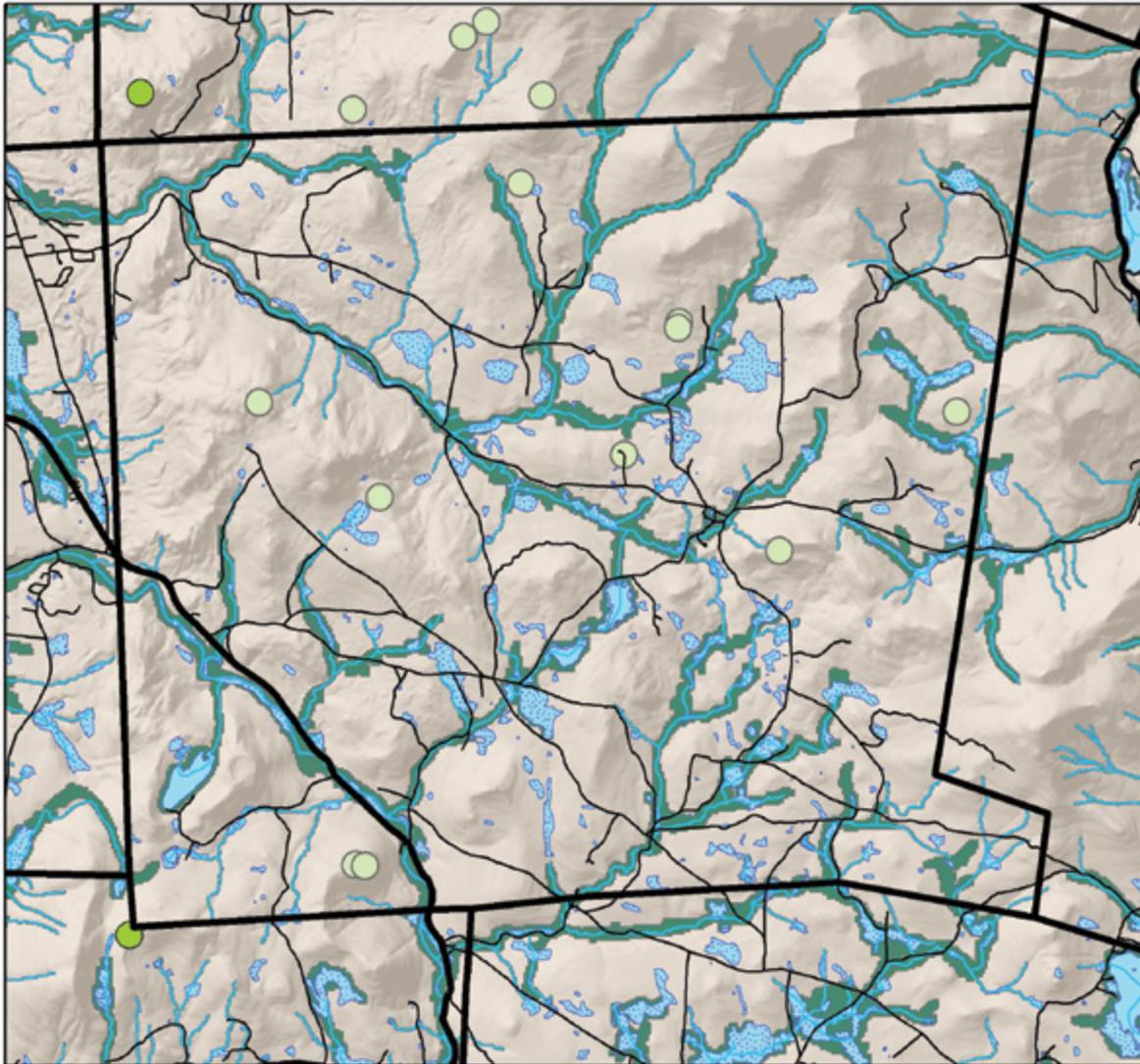


Map 5: Water

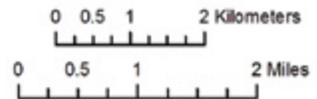


LEGEND

Town Boundary	Rivers & Streams	Vernal Pools
Roads	Lakes & Ponds	Unconfirmed Vernal Pools
Primary	Wetlands	Surface Waters and Riparian Areas
Secondary		Highest Priority Surface Waters and Riparian Areas



Data Source:
Vermont Center for Geographic Information
Vermont State Plane Projection
NAD1983 Datum
Map by Monica Przyperhart
October, 2017



Map 5 Water



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This map is intended to provide a broad overview of the water resources in your community.

Inventory Layers (Described Below)	Base Layers	Additional Online Data
<ol style="list-style-type: none"> 1. Rivers, Streams, Lakes & Ponds 2. Surface Waters and Riparian Areas 3. Vernal Pools (Confirmed and Unconfirmed) 4. Wetlands 	<p>Town Boundaries Roads</p>	<p>Stream Crossings Bridge and Culvert Inventory</p>

Water is an important resource for both [wildlife](#) and human communities. While not particularly scarce in the Northeast, water-based ecosystems can be both highly valued and highly vulnerable. In addition to the rivers, streams, lakes, and ponds included on other maps, this map includes wetlands, vernal pools, and a more extensive layer of riparian areas than included in other maps.

Additionally, you can use [BioFinder](#) to see the locations of bridges and culverts and stream crossing areas. This information has implications both ecologically and for determining safe and effective locations for human activities.

Inventory Layer #1: Rivers, Streams, Lakes, & Ponds

What do These Layers Show?

On the map, these data appear as two distinct layers: Rivers & Streams, and Lakes & Ponds. The same layers are included on other maps to provide geographic reference points. Together, this is the most complete set of rivers, streams, lakes, and ponds available in Vermont. While wetlands were not specifically delineated in this effort, those wetlands containing open water have also been captured.



To load Map 5 on BioFinder: Open the **Inventory** theme, then check the box next to **5: Water**. To see all available Map 5 layers, click on the + next to the layer name.

For additional guidance on using BioFinder, please see Getting Started in the introduction to this guide.

Rivers, Streams, Lakes, & Ponds: Significance

Rivers, streams, lakes, and ponds are by nature diverse ecosystems, with plant and animal communities changing according to water depth, turbulence, available oxygen, and a host of other features. Shorelines contribute additional variety to the communities found in aquatic ecosystems. Together, these communities form an extensive food web that includes everything from tiny microorganisms to bears and humans. This web also includes reptiles and amphibians, plants, waterfowl, songbirds, bats, mink, and otter.

Rivers, Streams, Lakes, & Ponds: Map Interpretation

These data are formally known as the Vermont [Hydrography](#) Dataset and are part of a larger, nationwide effort by the United States Geological Survey to map waterways across the country. Rivers and streams are represented by lines capturing the centerline of a stream, not the entire water body. This means that the data may be most meaningful in capturing a general sense of where water flows through the region, at the scale of an entire town or larger. We depict this information on Map 5

on top of **Riparian Areas** (Layer #2) because together, these show a much more complete picture of the geographic area influenced by each body of water.

Because waterways are dynamic by nature, their exact boundaries or extent can be expected to change, both seasonally and over time. For planning purposes, your community may therefore want to clearly define any planning or regulatory terms involving water through a measurement other than this static map that represents one moment in time (for example, the



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distance from the top of the streambank or slope). It should also be noted that while this layer is the most complete map available of Vermont's surface waters, data were derived through the interpretation of aerial photographs and topographic data and many have not been checked in the field.

Rivers, Streams, Lakes, & Ponds: Planning Considerations

In nearly all cases, the most important planning considerations for waterways include maintaining vegetation on the surrounding streambank, which is often called the riparian area. [Conservation](#) strategies for surface waters and [riparian areas](#) are therefore discussed together at the end of the Surface Waters and Riparian Areas description.

Rivers, Streams, Lakes, & Ponds: Additional Information

[Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities](#) is a good source of detailed information about different buffer widths and the species and functions they protect.¹

Inventory Layer #2: Surface Waters and Riparian Areas

What are Surface Waters and Riparian Areas?

Surface water refers to all water that appears on the ground's surface (rivers, streams, lakes, ponds, and some wetlands) but excludes groundwater. This layer therefore includes all the water bodies described in Layer #1, with two main differences: First, Layer #1 maps only the centerline of each stream or river. Surface Waters and Riparian Areas expands upon that centerline to estimate a width for the water body. Secondly, Surface Waters and Riparian Areas maps the entire area impacted by these waterways, including not only the water itself but also the surrounding land. This surrounding area is referred to as the riparian area.

The word "riparian" literally means "pertaining to the bank of a river or lake." Riparian areas are complex and interrelated networks of streams, rivers, lakes, wetlands, and the [floodplains](#) surrounding all

these waterways. Because the waterways themselves are discussed in Layer #1 above, this section focuses on the terrestrial portion of the riparian area.

In general, larger bodies of water have wider riparian areas. Mountainous headwater streams are usually contained within steep, narrow valleys, with narrow riparian areas that transition into [upland](#) forests. Large streams and rivers, however, wind through wider, flatter valleys, with riparian areas extending the width of these valleys. Even though small streams in steep valleys have narrow bands of riparian habitat, the forest surrounding these streams plays an important role in protecting the riparian habitat and stream, especially where steep slopes threaten landslides, rapid storm water [runoff](#), and hillside gullying.

Surface Waters and Riparian Areas: Significance

Riparian ecosystems are unique in their high biological diversity. Characterized by periodic disturbances—flooding, the deposition of sediments, erosion, and the forces of water and ice movement—riparian habitats are highly complex and variable, and therefore extremely ecologically diverse ([Verry et al., 2000](#)). In fact, for a community faced with limited resources, prioritizing the conservation of riparian areas can be one of the best ways to help a wide diversity of wildlife species.

Surface Waters and Riparian Areas: Map Interpretation

As mentioned above, Layer #1 depicts the centerlines of rivers and streams in Vermont, along with outlines of lakes and ponds. The Riparian Area dataset was built around these centerlines through estimation of a width for each water body and then by adding a [buffer](#) to capture the [floodplain](#). The overall width is therefore based on a combination of factors that includes relative stream size and [physical landscape](#) characteristics.

Once the floodplains were mapped, Vermont biologists divided this dataset into two categories. "Highest Priority" was given to those riparian areas in which there is currently no [development](#). This includes

Riparian Wildlife Connectivity vs. Surface Waters and Riparian Areas

In Map 3, we introduced Riparian Wildlife Connectivity. Now we introduce Surface Waters and Riparian Areas. There is substantial overlap between the two datasets. The difference is that Surface Waters and Riparian Areas includes developed areas and agricultural lands when they occur within the floodplain and projected riparian zone; Riparian Wildlife Connectivity includes only areas with vegetated cover.

areas with natural vegetation and agricultural lands. While lands covered by crops, hay, or pasture do not perform all the functions of a forested riparian area, they will be much easier to manage for function or restore than developed lands. To see a map of only vegetated riparian areas, go to [Riparian Wildlife Connectivity](#), in Map 3.

“Priority” status was given to riparian areas in which development currently exists. While all areas mapped are likely to be inundated by floodwaters periodically, these lands will be much more difficult to maintain or restore as functional riparian area for protecting [water quality](#), providing flood resilience, or for wildlife habitat.

In using these data, keep in mind that this is a state-wide model; there is no way to depict at this scale the specific area that functions as important habitat or protects water quality. Local factors play a large role, such as steepness of slope, the quality of surrounding habitat, and so forth. To get a better sense of riparian function in your town or region, a local inventory may provide more specific information.

Surface Waters and Riparian Areas: Planning Considerations

Maintaining a vegetated riparian area may be the single most effective way to protect a community’s natural heritage. The riparian area provides high quality habitat for a great diversity of both aquatic and terrestrial species. Downed wood, leaves, and similar organic material filter into the water to become important components of the food base and habitat structure. Mature trees in riparian areas shade aquatic habitats, helping to control water temperatures.

Terrestrial animals use riparian areas as travel corridors, while many plant and tree seeds float downstream to disperse. Streamside vegetation helps to control flooding, and it is crucial in filtering overland runoff—which protects water quality—and

Buffer Regulations

Some towns in Vermont have established buffer regulations to protect the riparian area. Read Georgia’s story here: vtconservation.com/success-stories/buffer-regulation

stabilizing stream banks, which prevents excessive streambank erosion and sediment buildup. What’s more, maintaining the riparian area is one of the most cost-effective ways to provide resilience for a changing climate.

In your town, your specific conservation goals will dictate how wide an area to consider for protection around a stream or lake. These areas are often referred to as riparian buffers. In general, a naturally vegetated 100-foot-wide riparian [buffer](#) protected from development or intense human activity on each side of a stream will protect many of the functions associated with healthy riparian habitat, while a 330-foot buffer will protect nearly all the functions we value, including high-quality cover for many wildlife species.

Of course, we value riparian areas for their contributions to human values, too—including water quality, recreation, education, spiritual well-being, and sense of place. Riparian habitats also play a critical role in flood resilience, which has become particularly important since Vermont is experiencing increasingly frequent flood events.

In most areas, the above buffers would protect these human values alongside wildlife needs. They would also allow rivers to be dynamic. Naturally, rivers and streams change course over time, widening their banks through erosion in some areas and depositing sediment in others as they meander. While these maps are not intended to predict future changes in stream shape, they do include the areas in which most these changes are most likely to occur.

Protecting Riparian Areas and Responsible Recreational Use

Some communities have been able to protect riparian areas alongside human interests. For example, the Lamoille River Paddler’s Trail promotes recreational use of the river by providing access points, portage trails, and primitive campsites while also promoting the conservation and stewardship of riparian areas.

Learn more at www.lamoillerverpaddlerstrail.org.



© LAMOILLE RIVER PADDLERS TRAIL.ORG

When looking for strategies effective at protecting water and riparian areas, you might consider:

Conservation Goal	Conservation Strategies for Water and Riparian Areas	
	<i>Nonregulatory Strategies</i>	<i>Regulatory Strategies</i>
Learn more	Learn about river planning, management, and protection through the Vermont Department of Environmental Conservation. ²	N/A
	Learn about managing and protecting lakes and ponds through the Vermont Department of Environmental Conservation. ³	
Provide baseline protection	Adopt language in the town plan, including statements about the importance of riparian areas policies on how they should be managed, protected, and restored.	Check clarity of definitions in zoning bylaws and update if needed. ⁴
Protect surface waters and riparian areas	Support the creation of River Corridor Easements ⁵ (conservation easements that allow rivers to change course naturally, without human interference).	Require forested riparian buffers in the general standards section of your bylaws, to apply in all districts, or in River Corridor bylaws, if you have them. ⁶
	Connect owners of riparian land to incentives programs for wildlife-friendly management practices, such as USDA or USFWS Partners for Fish and Wildlife.	Establish standards for minor activities (footpaths, etc.) acceptable within the riparian area.
		Add standards in subdivision regulations or zoning (River Corridor, Flood Hazard, Lakeshore Overlay, or Forest District) that require clustering or setting back development away from riparian areas, river meanders, or floodplains.
		Require minimum setbacks from waterways in zoning and subdivision regulations.
Adopt town road management standards to comply with Vermont’s Clean Water Act. ⁷		
Enhance Riparian Quality	Assist landowners in restoring riparian habitats. ⁸	Require restoration of riparian habitat in site plan or subdivision review by designating “no-mow” zones, allowing for regeneration of woody vegetation, or by planting native species.
	Create an invasive species control program for riparian areas. ⁹	
	Connect landowners to incentives programs, such as through USDA or USFWS Partners for Fish and Wildlife.	
Maintain Water Quality	Assist landowners in reducing stormwater runoff. ¹⁰	Recommend or require vegetated buffers to filter pollutants before they reach waterways.
	Encourage residents to reduce use of chemical lawn care products.	
	Identify ways to reduce flood damage to major infrastructure. ¹¹	
	Support public awareness of the <i>Acceptable Management Standards for Maintaining Water Quality of Logging Jobs in Vermont</i> . ¹²	

Most of these conservation tools are explained in detail in [Community Strategies for Vermont’s Forests and Wildlife \(vnrc.org/programs/forests-wildlife/guide\)](https://www.vnr.org/programs/forests-wildlife/guide).

Inventory Layer #3: Wetlands

What are Wetlands?

In a sense, wetlands combine the traits of upland and aquatic habitats. While they function differently than either, they provide an interface in which species of both communities dwell and interact, alongside numerous species that occur only in wetlands. They include the vegetated, shallow-water margins of lakes and ponds, the seasonally flooded borders of rivers and streams, and an amazing diversity of topographic settings across the landscape.

Although many definitions have been developed for the term and concept of “wetland,” we consider wetlands to have three basic characteristics. First, all are inundated by or saturated with water for at least two weeks during the growing season. Second, they contain wet (hydric) soils, which develop in saturated conditions and lack oxygen and other gases. Finally, they are dominated by plant species known to be adapted to these saturated soils.

Wetlands are known by many common names, with some common names associated with particular wetland conditions. For example, swamps are dominated by trees or shrubs. Marshes are dominated by herbaceous plants. [Fens](#) are peat-accumulating, open wetlands that receive mineral-rich groundwater. [Bogs](#), also peat-accumulating wetlands, receive most of their water and nutrients from precipitation rather than from an inflow of water from a stream, river, groundwater, or even the surrounding landscape. Recently, vernal pools have also been included as wetlands (although we map them separately in this guide). Each of these wetland types supports a unique group of plants and animals, many of which require these wetland habitats to survive.

Community Strategies for Vermont's Forests and Wildlife: Case Study

While statewide wetland protections are offered through the Vermont Wetland Rules, some towns have chosen to further protect these important natural features. The town of Warren protected wetlands and other ecologically sensitive areas by requiring a [Conservation Subdivision Design](#) in the review of major subdivisions, for example. You can read more about the town's process on page 58 in [Community Strategies for Vermont's Forests and Wildlife](#) (vnrc.org/programs/forests-wildlife/guide).



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Wetlands: Significance

Wetlands are beneficial to a variety of native plant and animal species, as well as to the health, safety, and welfare of the general public. They provide fish and wildlife habitat, flood and erosion protection, nutrient and pollution filtration, groundwater recharge, aesthetic diversity, and sites for educational and recreational activities.

It is estimated that 50 percent of Vermont's historic wetland area has been lost or severely impaired due to draining, dredging, filling, or excavation activities associated with industrial, residential, and agricultural activities. Since 1995, the current rate of wetland loss in Vermont is estimated at 20 acres per year. While restored wetlands offset this number somewhat, these restored wetlands generally take many years before they provide the full functionality of a natural wetland.

Fish and wildlife that depend on wetlands for survival tend to be easily disturbed or negatively affected by human activities, and activities often associated with residential development can disturb habitat or cause displacement of a variety of wildlife.

Wetlands: Map Interpretation

This [map layer](#) uses the most comprehensive source of information on wetlands available: the Vermont Significant Wetlands Inventory (VSWI), which is a subset of the larger National Wetlands Inventory. This inventory was created to provide a broad-scale overview of where wetlands are located. Keep in mind, however, that these maps were prepared using aerial photography. Wetlands that are hard to see on aerial photos—such as those that are forested—may not show up, while other features were occasionally mistaken for wetlands and displayed on this map. Before using these data for specific planning purposes, you will want to verify this information, but it can be a good starting place.

Wetlands: Planning Considerations

Wetlands receive some protection through the Vermont Wetland Rules. These rules regulate land use, including restrictions on development, guidelines on acceptable management activities, and a list of allowed uses. They apply within the wetland itself and a surrounding buffer. On maps, you will find wetlands to be classified as Class I or Class II, with Class I wetlands receiving the highest level of protection, and with most mapped wetlands falling into the Class II category. You can learn more through [Vermont's Department of Environmental Conservation](#).¹³

The first step in planning for wetlands locally generally involves an evaluation of how well the state-level rules achieve your community's goals for wetland conservation. To achieve local or regional goals, some communities take additional steps to protect certain functions. The most common additional steps address either the extent of the undeveloped strip of land (a "buffer") encircling the wetland or the land that extends between a wetland and a nearby natural area or body of water. While Vermont Wetland Rules generally apply within a 50-foot area around a Class II wetland, for example, a wetland that provides extensive habitat for breeding waterfowl or that is surrounded by steep slopes and is therefore at a high risk of erosion may benefit from a 100- to 300-foot buffer wherever possible. In other locations, maintaining a vegetated area that connects a wetland to nearby natural areas or waterways provides a pathway for traveling wildlife.

In addition to considering the specific benefits a wetland provides to fish and wildlife, your community may also want to consider the wetland's role in flood and erosion protection, nutrient and pollution filtration, groundwater recharge, aesthetic diversity, and potential use for educational and recreational activities.

Conserving Vermont's Natural Heritage Tip

There are a variety of ways to plan for the future of the wetlands in your community. *Conserving Vermont's Natural Heritage* suggests starting with creating goals such as the following for the conservation of wetlands:

1. Protect or provide for long-term stewardship of wetlands that support significant functions and values for natural communities, rare species habitat, or wildlife habitat, and prevent additional loss of wetlands within the town.
2. Restore and/or enhance the functions and values of wetlands already affected by human disturbance.

The book goes on to provide specific recommendations of tools—both regulatory and non-regulatory—that may be useful in fulfilling these goals. See more on page 62 of the book.



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To protect or restore wetlands in your region, consider the following strategies:

Conservation Goal	Conservation Strategies for Wetlands	
	Nonregulatory Strategies	Regulatory Strategies
Seek additional information	Improve knowledge of local wetlands and create a town wetlands map.	
Provide baseline protection	Adopt language in the town plan, including statements about the importance of wetlands and policies on how they should be managed, protected, and restored.	Check clarity of definitions in zoning bylaws and update if needed. ¹⁴
Protect wetlands and surrounding habitat	Encourage residents and/or businesses to conserve their wetlands through conservation easements. ¹⁵	Petition for reclassification of significant wetlands to Class I, which receive the highest level of protection. If wetlands are not mapped, seek to add them as Class II wetlands on inventory maps. ¹⁶
	Encourage residents to enroll their wetlands in Current Use, in an Ecologically Significant Treatment Area (ESTA). ¹⁷	Require buffers through the general standards section of your bylaws, to apply in all districts. ¹⁸
	Encourage landowners to work with a forester to choose forest management practices that protect wet soils and fragile species.	Require development design that clusters development away from wetlands and their buffers in subdivision and zoning regulations. ¹⁹
	Support public awareness of Vermont's Wetlands Rules. ²⁰	Incorporate minimum setbacks from wetlands in zoning and subdivision regulations.
Restore wetlands	Restore wetlands on town-owned lands. ²¹	Create town road management standards to maintain and restore natural vegetation and hydrology. ²²
	Connect landowners with incentives programs (USDA, USFWS, etc.) to aid in restoring wetland habitat. ²³	

Information about many of the tools above can be found in [Community Strategies for Vermont's Forests and Wildlife](#).

Wetlands: For More Information

National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service (USFWS): This is the agency responsible for mapping wetlands throughout the United States, including the data displayed. Information about the USFWS's classification system can be found on the [National Wetlands Inventory website](#)²⁴ or in the book *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979).

Wetlands Section, Vermont Department of Environmental Conservation:²⁵ This program regulates wetlands in Vermont, monitors the biological condition and status of Vermont's wetlands, and provides technical assistance on wetland identification, delineation, and protection through planning and other mechanisms. It is also a source of information on the functions, values, and locations of wetlands throughout the state.

Inventory Layer #4: Vernal Pools

What are Vernal Pools?

A vernal pool is a depression in the forest floor that fills with water each spring and often dries out later in the growing season. Although trees and shrubs rarely grow in vernal pools, typical vernal pools are well shaded by the surrounding forest.

In the Northeast, many vernal pools start filling with fall rains; retain water, ice, and snow through the winter; and collect more water with the arrival of spring rain and snowmelt. Some are further influenced by rising groundwater in the fall and spring.

The pools typically lack inlets and outlets, and while many vernal pools are dry by mid-summer, some may retain water throughout the year in wet years.

Vernal Pools: Significance

Vernal pools may take up a small amount of land area, but they are necessary habitat for amphibians

and very important for a number of additional species. In Vermont, vernal pool-dependent species include mole salamanders (spotted salamander, blue-spotted salamander, and Jefferson salamander), Eastern four-toed salamander, and wood frog. All of these species may breed in other wetlands but rely heavily on vernal pools to maintain their populations.

For vernal pools to be effective breeding habitats for these amphibians, they must retain water for at least two months during the spring and summer breeding season most years so that amphibians can complete their aquatic larval stage. The periodic drying of a vernal pool is essential, too, as this eliminates populations of fish and diving beetles that prey on amphibian larvae.

Other animals use pools as well, such as fairy shrimp, fingernail clams, snails, eastern newts, green frogs, American toads, spring peepers, and a diversity of aquatic insects. Fairy shrimp are thought to survive only in these temporary pools. Because the amphibians and invertebrates found in vernal pools constitute a rich source of food, various species of birds, mammals, and reptiles may be attracted to the pools. Despite their small size and temporary nature, vernal pools are highly productive ecosystems.

Vernal Pools: Map Interpretation

The data depicted in this layer were collected through the Vermont Vernal Pool Mapping Project, a statewide effort to map the locations of vernal pools. These pools were initially mapped using aerial photographs; many have also been visited to confirm existence and to collect data.

You will notice that this information is divided into two similar layers: a “vernal pools” layer and a “vernal pools (potential)” layer. “Potential” vernal pools have been mapped purely using aerial photographs but have not been confirmed in the field; others have been visited and enough data has been collected to say for certain that these pools exist and are used by wildlife.



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Vernal Pool Mapping Project

By using a combination of professional expertise and volunteer vigor, the Vernal Pool Mapping Project continues to identify vernal pools throughout the state. Learn more at vtconservation.com/success-stories/vernal-pool-mapping-project.

The locations of confirmed pools are therefore accurate to a fine scale and can be used even down to a parcel level; “potential” vernal pools should be visited (with landowner permission) prior to taking any next steps.

Vernal Pools: Planning Considerations

Vernal pools and the organisms that depend on them are threatened by activities that change the way water flows into and around the pool, alter the [substrate](#) at the base of the pool, or significantly modify the surrounding forest. Construction of roads and other development in the upland forests around vernal pools can negatively affect salamander migration or result in mortality ([Forman et al., 2003](#)).

Some types of timber harvesting can also have significant effects on vernal pools, including alteration of the vernal pool depression, changes in the amount of sunlight, leaf fall, and woody debris (such as branches, decaying wood, and so on) in the pool, and disruption of amphibian migration routes by the creation of deep ruts. Even when the pool is dry, alteration of the depression substrate may affect its ability to hold water and may disrupt the eggs and other drought-resistant stages of invertebrate life that form the base of the vernal pool food chain.

In Vermont, vernal pools with breeding amphibian populations have recently been included as Class II wetlands and are therefore offered some protection under the Vermont Wetland Rules. However, many wetland maps used for regulatory purposes do not include vernal pools, limiting the rules’ enforceability. Similarly, town plan and bylaw definitions of wetlands generally lack inclusion of vernal pools.

When planning for the conservation of vernal pools, one starting place may be to update maps of Class II wetlands to include vernal pools and to re-define a “wetland” in the town plan or bylaws. At that point, planning for vernal pools and wetlands could be accomplished simultaneously, if this would achieve your community’s goals.

You might also consider the following strategies for conserving vernal pools:

Conservation Goal	Conservation Strategies for Vernal Pools	
	Nonregulatory Strategies	Regulatory Strategies
Seek additional information	Conduct field inventories as needed to improve maps of vernal pools.	
Protect vernal pools and associated amphibian populations	Write management plans for town-owned land designed to protect vernal pools. ²⁶	Require buffers in the general standards section of your bylaws, to apply in all districts. ²⁷
	Encourage landowners to create forest management or stewardship plans to conserve vernal pools and surrounding habitat.	Create a Wildlife Habitat Overlay District that includes vernal pools and surrounding habitat. ²⁸
	Provide citizen educational opportunities.	Encourage subdivision and site plan designs in zoning or subdivision regulations that cluster development away from vernal pools. ²⁹
	Adopt language in the town plan, including statements about what resources are important, and policies on how they should be managed, protected, and restored.	Require minimum setbacks in zoning or subdivision regulations. Seek to add vernal pools as Class II wetlands on inventory maps (where they are often missing).
Protect or restore forested habitat between vernal pools	Include a map in your town plan to show possible dispersal corridors between pools.	
	Target high priority corridors in land conservation efforts.	

Information about many of the tools above can be found in [Community Strategies for Vermont's Forests and Wildlife](#).

Additional Online Data

The following datasets are available on [BioFinder](#), but they are not featured on the included inventory maps.

Stream Crossings

This dataset shows how well aquatic organisms, such as fish or bottom-dwelling macroinvertebrates, are able to pass through culverts and other road-associated structures.

Many aquatic species need to travel both up- and downstream during different life stages. For example, some trout species lay eggs in cooler, upstream locations but must find deeper pools, generally downstream, in which to spend the winter months. When culverts (or other natural landforms or human-made structures) form waterfalls too high for fish and other organisms to travel across, these species are cut off from upstream habitat.

This layer describes a fish's ability to pass through culverts, bridges, and other road-related structure with the following categories:

- ▶ Fully Passable
- ▶ Reduced Passage

- ▶ Impassable except for Adult Trout (Adult trout can leap higher distances than younger trout or other species.)
- ▶ Impassible
- ▶ Bridge/Arch (fully passable)

When conducting planning efforts, your municipality may want to consider efforts to enhance structures that impair passage. In doing so, remember that roads may fall under the jurisdiction of private parties, towns, or the state.

Bridge and Culvert Inventory

In many Vermont towns, you can view data on the locations of all bridges and culverts. This information is divided into:

- ▶ VTRANS State and Town Long Structures (with a span greater than 20 feet)
- ▶ VTRANS State Short Structures (with a span less than 20 feet)
- ▶ Town Bridge
- ▶ Town Culvert

This information can be useful when thinking about how water flows through an area or how some wildlife might move safely across roads (by traveling underneath).

Suggested Additional Data

The 100-Year Floodplain

In some parts of Vermont, maps of the 100-Year Floodplain are available. While not included on [BioFinder](#), these maps can be helpful in understanding an area's flood potential. It can be found on the [Natural Resources Atlas](#). There, it is entitled DFIRM and includes several individual components. Compiled by the Federal Emergency Management Agency, these data have strong implications for both human and ecological communities.

While streams and rivers overflow their banks on a yearly basis in many communities, the highwater mark from one year to the next varies greatly. If we compare the water level reached in one flood to that of the next flood, we can calculate a recurrence interval for each inundation level. Some land is inundated every year. Some land floods on an average of every five years. A [100-year flood](#) reaches very high water levels and can dramatically alter the landscape of our communities.

Hundred-year floodplain information is used commonly for economic and emergency management purposes, namely insurance. Using this map, we can visualize the area most likely to be underwater in a dramatic flood event—including houses, roads, and other infrastructure.

While the data were compiled with human communities in mind, they have ecological implications, too. Historically, these are lands in which flood sediments, such as sand, gravel, and other materials, have been deposited, and these materials create the [substrate](#). Periodic flooding also creates disturbances that prevent certain vegetation from growing and allowing other species to rely on these regular inundations of water, sediments, and nutrients. In general, the [100-year floodplain](#) is a dynamic region that acts as an interface between water and land.

Compiled by the Federal Emergency Management Agency, these data are the basis for floodplain

Climate Change & the 100-Year Floodplain

Flood recurrence intervals are based on historic averages. However, high-intensity flood events are predicted to occur with increasing frequency as our climate changes. For example, a 2015 study of the Winooski River in Waterbury found that when climate change predictions are factored in, the land currently mapped as the 500-year floodplain (with a 0.2 percent annual chance of inundation) will more likely be a 100-year floodplain (with a 1 percent annual chance of inundation) by 2065 ([Schiff et al. 2015](#)).

management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). In other words, this [map layer](#) is based on the database used by flood insurance companies to predict the likelihood of flooding for any particular location. The categories pictured are therefore classifications of flood risk: 1 percent annual chance of a flood event (the 100-year floodplain) and 0.2 percent annual chance of a flood event (the 500-year floodplain).

Flood hazard areas are determined through the analysis of records of river flow, storm tides, and rainfall, consultation with communities, topographic surveys, and analysis of water flow. The map also uses elevation models. This information is not available in all counties of Vermont.

Of course, the extent to which water will cover any given piece of land in a future flood is not predictable, because there are so many factors affecting the locations where water will flow. Data are based on past events and provide a historic record of inundation rather than predictions for the future.

This map has strong implications for both human communities and ecological conservation. As described above, this information was compiled with emergency management in mind, and its implications for human safety and financial costs are clear. However, these lands are also critical for a variety of wildlife, making the 100-year floodplain a place of common ground. While historic development within this region was common and substantial infrastructure currently exists inside the limits of the 100-year floodplain, there is a good chance that infrastructure built on the floodplain will not last without substantial effort and cost. On the other hand, wildlife thrive in an undeveloped floodplain. Rivers and streams provide corridors for movement between one block of quality habitat and the next. Some species rely on floodplain sediments or nutrients.

The 100-Year Floodplain=1% Annual Chance

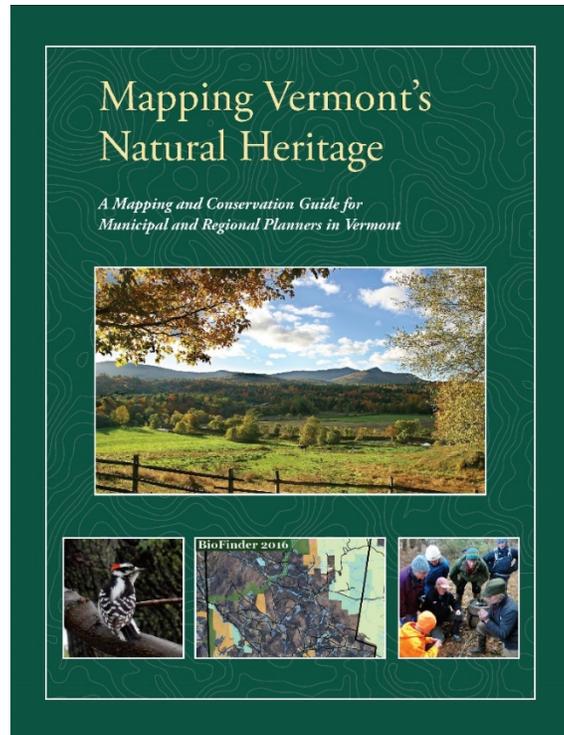
The 100-year floodplain is all the land inundated by a flood with a recurrence interval of 100 years. A flood of this magnitude has a 1 percent chance of occurring each year.

An insurance company might look at this statistic from a different angle: Over the life of a 30-year mortgage, property within the 100-year floodplain has a 26 percent likelihood of flooding.



Mapping Vermont's Natural Heritage

This is one chapter of a larger publication called *Mapping Vermont's Natural Heritage: A Mapping and Conservation Guide for Municipal and Regional Planners in Vermont*. Please visit <https://anr.vermont.gov/node/986> for additional information or to see the entire guide.



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