land acquisition or conservation easements. They can inform the planning board's requests for information from or recommendations to applicants, and also individual landowners' management decisions. The section below on **Achieving Conservation Goals** describes some regulatory and non-regulatory tools for protecting areas deemed important for conservation, and some specific actions that can be undertaken by the town.

Common garter snake. Nava Tabak © 2019

Achieving Conservation Goals

Conservation of natural resources can happen on every land parcel in the town, whether it is a half-acre residential lot, or a 50-acre wood lot, or a 200-acre farm. It can happen through a variety of means, including voluntary land management efforts of individual landowners, land trust acquisition of land from willing landowners, establishment of conservation easements, or restrictions imposed by local policy or legislation. 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 conservation and 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.

> Conservation of natural resources can happen on every small and large land parcel in the town.

Conservation Tools

Landowner Education

Educating landowners about their potential stewardship roles will 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. 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.

Land Acquisition

Although the town 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 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. The latter arrangement may be called a "purchase of development rights."

A conservation easement allows the current landowner to maintain ownership and use of the property, and secure a conservation legacy for future generations.

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 agreements with, e.g., the Dutchess Land Conservancy 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. Over 1200 acres of land in Dover are in conservation easements held by the Dutchess Land Conservancy. Other easements are held by the Appalachian Trail Conservancy and the US Fish and Wildlife Service.

Land Use Legislation and Other Local Measures

Dover regulates land use through zoning and other ordinances 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.

Some of the regulatory means of protecting important natural resources include 1) establishing or increasing required setbacks or **buffer zones around sensitive areas** such as wetlands, streams, ponds, rare habitats, or habitats known to be used by rare species; 2) restricting certain activities in or near other sensitive areas such as fens or kettle wetlands; 3) adopting regulations to ensure that exterior lighting has minimal impacts on nearby habitats and the larger viewshed; and 4) establishing standards for environmental reviews and land development in areas of special conservation importance (Metropolitan Conservation Alliance 2002). The Dover code has established overlay districts for protection of floodplains, aquifers, and streams.

The Dover code has established overlay districts for protection of floodplains, streams, and aquifers.

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 (http://www.dec.ny.gov/permits/45500.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 [in the SEQR process] that may affect the CEA" (http://www.dec.ny.gov/permits/45500.html, accessed September 2017). Thus, the regulatory review of any new development project that might affect the special characteristics of the CEA must include a written assessment of those impacts. 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. In 1985 Dutchess County established a Critical Environmental Area at the inactive Mica landfill site due to the potential for pollutants leaching to surrounding areas and the Ten Mile River. In 1986 the Town of Dover established the Deuel Hollow CEA because of concern for Deuel Hollow Brook and the surrounding natural areas. In 1992 Dutchess and Putnam counties

The purpose of a CEA is to raise awareness of the unusual resource values (or hazards) that deserve special attention during land use decisions.

established the Great Swamp Critical Environmental Area for its biological and water resource values. There may be other places in Dover where CEA designations would be worthwhile.

With authorization from the State of New York, Dover could establish a **Community Preservation Fund** 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 could be earmarked for establishment of parks or preserves, purchase of recreation lands, aquifer recharge areas, important habitat areas, scenic areas, or historic sites, purchase of conservation easements, and other purposes related to conservation of natural or cultural resources. Before embarking on such a program, the town could learn from the experience of others in the region (e.g., the towns of Red Hook and Warwick) that have established such funds.

Non-regulatory measures include:

- educating the public and land use applicants about techniques for protecting sensitive areas;
- establishing Best Management Practices for specific activities such as logging, mining, and farming;
- providing incentives to land use applicants willing to set aside certain important areas of development sites; or
- developing 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.

The model *Habitat Assessment Guidelines* in Appendix E can be adapted to fit the town's needs.

Requiring a habitat assessment in the early stages of planning land development projects 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. Hudsonia has developed model *Habitat Assessment Guidelines* (https://hudsonia.org/resources/) that can be used or adapted by a town to fit their own needs. The *Guidelines* are designed to help applicants gather the kinds of information that a planning board or other lead agency needs to make informed recommendations and decisions about a proposed land use project.

The Ten Mile and Swamp rivers have been designated by the NYS legislature as Inland Waterways for purposes of waterfront revitalization (Senate Bill S4244A). The designation makes Dover eligible to participate in the Coastal and Inland Waterways Program and to apply to New York State for grants through the Local Waterfront Revitalization Program (LWRP). LWRP's can help address streamside redevelopment, expansion of public access to the water, resource protection, and other water dependent uses such as boating, fishing, and swimming.

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 are listed below.

> The New York State Open Space Conservation Plan identifies the Great Swamp, the Taconic Ridge, and the Harlem Valley as high-priority areas for conservation.

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 State Open Space Conservation Plan (2016). Projects that fit the scope of a listed priority conservation project and pass a thorough review process are eligible for funding from the State's Environmental Protection Fund and other state, federal and local funding sources. The state-identified open space priorities in Dover include:

The **Great Swamp and surrounding uplands**, because of its large size, diverse habitats and biota, extensive wetlands, rare species, water resource management, and educational and recreational opportunities.

The **Taconic Mountain Ridge, the Harlem Valley, and their viewsheds**. In Dover these areas include the East Mountain and West Mountain ridges and the Route 22 corridor. These areas are considered conservation priorities due to their high biodiversity, the presence of threatened and endangered species, scenic views, substantial recreational value, large areas of intact, unfragmented forest, steeply sloping hillsides, unusual geology, working farm landscapes, and multiple opportunities to connect to public and private lands with formal conservation status. The Taconic Ridge is a Forest Legacy Area and is qualified for land acquisition grants through the federal Forest Legacy Program.

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 preparation of this *NRI* is part of the process for the Town of Dover to achieve Bronze-level certified Climate Smart Community designation.

Other offices of the 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 State Environmental Quality Review (SEQR) process and developing local legislation. SEQR and local legislation can be powerful tools in the protection and stewardship of local resources.

Cornell Cooperative Extension—Dutchess County

The Cooperative Extension is part of a statewide program that aims to put "knowledge to work in pursuit of economic vitality, ecological sustainability and social well-being," serving local families, farms, and communities. Their agricultural education programs provide research-based information on production and marketing of agricultural and horticultural products through workshops, publications, and consultations. The CCE has provided valuable map-making services to Dover, and their natural resource programs provide information, workshops, and assistance on such topics as woodland stewardship, water resource protection, invasive species, and agroforestry.

Natural Resource Conservation Service

The NRCS (of the US Department of Agriculture) 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.

Dutchess 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, and assist with obtaining funding for projects that enhance environmental quality or economic viability of farm-related enterprises.

Dutchess County Environmental Management Council

The Dutchess County Environmental Management Council is an advisory board on matters that affect the local natural environment. Its mission is to advise and educate county and local governments and the public on local environmental issues. EMC members include at-large members appointed by the Dutchess County legislature, ex-officio members, and representatives from each Conservation Advisory Council or Board in the county. The EMC works closely with the Cornell Cooperative Extension of Dutchess County's (CCEDC) to provide educational and technical resources and programs.

Dutchess County Department of Planning and Economic Development
The Department of Planning gathers and provides information and assistance to municipalities and the public on issues related to land development, land use planning, and economic development. Their mission is to maintain and enhance the county's quality of life and economic climate. The agency could assist Dover with identifying local measures that would support natural resource-based economic development.

Dutchess County Department of Behavioral and Community Health
The agency conducts research, disseminates information, and provides assistance to municipalities, medical institutions, and organizations on a wide range of topics related to human health, including waterborne pathogens, rabies, tick-borne, mosquito-borne, and other zoonotic diseases, in addition to a host of other public health topics that are less closely related to the natural environment. The agency monitors the water quality of public water systems in the county, and monitors local summer camps, beaches, and pools to ensure the safety of residents and visitors who use those facilities.

Municipal Agencies

In 2016 the Dover Town Board adopted the Climate Smart Communities Pledge asserting the town's commitment to reducing greenhouse gas emissions in town government operations, reducing waste, and increasing the town's resilience to climate change. The **Climate Smart Dover Task Force** is leading the efforts to achieve these ends. Among other projects, they have completed an inventory and assessment of aquatic barriers along streams, and completed this *Natural Resources Inventory*.

Agencies of neighboring towns can be valuable partners in land conservation, especially where shared natural resources straddle municipal boundaries. Adjoining towns can collaborate on developing conservation funding, supportive land use ordinances and other regulatory measures, strong open space plans, and ownership and management of conservation lands. An example is the Ten Mile River Watershed Collaborative which, under the leadership of the Housatonic Valley Association, includes municipal officials, NGOs, and professionals who are developing a comprehensive watershed management plan for the large watershed.

Statewide, Regional, and National Conservation Organizations

Appalachian Trail Conservancy
The Appalachian Trail Conservancy (ATC) is a non-profit organization that works to develop, maintain, and protect the Appalachian Trail, a ca. 2200-mile foot trail—the longest in the world—extending from Georgia to Maine. The ATC works closely with local, state, and federal agencies and organizations, and benefits from the assistance of local volunteers in all aspects of their mission.

Dutchess Land Conservancy

The Dutchess Land Conservancy is a land trust that seeks to protect scenic resources, agricultural land, historic settlement patterns, and diverse natural ecosystems through land conservation, land stewardship, and public education. They have protected over 42,000 acres, mostly in Dutchess County, and over 1200 acres in Dover. The DLC also sponsors education programs for landowners and residents about caring for natural resources.

Ducks Unlimited

Ducks Unlimited (DU) is a nonprofit organization dedicated to the conservation of wetlands and other habitats for waterfowl and other wildlife. They collaborate with scientists, conservation NGOs, and public agencies to identify the needs and habitats of wildlife, educate landowners, and pursue effective conservation policies and projects. The Dutchess County Chapter of DU has been especially active in conservation efforts associated with the Great Swamp.

Harlem Valley Appalachian Trail Community

The HVATC is an organization of volunteers that maintains trails in the Pawling-Dover segment of the Appalachian Trail, advocates for large landscape conservation in the Harlem Valley, encourages sustainable economic development, and educates the public on matters related to conservation and outdoor etiquette.

Housatonic Valley Association

The Housatonic Valley Association (HVA) is a non-profit organization that "works to conserve the natural character, environmental health, and economies of our region by protecting and restoring its land and waters…" The HVA works in the three states—New York, Massachusetts, and Connecticut—that contain the watershed of the Housatonic River. (All of Dover is in the watershed of the Ten Mile River—a tributary to the Housatonic.) The HVA conducts research, sponsors public education, and works with other agencies and organizations on many fronts to improve environmental quality and promote land conservation throughout its service area.

The Nature Conservancy

The Nature Conservancy (TNC) is an international land conservation organization that has worked extensively throughout the state to further land protection (including conservation easements) through partnerships with other organizations and agencies and private landowners to prevent further fragmentation of important ecosystems. TNC's conservation targets include protecting matrix forest blocks, wetlands and vernal pools, drinking water sources, rare and endangered plants, the timber rattlesnake,† and the bog turtle,† and they have a particular interest in helping communities adapt to climate change. TNC has designated the Berkshire-Taconic region as one of the world's "Last Great Places" and has joined with other organizations and public agencies to develop a recovery plan for the bog turtle.

Open Space Institute

The Open Space Institute (OSI) works in the eastern U.S. to protect scenic, natural, and historic landscapes through direct acquisition and conservation easements, and partners with local and state

government to expand parklands. OSI's conservation strategy focuses on permanent protection at the landscape-level scale. OSI has protected over 46,000 acres in southeastern New York, creating connecting corridors that benefit both recreationists and wildlife, and protecting prime farmland.

Preservation League of New York State

The Preservation League of New York State seeks to protect New York's heritage of historic buildings, districts, and landscapes. It leads advocacy, economic development, and education programs, and provides grants, loans, and technical assistance to individuals, organizations, and communities.

Trout Unlimited

Trout Unlimited (TU) is a national organization whose mission is to conserve, protect and restore the cold-water streams and fisheries of North America through habitat restoration, land conservation, public education, and legislative advocacy. They have a long history of collaborating with local, county, state and federal government agencies as well as other conservation organizations to achieve shared conservation goals. The Mid-Hudson Chapter is the local TU chapter. TU has an extensive network of volunteers that work on local conservation projects and issues. The New York State Council Trout Unlimited Conservation Fund provides small grants to local TU chapters for coldwater fisheries conservation projects. The TU has been active in conservation programs for the Great Swamp and other special places in Dutchess County.

Trust for Public Land

The Trust for Public Land (TPL) works to protect working farms and forests; lands of historical and cultural importance; rivers, streams, and watersheds; and other special places where people can experience nature close at hand. TPL buys land from willing landowners and transfers it to public agencies, land trusts, or other groups for permanent protection.

Waterman Bird Club

The Ralph T. Waterman Bird Club is a membership organization that hosts field trips and educational programs, compiles data on bird occurrences in Dutchess County, and provides information to their membership and the public about bird habitats, ecology, and conservation.

Recreation Organizations

New York–New Jersey Trail Conference

The New York–New Jersey Trail Conference (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 (www.nynjtc.org). The NYNJTC is one of 31 clubs who maintain the Georgia to Maine Appalachian Trail under an agreement with the Appalachian Trail Conservancy. The Dover-Pawling segment is maintained by the Dutchess-Putnam Appalachian Trail Management Committee.

Research and Education Organizations

Cary Institute of Ecosystem Studies

The Cary Institute of Ecosystem Studies is an environmental research organization with specialties in forest and freshwater ecology, disease ecology, urban ecology, climate change, and invasive species. They seek to advance understanding about the structure and function of ecological systems, provide the scientific knowledge needed to solve environmental problems, inform students, decision makers, and the public, and train the next generation of ecologists and resource managers. In addition to their research activities, they hold lectures, field outings, and other events for scientists, environmental practitioners, and the public.

Hudsonia Ltd.

Hudsonia is an environmental research institute that studies the plants, animals, and habitats of the region, their ecology, and conservation. Hudsonia biologists conduct pure and applied research throughout southeastern New York and elsewhere in the Northeast, produce educational and scientific publications, and conduct training and other educational programs for scientists, environmental practitioners, and land use decision-makers to help participants better understand how to recognize, assess, and protect important biological resources.

Local Businesses

Many local business owners 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 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. For all these reasons businesses are often enthusiastic partners in conservation initiatives and should not be overlooked in the quest for funding, publicity, and in-kind assistance. For example, recognizing the economic benefits to businesses and residents, local businesses have become supporters of the geotourism pilot for the Harlem Valley initiated by the Appalachian Trail Conservancy.

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 take 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 the town 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 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.

CONSERVATION ACTION PLAN

Actions for Protection of Air Quality and Enduring Features

In addition to the general conservation measures outlined on page 140, listed below are actions that can be carried out by the Town of Dover.

- Use air monitoring station data to track determinants of local air quality in comparison with Dutchess County and Hudson Valley ambient air quality data over time.
- Implement one-, five-, and ten-year goals of Dover's Government Operations Climate Action Plan to reduce the town-generated greenhouse emissions.
- Install a public zero-emission vehicle (ZEV) charging station at a convenient town-owned location to promote residents' interest in use of electric vehicles.
- Purchase a zero-emission vehicle for use by Dover officials who conduct regular site visits and inspections.
- Upgrade/convert the Town's 282 street lights from non-LED to LED fixtures to improve energy efficiency and reduce greenhouse gas emissions.
- Install photovoltaic (solar) panels at all Town of Dover office facilities for electricity generation.
- Develop an outreach and education program for large landowners in Dover to learn about the merits of conservation easements or the purchase of property development rights.
- Use information in the 2019 *Natural Resources Inventory* to identify and prioritize areas with unique enduring features (i.e., marble knolls, cool ravines, quarry areas, fishing banks) for future conservation.
- Adopt a Town of Dover anti-idling ordinance.
- Continue to prohibit new mining operations and monitor potential over-mining at existing permitted mining operations.
- Educate residents about the history of the Town of Dover about past over-harvesting of natural resources and enduring features to better understand the need for protection.
- Implement recommendations of the Town's 2019 Climate Smart Communities publication, *A Review of Plans, Policies and Procedures Using the Climate Smart Resiliency Checklist*, to develop new and updated plans, policies and procedures that increase Dover's resilience to climate change, disaster preparedness and recovery, and reduce risks to people and property from natural hazards.

Actions for Water Resource Conservation

In addition to the conservation measures outlined on p. 144 which can be applied everywhere by individual landowners and the town, the actions listed below can be undertaken by town agencies and commissions.

- Educate residents who live along the Ten Mile River, Swamp River, and their tributaries about the benefits of riparian borders, broad buffer zones and best practices of stream stewardship (e.g., Lower Hudson Coalition of Conservation District's " Life at the Water's Edge: Living in Harmony with Your Backyard Stream" (https://www.lhccd.net/uploads/7/7/6/5/7765286/life_at_the_waters_edge.pdf).

- Monitor and track stream gauge data on the Swamp River and Ten Mile River to better understand seasonal and atypical fluctuations and inform residents about conservation measures as indicated.

- Use the town's Road-Stream Crossing Inventory and Vulnerability Assessment Study to prioritize repairs to culverts and bridges and identify municipal and grant-funded resources to make necessary upgrades.

- Contact businesses and homeowners in main floodplains within the town regarding restricted activities and structural requirements for the town's compliance for participation in the National Flood Insurance Program (NFIP).

- Conduct a hydraulic and hydrologic study of J. H. Ketcham Memorial Park in Dover Plains to prevent redevelopment that results in an increase in base flood elevation.

- Develop a drought emergency ordinance with proactive measures and incremental instructions for residents to follow in the event of short- and long-term drought conditions.

- Prepare a Ten Mile River watershed management plan to protect water quality and monitor riverine changes over time.

- Expand conservation easement of parcels in the Dover Plains hamlet (e.g., Seven Wells) to protect water quality from contamination due to overdevelopment.

- Use environmentally friendly de-icing substances on town roads and educate residents about alternative products for business and home use.

- Consider implementing a government operations stormwater management program with pollution prevention measures that include reducing use of pesticides, regular catch basin maintenance, water conservation, and practices to prevent erosion, sedimentation and flooding of town facilities and properties.

- Implement recommendations of the Town's 2019 Climate Smart Communities publication, *A Review of Plans, Policies and Procedures Using the Climate Smart Resiliency Checklist*, to develop new and updated plans, policies and procedures that increase Dover's resilience to climate change, disaster preparedness and recovery, and reduce risks to people and property from natural hazards.

Actions for Biological and Scenic Resource Conservation

In addition to the conservation measures outlined on p. 143 and 146, which can be applied everywhere by individual landowners and the town, below are actions that can be undertaken by town agencies and commissions.

- Expand conservation of existing parcels (i.e., former Nellie Hill Preserve) and facilitate new easements of contiguous areas of rare and sensitive habitats in the Town of Dover through inclusion in the Great Thicket National Wildlife Refuge.
- Educate residents and visitors using local recreational facilities about the dangers of leaving litter and trash by promoting "Leave No Trace" principles at Dover Stone Church, the Pawling-Dover segment of the Appalachian Trail and town-based preserves of The Nature Conservancy.
- Develop new biking and hiking trails at Thomas Boyce and J. H. Ketcham Memorial Park.
- Consider implementing the "Complete Streets" program and standards to improve and expand sidewalks in the Dover Plains hamlet.
- Consider traffic calming measures in the Wingdale and Dover Plains hamlets.
- Develop short-term parking areas for scenic views and sites along the Ten Mile River and other natural areas.
- Employ park monitors at Boyce Park, Dover Stone Church and J. H. Ketcham Memorial Park during times of increased visitorship for improved public safety and park security.
- Assist local farms and community-supported agriculture programs with access to town resources (website, cable television, printed annual directory) to help publicize events, offerings, and special programs.
- Support the continuation of the farmer's market in Dover Plains and facilitate its expansion as feasible.
- Promote the purchase and consumption of Town of Dover-produced foods and products.
- Develop an outdoor recreation economic plan for town-owned scenic areas.
- Develop a town program for students to complete school-based service learning/community service by assisting with maintenance at Dover Stone Church, Thomas Boyce Park and J. H. Ketcham Memorial Park.
- Educate students and residents about endangered and threatened flora and fauna specific to the Town of Dover and ways to protect their habitats.
- Expand the town's Annual Community Clean-Up/Beautification Weekend to additional events through the year and participate in the Arbor Day Foundation's "Time for Trees" initiative.
- Disseminate and inform residents about local organizations and programs dedicated to conservation goals: Appalachian Trail Conservancy, Cary Institute of Ecosystems Studies, Cornell Cooperative Extension-Dutchess County, Ducks Unlimited (Dutchess County Chapter), Dutchess Land Conservancy, Friends of the Great Swamp, Harlem Valley Appalachian Trail Community, Housatonic Valley Association, Hudsonia, Ltd., , the New York-New Jersey Trail Conference, Oblong Land Conservancy, Ralph T. Waterman Bird Club, Trout Unlimited (Mid-Hudson Chapter), Trust for Public Land.
- Implement recommendations of the Town's 2019 Climate Smart Communities publication, *A Review of Plans, Policies and Procedures Using the Climate Smart Resiliency Checklist*, to develop new and updated plans, policies and procedures that increase Dover's resilience to climate change, disaster preparedness and recovery, and reduce risks to people and property from natural hazards.

Epilogue

by
the Dover Conservation Advisory Council and the Climate Smart Dover Task Force

For over two centuries, the Town of Dover has been a destination for outdoor enthusiasts, and a rural haven where visitors and residents have enjoyed the natural beauty that refreshes and calms the human soul. This *Natural Resource Inventory* provides a timely opportunity for members of the Town of Dover Conservation Advisory Council and the Climate Smart Dover Task Force to present our vision for residents and entrepreneurs interested in ecological and sustainable economic development for the town.

In July 2016, the Town of Dover adopted the NYSDEC's Climate Smart Communities (CSC) Pledge to initiate proactive steps to quantify and reduce government-generated greenhouse gas emissions, reduce waste, and increase the town's resilience to climate change. Dutchess County and 17 of its 29 municipalities, including the Town of Dover, are now registered as Climate Smart Communities. Across New York State, more than 240 communities are in pursuit of or have achieved Bronze-level CSC certification.

The Town of Dover CAC and Climate Smart Dover Task Force have led efforts to achieve Climate Smart Communities' certification with the enthusiastic support of the Dover Town Board. Certification in the CSC program requires the completion of at least 120 points of tasks and actions verified by the NYSDEC's Office of Climate Change.

In 2017, the town received a NYSDEC grant to complete several CSC priority actions that included a town-wide natural resource inventory; a government operations greenhouse emissions (GHG) inventory; a one-, five-, and ten-year target reduction plan and climate action plan; and a road-stream crossing vulnerability study. Grant funds also assisted with a review of town policies, procedures, and plans using the Climate Smart Resiliency Checklist.

The town's website (www.townofdoverny.us) contains a Climate Smart Dover webpage with certification progress updates. For the benefit of residents, the Climate Smart Dover Task Force provides information about waste reduction and recycling, and strategies to increase household energy efficiency and reduce greenhouse gas emissions. The town has set a goal to achieve Bronze-level Climate Smart Certification by the end of 2020.

In 2017 regulatory approvals were granted for the construction of a natural gas-fired electricity generating plan in Dover using resources of a pre-existing underground gas pipeline with future capacity to power 1,000,000 homes. In 2018 the Dover Town Board granted a special permit and site plan approval to a community solar panel farm that will provide locally-produced renewable energy to approximately 500 homes and businesses.

The following list offers some additional ideas for possible environmentally-conscious and climate smart business ventures that align with and support the town's goals and objectives to steward our natural resources for generations to come:

- "Rail to Trail" guided nature hikes and interpretative walks at the Dover Stone Church Preserve, the Dover segment of the Great Thicket Wildlife Refuge, and the Slocum-Mostachetti, Roger Perry, and Sand Hill Nature Preserves;
- fly-fishing instructions and excursions on the Ten Mile River;
- "Day in the Garden" or "Day at the Farm" outdoor experiences for children, adults, and families;
- guided winery and craft brewery tours of the Harlem Valley area and northwest Connecticut producers;
- Zip Car stations from the Harlem Line train station for day-trippers;
- locally-produced and tourism-friendly retail;
- day spa, weekend retreats and forest bathing for personal growth and renewal;
- rustic-feel with modern amenities and boutique lodging for history buffs and nature enthusiasts;
- guided weekend camping on the Appalachian Trail; and
- kayaking and canoeing with interpretive habitat tours of the Great Swamp.

We welcome and invite individuals and businesses with interests in specialty and natural food production, agritourism, farm-to-table hospitality, adventure-based education, retail sporting goods, and other "escape to nature" endeavors to consider starting and growing your dream in the Town of Dover.

Woolly chanterelle along the Appalachian Trail

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Appendices

Appendix A

Glossary

GLOSSARY

Active River Area The area along a stream that is dynamically involved with the physical and ecological processes that drive and sustain the stream (Smith et al. 2008).

aggregate Raw material of different sizes—sand, gravel, crushed stone—used for load-bearing material, fill, and infiltration material. Typical uses are for road construction, concrete, and water filtration and sewage treatment.

alluvial Adjectival form of alluvium (which see).

alluvium Material, such as sand, silt, clay, and gravel, deposited on land by moving water.

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; some are especially sensitive to human disturbance or are vulnerable to predators or nest parasites that frequent habitat edges.

asl Above sea level.

aspect Facing a particular direction; for example, a north-facing slope has a northern *aspect*.

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.

bog A wetland with permanently saturated soils, and that receives most of its water from precipitation instead of groundwater, and that accumulates a deep layer of peat.

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).

calcitic In the form of calcite, calcium carbonate ($CaCO_3$)

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.

carbonate rock Limestone, dolostone, and related rocks composed largely of calcium carbonate or calcium magnesium carbonate. Carbonates also occur as cementing materials in some sandstones.

circumneutral Having a pH at or near 7.0 (approximately 6.6–7.3).

conglomerate Gravel-rich sedimentary rock with grains over 2mm in diameter with relatively rounded, smooth grain margins.

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 voluntary 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 (http://www.dec.ny.gov/permits/45500.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. The municipality can 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.

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.)

distributed wind Small turbines for residential, farm, school, or community that offset some or all grid power usage near the point of end use.

dolomite The mineral calcium magnesium carbonate ($CaMg(CO_3)_2$).

dolomitic In the form of dolomite, calcium magnesium carbonate ($CaMg(CO_3)_2$).

dolostone A durable sedimentary rock composed primarily of dolomite (calcium magnesium carbonate); similar to limestone in appearance, hardness, solubility, and human uses.

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, 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.

enduring features The hills, valleys, bedrock, and other parts of the landscape that resist change; these are the foundational features that are substantially unaffected by human land uses, wildfires, droughts, floods, hurricanes, climate change, and other significant events that alter the land surface.

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.")

gabion A wire-mesh container filled with rocks, broken concrete, or other coarse material used to fortify retaining walls and other structures.

glacial outwash Mineral material (gravel, sand, and silt) 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.

gneiss A metamorphic rock with bands, streaks, or speckles of light and dark minerals. The rock is usually transformed by sequential metamorphosis of shale into slate, slate into phyllite, phyllite into schist, and schist into gneiss.

gradient (As used in this *NRI*) slope, or degree of slope (e.g., a steep or gentle gradient).

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 seams.

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.

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 fragmentation Dividing (by roads, driveways, utility corridors, other developed features) large, continuous habitat areas into smaller, more isolated remnants.

habitat edge The boundary between two different kinds of habitats or biological communities or between other different landscape elements.

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.

herbivory Feeding on plants.

human-subsidized predators Predators that benefit from resources provided by humans—such as food, water, nesting substrates, shelter—and whose populations increase in size and range in the vicinity of human settlements and human-altered landscapes, putting greater predation pressure on native prey populations.

impervious surface Surfaces 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.

kettle A depression in the ground surface formed by the melting of a stranded block of glacial ice that was buried or partially buried by outwash drift.

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.

linkage zones Areas identified by The Nature Conservancy and the New York Natural Heritage Program that may provide the best avenue of connectivity for the populations of plants and animals of the matrix forests (which see); that is, the parts of the landscape that are most permeable for safe and efficient movement of migrating organisms between larger forest blocks. Some of these zones are "stepping stone" patches or stream corridors, and others are broad areas of undeveloped land.

limestone A fine-grained sedimentary rock composed of calcium carbonate.

marble A medium-grained metamorphic rock of interlocking calcite crystals derived from limestone.

marl A mud or mudstone rich in calcium carbonate but also containing admixtures of clay and silt. It is chemically similar to limestone, and may occur as rock or in semi-liquid form. Marl forms from decaying plant and animal material in certain kinds of wetlands.

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.

matrix forest Substantially contiguous forest areas, identified by The Nature Conservancy and the New York Natural Heritage Program, 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.

mélange A mappable unit (at 1:25,000 scale) that includes blocks of many sizes of varied rocks separated by a matrix of fine-grained materials.

metagraywacke A partially metamorphosed graywacke.

metamorphic rock Rock that has been changed in form by heat and pressure from a pre-existing rock type.

metasedimentary rock A type of metamorphic rock formed from sedimentary rock that recrystallized after subjection to high pressure and temperature; for example, marble is the metasedimentary equivalent of limestone, and slate is the metasedimentary equivalent of shale.

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 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.

muck Highly decomposed organic matter that accumulates under conditions of prolonged saturation.

NGO Non-governmental organization.

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.

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.)

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.

peat Partially decomposed organic matter that accumulates under conditions of prolonged water saturation.

perennial stream A stream that typically flows year-round.

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 and thus lower landscape permeability.)

phyllite A fine-grained metamorphic rock intermediate in grade between slate and schist (Fisher 2006).

pioneering plant species Plant species that are the first to colonize areas of stripped, disturbed, or damaged soils or other substrate.

point source pollution *Pollution* emanating from a single *point*, such as an industrial chimney or 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 or climate change.

riparian Within or adjacent to a stream or river.

riparian buffer zone (As used in this *NRI*) a zone delineated by the New York Natural Heritage Program that encompasses an estimated 50-year flood zone and adjacent wetlands (Conley et al. 2018).

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.

sedimentary rock Rock formed by deposition of pre-existing rocks and parts of once-living organisms. Examples are sandstone, limestone, and shale.

seep Diffuse groundwater discharge to the ground surface. (Compare with "spring.")

SGCN Species of Greatest Conservation Need: a list drawn up by the DEC 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 the DEC 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.

soil Unconsolidated mineral materials or organic material that have been acted on by weathering and organic processes.

spring Concentrated groundwater discharge to the ground surface. (Compare with "seep.")

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.

vegetation structure The arrangement of vertical layers and horizontal spacing of vegetation.

vernal pool A wetland—usually small—that is isolated from other wetlands or streams, and that typically holds water in winter and spring, but typically dries up at some time during the growing season. (See "intermittent woodland pool" for comparison.)

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.

wind farm A utility site with multiple large wind turbines that connect to the grid via high-voltage transmission lines.

Appendix B

Priority Waterbody Data Sheets

Tenmile River, Lower, and minor tribs (1601-0011) Need Verific

Waterbody Location Information

Revised: 06/30/2008

Water Index No: Conn 15 **Drain Basin:** Housatonic River
Hydro Unit Code: 0110005/480 **Str Class:** C*
Waterbody Type: River **Reg/County:** 3/Dutchess Co. (14)
Waterbody Size: 47.3 Miles **Quad Map:** DOVER PLAINS (O-26-2)
Seg Description: stream and select tribs, fr state line to Dover Plains

Water Quality Problem/Issue Information

(CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
Public Bathing	Stressed	Possible
Recreation	Stressed	Possible

Type of Pollutant(s)
Known: - - -
Suspected: PATHOGENS
Possible: - - -

Source(s) of Pollutant(s)
Known: - - -
Suspected: - - -
Possible: UNKNOWN SOURCE

Resolution/Management Information

Issue Resolvability: 1 (Needs Verification/Study (see STATUS))
Verification Status: 1 (Waterbody Nominated, Problem Not Verified)
Lead Agency/Office: DOW/BWAM **Resolution Potential:** Medium
TMDL/303d Status: n/a

Further Details

Overview
Recreational use of Tenmile River may experience impacts from elevated coliform levels from undetermined sources.

Water Quality Sampling
NYSDEC Rotating Intensive Basin Studies (RIBS) Intensive Network monitoring of Tenmile River in Webatuck, Dutchess County, (at Ellis Lake Road) was conducted in 2003. Intensive Network sampling typically includes macroinvertebrate community analysis, water column chemistry, sediment and invertebrate tissues analysis and toxicity evaluation. During this sampling the biological (macroinvertebrate) sampling results indicated non-impacted water quality conditions. The fauna was well-balanced and included a diverse assemblage of clean-water mayflies, stoneflies, caddisflies and hellgrammites. Water column sampling revealed coliform and iron to be parameters of concern. The coliform results were occasionally quite high, which is surprising given that other monitoring indicators showed good water quality. Regarding the iron results, this substance is considered to be naturally occurring and not a source of water quality impacts. Bottom sediment sampling results revealed no contaminants to be exceeding the Probable or Threshold Effects levels. Toxicity testing of the water column showed no significant mortality or reproductive impacts. Based on the consensus of these established assessment methods, overall water quality at this site supports aquatic life. Follow-up

coliform sampling is recommended. (DEC/DOW, BWAM/RIBS, January 2005)

A biological (macroinvertebrate) assessment of Tenmile River at this site was also conducted in 2002 during the Biological Screening effort in the basin. Sampling results also indicated non-impacted water quality conditions, with a well-balanced and diverse fauna of clean-water mayflies, stoneflies, caddisflies and hellgrammites. (DEC/DOW, BWAM/SBU, June 2005)

Previous Sampling
A biological (macroinvertebrate) survey of Tenmile River at five sites between Webatuck and Wassaic was conducted in 1992. Sampling results indicated non-impacted water quality conditions at all sites. Three of the sites are along this reach of the stream; one other site is just above the reach. (Tenmile River Biological Stream Assessment, Bode et al., DEC/DOW, BWAM/SBU, April 1993)

Segment Description
This segment includes the portion of the stream and selected/smaller tribs from the Connecticut state line to/including Stone Church Brook (-6). The waters of this portion of the stream are Class B(T) from the state line to Lake Ellis Road Bridge and Class C(T) for the remainder of the reach. Tribs to this reach/segment, including Ellis Pond Outlet (-1), Deuel Hollow Brook (-2) and Stone Church Brook, are Class C,C(T),C(TS). Swamp River (-4) and Wells Stream (-6-1) are listed separately.

Tenmile River, Upper, and minor tribs (1601-0012) NoKnownImpct

Waterbody Location Information

Revised: 06/23/2008

Water Index No: Conn 15 **Drain Basin:** Housatonic River
Hydro Unit Code: 0110005/480 **Str Class:** C(T)*
Waterbody Type: River **Reg/County:** 3/Dutchess Co. (14)
Waterbody Size: 21.0 Miles **Quad Map:** AMENIA (N-26-3)
Seg Description: stream and select tribs, above Dover Plains

Water Quality Problem/Issue Information

(CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
NO USE IMPAIRMNT		

Type of Pollutant(s)
Known: - - -
Suspected: - - -
Possible: - - -

Source(s) of Pollutant(s)
Known: - - -
Suspected: - - -
Possible: - - -

Resolution/Management Information

Issue Resolvability: 8 (No Known Use Impairment)
Verification Status: (Not Applicable for Selected RESOLVABILITY)
Lead Agency/Office: n/a **Resolution Potential:** n/a
TMDL/303d Status: n/a

Further Details

Water Quality Sampling
A biological (macroinvertebrate) survey of Tenmile River at five sites between Webatuck and Wassaic was conducted in 1992. Sampling results indicated non-impacted water quality conditions at all sites. Two of the sites are along this reach of the stream. (Tenmile River Biological Stream Assessment, Bode et al., DEC/DOW, BWAM/SBU, April 1993)

Segment Description
This segment includes the portion of the stream and selected/smaller tribs above Stone Church Brook (-6). The waters of this portion of the stream are Class B(T) Stone Church Brook to unnamed trib (-7) and Class C(T) for the remainder of the reach. Tribs to this reach/segment, including Butts Hollow Book (-8), are Class C,C(T),C(TS). Wassaic Creek (-11) and Webatuck Creek (-12) are listed separately.

Swamp River, Lower, and minor tribs (1601-0015) MinorImpacts

Waterbody Location Information

Revised: 06/30/2008

Water Index No: Conn 15- 4
Drain Basin: Housatonic River
Hydro Unit Code: 0110005/480 **Str Class:** C(T)
Waterbody Type: River
Reg/County: 3/Dutchess Co. (14)
Waterbody Size: 34.0 Miles
Quad Map: DOVER PLAINS (O-26-2)
Seg Description: stream and select tribs, from mouth to Wingdale

Water Quality Problem/Issue Information

(CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
Aquatic Life	Stressed	Suspected

Type of Pollutant(s)

Known: - - -
Suspected: NUTRIENTS
Possible: - - -

Source(s) of Pollutant(s)

Known: - - -
Suspected: AGRICULTURE
Possible: - - -

Resolution/Management Information

Issue Resolvability: 1 (Needs Verification/Study (see STATUS))
Verification Status: 4 (Source Identified, Strategy Needed)
Lead Agency/Office: DOW/BWAM
Resolution Potential: Medium
TMDL/303d Status: n/a

Further Details

Overview

Aquatic life in Swamp River is thought to experience minor impacts due to nutrient enrichment from agricultural activities and other nonpoint sources.

Water Quality Sampling

A biological (macroinvertebrate) assessment of Swamp River in Dover Plains (at Route 6) was conducted in 2002. Sampling results indicated slightly impacted water quality conditions. The fauna was dominated by filter-feeding midges and algal-feeding riffle beetles, indicating nutrient enrichment. Diatoms, macrophytes and filamentous algae were abundant in the stream. These conditions represent a decline from conditions found during 1992 sampling. Continued monitoring is recommended in order to further document this apparent decline. (DEC/DOW, BWAM/SBU, June 2005)

Segment Description

This segment includes the portion of the stream and selected/smaller tribs from the mouth to/including unnamed trib (-6) in Wingdale. The waters of this portion of the stream are Class C(T). Tribs to this reach/segment, including Burton Brook (-4), are Class C,C(T),C(TS). Mill River (-2) and Upper Swamp River are listed separately.

Swamp River, Upper, and tribs (1601-0016) Need Verific

Waterbody Location Information

Revised: 07/14/2008

Water Index No: Conn 15- 4
Drain Basin: Housatonic River
Hydro Unit Code: 0110005/480 **Str Class:** A(T)
Waterbody Type: River
Reg/County: 3/Dutchess Co. (14)
Waterbody Size: 31.1 Miles
Quad Map: ()
Seg Description: stream and tribs, above Wingdale

Water Quality Problem/Issue Information

(CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
Water Supply	Threatened	Suspected

Type of Pollutant(s)

Known: - - -
Suspected: OTHER POLLUTANTS (unspecified)
Possible: Nutrients, Pathogens

Source(s) of Pollutant(s)

Known: - - -
Suspected: OTHER SOURCE (unspecified)
Possible: Agriculture, Landfill/Land Disp., Municipal

Resolution/Management Information

Issue Resolvability: 3 (Strategy Being Implemented)
Verification Status: 5 (Management Strategy has been Developed)
Lead Agency/Office: ext/WQCC **Resolution Potential:** High
TMDL/303d Status: n/a

Further Details

Overview
Water supply use of this portion of Swamp River is thought to be threatened by unspecified pollutants from point wastewater, agricultural activities and various other nonpoint sources.

NYSDOH Source Waters Assessment
The NYSDOH Source Waters Assessment Program (SWAP) compiles, organizes, and evaluates information regarding possible and actual threats to the quality of public water supply (PWS) sources. The information contained in SWAP assessment reports assists in the oversight and protection of public water systems. It is important to note that SWAP reports estimate the potential for untreated drinking water sources to be impacted by contamination. These reports do not address the safety or quality of treated finished potable tap water. This water supply reservoir provides water to private/commercial/institutional facilities. This assessment found an elevated susceptibility to contamination for this source of drinking water. The amount of pasture in the assessment area results in a high potential for protozoa contamination. There is also a high density of sanitary wastewater discharges which results in elevated susceptibility for all contaminate categories. In addition, it appears that the total amount of wastewater discharged to surface water in this assessment area is high enough to further raise the potential for contamination. Non-sanitary wastewater discharges may also contribute to contamination. There is also noteworthy contamination susceptibility associated with other discrete

contaminant sources, including hazardous waste sites, landfills and other toxic releases. Finally, it should be noted that relatively high flow velocities make river drinking water supplies highly sensitive to existing and new sources of microbial contamination. (NYSDOH, Source Water Assessment Program, 2005)

Segment Description

This segment includes the portion of the stream and all tribs above unnamed trib (-6) in Wingdale. The waters of this portion of the stream are Class A(T) from unnamed trib (-6) to unnamed trib (-8) and Class C(T) for the remainder of the reach. Tribs to this reach/segment, including Lower Hiller Brook (-11), are Class C,C(T),C(TS). Lower Swamp River is listed separately.

Appendix C

Plants and Animals of Dover

Table C-1. Common and scientific names of vascular plants mentioned in the *Natural Resources Inventory*. Scientific nomenclature follows Weldy et al. (2019)

Common Name	Scientific Name	Common Name	Scientific Name
apple	*Malus*	cedar, eastern red	*Juniperus virginiana* var. *virginiana*
arrowhead, broad-leaved	*Sagittaria latifolia*	cherry, black	*Prunus serotina* var. *serotina*
arrowwood, northern	*Viburnum dentatum* var. *lucidum*	cherry/plum	*Prunus*
ash	*Fraxinus*	chokeberry	*Aronia*
ash, black	*Fraxinus nigra*	chokeberry, black	*Aronia melanocarpa*
ash, green	*Fraxinus pennsylvanica*	cinquefoil, shrubby	*Dasiphora fruticosa*
ash, white	*Fraxinus americana*	cliffbrake, purple-stemmed	*Pellaea atropurpurea*
aster	*Symphyotrichum*	cliffbrake, smooth	*Pellaea glabella* ssp. *glabella*
autumn-olive	*Elaeagnus umbellata*	clover	*Lespedeza*
azalea, swamp	*Rhododendron viscosum*	columbine, wild	*Aquilegia canadensis*
barberry, Japanese	*Berberis thunbergii*	corydalis, pale	*Capnoides sempervirens*
basswood, American	*Tilia americana* var. *americana*	cottongrass, green-keeled	*Eriophorum viridicarinatum*
beech, American	*Fagus grandifolia*	cranberry	*Vaccinium*
beechdrops	*Epifagus virginiana*	cutgrass, rice	*Leersia oryzoides*
bentgrass	*Agrostis*	dogwood, gray	*Cornus racemosa*
birch	*Betula*	dogwood, red-osier	*Cornus sericea*
birch, black	*Betula lenta*	dogwood, silky	*Cornus amomum* ssp. *amomum*
birch, gray	*Betula populifolia*	elm	*Ulmus*
birch, white	*Betula papyrifera*	elm, American	*Ulmus americana*
birch, yellow	*Betula alleghaniensis*	elm, slippery	*Ulmus rubra*
bittersweet, oriental	*Celastrus orbiculatus*	fern, cinnamon	*Osmundastrum cinnamomeum* var.
bladdernut	*Staphylea trifolia*	fern, fragile	*Cystopteris fragilis*
blueberry, highbush	*Vaccinium corymbosum*	fern, maidenhair	*Adiantum pedatum*
blueberry, lowbush	*Vaccinium angustifolium*	fern, sensitive	*Onoclea sensibilis*
bluegrass, Kentucky	*Poa pratensis* ssp. *pratensis*	fern, walking	*Asplenium rhizophyllum*
bluestem, little	*Schizachyrium scoparium* var. *scoparium*	flag, blue	*Iris versicolor*
breeches, Dutchman's	*Dicentra cucullaria*	fleabane, common	*Erigeron philadelphicus*
bur-reed	*Sparganium*	garlic-mustard	*Alliaria petiolata*
butternut	*Juglans cinerea*	ginseng, American	*Panax quinquefolius*
buttonbush	*Cephalanthus occidentalis*	goldenrod	*Solidago*
canary-grass, reed	*Phalaris arundinacea*	goldenrod, bog	*Solidago uliginosa*
cattail	*Typha*	goldenrod, early	*Solidago juncea*

(continued)

Table C-1. (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
goldenrod, grass-leaved	*Euthamia graminifolia*	mile-a-minute	*Persicaria perfoliata*
goldenrod, rough-leaved	*Solidago patula*	milkweed, common	*Asclepias syriaca*
goldenrod, wrinkle-leaved	*Solidago rugosa*	milkweed, green	*Asclepias viridiflora*
goldenseal	*Hydrastis canadensis*	milkweed, swamp	*Asclepias incarnata*
grape	*Vitis*	nut, ground	*Apios americana*
grass, sweet vernal	*Anthoxanthum odoratum*	oak	*Quercus*
grass-of-Parnassus	*Parnassia glauca*	oak, black	*Quercus velutina*
hackberry, American	*Celtis occidentalis*	oak, chestnut	*Quercus montana*
hairgrass, common	*Avenella flexuosa*	oak, chinquapin	*Quercus muehlenbergii*
hemlock, eastern	*Tsuga canadensis*	oak, bur	*Quercus macrocarpa*
hickory	*Carya*	oak, red	*Quercus rubra*
hickory, bitternut	*Carya cordiformis*	oak, scarlet	*Quercus coccinea*
hickory, mockernut	*Carya tomentosa*	oak, scrub	*Quercus ilicifolia*
hickory, pignut	*Carya glabra*	oak, swamp white	*Quercus bicolor*
hickory, shagbark	*Carya ovata* var. *ovata*	oak, white	*Quercus alba*
hobblebush	*Viburnum lantanoides*	pear	*Pyrus*
holly, winterberry	*Ilex verticillata*	pine, eastern white	*Pinus strobus*
honeysuckle, Bell's	*Lonicera* x *bella*	pine, pitch	*Pinus rigida*
ironweed, New York	*Vernonia noveboracensis*	pitcher-plant	*Sarracenia purpurea*
Joe-Pye-weed, spotted	*Eutrochium maculatum* var. *maculatum*	polypody, rock	*Polypodium virginianum*
knapweed, spotted	*Centaurea stoebe* ssp. *micranthos*	pond-lily, fragrant	*Nymphaea odorata* ssp. *odorata*
knotweed, Japanese	*Reynoutria japonica* var. *japonica*	pond-lily, yellow	*Nuphar variegata*
lady's-slipper	*Cypripedium*	prickly-ash, American	*Zanthoxylum americanum*
leatherleaf	*Chamaedaphne calyculata*	ragweed, common	*Ambrosia artemisiifolia*
leek, wild	*Allium tricoccum* var. *tricoccum*	ragwort, golden	*Packera aurea*
lobelia, Kalm's	*Lobelia kalmii*	reed, common	*Phragmites australis*
loosestrife, purple	*Lythrum salicaria*	rose, multiflora	*Rosa multiflora*
madder, wild	*Galium album*	rush, soft	*Juncus effusus* ssp. *solutus*
maple	*Acer*	sage, sticky	*Salvia glutinosa*
maple, red	*Acer rubrum*	sarsaparilla, bristly	*Aralia hispida*
maple, sugar	*Acer saccharum*	skullcap, marsh	*Scutellaria galericulata*
marsh-marigold	*Caltha palustris*	sedge, bristly	*Carex comosa*
meadowsweet	*Spiraea alba* var. *latifolia*	sedge, cattail	*Carex typhina*

(continued)

Table C-1. (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
sedge, Davis'	*Carex davisii*	stiltgrass, Japanese	*Microstegium vimineum*
sedge, false hop	*Carex lupuliformis*	sundew	*Drosera*
sedge, fox	*Carex vulpinoidea*	sundew, round-leaved	*Drosera rotundifolia*
sedge, lakeside	*Carex lacustris*	sunflower	*Helianthus*
sedge, Pennsylvania	*Carex pensylvanica*	sweetflag	*Acorus*
sedge, pointed broom	*Carex scoparia*	tamarack	*Larix laricina*
sedge, porcupine	*Carex hystericina*	timothy	*Phleum pratense* ssp. *pratense*
sedge, tussock	*Carex stricta*	tree-of-heaven	*Ailanthus altissima*
sedge, woolly-fruited	*Carex lasiocarpa* ssp. *americana*	twisted-stalk, rose	*Streptopus lanceolatus*
sedge, yellow	*Carex flava*	vervain, blue	*Verbena hastata*
serviceberry	*Amelanchier*	violet, sweet white	*Viola blanda*
sheep-laurel	*Kalmia angustifolia* var. *angustifolia*	wall-rue	*Asplenium ruta-muraria*
skunk-cabbage	*Symplocarpus foetidus*	water-plantain	*Alisma*
spikemoss, hidden	*Selaginella eclipes*	wild-flax, yellow	*Linum sulcatum*
spike-muhly	*Muhlenbergia glomerata*	willow, autumn	*Salix serissima*
spleenwort, ebony	*Asplenium platyneuron*	willow, sage-leaved	*Salix candida*
spleenwort, maidenhair	*Asplenium trichomanes*	yarrow	*Achillea millefolium*
spruce, black	*Picea mariana*	yew, Canada	*Taxus canadensis*
steeplebush	*Spiraea tomentosa*		

Table C-2. Vascular plants of statewide conservation concern known to occur or possible in the Town of Dover, Dutchess, County, NY. Scientific nomenclature follows Weldy et al. 2019.

Common Name[1]	Scientific Name	NYS Rank[1]	NYNHP Rank1[2]	Habitat
agalinis, small-flowered	*Agalinis paupercula*	R	S3	calcareous marsh
agrimony, small-flowered	*Agrimonia parviflora*	R	S3	pasture, thicket
angelica, hairy	*Angelica venenosa*	R	S1	dry forest
avens, cream	*Geum virginianum*	T	S2	wet upland forest
birch, bog	*Betula pumila*	T	S2	calcareous marsh
bittersweet, American	*Celastrus scandens*	R	S3	dry forests, hedgerow
bladderwort, hiddenfruit	*Utricularia geminiscapa*	R	S3	open swamp, pond, marsh
bladderwort, lesser	*Utricularia minor*	R	S3	calcareous bog
blazing-star, northern	*Liatris scariosa* var. *novae-angliae*	T	S2	dry forest or opening
bulrush, Georgia	*Scirpus georgianus*	E	S1S2	marsh, wet meadow
bur-reed, narrowleaf	*Sparganium angustifolium*		S3S4	deep or shallow water
bush-clover, bushy	*Lespedeza frutescens*	R	S3	dry forest, edge of forest, rocky summit
buttercup, small-flowered	*Ranunculus micranthus*	R	S3	wet forested rock outcrop, ledge
cliffbrake, smooth	*Pellaea glabella* ssp. *glabella*	T	S2	limestone cliff
coontail, spiny-fruited	*Ceratophyllum echinatum*	R	S3	pond, lake, slow moving stream
Culver's-root	*Veronicastrum virginicum*	T	S2	wet meadow, streambank
dodder, smartweed	*Cuscuta polygonorum*	E	S1	open (unforested) habitats
fairywand	*Chamaelirium luteum*	E	S1S2	wet forest, bog
flatsedge, red-rooted	*Cyperus erythrorhizos*	R	S3	wettish soils at edges of ponds and streams
flax, grooved yellow	*Linum sulcatum*	T	S2	dry, sandy, or stony soil
false-gromwell, Virginia	*Lithospermum virginianum*	E	S1	calcareous, open, rocky or sandy habitats
flatsedge, red-rooted	*Cyperus erythrorhizos*	R	S3	wettish soils at edges of ponds and streams
flax, grooved yellow	*Linum sulcatum*	T	S2	dry, sandy, or stony soil
false-gromwell, Virginia	*Lithospermum virginianum*	E	S1	calcareous, open, rocky or sandy habitats
goldenseal	*Hydrastis canadensis*	T	S2	rich soil at base of calcareous slopes
grama, side oats	*Bouteloua curtipendula* var. *curtipendula*	E	S2	dry shaly slope

(continued)

Table C-2. (cont.)

Common Name[1]	Scientific Name	NYS Rank[2]	NYNHP Rank[3]	Habitat
grass, northern reed	*Calamagrostis stricta* ssp. *inexpansa*	T	S2	rocky (schist) slope
grass, pod	*Scheuchzeria palustris*	R	S3	bog
grass, prairie wedge	*Sphenopholis obtusata*	E	S1	dry soil
hyssop, yellow giant	*Agastache nepetoides*	T	S2S3	open forest
knotweed, pleated leaved	*Polygonum tenue*	R	S3	dry, shaly, sandy hill & knoll
lady's-slipper, greater yellow	*Cypripedium parviflorum* var. *pubescens*		S3	rich, often calcareous forest
lady's-slipper, showy	*Cypripedium reginae*		S3	rich swamp
lousewort, marsh	*Pedicularis lanceolata*	T	S2S3	rich wetland
lupine, wild	*Lupinus perennis* ssp. *perennis*	R	S3	dry, sandy, or shaly soil
mercury, Virginia three-seeded	*Acalypha virginica*	E	S1	forest, field, roadside
milkweed, green	*Asclepias viridiflora*	T	S2	dry shaly slope
milkweed, whorled	*Asclepias verticillata*	R	S3	dry shaly slope
mock-pennyroyal	*Hedeoma hispida*	T	S2S3	dry, rocky, open, calcareous habitats
monkey-flower, sharp-winged	*Mimulus alatus*	R	S3	wet area along stream, wetland, pond
mountain-mint, basil	*Pycnanthemum clinopodioides*	E	S1	open forests, often rocky, calcareous
mountain-mint, Torrey's	*Pycnanthemum torrei*	E	S1	dry forests, ledges, barrens
mouth, dragon's	*Arethusa bulbosa*	T	S2	*Sphagnum* bog
orchid, Hooker's	*Platanthera hookeri*	E	S1	steep rocky acidic slope
paintbrush, Indian	*Castilleja coccinea*	E	S1	open calcareous habitats
pennyroyal, false	*Trichostema brachiatum*	R	S3	dry, sandy or gravelly soil
pink, wild	*Silene caroliniana* ssp. *pensylvanica*	T	S2	dry forest on shaly or schistose rock
pondweed, Hill's	*Potamogeton hillii*	T	S2	clear, cold calcareous water
pondweed, Ogden's	*Potamogeton x ogdenii*	E	S1	alkaline water
pondweed, spotted	*Potamogeton pulcher*	T	S2	shallow acidic water, muddy shore
pondweed, straight-leaved	*Potamogeton strictifolius*	E	S1	alkaline pond, stream
rattlebox, common	*Crotalaria sagittalis*	E	S1	sandy or waste ground
sedge, ambiguous	*Carex amphibola*	E	S3	forest, forested slope, floodplain of small creek
sedge, Bicknell's	*Carex bicknellii*	R	S3	dry shaly bank

(continued)

Table C-2. (cont.)

Common Name[1]	Scientific Name	NYS Rank[2]	NYNHP Rank[3]	Habitat
sedge, blue	*Carex glaucodea*	T	S2	hardwood forest, disturbed area, meadow
sedge, Bush's	*Carex bushii*	R	S3	rich meadowland
sedge, Buxbaum's	*Carex buxbaumii*	T	S2	swamp
sedge, cattail	*Carex typhina*	E	S2	wet forest, marsh
sedge, Davis'	*Carex davisii*	T	S2	alluvial forest, calcareous
sedge, Emmons'	*Carex emmonsii*	R	S3	various forested, open, wet, and dry habitats
sedge, false hop	*Carex lupuliformis*	T	S2	floodplain forest, marsh, shoreline, intermittent woodland pool
sedge, handsome	*Carex formosa*	T	S2	calcareous forest, thicket
sedge, reflexed	*Carex retroflexa*	T	S2S3	calcareous forest, rocky slope, meadow
sedge, Schweinitz's	*Carex schweinitzii*	T	S2S3	swamp, springy bank
sedge, troublesome	*Carex molesta*	T	S2S3	swamp
sedge, Willdenow's	*Carex willdenowii*	R	S2S3	dry acidic forest
sorrel, violet wood	*Oxalis violacea*	T	S2S3	dry upland forest
spikerush, Engelmann's	*Eleocharis engelmannii*	E	S1	marsh, wet area
spikerush, ovate	*Eleocharis ovata*	E	S1S2	open wetlands, disturbed soils
St. Johnswort, shrubby	*Hypericum prolificum*	T	S2	forest, cliff, swamp-margin, oldfield
tree, Kentucky coffee	*Gymnocladus dioicus*	E	S1	rich bottomland, thicket, forest edge
trillium, nodding	*Trillium cernuum*		S3	moist forests
twayblade, large	*Liparis liliifolia*		E, S1	open calcareous forest
valerian, marsh	*Valeriana uliginosa*	E	S1S2	calcareous marsh
water-marigold, Beck's	*Bidens beckii*		S3	shallow water at pond or lake edge
whitlow-grass, Carolina	*Tomostima reptans*	T	S2	open calcareous habitats

[1] New York State ranks:
E = Endangered
T = Threatened
R = Rare

[2] New York Natural Heritage Program ranks are explained in Appendix D.

Table C-3. Prominent non-native invasive plants of the region, 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/system/files/documents/Species%20Categorization%20LHPRISM.pdf.

Common Name	Scientific Name	Common Name	Scientific Name
Tier 1 - Threat Invasive Species (do not yet occur in the region)			
alligatorweed	*Alternanthera philoxeroides*	parrot feather	*Myriophyllum aquaticum*
Asiatic sand sedge	*Carex kobomugi*	pygmyweed	*Crassula helmsii*
beach vitex	*Vitex rotundifolia*	reed mannagrass	*Glyceria maxima*
bog bulrush	*Schoenoplectiella mucronata*	sacred lotus	*Nelumbo nucifera*
broadleaf milfoil hybrid	*Myriophyllum heterophyllum* x *M. laxum*	saltcedar	*Tamarix ssp.*
broad-leaved peppergrass	*Lepidium latifolium*	starry stonewort	*Nitellopsis obtusa*
Cogon grass	*Imperata cylindrica*	swamp morning-glory	*Ipomoea aquatica*
European water-fern	*Marsilea quadrifolia*	swampweed	*Hygophila polysperma*
floating primrose willow	*Ludwigia peploides*	Uruguayan primrose willow	*Ludwigia hexapetala*
fountain grass	*Pennisetum alepecuroides*	variable flat-sedge	*Cyperus difformis*
giant salvinia	*Salvinia molesta*	water fern	*Salvia minima*
heavenly bamboo	*Nandina domestica*	water lettuce	*Pistia stratiotes*
Himalayan balsam	*Impatiens glandulifera*	water primrose	*Ludwigia adscendens*
Japanese chaff flower	*Achyranthes japonica*	water soldiers	*Stratiotes aloides*
largehead sedge	*Carex macrocephala*	waterwheel	*Aldrovanda vesiculosa*
marsh dewflower	*Murdannia keisak*	wavyleaf basketgrass	*Oplismenus hirtellus* ssp. *undulatifolius*
oxygenweed	*Lagarosiphon major*		
Tier 2 - Emerging Invasive Species (just starting to become established in the region)			
beefsteak plant	*Perilla frutescens*	Japanese spiraea	*Spiraea japonica*
Brazilian elodea	*Egeria densa*	Japanese wisteria	*Wisteria floribunda*
castor aralia	*Kalopanax septemlobus*	Katsura tree	*Cercidiphyllum japonicum*
Chinese bush-clover	*Lespedeza cuneata*	kudzu	*Pueraria montana*
Chinese privet	*Ligustrum sinense*	large gray willow	*Salix atrocinerea*
Chinese wisteria	*Wisteria sinensis*	leatherleaf mahonia	*Mahonia bealei*
Chinese yam	*Dioscorea oppositifolia*	linden arrowwood	*Viburnum dilatatum*
crested late summer mint	*Elsholtzia ciliata*	oriental photinia	*Photinia villosa*
cup-plant	*Silphium perfoliatum*	pale swallow-wort	*Cynanchum rossicum*
cut-leaf blackberry	*Rubus laciniatus*	paper mulberry	*Broussonetia papyrifera*
cut-leaf teasel	*Dipsacus laciniatus*	pogoda tree	*Styphnolobium japonicum*
Eurasian watermilfoil	*Myriophyllum spicatum*	purple beautyberry	*Callicarpa dichotoma*
European alder	*Alnus glutinosa*	Russian olive	*Elaeagnus angustifolia*
European frogbit	*Hydroacharis morsus-ranae*	sapphireberry	*Symplocos paniculata*
fanwort	*Cabomba caroliniana*	Scotch broom	*Cytisus scoparius*
five-leaf akebia	*Akebia quinata*	Siebold's arrowwood	*Viburnum sieboldii*
garden yellow-loosestrife	*Lysimachia vulgaris*	silver vine	*Actinidia polygama*
giant hogweed	*Heracleum mantegazzianum*	slender false brome	*Brachypodium sylvaticum*
giant reed	*Arundo donax*	small carpetgrass	*Arthraxon hispidus*
golden rain tree	*Koelreuteria paniculata*	sticky sage	*Salvia glutinosa*
hardy kiwi	*Actinidia arguta*	tall baby's-breath	*Gypsophila paniculata*
Higan cherry	*Prunus subhirtella*	tea crabapple	*Malus hupehensis*
hydrilla	*Hydrilla verticillata*	tree lilac	*Syringa reticulata*
incised fumewort	*Corydalis incisa*	water hyacinth	*Eichhornia crassipes*
Italian arum	*Hairy jointgrass*	weeping lovegrass	*Eragrostis curvula*
Japanese primrose	*Primula japonica*	yellow floating-heart	*Nymphoides peltata*
Japanese snowball	*Viburnum plicatum*		

(continued)

Table C-3. (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
Tier 3 - Established Invasive Species (common or abundant in the region)			
Amur corktree	*Phellodendron amurense*	lesser celandine	*Ficaria verna*
Amur honeysuckle	*Lonicera maackii*	mile-a-minute weed	*Persicaria perfoliata*
bishop's goutweed	*Aegopodium podagraria*	narrowleaf bittercress	*Cardamine impatiens*
black jetbead	*Rhodotypos scandens*	porcelain berry	*Ampelopsis brevipedunculata*
black swallowwort	*Cynanchum louiseae*	princess tree	*Paulownia tomentosa*
border privet	*Ligustrum obtusifolium*	Siberian elm	*Ulmus pumila*
Bradford pear	*Pyrus calleryana*	Siberian peashrub	*Caragana arborescens*
brittle naiad	*Najas minor*	smooth buckthorn	*Frangula alnus*
Chinese silver grass	*Miscanthus sinensis*	sycamore maple	*Acer pseudoplatanus*
climbing spindle-tree	*Euonymus fortunei*	Toringo crabapple	*Malus sieboldii*
cypress spurge	*Euphorbia cyparissias*	water-chestnut	*Trapa natans*
Japanese angelica-tree	*Aralia elata*	watercress	*Nasturtium officinale*
Japanese hops	*Humulus japonicus*	wild chervil	*Anthriscus sylvestris*
leafy spurge	*Euphorbia esula*	yam-leaved virgin's-bower	*Clematis terniflora*
Tier 4 - Widespread Invasive Species (abundant throughout the region)			
autumn-olive	*Elaeagnus umbellata*	Japanese honeysuckle	*Lonicera japonica*
bird cherry	*Prunus avium*	Japanese knotweed	*Reynoutria japonica*
black knapweed	*Centaurea nigra*	Japanese stilt-grass	*Microstegium vimineum*
black locust	*Robinia pseudoacacia*	Morrow's honeysuckle	*Lonicera morrowii*
Bohemian knotweed	*Reynoutria x bohemica*	mugwort	*Artemisia vulgaris*
brown knapweed	*Centaurea jacea*	multiflora rose	*Rosa multiflora*
bull thistle	*Cirsium vulgare*	Norway maple	*Acer platanoides*
burning-bush	*Euonymus alatus*	oriental bittersweet	*Celastrus orbiculatus*
Canada thistle	*Cirsium arvense*	purple loosestrife	*Lythrum salicaria*
common buckthorn	*Rhamnus cathartica*	reed canarygrass	*Phalaris arundinacea*
common reed grass	*Phragmites australis*	spotted knapweed	*Centaurea stoebe*
curly-leaf pondweed	*Potamogeton crispus*	tree-of-heaven	*Ailanthus altissima*
English ivy	*Hedera helix*	true forget-me-not	*Myosotis scorpioides*
Eurasian watermilfoil	*Myriophyllum spicatum*	white mulberry	*Morus alba*
European barberry	*Berberis vulgaris*	wild parsnip	*Pastinaca sativa*
fuller's teasel	*Dipsacus fullonum*	wineberry	*Rubus phoenicolasius*
garlic-mustard	*Alliaria petiolata*	yellow iris	*Iris pseudacorus*
Japanese barberry	*Berberis thunbergii*	yellow watercress	*Rorippa amphibia*

Table C-4. Dragonflies and damselflies of Dover.

Occurrence data are vouchered and unvouchered records from the NYSDEC 2005-2009 statewide survey and earlier records documented in White et al. (2010) in or near Dover. Habitats are from Vispo (2017) and Abbott (2006-2019).

Common name	Scientific name	Habitat	Statewide Status[1]
AESHNIDAE			
darner, black-tipped	*Aeshna tuberculifera*	over fields & along edges of ponds & lakes	
darner, Canada	*Aeshna canadensis*	over fields & along shores of slow-moving water	
darner, common green	*Anax junius*	over small ponds, skimming lake edges, or over fields	
darner, Cyrano	*Nasiaeschna pentacantha*	forested ponds, streams, lake coves	S2S3
darner, fawn	*Boyeria vinosa*	in forested swamps & over shaded streams	
darner, green-striped	*Aeshna verticalis*	over fields	
darner, harlequin	*Gomphaeschna furcillata*	edges of forests	
darner, lance-tipped	*Aeshna constricta*	over fields & ponds	
darner, shadow	*Aeshna umbrosa*	along forest edges, shaded areas	
darner, spatterdock	*Rhionaeschna mutata*	around forest edges & fields near vegetated ponds & lakes	S2S3
darner, springtime	*Basiaeschna janata*	shores of lakes & slow-moving streams	
darner, swamp	*Epiaeschna heros*	wooded ponds & streams (incl. ephemeral pools & ponds)	S3
CALOPTERYGIDAE			
jewelwing, ebony	*Calopteryx maculata*	in shaded areas & along small streams	
jewelwing, river	*Calopteryx aequabilis*	around all types of rivers & streams	S3S4
COENAGRIONIDAE			
bluet, azure	*Enallagma aspersum*	near most slow-moving water	
bluet, double-striped	*Enallagma basidens*	around edges of still water where vegetation present	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*	ponds & lakes with forested shores	S3
bluet, stream	*Enallagma exsulans*	along sides of streams & lakes	
bluet, turquoise	*Enallagma divagans*	slow-moving streams, lakes	S3
bluet, vesper	*Enallagma vesperum*	around ponds & lakes	

(continued)

Table C-4. (cont.)

Common name	Scientific name	Habitat	Statewide Status[1]
COENAGRIONIDAE (cont.)			
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
dancer, dusky	*Argia translata*	unshaded streams	S1
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 pond-lilies	S3
sprite, sedge	*Nehalennia irene*	in wet, grassy, mostly open areas	
CORDULEGASTRIDAE			
spiketail, delta-spotted	*Cordulegaster diastatops*	unshaded seeps, small streams	
spiketail, twin-spotted	*Cordulegaster maculata*	around rocky, shaded streams & along field edges	
CORDULIIDAE			
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*	marshy lakes, ponds, slow streams	S3
emerald, American	*Cordulia shurtleffii*	near still ponds, bogs, fens, marshes, small lakes, & over meadows	
emerald, brush-tipped	*Somatochlora walshii*	slow-moving clear streams through bogs, fens, & marshes	S3
emerald, clamp-tipped	*Somatochlora tenebrosa*	edge of fields & along shady tree lines	
emerald, mocha	*Somatochlora linearis*	forested streams	S1
emerald, Williamson's	*Somatochlora williamsoni*	shaded ponds & slow-moving streams	S3S4
GOMPHIDAE			
clubtail, arrow	*Stylurus spiniceps*	over sandy streams or on the banks	S3
clubtail, ashy	*Gomphus lividus*	moderately fast-moving streams & sheltered inlets of lakes	
clubtail, lancet	*Gomphus exilis*	over fields, roads, & on rocks near water	
clubtail, least	*Stylogomphus albistylus*	around rocky streams	
clubtail, lilypad	*Arigomphus furcifer*	around still water & slow-moving streams	

(continued)

Table C-4. (cont.)

Common name	Scientific name	Habitat	Statewide Status[1]
GOMPHIDAE (cont.)			
clubtail, northern pygmy	*Lanthus parvulus*	over small shaded streams	S3
clubtail, unicorn	*Arigomphus villosipes*	around ponds & lakes	
clubtail, northern pygmy	*Lanthus parvulus*	clean, rocky streams	S3
snaketail, brook	*Ophiogomphus aspersus*	over clean running water, open sunny streams	S3
snaketail, Maine	*Ophiogomphus mainensis*	clear streams & lakes, gravel or sandy bottoms	S3
snaketail, rusty	*Ophiogomphus rupinsulensis*	near rivers & on nearby rocks	S3S4
LESTIDAE			
spreadwing, amber-winged	*Lestes eurinus*	near still water; esp. boggy or temporary ponds	S3S4
spreadwing, common	*Lestes disjunctus*	slow-moving streams with emergent veg, marshes, swamps, & bogs	
spreadwing, elegant	*Lestes inaequalis*	near still water & in shaded environments	
spreadwing, lyre-tipped	*Lestes unguiculatus*	open pools, ponds, slow-moving streams	S2S3
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	
LIBELLULIDAE			
amberwing, eastern	*Perithemis tenera*	around ponds & other still water, or in nearby fields	
corporal, chalk-fronted	*Ladona julia*	near ponds & small lakes	
dasher, blue	*Pachydiplax longipennis*	over still ponds	
glider, spot-winged	*Pantala hymenaea*	open temp. ponds, pools (incl. artificial)	
meadowhawk, band-winged	*Sympetrum semicinctum*	in meadows & fields	
meadowhawk, cherry-faced	*Sympetrum internum*	around small ponds & nearby fields	
meadowhawk, yellow-legged	*Sympetrum vicinum*	near still water 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, black	*Tramea lacerata*	over fields & meadows	
skimmer, four-spotted	*Libellula quadrimaculata*	around ponds, swamps, & marshy streams	
skimmer, painted	*Libellula semifasciata*	marshy forested seeps, ponds, & slow-moving streams	
skimmer, slaty	*Libellula incesta*	around edges of ponds & lakes	

(continued)

Table C-4. (cont.)

Common name	Scientific name	Habitat	Statewide Status[1]
LIBELLULIDAE (cont.)			
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, red-waisted	*Leucorrhinia proxima*	bogs, fens, acidic ponds	S3S4
whitetail, common	*Plathemis lydia*	all types of water (except fast-moving) & in fields	
MACROMIIDAE			
cruiser, stream	*Didymops transversa*	medium to large streams & rivers	

[1] New York Natural Heritage Program ranks are explained in Appendix D. Only ranks of S1, S2, and S3 (and combinations) are given here.

Table C-5. Butterflies of Dutchess County, New York.

Occurrence data are from butterfliesandmoths.org, Shapiro (1974), iNaturalist, and Hudsonia Ltd. Flight time, foods, and habitats from Cech and Tudor (2005).

Common Name	Statewide Status[1,2]	Flight Time	Caterpillar Food	Habitat
HESPERIIDAE				
broken-dash, northern		early Jun-mid Aug	panic grasses	oldfield
cloudywing, northern		late May-early Jul	clovers & other legumes	"scrubby field"
cloudywing, southern		early Jun-mid Jul	legumes	open habitats
dash, black		late Apr-early Jun	sedges	sedgy wetlands
dash, long		early Jun-early Jul; Aug	grasses	open grassy meadow, often moist
duskywing, columbine		May-Jun, Jul	columbine	calcareous ledge
duskywing, dreamy		mid-May-Jun	willows, aspen, black locust	open forest & edges
duskywing, Juvenal's		late Apr-early Jun	oaks	open upland habitats, usually not disturbed
duskywing, mottled	SC, S1, SGCN[HP]	May-Jun, Jul-Aug	New Jersey tea	open, dry forest
duskywing, Persius	E, S1, SGCN[HP]	May-early Jun	wild indigo	barrens
duskywing, sleepy		May	scrub oak	balds, barrens
duskywing, wild indigo		May-Aug	wild indigo, vetches	in or near alfalfa fields
edge, hoary		Jun-Jul	legumes, e.g., tick trefoil	oldfield & field edges
glassywing, little		late Jun-Jul	purple top & other grasses	oldfield & pasture
skipper, broadwing	S3	mid-Jul-Aug	reeds, sedges, wild rice	wet areas with *Phragmites*
skipper, crossline		late Jun-early Aug	grasses	dry and moist fields
skipper, Delaware		mainly Jul	little bluestem, switchgrass, other grasses	open habitats, dry to wet
skipper, Dion	S3	Jul	sedges	wetlands
skipper, dun		Jul-Aug	sedges, maybe grasses	oldfield
skipper, European		Jun-Jul	timothy & other introduced grasses	meadow
skipper, Hobomok		late May-early Jul	grasses	oldfield
skipper, Indian		May-Jun	grasses, e.g., bluestem	dry, often shrubby, meadows

(continued)

Table C-5. (cont.)

Common Name	Statewide Status[1,2]	Flight Time	Caterpillar Food	Habitat
HESPERIIDAE (cont.)				
skipper, least		Jun-Oct	grasses	wet meadow, grassy marsh
skipper, Leonard's		end of Aug/early Sep	native grasses, e.g., little bluestem	dry upland grassland near wet area
skipper, Peck's		late May-Sep	grasses	meadow
skipper, pepper & salt		May-Jun	grasses	forest openings
skipper, roadside		late May-mid Jun	grasses	forest openings
skipper, silver-spotted		Jun-Aug	black locust	shrubby fields
skipper, tawny-edged		late May-mid Jul; early Aug-Sep	grasses	grassy, often moist
skipper, Zabulon		late May-mid Jun; mid Aug-mid Sep	grasses	shrubby fields, roadside
sootywing, common		mid-May-mid Jun; late Jul-Aug	lamb's quarters & others	open habitats
wing, mulberry		mid Jul-early Aug	sedges	sedgy wetlands
LYCAENIDAE				
azure, Appalachian	S1S3	Apr-Jul	black cohosh	deciduous woods, near streams
azure, northern		Mar-May	blueberry, cherry & viburnum buds	barrens, woods
azure, spring		Apr-Sep	dogwood, various	deciduous woods
azue, summer		May-Sep	various	woodlands
blue, eastern tailed		May-Sep	legumes	open, disturbed, low growth
copper, American		May-Sep	Rumex (docks)	drier meadows
copper, bronze		mid Jun-mid Jul; early Aug-mid Sep	Rumex (docks)	wetlands around ponds or streams
elfin, brown		May	heaths	barrens, dry forest
elfin, eastern pine		May-Jun	pines	near pine woods
hairstreak, Acadian		Jul	willows	shrubby wet meadows & swamps
hairstreak, banded		May-Aug	oaks, hickories	edges, open habitats
hairstreak, coral		Jun	cherries, plums	oldfield, second growth
hairstreak, Edward's	S3S4	Jul	scrub oak	scrub oak forest, rocky barren

(continued)

Table C-5. (cont.)

Common Name	Statewide Status[1,2]	Flight Time	Caterpillar Food	Habitat
LYCAENIDAE (cont.)				
hairstreak, grey		early May-mid Jun	various meadow & shrubland plants	open, weedy, disturbed
hairstreak, hickory		late Jun-early Aug	hardwood trees	edges of rich, deciduous forests
hairstreak, juniper		mid May-Jun; Aug	eastern red cedar	open uplands with red cedar
hairstreak, red-banded		May-Jun; Aug-Sep	rotting leaves	open habitats
hairstreak, striped		late Jun-mid Jul	roses, cherries, hawthorns, heaths, American hornbeam	forest openings & edges
harvester		May-Sep	alder aphids	alder swamp
RIODINIDAE				
northern metalmark	S1	mid Jun-late Jul	roundleaf ragwort, common fleabane	open-forested streams near limestone or shale barrens
NYMPHALIDAE				
admiral, red		May-Oct	nettles	moist forest & meadow, esp. floodplain forests
admiral, white		mid Jun-early Aug; mid Aug-mid Sep	cherries	forests, edges, shrubland
brown, Appalachian		late Jun-Aug	sedges	forested wet areas, near sedges
brown, eyed		late Jun-early Aug	sedges	sedgy habitats
buckeye, common		Jul-Sep	plantains, figworts, vervains	open habitats with some bare ground
checkerspot, Baltimore		mid Jun-mid Jul	turtlehead, English plantain	meadow
checkerspot, Harris'		Jun-Jul	flat-topped white aster	wet, open habitats
cloak, mourning		year-round; most common in summer	willows, other trees	wanders among many habitats
comma, eastern		3 flights, Apr-Sep?	elms and nettles	woods, especially floodplain forests
comma, green		3 flights, Apr-Sep?	gooseberry, currant	"boreal woodlands"
crescent, pearl		mid May-early Sep	asters	meadow
emperor, hackberry	S3S4	Jul-Aug	hackberry	floodplains with hackberry

(continued)

Table C-5. (cont.)

Common Name	Statewide Status[1,2]	Flight Time	Caterpillar Food	Habitat
NYMPHALIDAE (cont.)				
emperor, tawny	S2S4	Jul-Aug	hackberry	hackberry habitats
fritillary, Aphrodite		late Jun-early Sep	violets	upland habitats on acidic soils, moist grasslands
fritillary, great spangled		late Jun-early Sep	violets	forest edges
fritillary, meadow		May-Sep	violets	moist fields
fritillary, regal	E, SH	late Jun-mid Sep	violets	extensive open areas with some wetness
fritillary, silver-bordered		Jun-Sep	wetland violets	overgrowing wet habitats, marshes, bogs
lady, American		mid May-late Oct	composites (asters, goldenrods, etc.)	(various)
lady, painted		May-Oct	various meadow plants	open habitats
mark, question		late Jun-Oct	elms	forests and edges
monarch	SPCN	mid Jun-Sep	milkweeds	oldfield, edges
nymph, common wood		Jul-early Sep	grasses	meadow with shrubs or other tall vegetation
pearly-eye, northern		late Jun-early Aug	grasses	forest, often near water
purple, red-spotted		mid Jun-early Aug; mid Aug-mid Sep	cherries	near deciduous, often moist forest
satyr, little wood		late May-early Aug	grasses	edges, forest openings
snout, American		late Jun-mid Oct	hackberry	forested stream edges
tortoiseshell, Compton		March-fall	birches, willows	forest openings and edges
tortoiseshell, Milbert's		mid Jun-Oct?	nettles	wet or moist habitats near forest
viceroy		late May-early Oct	willow	moist, shrubby habitats
PAPILIONIDAE				
swallowtail, black		May-Sep	parsley, carrot, & related plants	mainly open meadows
swallowtail, Canada		May-early Jun?	birch, aspen, cherry	near deciduous trees
swallowtail, eastern tiger		late May-Oct	black cherry, tulip tree, ash	near deciduous trees

(continued)

Table C-5. (cont.)

Common Name	Statewide Status[1,2]	Flight Time	Caterpillar Food	Habitat
PAPILIONIDAE (cont.)				
swallowtail, giant		May-Sep	plants in the rue family	various habitats, often semi-open
swallowtail, pipevine		Jun-early Oct	pipevine	gardens, rocky forested uplands
swallowtail, spicebush		May-Aug	spicebush	various open habitats, usually near forest
PIERIDAE				
sulphur, clouded		May-mid Oct	legumes	open habitats
orange-tip, falcate	S3S4	May	mustards, rock cresses, two-leaved toothwort	"trap rock hills"
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, West Virginia	S3	early Apr-late May	mainly *Dentaria* & *Cardamine diphylla*	rich moist woods

[1] New York Natural Heritage Program ranks are explained in Appendix D. Only ranks of S1, S2, S3, and SH (and combinations) are given here.

[2] New York State ranks:

E = endangered
T = threatened
SC = special concern (Environmental Conservation Law 6NYCRR Part 182.[g]
SGCN = Species of Greatest Conservation Need (https://www.dec.ny.gov/animals/9406.html)
SGCN^{HP} = Highest Priority Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)
SPCN = Species of Potential Conservation Need (https://www.dec.ny.gov/docs/wildlife_pdf/spnc2015list.pdf)

Table C-6. Fishes of Dover's streams and ponds.

Occurrence data are historic and recent records (1936-2009) from the Atlas of Inland Fishes of New York (Carlson et al. 2016). Because of limited sampling, the list is expected to be incomplete for Dover, and especially so for lakes and ponds.

Common Name	Scientific Name	Native (Yes/No)	Statewide Status[1]	Streams	Ponds/ Lakes
American eel	*Anguilla rostrata*	Y	S2S3, SGCN^{HP}	x	
banded killifish	*Fundulus diaphanus*	Y		x	
bluegill	*Lepomis macrochirus*	N		x	x
bluntnose minnow	*Pimephales notatus*	Y			
bridle shiner	*Notropis bifrenatus*	Y	S2?, SGCN		
brook trout	*Salvelinus fontinalis*	Y	SGCN	x	x
brown bullhead	*Ameiurus nebulosus*	Y		x	x
brown trout	*Salmo trutta*	N		x	
chain pickerel	*Esox niger*	Y			x
common shiner	*Luxilus cornutus*	Y		x	
creek chub	*Semotilus atromaculatus*	Y		x	
cutlip minnow	*Exoglossum maxillingua*	Y		x	
eastern blacknose dace	*Rhinichthys atratulus*	Y		x	
fallfish	*Semotilus corporalis*	Y		x	
golden shiner	*Notemigonus crysoleucas*	Y		x	x
green sunfish	*Lepomis cyanellus*	N			x
largemouth bass	*Micropterus salmoides*	N		x	x
longnose dace	*Rhinichthys cataractae*	Y		x	
pumpkinseed	*Lepomis gibbosus*	Y		x	x
rainbow trout	*Oncorhynchus mykiss*	N			x
redbreast sunfish	*Lepomis auritus*	Y		x	
redfin pickerel	*Esox americanus americanus*	Y		x	
rock bass	*Ambloplites rupestris*	N		x	
slimy sculpin	*Cottus cognatus*	Y		x	
smallmouth bass	*Micropterus dolomieu*	N		x	x
tessellated darter	*Etheostoma olmstedi*	Y		x	
white sucker	*Catostomus commersonii*	Y		x	x
yellow bullhead	*Ameiurus natalis*	Y		x	
yellow perch	*Perca flavescens*	Y		x	x

[1] Statewide Status:
New York Natural Heritage Program (NYNHP) ranks (S1, S2, S3) are explained in Appendix D.
SGCN = Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)
SGCN^{HP} = Highest Priority Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)

Table C-7. Amphibians and reptiles of Dover, New York.

Occurrence data are mainly from the New York State Reptile and Amphibian Atlas.

Common Name	Scientific Name	Habitat	Statewide Status[1]
SALAMANDERS			
blue-spotted salamander	*Ambystoma laterale*	swamp, vernal pool, upland forest	SC
eastern newt	*Notophthalmus viridescens*	perennial pond, other wetland, upland forest	
eastern red-backed salamander	*Plethodon cinereus*	upland forest	
four-toed salamander	*Hemidactylium scutatum*	swamp, upland forest	$SGCN^{HP}$
Jefferson salamander	*Ambystoma jeffersonianum*	vernal pool, upland forest	SC, SPCN
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	
TOADS & FROGS			
eastern spadefoot toad	*Scaphiopus holbrookii*	unforested habitats with sandy soils	SC, S2S3
American toad	*Bufo americanus*	everywhere	
bullfrog	*Rana catesbeiana*	forest, meadow	
gray treefrog	*Hyla versicolor*	shallow pool, upland forest	
green frog	*Rana clamitans*	pond, marsh	
Atlantic coast leopard frog[2]	*Lithobates kauffeldi*	pond, marsh, wet meadow	S1S2, $SGCN^{HP}$
northern leopard frog	*Rana pipiens*	pond, marsh, meadow	
pickerel frog	*Rana palustris*	meadow, forest, wetland	
spring peeper	*Pseudacris crucifer*	upland forest, wetland	
wood frog	*Rana sylvatica*	vernal pool, upland forest	
TURTLES			
bog turtle	*Glyptemys muhlenbergii*	fen, nearby wetland	E, S2
eastern box turtle	*Terrapene carolina*	upland forest, meadow	SC
painted turtle	*Chrysemys picta*	pond, marsh, stream	
snapping turtle	*Chelydra serpentina*	pond, lake, wetland, meadow	SGCN

(continued)

Table C-7. (cont.)

Common Name	Scientific Name	Habitat	Statewide Status[1]
TURTLES (cont.)			
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	SC
SNAKES & SKINKS			
five-lined skink	*Eumeces fasciatus*	forest, ledge, talus	
common garter snake	*Thamnophis sirtalis*	everywhere	
copperhead	*Agkistrodon contortrix*	forest, ledge, meadow	SGCN
Dekay's brown snake	*Storeria dekayi*	forest, meadow, wetland, yard	
eastern racer	*Coluber constrictor*	forest, meadow, ledge, talus	SGCN
eastern rat snake	*Elaphe alleghaniensis*	forest, ledge, talus	SGCN
eastern hog-nosed snake	*Heterodon platirhinos*	forest and oldfield on sandy soils	$SGCN^{HP}$
eastern ribbon snake	*Thamnophis sauritus*	open wetland	SGCN
milksnake	*Lampropeltis triangulum*	meadow, forest, barnyard	
northern water snake	*Nerodia sipedon*	pond, lake, wetland, stream	
red-bellied snake	*Storeria occipitomaculata*	forest, meadow, wetland, yard	
ring-necked snake	*Diadophis punctatus*	forest, forest opening	
smooth green snake	*Liochlorophis vernalis*	wet meadow, other wetland, open forest	SGCN
timber rattlesnake	*Crotalus horridus*	forest, meadow, ledge, talus	T, S3

[1] Statewide ranks:

E = Endangered; T =Threatened; SC = Special Concern (Environmental Conservation Law 6NYCRR Part 182.[g])
SGCN = Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)
$SGCN^{HP}$ = Highest Priority Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)
(The SGCN rank also applies to all species ranked as NYS Endangered or Threatened.)
SPCN = Species of Potential Conservation Need (http://www.dec.ny.gov/docs/wildlife_pdf/spnc2015list.pdf)

New York Natural Heritage Program ranks are explained in Appendix D. Only ranks of S1, S2, and S3 (and combinations) are given here.

[2] Dover is within the potential range of the Atlantic coast leopard frog, but the species has not yet been confirmed here.

Table C-8. Breeding birds of conservation concern known or likely to occur in Dover. Occurrence data are mostly from the NYS Breeding Bird Atlas (McGowan and Corwin 2008). Included are birds recorded as "confirmed" or "probable" breeders in Atlas survey blocks within or near Dover in either the 1980-1985 or 2000-2005 surveys. A few additional species are included if there are historic or recent records (e.g., in DeOrsey and Butler 2019 or Hudsonia surveys) in the Dover vicinity and future occurrence seems likely.

Group	Species	General Habitat Type for Nesting	NYNHP rank[1]	NYS rank[2]	BBA 1980-85[3]	BBA 2000-05[3]	Trend[4]
WATERFOWL							
	American black duck	marsh	S3B	SGCN[HP]	y	y	d
GALLINACEOUS BIRDS							
	northern bobwhite	meadow		SGCN[HP]	y	y	d
	ruffed grouse	forest		SGCN	y	y	d
GREBES							
	pied-billed grebe	pond, marsh	S3B, S1N	T	y	y	i
CUCKOOS							
	black-billed cuckoo	forest		SGCN	y	y	d
NIGHTJARS							
	whip-poor-will	forest	S3B	SC, SGCN[HP]	y	y	d
SHOREBIRDS							
	American woodcock	shrubland, forest		SGCN	y	y	d
HERONS							
	American bittern	marsh		SC, SGCN	y	y	s
	least bittern	marsh	S3B, S1N	T	y	n	d
RAPTORS							
	bald eagle	forest (near water)	S2S3B, S2N	T	n	y	i
	sharp-shinned hawk	forest		SC	n	y	i
	Cooper's hawk	forest		SC	y	y	i
	northern goshawk	forest	S3S4B,S3N	SC, SGCN	y	y	d
	red-shouldered hawk	forest		SC, SGCN	n	y	i
	American kestrel	meadow		SGCN	y	y	d

(continued)

Table C-8. (cont.)

Group	Species	General Habitat Type for Nesting	NYNHP rank[1]	NYS rank[2]	BBA 1980-85[3]	BBA 2000-05[3]	Trend[4]
WOODPECKERS							
	red-headed woodpecker	forest (& various other)	S2?B	SC, SGCN^{HP}	n	y	d
PERCHING BIRDS							
	Acadian flycatcher	forest	S3B		y	y	d
	wood thrush	forest		SGCN	y	y	d
	brown thrasher	shrubland		SGCN^{HP}	y	y	d
	vesper sparrow	meadow		SC, SGCN^{HP}	y	y	d
	grasshopper sparrow	meadow		SC, SGCN^{HP}	y	y	d
	bobolink	meadow		SGCN^{HP}	y	y	d
	eastern meadowlark	meadow		SGCN^{HP}	y	y	d
	worm-eating warbler	forest		SGCN	y	y	d
	Louisiana waterthrush	streamside (in forest)		SGCN	y	y	d
	golden-winged warbler	shrubland		SC, SGCN^{HP}	y	y	d
	blue-winged warbler	shrubland		SGCN	y	y	d
	Kentucky warbler	forest	S2B	SGCN^{HP}	y	y	d
	cerulean warbler	forest		SC, SGCN	y	y	d
	northern parula	forest	S3S4B		n	y	i
	black-throated blue warbler	forest		SGCN	y	y	i
	prairie warbler	meadow		SGCN	y	y	d
	Canada warbler	forest		SGCN^{HP}	y	y	s
	scarlet tanager	forest		SGCN	y	y	s

[1] New York Natural Heritage Program ranks are explained in Appendix D. Only species with ranks of S1, S2, or S3 (or combinations) are listed here.

[2] New York State ranks

E = Endangered; T = Threatened; SC = Special Concern (Environmental Conservation Law 6NYCRR Part 182.[g])

SGCN = NYS Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)

SGCN^{HP} = NYS Highest Priority Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)

(The SGCN rank also applies to all species ranked as NYS Endangered or Threatened.)

[3] NYS Breeding Bird Atlas data for survey periods 1980-85 and 2000-05: y = recorded in Dover vicinity; n = not recorded in Dover vicinity

[4] Trend in BBA data between the two survey periods: i = increasing; d = declining; s = similar; ? = trend uncertain.

Table C-9. Mammals of the Town of Dover, New York.

Occurrence data are from Whitaker (in prep) and Hudsonia Ltd.

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*	
hairy-tailed mole	*Parascalops breweri*	
star-nosed mole	*Condylura cristata*	
BATS		
big brown bat	*Eptesicus fuscus*	
eastern red bat	*Lasiurus borealis*	SGCN
eastern small-footed bat	*Myotis leibii*	SC
hoary bat	*Lasiurus cinereus*	SGCN
Indiana bat	*Myotis sodalis*	E
little brown bat	*Myotis lucifugus*	
northern long-eared bat	*Myotis septentrionalis*	T
silver-haired bat[2]	*Lasionycteris noctivagans*	SGCN
tri-colored bat	*Perimyotis subflavus*	SGCN
CARNIVORES		
black bear	*Ursus amercanus*	
raccoon	*Procyon lotor*	
ermine	*Mustela erminea*	
fisher	*Martes pennanti*	
long-tailed weasel	*Mustela frenata*	
American mink	*Mustela vison*	
river otter	*Lutra canadensis*	
striped skunk	*Mephitis mephitis*	
eastern coyote	*Canis latrans*	
gray fox	*Urocyon cinereoargenteus*	
red fox	*Vulpes vulpes*	
bobcat	*Lynx rufus*	
RODENTS		
woodchuck	*Marmota monax*	
southern flying squirrel	*Glaucomys volans*	
eastern gray squirrel	*Sciurus carolinensis*	

(continued)

Table C-9. (cont.)

Common name	Scientific name	Statewide [1]
RODENTS (cont.)		
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*	
woodland vole	*Microtus pinetorum*	
muskrat	*Ondatra zibethicus*	
Norway rat	*Rattus norvegicus*	
black rat	*Rattus rattus*	
house mouse	*Mus musculus*	
meadow jumping mouse	*Zapus hudsonius*	
woodland jumping mouse	*Napaeozapus insignis*	
common porcupine	*Erethizon dorsatum*	
HARES & RABBITS		
eastern cottontail	*Sylvilagus floridanus*	
New England cottontail	*Sylvilagus transitionalis*	SC
snowshoe hare	*Lepus americanus*	
HOOFED MAMMALS		
white-tailed deer	*Odocoileus virginianus*	

[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 (http://www.dec.ny.gov/animals/9406.html)
$SGCN^{HP}$ = Highest Priority Species of Greatest Conservation Need (http://www.dec.ny.gov/animals/9406.html)
(The SGCN rank also applies to all species ranked as NYS endangered or threatened.)

[2] Occurrence in Dover is uncertain.

Appendix D

Explanation of Rarity Ranks

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.

(continued)

A. ANIMALS (cont.)

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
C candidate

NY Natural Heritage 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.

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.

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.

(continued)

A. ANIMALS (cont.)

For the most part, global and state ranks follow a straightforward scale of 1 (rarest/most imperiled) to 5 (common/secure). The Town of Dover *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.

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) 6 to fewer than 20 extant sites, or
2) 1,000 to fewer than 3,000 individuals, or
3) restricted to not less than 4 or more than 7 U.S.G.S. 7 1/2 minute topographical maps, or
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.

(continued)

B. PLANTS (cont.)

New York Natural Heritage Program Ranks

The explanation below is from the New York Natural Heritage Program Rare Plant Status Lists (Young 2017). The Town of Dover *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.

Appendix E

Tools for Site-Specific Resource Assessment

CHECKLIST FOR SITE RESOURCE ASSESSMENT

(A model)

Hudsonia Ltd., December 2019

Project: _____ Date: _____

Location: _____

Checklist

	Yes	No	Not sure
Are there intermittent or perennial streams on or near the site (Fig 11a)?			
If so, are the streams classified as "trout" or "trout spawning" or "sensitive coldwater" streams (Fig 9, Fig 17b)?			
Is there a mapped flood zone or riparian zone on the site (Fig 11a)?			
Is there a mapped unconsolidated aquifer on the site (Fig 8)?			
Are there mapped wetlands or wetland soils on the site (Fig 15)?			
Have wetlands been delineated onsite, surveyed, and mapped onto a site-specific plan or subdivision plat?			
If there is forest on the site, is it part of a large forest (Fig 13)?			
If there is meadow on the site, is it part of a large ($\geq$ 10 ac) meadow (Fig 14)?			
Are there other unusual or sensitive habitats on the site (Fig 12, Fig 17b)? If so, name them here:			
Is the site within a Critical Environmental Area (Fig 17a) adopted by the town, or in a regulated Overlay District designated in the municipal code (see Dover zoning map)?			
If so, name the CEA or Overlay District here:			
Are there Prime Farmland Soils or Farmland Soils of Statewide Importance on the site (Fig 20)?			
Is the parcel in a significant scenic viewshed (Fig 23 and local knowledge)?			
Would the proposed development significantly alter the visual character of the viewshed?			

(see over)

Follow-Up Questions

	Yes	No
Streams, Floodplains, Wetlands, and Aquifers		
If there are streams or wetlands on or near the site, have the proposed development features been located to preserve broad, undisturbed buffer zones along the streams and around the wetlands?		
If there is a mapped flood zone or riparian zone on the site, have the proposed development features been located outside of those zones?		
If there is a mapped unconsolidated aquifer on the site, does the proposed development avoid or minimize impervious surfaces in the aquifer area?		
Are stormwater management measures designed to preserve pre-construction patterns and volumes of surface water runoff from the site?		
Forests		
If there is a large forest on (or partially on) the site, have the proposed development features been located to minimize fragmentation of the forest?		
Meadows		
If there is a large meadow on (or partially on) the site, have the proposed development features been located to minimize fragmentation of the meadow?		
Connectivity		
Have the proposed development features been located to preserve broad connectivity between onsite and offsite habitats?		
Farmland		
If there are good farmland soils on the site, have the proposed development features been located to minimize encroachment on those soils?		
Scenic Resources		
If the project is in a scenic location, has the project been designed to minimize the visual impacts on the viewshed?		

Summary Results of Assessment

High priority and sensitive resources on or near the site:

Recommendations:

Date of site visit: _____ By whom: ----------

Hudsonia created this template for Habitat Assessment Guidelines to assist municipal planning boards in their reviews of land development projects. By obtaining specific information about biological and water resources from the land-use applicant early in the application process, the planning board and applicant can better understand potential impacts to sensitive resources and better design the project to minimize those impacts.

Guidelines for Habitat Assessment

(a model)

Hudsonia Ltd., November 2013

These Guidelines are designed especially for use by applicants who are presenting proposed land development projects to the local planning board or other reviewing agency.

The planning board recommends that an applicant conduct the habitat assessment prior to developing any detailed design or drawing for their project.

The purposes of a habitat assessment are 1) to provide information that will help the applicant, the planning board, and other reviewers and decision-makers adequately assess the biological and water resource features of the site, 2) to help the applicant design the development project in ways that minimize and mitigate potential impacts of the project on important sensitive areas, 3) to help the applicant avoid costly reworking of the project design, and 4) to streamline the environmental review.

A habitat assessment must be carried out by biologists familiar with habitats and biota of the region, and the life history needs of species of conservation concern. The field assessments described below may be carried out at any time of year as long as field conditions (e.g., deep snow, flooding, ice, recent fire) do not obscure the features necessary for identifying habitats.

The findings are to be submitted in a brief written report using the following outline. The annotations in the outline constitute the Habitat Assessment Guidelines recommended by the planning board.

Habitat Assessment Report -- Basic Components

1. **Executive Summary.**
   A brief (e.g., one paragraph) summary description of the site, the features of conservation concern, the proposed project, potential impacts on biological and water resources, and proposed mitigation.

2. **General Site Description.**
   Describe the general characteristics of the site—the topography, bedrock geology, soils, vegetation cover types, surface water drainage, water bodies, and elevations.

3. **New York Natural Heritage Program (NYNHP) Data.**
   Discuss the results of an inquiry to the NYNHP about records of rare species and rare natural communities on and near the site. Append the inquiry letter, map, and the NYNHP response.

4. **Habitats or Ecological Communities.**
   Describe the habitats or ecological communities on and near the site, using classifications in the *Draft Ecological Communities of New York State* (Edinger et al. 2002), the *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Stevens and Kiviat 2001), or other standard reference relevant to this region. Include intermittent and perennial streams, lakes, and ponds, as well as all upland and wetland communities or habitats. Offsite areas may be assessed using topographic maps, soils maps, aerial photographs, and other remote sensing resources.

   For each habitat or community, list the dominant trees, shrubs, herbs, and mention any species that are unusual or may be indicative of special habitat conditions. Comprehensive plant lists are not required.

   Include general assessments of habitat quality, to the extent possible given the seasonal or other field conditions at survey time. Measures of quality may include, but are not limited to:
   - age (e.g., of forests),
   - age or size of trees,
   - size of habitat area (e.g., for forests or meadows),
   - connectivity with other habitat areas, including streams,
   - abundance of downwood, standing snags, bedrock outcrops, loose rocks, organic debris, and other microhabitat features,
   - levels of human disturbance (e.g., from recent or historic logging, ATV use, foot traffic),
   - presence and abundance of non-native or invasive species,
   - diversity of native plant species (a qualitative assessment is adequate),
   - observable indicators of surface water,

- (for streams, ponds, wetlands) water depths, clarity/turbidity, substrates, flow at survey time, entrenchment, condition of streambanks, etc.; describe intermittent as well as perennial streams, and
- presence and quality of vegetated buffer zones adjacent to streams, wetlands, other aquatic habitats, and other sensitive habitat areas.

Explain the timing, duration, and limitations of the field surveys, and make recommendations for further surveys at other seasons or in other conditions if needed for an adequate assessment.

5. **Connectivity.**
Describe the connectivity and barriers between significant habitat areas, including streams, on and off the site. Barriers include roads, driveways, pavement, curbs, walls, buildings, culverts, dams, and other features that might impede the movement of small and large animals through and between habitats.

6. **Map.**
Provide a map of the site and vicinity, illustrating habitats, watercourses (both perennial and intermittent streams, including those not identified on USGS topographic maps), existing developed features (e.g., roads, driveways, structures), and proposed new features. A sketch map drawn with reasonable care is sufficient; it need not be an engineer's or surveyor's drawing at this stage.

7. **Species of Conservation Concern.**
Considering the habitats present on and near the site, list and discuss the plants and animals of conservation concern that do or may use the site and nearby areas, and may be affected by the proposed project. Consider data from the New York Natural Heritage Program, the New York State Breeding Bird Atlas and the New York State Herp Atlas to help determine likely or potential occurrence on the site, but do not limit your assessment to those sources.

For the purposes of this assessment, "species of conservation concern" include the following, at a minimum:
-- those listed by the New York State Department of Environmental Conservation (NYSDEC) as Endangered, Threatened, Rare, or Special Concern;

-- those listed by NYSDEC as New York State Species of Greatest Conservation Need (SGCN) (www.dec.ny.gov/animals/9406.html);

-- those listed by the New York Natural Heritage Program as S1, S2, or S3; and

-- birds listed by Audubon New York as Hudson River Valley Priority Species (ny.audubon.org/hudson-river-valley-conservation).

Consider habitat uses for breeding/nesting, nursery, foraging, seasonal migration, and overwintering habitat, as appropriate, for the species of concern. In some situations the discussion can treat groups of organisms (e.g., "forest interior breeding birds" or "fish of coldwater streams" or "spring ephemeral wildlflowers"), and need not discuss each species separately.

8. **Potential Impacts.**
   Describe the proposed development project, and assess the potential impacts of the proposed project on biological and water resources. Consider the effects of habitat loss, fragmentation, and other degradation, the edge effects of human activities, the effects of impervious surfaces, increased runoff of surface water, and contamination of surface water or groundwater.

9. **Potential Mitigation.**
   Discuss preliminary site design, engineering, infrastructure features, or other measures that could be employed to mitigate any adverse effects of the proposed project on biological or water resources. Because this assessment is carried out at an early stage of planning, this discussion is expected to be fairly general, and need not be accompanied by engineer's drawings.

10. **References Cited.**