2016 BioFinder Update Report

Prepared by the

Vermont Agency of Natural Resources'
BioFinder / Vermont Conservation Design Team

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BioFinder Update 2016

Produced by the Vermont Agency of Natural Resources 2016
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About BioFinder

The text, graphics and data provided in this report describe the 2016 Update to BioFinder. To learn about the creation of the original BioFinder, see the 2013 BioFinder Development Report. To access, use and explore BioFinder, please go to: www.BioFinder.Vermont.gov

Acknowledgements

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Executive Summary

BioFinder is a database and mapping tool for identifying Vermont's lands and waters that support important ecosystems, natural communities, habitats, and species. It was developed by the Agency of Natural Resources and partners to support stewardship and conservation. BioFinder highlights networks of forests, streams and other features that together create the heart and backbone of Vermont's landscape.

BioFinder was updated in 2016 to replace the Tiered Ecological Priorities dataset with a landscape scale prioritization and a community and species scale prioritization. All landscape scale components in the old version were replaced with new components (called Vermont Conservation Design Landscape Scale), while community and species scale elements were not changed but were ranked as highest priority or priority.

As of 2016, the data that constitute priority rankings for community and species scale components are undergoing rigorous scientific study. Currently, entire components are ranked as either "priority" or "highest priority," as listed above. For example, rare natural communities are all given "highest priority" status, while uncommon natural communities are labeled "priority." As state biologists learn more about the relative importance of individual occurrences within each natural community, however, the data displayed on BioFinder maps will change to reflect the most up-to-date understanding. For example, some occurrences of a single rare natural community are more important to local and state ecological function than others, and once it is known which these are, the status of some individual rare natural communities may change to "priority."

BioFinder components represent terrestrial and aquatic biological, ecological, and natural heritage data at various scales. These datasets are ranked separately into highest priority and priority areas.

The 22 BioFinder components are separated into two different scales: 1)Landscape scale which shows the patterns of forests, waterways, and places that connect them into functional networks. 2)Community & Species scale which includes natural communities, grasslands, and other features used by groups of plants and animals as well as components that support particular species, such as the habitats needed by rare species.

The Agency of Natural Resources seeks to preserve, enhance, restore, and conserve Vermont's natural resources, and protect human health for the benefit of this and future generations. The Agency is comprised of the Departments of Environmental Conservation, Fish & Wildlife, and Forests, Parks & Recreation.

Introduction

Vermont has a rich natural heritage and legacy, treasured by Vermonters and visitors alike. Strong public support for conservation is evidenced by numerous public surveys (Roman and Ericson 2015). Vermonters strongly value wildlife, nature, and the state's rural, sparsely developed landscape, including the working lands supporting forestry and agriculture.

This valued natural legacy is threatened. Development and fragmentation of natural habitats, the spread of non-native and invasive plants and animals, and the effects of a changing climate all have the potential to dramatically alter Vermont's natural landscape and the native plants and animals that rely on it. Nevertheless, thanks to the resilience of our forests and natural communities, much of the state is currently in good ecological condition. Following the severe deforestation and soil loss of the heavily agricultural 19th century, Vermont is now largely forested, with many large and intact forest blocks. Vermont's small size belies its rich diversity of species and habitats. The state has many pristine lakes and wetlands; abundant calcium-rich bedrock which supports high species diversity, rare species, and productive forests; and a range of elevations and soil types from the clay soils of Addison County to the rugged alpine summit of Mount Mansfield.

These ecological conditions and strong public support for conservation highlight the opportunity that now exists to protect biological diversity.

Maintaining and enhancing ecological function across the landscape is fundamental to conserving biological diversity. Ecological function – the ability of plants and animals to thrive, reproduce, migrate, and move as climate changes and the ability of natural ecosystems to function under natural processes – is served by high-quality terrestrial and aquatic habitat, natural connections across the landscape, a wide variety of habitat features from low elevation to high, clean water, and healthy rivers, streams, lakes, ponds, and wetlands.

This is a practical approach to protecting and enhancing ecological function into the future. This approach, a landscape-level conservation design for Vermont, is based on a rigorous scientific process using the best available data. The lands and waters identified here are the areas of the state that are of highest priority for maintaining ecological integrity. Together, these lands comprise a connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend. When conserved or managed appropriately to retain or enhance ecological function, these lands will sustain Vermont's natural legacy into the future.

Coarse-filter Conservation Approach

It would be overwhelming to identify and manage for the individual needs of the thousands of species of plants, animals, invertebrates, and fungi in Vermont. The coarse-filter conservation approach treats larger-scale components (or "elements") of the landscape as proxies for the species they contain (Panzer and Schwartz 1998; Molina et al. 2011; Shuey et al. 2012). If examples of all coarse-filter elements are conserved at the scale at which they naturally occur, most of the species they contain—from the largest trees and mammals to the smallest insects—will also be conserved

(Hunter 1991; NCASI 2004; Schulte et al. 2006). This approach is well-documented in the scientific literature (Jenkins 1985; Noss 1987; Hunter et al. 1988; Hunter 1991; Noss and Cooperrider 1994; Haufler et al. 1996; Jenkins 1996; Poiani et al. 2000; USDA 2004).

The coarse-filter conservation approach can provide for the habitat needs of many of Vermont's species, allowing for efficiency in conservation planning and design. This project focused on identifying landscape-level coarse filters. We have very high confidence that this conservation design identifies areas essential for the long-term functioning of Vermont's landscape and the species it contains. However, coarse-filter conservation alone cannot adequately address all the needs of Vermont's species, habitats, and natural communities. Very rare species, whose distribution on the landscape is too infrequent and unpredictable to be captured by most coarse filters, and species with very specific habitat needs (such as grassland nesting birds that in Vermont are only associated with very specific agricultural mowing regimes) require additional considerations. A complementary "fine-filter" conservation approach is needed for these species and habitats, and we are planning to address a conservation design for these species and habitats in a subsequent project.

Conserving Ecological Function

It is important to note that the goal for all of these areas is to maintain the ecological functions provided by that landscape element. For example, the goal for Interior Forest Blocks is to maintain the unfragmented, interior forest of these areas that provides critical habitat for many species of plants and animals. There is considerable leeway on what can happen within a forest block and still maintain interior forest function. For example, most forest management activities are compatible with maintaining the long-term interior forest functions for these blocks, providing these activities are thoughtfully planned.

Many tools can be used to achieve the overall goal of retaining ecological function. With approximately 80% of Vermont's land privately-owned, management and stewardship of private lands will be an essential path to success. Other tools include conservation easements, local planning and zoning, state regulations, and ownership by a state or federal agency or a private conservation organization. This document and these maps do not provide the detail as to which of these tools are best suited to specific places, but there are recommendations for further prioritization filters that users can apply to make these decisions.

Methods

A BioFinder core team was established by the Vermont Fish & Wildlife Department to conduct the 2016 BioFinder upgrade. This included Eric Sorenson, Robert Zaino & Jens Hilke. The core team was responsible for overseeing the overall scope of the upgrade under the direction of Department Leadership. New data was created under the direction of the Vermont Conservation Design Steering Committee.

The 2016 update to BioFinder involved replacing the 2012 Tiered Ecological Priorities dataset with a landscape scale prioritization and a community and species scale prioritization. All landscape scale components in the 2012 version of BioFinder were replaced with new components (called Vermont Conservation Design Landscape Scale) and are separated into Highest Priority and Priority areas.

Highest Priority areas and priority areas from each component were then separately combined to create the Landscape Scale Prioritization seen in BioFinder 2016. Community and species scale elements were ranked as highest priority or Priority. Further prioritization will occur for each of these components in Vermont Conservation Design Phase 2.

A steering committee was established with representation from the three departments of the Vermont Agency of Natural Resources (ANR) to create the landscape scale data in BioFinder (Vermont Conservation Design Phase 1). Additional members were recruited for their scientific expertise. The steering committee was responsible for developing and guiding the scientific process.

Roster of Vermont Conservation Design Steering Committee

John Austin	VT Fish and Wildlife Department
Jayson Benoit	NorthWoods Stewardship Center
Jeff Briggs	VT Department of Forests Parks & Recreation
Dan Farrell	The Nature Conservancy
Jens Hilke	VT Fish and Wildlife Department
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Eric Sorenson	VT Fish and Wildlife Department
Liz Thompson	Vermont Land Trust
Bob Zaino	VT Fish and Wildlife Department

The following details the creation of the new landscape scale components, Vermont Conservation Design Phase 1.

Our first step in applying the coarse-filter approach to this project was to list landscape scale elements that could serve as coarse filters and the finer scale elements that could effectively be captured by each. The list of finer scale elements included a broad range of ecological processes, natural communities, habitats, and species. Analyses of the effectiveness of several proposed coarse filters were compiled in a tabular format. This analysis informed our selection efforts. The table is a significant product of this project and serves as a strong conceptual foundation for identifying those landscape elements that most effectively represent the ecologically functional landscape needed to support most of the fine filter elements into the future. The table will be expanded in a later phase of the project to include many more natural communities, habitats, and species and will be the basis for identifying which of these finer scale elements are not “captured” by the landscape scale coarse filters and therefore need specific conservation and/or management attention.

Based on these first steps, we selected five landscape elements from an initially longer list as collectively being the most effective and parsimonious for maintaining an ecologically functional landscape. These are:

1. Interior Forest Blocks
2. Connectivity Blocks
3. Surface Waters and Riparian Areas
4. Riparian Areas for Connectivity
5. Physical Landscape Diversity Blocks

We also identified Wildlife Road Crossings as a key element of the conservation design. Wildlife road crossings are road segments with suitable habitat on both sides of the road. Although not actually a coarse filter, wildlife road crossings are essential to the success of the five chosen landscape elements and therefore are a critical component of maintaining and enhancing Vermont's ecologically functional landscape.

When the ecological functions of each of these landscape elements are maintained and enhanced, and when each is conserved at the appropriate scale and distribution across the landscape, the majority of Vermont's species and natural communities are very likely to be conserved even as the climate changes.

While each landscape element is important on its own, it cannot function in isolation. Maintaining or enhancing an ecologically functional landscape in Vermont depends on both the specific functions of each element, and the ability of the landscape elements to function together. Interactions between elements are what support Vermont's environment and are essential for long-term conservation of Vermont's biological diversity and natural heritage.

Each of these landscape elements is described below, and a map shows the areas identified as "priority" and "highest priority" for each. The highest priority areas are those that are critical for maintaining an ecologically functional landscape. The priority areas are also important but there is more flexibility available for conserving ecological function within these areas. The highest confidence in maintaining an ecologically functional landscape will be achieved by conservation of both priority levels for all of these landscape level elements.

Component Abstracts

Interior Forest Blocks

Description

Interior Forest Blocks are a selection of habitat blocks that best provide interior forest conditions in each Biophysical region. Habitat blocks themselves are areas of contiguous forest and other natural habitats that are unfragmented by roads, development, or agriculture and identified by Vermont Fish & Wildlife Department (Sorenson & Osborne, 2014.). This dataset is a selection among all the available habitat blocks (4,052) of those with the best likelihood of offering interior forest conditions. Vermont's habitat blocks are primarily forests, but also include wetlands, rivers and streams, lakes and ponds, cliffs, and rock outcrops. Forests included in habitat blocks may be young, early-successional stands, actively managed forests, or mature forests with little or no recent logging activity. The defining factor is that there is little or no permanent habitat fragmentation from roads, agricultural lands and other forms of development within a habitat block. BioFinder's Interior Forest Blocks includes a subset of the best examples of habitat blocks 500 to 1,000 acres and larger. Developed lands, most roads and lands in most agricultural cover classes (including cultivated crops, grasslands and pasture) are not considered natural cover. The effects of roads on interior forests vary with road size and traffic volume and the effects generally extend 100-300 feet into the adjacent forest. To more accurately identify interior forest conditions, buffers were assigned to roads with wider buffers assigned to larger and busier roads. Class four roads and most logging roads are fragmenting features for some species, but not necessarily for wide-ranging species that are the focus of the habitat block analysis.

Interior Forest Blocks serve as a course filter for a host of finer scaled elements detailed in the attached matrix. (Panzer and Schwartz 1998; Molina et al. 2011; Shuey et al. 2012)(Hunter 1991; NCASI 2004; Schulte et al. 2006). (Jenkins 1985; Noss 1987; Hunter et al. 1988;; Noss and Cooperrider 1994; Haufler et al. 1996; Jenkins 1996; Poiani et al. 2000; USDA 2004).

Priority Interior Forest Blocks are highly ranked forest blocks from all biophysical regions that provide important interior forest habitat and provide ecological support to the highest priority Forest Interior Blocks. *Highest Priority Interior Forest Blocks*: are the largest and/or highest ranked *(i.e. Sorenson and Osborne Habitat Blocks 2014 Ecological Priority score of 7 & higher*) from all biophysical regions that provide the foundation for interior forest habitat and associated ecological functions.

Ecological Importance

Interior forest blocks support the biological requirements of many native plants and animals. They support viable populations of wide-ranging animals, including bobcat, American Marten, and black bear, that require large areas to survive by allowing access to important feeding habitat, the ability to move and find mates for reproduction, and as a result ensure genetic integrity of populations. Larger forest blocks serve as habitat for source populations of dispersing animals for recolonization of nearby areas that may have lost their original populations of those species. Such habitat, together with other important habitats such as wetlands, also supports natural ecological processes such as predator/prey interactions, hydrologic regimes and natural disturbance. They also serve to buffer species against the negative consequences of fragmentation, maintain air and water quality.

In addition, large, topographically diverse forest blocks will allow many species of plants and animals to shift to suitable habitat within a forest block in response to climate change within the next century without having to cross developed areas to other forest blocks (Beier 2012).

The coarse-filter conservation approach can provide for the habitat needs of many of Vermont's species, allowing for efficiency in conservation planning and design. We have very high confidence that this conservation design identifies areas essential for the long-term functioning of Vermont's landscape and the species it contains.

Guidelines for Maintaining Ecological Function: The primary goal is to maintain the interior forest conditions that forest blocks provide by avoiding permanent interior forest fragmentation resulting from development. Limited development on the margins of existing large forest blocks may not have significant adverse effects as long as it does not reduce connectivity between blocks and does not encroach into the forest block interior. Forest management that maintains forest structure within the block and results in a distribution of all age classes is compatible with maintaining interior forest conditions over the long term.

Interior Forest Blocks Conservation Goal

To conserve interior forest blocks across Vermont that support interior forest ecological processes as well as viable populations of Vermont's native fish and wildlife, including a variety of interior forest birds, wide ranging species such as black bear, bobcat, and American marten, and form a network of lands and waters that include representation of the state's physical landscape diversity.

Component Mapping Goal

To identify the best examples of habitat blocks across Vermont and include appropriate representation of habitat blocks in all biophysical regions.

Source Data and Selection Criteria

Habitat Blocks, Vermont Fish & Wildlife Department (Sorenson & Osborne, 2014.)

Description

Habitat blocks show all areas of natural cover (Using 2006 landcover data from NOAA Coastal Change Analysis Program (CCAP)) surrounded by roads, development and agriculture, ranging in size from 500-acres to 153,000-acres and prioritized for biological importance.

Selection Criteria

Habitat block selection criteria were designed to consider the varying land use patterns within each biophysical region as follows:

Piedmont Biophysical Region (BPR)–all blocks larger than 1000a and all blocks with priority ranks 6-10.

Champlain Valley BPR–all blocks larger than 250a and all blocks with priority ranks 6-10.

Vermont Valley BPR–all blocks larger than 500a and all blocks with priority ranks 6-10.

Taconics, Greens, & NE Highlands BPRs all bocks with priority ranks 6-10

Component Strengths

Interior Forest Blocks are spatially accurate. They are not modeled, but rather are based on land cover data. They reflect a mix of different land cover types, and hence serve as a coarse filter for a wide variety of plant and wildlife species. This dataset includes its own ranking. This ranking system evaluated biological values and physical landscape characteristics for each block allowing for a full range of biological diversity present within the blocks to be highlighted. This dataset excludes roads, development, and agriculture, ensuring that only unfragmented habitat is included.

Component Limitations

The Interior Forest Blocks dataset is biased towards higher elevation lands away from larger river valleys and lowlands as it excludes roads and a buffer around each road, and most of Vermont's roads and development are along rivers and in lowlands. This is a very typical development pattern in Vermont, where roads often closely follow streams and rivers where it is easiest to build. It results in some areas of streams not being considered due to their proximity to roads and development. However, the important influence of aquatic habitats is captured through other data sources, as described later, for purposes of this project.

Component Priority & Justification

The Interior Forest Blocks dataset is divided into Highest Priority and Priority selections as described in Selection Criteria. These areas are important components of Vermont's biological diversity. These habitats provide critical contiguous natural cover for a variety of wide-ranging animal species and room for natural processes. They also serve as a coarse filter for a variety of finer scaled natural communities and species that occur therein.

References

Sorenson, E. and J. Osborne. 2014. Vermont Habitat Blocks & Wildlife Corridors, an analysis using geographic information systems. Vermont Fish & Wildlife Department.

For more information

A complete report on BioFinder development, methods and findings, including all 22 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Eric Sorenson, Vermont Fish & Wildlife Department, 802-476-0126, eric.sorenson@vermont.gov

Physical Landscape Diversity

Description

Physical landscapes (often referred to as enduring features) are the parts of the landscape that resist change. They are the hills and valleys, the underlying bedrock, and the deposits left behind by glaciers. They remain largely unchanged when changes in land cover and wildlife occur, as plants and animals move, and even as the climate changes. However, these physical landscapes cannot continue to drive ecological processes or support plants, animals, or natural communities if they are developed or otherwise significantly altered by human activities.

If nature is likened to a dramatic play, it's possible to think of the enduring features as the stage and the individual species as the actors. The play is the natural communities, habitats and species that occur in a given place at a given time, but regardless of the action, the stage does not change. The importance of "conserving nature's stage" is that we can be much more confident in our ability to conserve biological diversity and maintain a functional landscape into the future, with the capacity to adapt and be resilient to climate change, if all elements of physical landscape diversity are represented in a landscape-scale conservation design (Anderson & Ferree 2010; Beier and Brost 2010; Beier et al. 2012).

BioFinder recognizes three broad categories of physical landscape diversity.

> ***Representative Physical Landscapes***: those that occur commonly in Vermont, based on percent of the landscape covered. Examples at the Land Type Association level include Low Rolling Upland and Mountain Slopes.
>
> ***Rare Physical Landscapes***: those that are rare in Vermont, based on percent of the landscape covered. Examples at the Land Type Association scale include the Vermont Escarpment and water-deposited sediments along major rivers and streams. Table 1 lists all the rare LTA categories we considered, but see "Notes on scale" for further explanation.
>
> ***Responsibility physical landscapes***: those that occur more commonly in Vermont than in other areas of the northeastern United States and adjacent Canada, and for which we therefore have a regional-level responsibility to protect. The most obvious examples include mid-to high elevation calcareous and moderately calcareous bedrock.

Unlike other BioFinder components, we used a multi-step, iterative process to incorporate physical landscape diversity (geophysical settings) into our design. Incorporating physical diversity was done after other highest-priority components of the overall conservation design – interior forest blocks, connectivity blocks, surface waters and riparian areas, and riparian areas for connectivity – had been identified. That design was then evaluated for its representation of physical landscape diversity, and gaps identified.

We then attempted to fill the gaps and meet the goals laid out below, using a variety of methods and data sources, at a variety of scales, so that each feature or set of features could be included with high confidence. Forest blocks were the primary, but not exclusive tool used to add areas to the design for physical landscape diversity. When forest blocks were not used, we limited selections to areas of natural vegetation.

For the 2016 BioFinder, Highest Priority Physical Landscape includes all three categories, Rare, Representative and Responsibility of physical landscapes. Physical Landscape Diversity is considered Highest Priority because of the strong relationship between physical diversity and biological diversity and the need to represent physical landscape diversity, particularly in a changing climate.

Ecological Importance

Enduring features are important for understanding biological diversity and informing conservation planning because they can serve as a surrogate, or substitute, for information on natural communities and species when that information is not available. Conserving and providing stewardship for the diversity of enduring features will in turn help protect the diversity of natural communities and species.

Some enduring features are helpful in locating specific natural communities and species. For example, the Valley Clayplain Forest is a natural community that is associated with the Valley Floor Glacial Lake/Marine Plains LTA and is found exclusively on clay soils. Two of its component plant species, bur oak and barren strawberry, are also most common on those soils. Therefore, it is possible to examine information on surficial geology to determine where clay deposits exist and, with that information, predict the potential location of a Valley Clayplain Forest and its component species. Conservation scientists and practitioners have used specific physical landscape features successfully to locate places to search for particular natural communities or rare species.

In the face of global climate change, it is clear that plant and animal species will continue to move around on the landscape to adjust their ranges to more climatically suitable conditions. Areas of diversity in the physical landscape are likely to continue as the stage for diversity in the biological landscape even as species composition changes.

Physical Landscape Diversity Conservation Goal

Represent all of the geophysical settings that occur in Vermont in a naturally vegetated network of connected lands to provide the "stage" for present and future biota and natural ecological processes (the "actors" and the "play").

Specifically, each of the three broad categories of physical landscapes included in BioFinder has a conservation goal.

> *Rare Physical Landscapes*: In the design, capture 100% of these whenever possible.
>
> *Representative Physical Landscapes*: In the design, capture these proportional to their overall occurrence in Vermont.
>
> *Responsibility geophysical settings*: In the design, capture 80% of these where possible.

Component Mapping Goal

To identify Vermont's enduring physical features, especially those places with considerable landscape diversity that may continue to foster biological diversity in the future, even as the climate changes and species composition shifts.

Data Source(s) & Selection Criteria

1. **Land Type Associations**, Ferree & Thompson 2008.

   Description

   Land Type Associations are a modeled product for use as analysis units to organize broad areas by suitability, identify restoration priorities, and serves as a coarse filter for protecting biodiversity. LTAs are landscape scale map units defined by multiple biotic and abiotic factors.

   Selection Criteria

   LTA sub-blocks were created from the LTA dataset to create in order to have smaller scale units for BioFinder analysis. All rare LTA sub-blocks were initially selected for inclusion (Table 1), but then modified as follows:

- *Valley Floor Glacial Lake/Marine Plains*: This LTA was removed and replaced in the selection because it included large areas of agricultural land. Instead, we used a combination of layers to identify high quality clayplain sites. For the southern Champlain Valley, we used Lapin's (2008) clayplain inventory from which we selected all clayplain forest patches with a ranking of "Medium" or "High." In the northern Champlain Valley, NRCS soils mapping was used to select forest blocks which contain substantial area of clay soil.
- *Granitic Mid-Elevation Hills*: 19 forest blocks were selected that encompassed all of the LTA. These blocks ranged in size from 35 to 45.976 acres.
- *Marine-Lacustrine-Glaciofluvial Coarse Sediments*: Removed and replaced with the two units described below.
- *Sandplain*: 36 forest blocks were selected that contained a high percentage of Adams-Windsor soils, ranging in size from 22 to 1,828 acres. An additional 56 areas of Adams-Windsor soils were selected where they overlapped with forest blocks, ranging in size from 52 to 621 acres.
- *Hinesburg Sand and Gravels*: Areas of Marine-Lacustrine-Glaciofluvial Coarse Sediments LTA on the eastern edge of the Champlain Valley were clipped to the forest blocks in which they occur, resulting in 23 polygons ranging in size from 55 to 370 acres.

Table 1. Selected Rare Land Type Associations

Type	% of VT
Calcareous Metamorphic High Hills/Low Mountains	0.3
Connecticut River Valley - Lake Hitchcock Sediments	0.8
Enriched Slopes	0.6
Granitic Basin	0.4
Granitic High Hills/Low Mountains	0.5
Granitic Mid-Elevation Hills	1.1

Marine-Lacustrine-Glaciofluvial Coarse Sediments	0.9
Precambrian Plateau	2.2
Upper Mtn Slopes/Mountaintops	2.7
Valley Floor Glacial Lake/Marine Plains	4.4
Vermont Escarpment	0.8
Water-deposited glacial sediments along major riverways	2

2. Serpentine Bedrock – 2011 Bedrock Geology map, Ratcliffe et. al. Vermont Geological Survey

Description

New bedrock geology map for the state of Vermont at the 1:100,000 scale. This includes mapping of the rare serpentine bedrock type.

Selection Criteria

Six forest blocks were selected that contained a high percentage of serpentinite bedrock based on the 2012 VT Geologic Map. An additional 89 areas of serpentinite bedrock were selected where they overlapped with forest blocks, ranging in size from 5 to 663 acres.

3. Ecological Land Units, Ferree & Anderson 2008.

Description

Ecological Land Units are a modeled product for use as analysis units to organize small areas by suitability, identify restoration priorities, and serves as a coarse filter for protecting biodiversity. LTAs are fine-scale map units defined by multiple biotic and abiotic factors.

Selection Criteria

After the selection of Rare LTA and Serpentine features, we conducted an initial analysis of the representation of overall physical landscape diversity. We based this on Ecological Land Units, developed by TNC but used the broadest set of categories possible with the dataset. By using all elevation, geology, and landform categories, we generated 459 unique combinations, which we called ELU-459s. We reviewed all of the ELU-459s to see if the combinations generated were ecologically meaningful or described physical settings that are likely to occur on the landscape. Almost all of the ELU-459s were considered reasonable. An example of an ELU-459 without "ecological logic" is coarse sediments at hill slope base. The advantage of the ELU-459s over more coarsely-lumped classifications of ELUs is that they result in identifying all aspect, bedrock, elevation, and landform combinations. Although some of these combinations are very rare features on the landscape, overall, the combination of settings provides a strong basis for setting physical landscape diversity conservation targets that will be the most effective in conserving a functional landscape – one that allows adaptation to climate change and that results in effectively "conserving nature's stage."

Based on this analysis and the goals state above, we chose a subset of ELU-459s that were underrepresented in our design. These were units where we had achieved less than 50% of our desired target in this first analysis. We then identified priority interior forest or connectivity blocks that had these underrepresented ELU-459s in more than 50% of their total block area.

We moved these blocks into the highest priority category. We re-ran our ELU analysis and determined that these were satisfactory for achieving a result close to our targets. Because of development, land use, and a resulting bias in our design towards high-elevation areas, it simply was not possible to meet our targets for all 459 units. Gaps in targets identify important conservation and restoration needs.

Finally, we conducted a review of our connectivity blocks and selected blocks that would provide connectivity from otherwise isolated blocks selected for underrepresented ELUs. When these selections were complete, we ran a final analysis to arrive at final calculations for ELU representation in our design.

Component Priority & Justification

Physical Landscape Diversity is considered Highest Priority because of the strong relationship between physical diversity and biological diversity and the need to represent physical landscape diversity, particularly in a changing climate.

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For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Jens Hilke, Vermont Fish & Wildlife Department, 802-461-6791, jens.hilke@vermont.gov

Connectivity Blocks

Description

Connectivity Blocks are larger patches of forest habitat in VT that is connected across the landscape, allowing the movement, migration, and dispersal of animals and plants. These are a subset of Habitat Blocks (Sorenson & Osborne 2014) that include a mix of the largest "anchor" blocks of forest in VT >10,000 acres as well as many smaller blocks that serve as stepping stones to form the connected network of forest land.

The composition and functions of connectivity blocks support genetic heterogeneity and movement of populations of wide-ranging mammal species across huge swaths of the landscape; such as between the Adirondacks Mountains of New York, Vermont's Green Mountains and the White Mountains of New Hampshire. They include large blocks of contiguous, unfragmented core habitat, the source and principle home area of many species as well as areas of diversity in the physical landscape, and numerous smaller connecting lands either forested stepping stone blocks or riparian and surface water areas.

Habitat is also connected at fine scales, for example by **Riparian Wildlife Connectivity** and **Wildlife Road Crossings**, where individual terrestrial animals move along waterways and cross roads. This most local scale of movement may not necessarily be of regional significance, but of course, the regional connections cannot function without local movement. There can be no genetic exchange between wildlife populations in New York and Vermont, for example, without individual animals making sections of the trip, crossing roads and eventually breeding with other individuals. Therefore local and regional connectivity are both vital to the long-term sustainability of wildlife populations and the ecological functions that they support. For the purposes of BioFinder, habitat connectivity is captured in the following components:

Table 1. Habitat Connectivity at Regional & Local Scales as Used in BioFinder

Scale	Component	Description
Regional Connectivity	Connectivity Blocks (Highest Priority)	Habitat blocks that are of the greatest importance for wildlife movement and genetic exchange
	Connectivity Blocks (Priority)	Habitat blocks that play a supporting role in wildlife movement and genetic exchange at a statewide scale
Local Connectivity	Riparian Wildlife Connectivity	Lands along streams, rivers, lakes and ponds including those agricultural lands in pasture/hay, grasslands and all other natural-cover types. Does not include developed lands and agricultural lands with cultivated crop.
	Wildlife Road Crossings	Locations where wildlife is likely to cross roads based on the presence of adjacent natural cover.

Ecological Importance

Movement of animals from one habitat patch to another is the most common function associated with connecting habitat. This function is particularly important for wide-ranging animals, such as bobcats and black bears, or for animals that require a great deal of space to meet their daily life needs, such as barred owls or otter. Although connecting habitat is often associated with wide-ranging mammals, it is equally important for animals with relatively small ranges and even for plants over long time periods as climate changes. Spotted salamanders, for example, use connecting habitat in spring to move from their hibernation sites to breeding pools, sometimes crossing roads or agricultural fields. The value of connecting habitat is a function of both seasonal and spatial patterns of wildlife behavior. For example, connecting habitat may allow black bears to access important food resources during a specific time of year (seasonal), or it may prevent isolation of bear populations by allowing free exchange of breeding adults (spatial). Ultimately, connecting habitat can ensure that the habitat, movement, migration, and behavior requirements of most native plants and animals are conserved across a broad landscape. The broader ecological value of connecting habitat is to join fragmented pieces of habitat, thereby reducing the deleterious effects of habitat fragmentation and population isolation. Linking small or otherwise isolated habitat patches may reduce the risk of local population extinctions by ensuring immigration, recolonization, reproduction, and exchange of genes for some plant and animal species. While conserving corridors has great merit, do not assume that conserving threads of vegetative cover within a developing landscape will maintain an area's ecological values and biological diversity. Nor will corridors alone meet the habitat needs of all of an area's plant and animal species. Only in conjunction with the conservation of large areas of undeveloped land with diverse habitat conditions, will vegetative corridors assist in supporting ecosystem functions and related public benefits.

Connectivity Blocks Conservation Goal

Conserve local-scale connecting habitats that support seasonal and spatial patterns of wildlife movement and allow for movement between habitat patches across potential barriers. The larger conservation goal for landscape connectivity is to conserve a connected network of lands, waters, and riparian areas that allow for functioning of ecological processes across the landscape and dispersal, movement, and migration of plant and animal species in response to changing environmental conditions.

Component Mapping Goal

To identify and map the most vulnerable lands that contribute to connectivity at several scales. These important pinch points and stepping stones help form a multi-scaled network of connected land and water that includes core habitat, natural communities and connecting features.

Source Data and Selection Criteria

Description

1. **Habitat Blocks**, Vermont Fish & Wildlife Department (Sorenson & Osborne, 2014.) Habitat blocks show all areas of natural cover (Using 2006 landcover data from NOAA Coastal Change Analysis Program (CCAP)) surrounded by roads, development and agriculture, ranging in size from 20-acres to 153,000-acres and prioritized for biological importance.

2. **Northern Appalachian/Acadian Ecoregion: Priority Locations for Conservation Action** Trombulak et al., 2008. This work identifies priority linkages at the ecoregional scale.

3. **Resilient sites for terrestrial conservation in the Northeast and Mid-Atlantic region**. Anderson et al., 2012. Using Circuitscape software this work models flow concentration areas to assess regional-scale connectedness and pinch points.

4. **From the Adirondacks to Acadia: A Wildlands Network Design for the Greater Northern Appalachians**. Reining et al., 2006). This work identifies a network design for regional connectivity based on habitat models for far-ranging mammals.

5. **Linkage Areas of the Northern Appalachian and Acadian Ecoregion**. 2012. Staying Connected Initiative. Staying Connected used models and field data to identify high priority linkages which were incorporated in their entirety because of their finer granularity.

Selection Criteria

The 2016 **Connectivity Blocks** dataset is a refinement of the 2012 Network of Connected Lands that was posted in the first version of BioFinder, which included; Anchor Blocks, Connectivity Blocks and Connecting Lands. The 2016 edits refined the network into two tiers, highest priority and priority based on a review by the BioFinder Core team. Additional habitat blocks were selected for inclusion by the Core Team, to connect to areas of diversity in the physical landscape and places where the riparian network connects additional "stepping stone" habitat blocks to core habitat blocks. The 2016 Connectivity Blocks dataset reflects an understanding of connectivity that connects core habitat, areas of diversity in the physical landscape and the riparian network.

Connectivity Blocks is a selection of habitat blocks with a high ranking for cost-distance to core (Sorenson & Osborne, 2014.). Additional habitat blocks and connecting lands were added based on overlap with the regional scale datasets (*Northern Appalachian/Acadian Ecoregion: Priority Locations for Conservation Action* Trombulak et al., 2008, R*esilient sites for terrestrial conservation in the Northeast and Mid-Atlantic region*. Anderson et al., 2012, *From the Adirondacks to Acadia: A Wildlands Network Design for the Greater Northern Appalachians.* Reining et al., 2006, & S*taying Connected's Linkage Areas of the Northern Appalachian and Acadian Ecoregion*. 2012.) to represent connectedness within Vermont and outside of the state to the Adirondacks, Whites, Berkshires, Mahoosics, and Sutton Mountains, as well as numerous locations across the Connecticut River. Blocks were then split into Highest Priority and priority. The selection process for highest priority connectivity blocks focused on blocks that were critical in maintaining the ecological function of connectivity (highest priority) vs. those that supported connectivity but were somewhat "exchangeable" with other blocks (priority)

The Connectivity Blocks dataset is the best effort so far to map not only areas between core habitats for far ranging mammals, but also between areas of diversity in the physical landscape and connections to and with the riparian network. Together, these different types of connectivity combined offer us important insights into a resilient connected network that will maintain species movement and diversity into the future

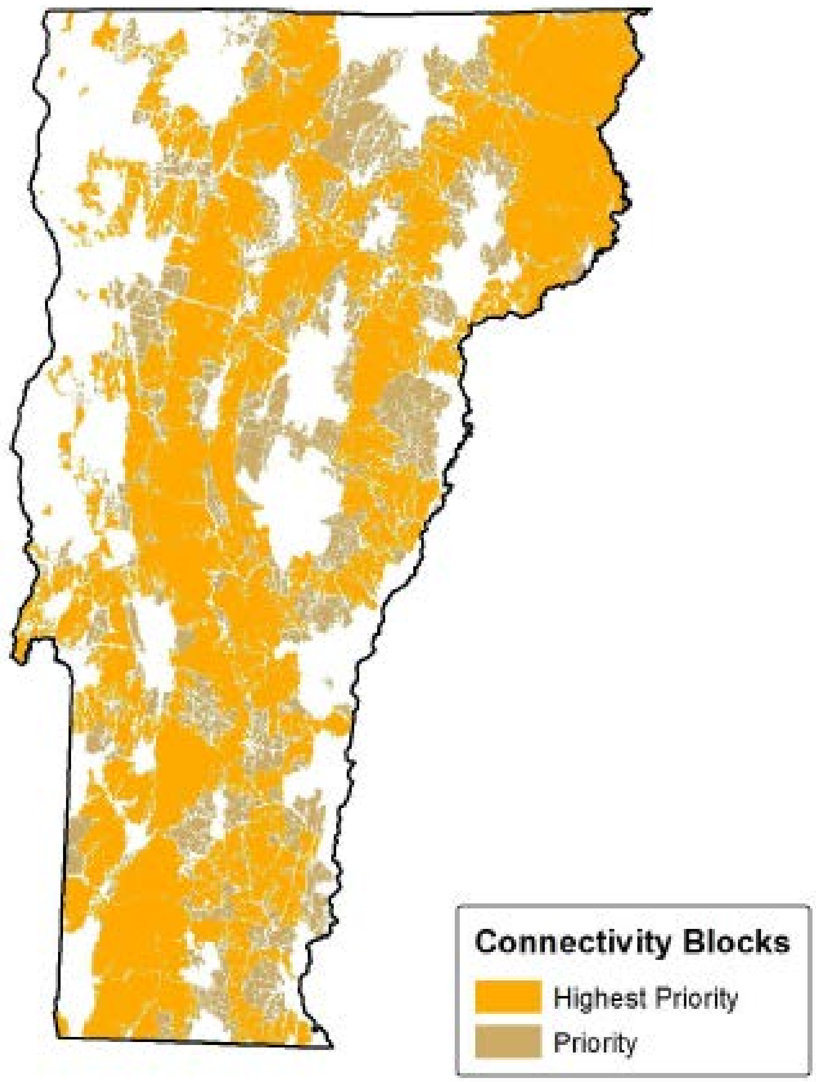

Figure 1. Highest Priority and Priority Connectivity Blocks

Component Strengths

The Connectivity Blocks dataset addresses regional scale habitat connectivity and associated wildlife and ecological movement. It uses the regional flow data developed by The Nature Conservancy, as well as habitat linkage areas identified by the Vermont Habitat Block project. This gives us a sense of lands within the State that play a role in connectivity well beyond the state's borders. This makes it possible to identify a network within Vermont important for climate change adaptation and other regionally pressing issues that occur at regional scales

The Connectivity Blocks component has the strength of focusing on several types of connectivity. It includes the large core habitats and stepping stone blocks in between them important for far-ranging mammal movement, but also includes some habitat blocks that are connected through the Surface Waters & Riparian Areas dataset, which is to say, wildlife or ecological processes moving to or from this forest block would do so through the riparian system. In some cases, habitat blocks that connect areas of diversity in the physical landscape were selected and included in this dataset. Together, these different types of connectivity combined offer us important insights into a resilient connected network that will maintain species movement and diversity into the future

Component Limitations

The Connectivity Blocks dataset focuses on lands important for regional-scale habitat connectivity. Only places that allow for movement between contiguous habitat (such as the Adirondacks or Green Mountains) are considered important. This leaves out areas of the state that are critically important for wildlife at a local scale. Movement between patches of habitat remains important even if the wildlife populations in question aren't operating at a regional scale of movement.

The Connectivity Blocks component is a selection of habitat blocks, so by definition, this leaves out roadsides,, agricultural and developed land. Due to the coarseness of the land cover data, there is often very suitable connecting features like hedge or tree rows or other continuous or semi-continuous cover included in these cover classes. This misses locally important connectivity areas, especially for amphibians and reptiles. We rely on the use of the Wildlife Road Crossings dataset and Riparian Wildlife Connectivity dataset to address more local scale movement areas. The connecting lands component is not based on field data and site visits are always needed to identify specific locations of functioning connectivity within the mapped polygons.

Component Priority & Justification

Connectivity Blocks was separated into Highest Priority and Priority areas. The selection process for highest priority connectivity blocks focused on blocks that were critical in maintaining the ecological function of connectivity (highest priority) vs. those that supported connectivity but were somewhat "exchangeable" with other blocks (priority). Together these represent the most advanced understanding of habitat connectivity in VT at this scale, integrating riparian corridors and areas of diversity in the physical landscape.

References

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For more information

A complete report on BioFinder development, methods and findings, including all component summaries can be found at www.BioFinder. . For more information specific to this component, contact Jens Hilke, Vermont Fish & Wildlife Department, 802-461-6791, jens.hilke@svermont.gov.

Riparian Wildlife Connectivity

Description

Habitat Connectivity is a complex process that functions at different scales for different species. Generally speaking, connecting habitat is represented by land that links larger patches of habitat within a landscape, allowing the movement, migration, and dispersal of animals and plants. Riparian wildlife connectivity refers specifically to lands along streams and rivers and lakes and ponds used by wildlife and plants to move. Sometimes these areas are called "corridors" even though they are not always linear, as the term implies.

The word "riparian" literally means of, or pertaining to, the bank of a river or lake. Riparian areas are ecosystems comprised of streams, rivers, lakes, wetlands, and floodplains that form a complex and interrelated hydrological system. These ecosystems extend up and down streams and along lakeshores, and include all land that is directly affected by surface water (Verry et al., 2000). Riparian ecosystems are generally high in biological diversity. They are "characterized by frequent disturbances related to inundation, transport of sediments, and the abrasive and erosive forces of water and ice movement that, in turn, create habitat complexity and variability…resulting in ecologically diverse communities" (Verry et al., 2000).

Riparian wildlife connectivity includes all non-developed cover classes within the Surface Waters and Riparian Area (A1) dataset. Developed land classes were filtered-out from the surface waters dataset to create the riparian connectivity component. This identifies stream reaches that haven't been developed and are critical travel corridors for a variety of wildlife species. Many of these areas are actively used for agriculture, which compromises their functionality as travel corridors.

Ecological Importance

Riparian wildlife connectivity is especially important for wildlife species that are closely associated with rivers and lakes, including mink, otter, beaver, and wood turtle but are used by a wide assortment of wildlife. The riparian connectivity component represents the vegetated portions of river and stream valley bottoms and lakeshores which provide numerous ecological functions relating to surface water quality, flood attenuation, and shoreline stability. It also includes floodplain forests and other riparian natural communities that together provide habitat for many rare species represent a concentration of biological diversity.

Riparian Wildlife Connectivity Conservation Goal

Conserve a connected network of lands, waters, and riparian areas that allow for functioning of ecological processes across the landscape and dispersal, movement, and migration of plant and animal species in response to changing environmental conditions. Restoration and conservation of riparian connectivity is especially important in areas of Vermont that are highly developed.

Component Mapping Goal

To identify riparian areas statewide with natural vegetation cover and those in agricultural use (e.g., hay, pasture, grassland) except for cultivated crops.

Input Datasets and Selection Criteria

Description

1. **Surface Waters & Riparian Areas Component (A1),** VT Agency of Natural Resources, Natural Resources Mapping Project, BioFinder. 2012.
2. **Regional Land Cover**, NOAA Coastal Change Analysis Program (CCAP), 2006.

Selection Criteria

BioFinder's Surface Waters and Riparian Areas component dataset (A1) was used as the basis for Riparian Connectivity. All developed land classes (using NOAA CCAP dataset) were filtered-out (removed) leaving only natural or modified land cover classes. These include grassland, herbaceous and shrub cover classes as well as all forested and wetland cover classes. Agricultural lands are included.

Component Strengths

The Riparian Wildlife Connectivity dataset is the first of its kind for all of Vermont as it identifies all river and lake riparian areas that have natural or semi-natural vegetation cover – a critical part of landscape connectivity. The other four datasets related to habitat connectivity all focus on terrestrial animals and are generally biased towards far-ranging mammals. This dataset includes all riparian habitats along rivers and streams that aren't currently developed to support movement along rivers, streams, and valley bottoms in general. It is still focused on terrestrial animal movement, but gets at the critically-important land-water interface. There is relatively high confidence that riparian connectivity dataset accurately maps the portions of valley bottoms with natural cover

Component Limitations

The Riparian Wildlife Connectivity dataset does not factor in aquatic organism passage or other within-stream connectivity functions, but instead looks at stream-side connectivity. This is a limitation given that both of these types of connectivity are ecologically important.

Even with this focus on streamside connectivity, there are still limitations. Stream and river sections are not ranked by length or ecological importance so sections that are longer and can facilitate greater movement, are not prioritized. With the limited time available for this project we could not develop mapping algorithms sufficiently sensitive enough to account for section length and ecological importance without over-weighting headwater streams relative to main-stem channels. Therefore all riparian connectivity sections are treated as equally important. We recommend that future efforts to refine this dataset incorporate a ranking factor.

This dataset uses the Vermont Hydrological Dataset (VHD) that identifies stream centerline data to which a standardized buffer was added to establish stream width at various locations. While centerline data is very accurate in showing the location of a waterbody, the process needed to show the area (width) of that stream section creates inaccuracies. We believe the final product is still the best available data that includes all of Vermont's waterways and as with all features included in BioFinder, we recommend site-specific surveys prior to making any land-use decision

Component Priority & Justification

Riparian Wildlife Connectivity was ranked as highest priority because it is critically important component of the larger system of wildlife movement and genetic exchange.

References

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For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Jens Hilke, Vermont Fish & Wildlife Department, 802-461-6791, jens.hilke@vermont.gov

Surface Waters and Riparian Areas

Description

This component includes all rivers, streams, lakes, and ponds – all aquatic habitats in Vermont. In addition, this component includes the valley bottoms in which rivers and streams flow. Specifically, the valley bottoms are the areas of alluvial soils (soils deposited by flowing water) through which rivers and streams migrate over time and where seasonal river or stream flooding is expected. Finally, this component includes a band of riparian habitat adjacent to all rivers, streams, lakes, and ponds or to the valley bottom.

Ecological importance

While Vermont's rivers, streams, lakes, and ponds cover a small percentage of Vermont's area, they provide vital habitat for a rich assemblage of aquatic species, including fish, amphibians, reptiles, invertebrates (e.g., insects, mussels, snails, worms, freshwater sponges), and plants. This represents an enormous contribution to Vermont's biological diversity. All of Vermont's rivers, streams, lakes, and ponds are important for the aquatic biota that they support.

As aquatic species are mobile, it is important to maintain connected aquatic habitats in order to protect the diversity of species. Water quality and temperature of upstream reaches directly influences the ability of downstream receiving waters to support aquatic assemblages. Fish and other aquatic populations may travel extensively throughout the lake and stream network for seasonal and life cycle needs. Therefore, it is critical to protect the entire aquatic network in order to maintain the ecological processes necessary to sustain these aquatic populations and assemblages. It is because of this that the decision was made to include all rivers, streams, lakes, and ponds in this BioFinder component.

The ecological integrity of rivers, streams, lakes, and ponds is closely linked with the condition of their riparian areas and contributing watersheds. Naturally vegetated riparian areas provide many critical ecological functions, including stabilizing shoreline against erosion, storage of flood waters, filtration and assimilation of sediments and nutrients, shading of adjacent surface waters to help moderate water temperatures, and direct contribution of organic matter to the surface water as food and habitat structure. Riparian areas are also critical habitat for many species of wildlife that are closely associated with open waters, including mink, otter, beaver, northern oriole, kingfisher, spotted sandpiper, and wood turtle. In addition, the shorelines and riparian areas of rivers and lakes support floodplain forests, several rare and uncommon natural communities, and many species of rare plants and animals.

The ecological integrity of rivers and streams is also closely linked to the stability of the river channel and the river corridor within which the river meanders. Rivers and streams channels naturally migrate within their meander belt widths – the part of a valley bottom across which a stream shifts its channel from time to time in response to erosion and deposition. Meander belts are governed by landforms in the valley bottoms, surficial geology and soils, and other characteristics of the river channels and watersheds. River corridors may be narrow in valleys restricted by bedrock or they may be wide in flat valley bottoms with deep alluvial soils.

Surface Waters and Riparian Areas Conservation Goal

To conserve the ecological integrity of all rivers, streams, lakes, and ponds and the aquatic biota they support and to contribute to a landscape that is more resilient in the face of increasingly frequent and severe flood events, by conserving and restoring watershed processes that support properly functioning aquatic habitats and riparian areas, and by maintaining or restoring river channel equilibriums.

Component Mapping Goal

To map all rivers, streams, lakes, and ponds and their associated riparian areas and river and stream valley bottoms.

Source Data and Selection Criteria

1. **Vermont Hydrographic Dataset (VHD) 1:5,000**

   Description

   The Vermont Hydrographic Dataset 1:5,000 is a spatially accurate statewide mapping of rivers, streams, lakes, and ponds.

   Selection Criteria

   All rivers, streams, lakes, and ponds mapped as lines or polygons. For those smaller rivers and streams mapped as line features in the VHD 1:5,000, the expected stream width from Table 6 is used to map these rivers and streams as polygons. Use the VHD 1:5,000 polygons for larger rivers and all lakes and ponds.

2. **Valley Bottom Land Type Associations (Ferree & Thompson 2008)**

   Description

   Valley Bottom LTAs, developed by Ferree & Thompson (2008), are used to map the valley bottoms, floodplains, and river corridors statewide. The Valley Bottom LTA data provides a statewide modeled map of river and stream valley bottom that effectively captures flat valley bottoms and associated alluvial soils, wetlands, and floodplains without extending mapped areas beyond the valley floors. Although partially a GIS model, major portions of the Valley Bottom LTA are based on soil mapping by Natural Resources Conservation Service and wetland mapping by National Wetlands Inventory.

   Selection Criteria

   All Valley Bottom LTAs are included. Riparian area widths are added to all streams and rivers as described in Table 1. This river and stream riparian area is measured from the outer edge of each side of the mapped river or stream polygon or the outer edge of the Valley Bottom LTA, whichever is wider. A 100 foot riparian area is mapped for all lakes and ponds.

Table 6. Stream Widths & Riparian

Stream Order	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Stream Width (feet)	4	10	20	33	66	150	230	
Riparian area (feet) measured from the outer edge of Valley Bottom LTA (if one exists) or the outer edge of stream width (whichever is wider).	50	50	50	100	100	100	100	100

Component Strengths

The Vermont Hydrographic Dataset 1:5,000 is a spatially accurate statewide mapping of rivers, streams, lakes, and ponds. The Valley Bottom LTA data provides a statewide modeled map of river and stream valley bottom that effectively captures flat valley bottoms and associated alluvial soils, wetlands, and floodplains without extending mapped areas beyond the valley floors. Although partially a GIS model, major portions of the Valley Bottom LTA are based on soil mapping by Natural Resources Conservation Service and wetland mapping by National Wetlands Inventory, for which there is relatively high confidence in the mapping accuracy. Valley bottom LTAs and riparian areas includes many of the ecological processes associated with these areas.

Component Limitations

The Vermont Hydrographic Dataset 1:5,000 does not include many small headwater streams which are critically important habitat for some species and the primary source of cool water to lower stream segments. The Valley Bottom LTA is constructed partially as a GIS model, so these portions are not based on field data.

Component Priority & Justification

Surface waters and riparian areas were divided into highest priority & priority based on land cover and land use data. Developed areas were considered priority, and all other areas are highest priority.

These areas are of critical importance for water quality, flood attenuation, erosion prevention and wildlife movement. This is based on the very high value of this component in its contribution to biological diversity along with the recognition that the values of these areas will also be represented by other components, including Riparian Wildlife Connectivity, Important Aquatic Habitats and Species Assemblages, and Representative Lakes.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Eric Sorenson, Vermont Fish & Wildlife Department, 802-476-0126, eric.sorenson@vermont.gov

Representative Lakes

Description

This component is a subset of lakes and ponds that occur in Vermont, representing the majority of lake types and examples of each type that are in the best condition for that type. While all lakes and ponds are included in the Surface Water and Riparian Areas component, only 100 lakes and ponds are selected for the representative lakes component. The lakes and ponds were classified based on their trophic status, depth, and alkalinity, which are generally the main factors that shape biological communities in lakes (Wetzel 2001).

Ecological importance

Lakes and ponds provide critical habitat for many species of fish, amphibians, reptiles, invertebrates (e.g., insects, mussels, snails, worms, freshwater sponges), and plants. They also provide supporting habitat for many terrestrial wildlife species such as otter, mink, deer and moose. The distribution of species found in Vermont's lakes and ponds is partially the result of variations in their physical and chemical nature. The lakes and ponds in this component are therefore a tool for ensuring that this physical and chemical variation and the aquatic habitats and species assemblages they support are adequately represented.

Representative Lakes Conservation Goal

To conserve examples of all of Vermont's lake and pond types, including the preservation, maintenance or restoration of the ecological integrity of aquatic habitats and their riparian areas and watersheds.

Component Mapping Goal

To classify Vermont's lakes and ponds based on best available data and to identify and map the highest quality examples of all lake and pond types. The selection of lakes and ponds should ensure that all lake and pond types are represented, and that for each type, the examples that are in the best ecological condition are included.

Source Data and Selection Criteria

Lakes and Ponds Management and Protection Section, Vermont Dept of Environmental Conservation

Description

The Vermont Department of Environmental Conservation's Lakes & Ponds Management and Protection Section maintains an extensive database on the biological, physical, and chemical status of 871 lakes and ponds.

Selection Criteria

The 100 lakes and ponds selected (table 7) are classified based on alkalinity and trophic status into 20 types, with Lake Champlain treated separately. Lakes and ponds were selected based on condition criteria, including naturalness of the outlet, water quality, milfoil abundance, degree of acid impairment, and lack of seasonal drawdown. Three additional lakes with special physical features were also added to the selection. Lily Pond, in Vernon, is included because of its similarity to ponds in the coastal plain. Lakes Champlain and Memphremagog are included because of their size and the extensive fisheries they support despite not meeting three other standards.

Table 7. Representative Lakes

	Low Alkalinity		Moderate Alkalinity		High Alkalinity	
	Lake	Pond	Lake	Pond	Lake	Pond
Dystrophic	Wheeler (Brunswick)	Dennis McConnell Notch South America West Mountain Wolcott				
Oligotrophic	Little Averill* Great Averill*	Norford*	Miller* Crystal* Willoughby*		Caspian*	Mitchell*
Mesotrophic	Beaver (Holland) Holland May Ricker	Kettle, Lewis, Lily (Londonderry), Little, Elmore, Nulhegan, Osmore, Paul Stream, Schofield, Stratton Athens, Gates, Gillett, Hancock (Stamford), Kenny, Lakota, Lowell, Shippee, Turtlehead, Lily (Vernon), McAllister, Pigeon, Tiny, Ninevah	Buck Center Long (Greensboro) Long (Sheffield) Perch	Bruce Daniels Flagg Fosters Horse Lower Symes Stannard Abenaki, Milton, Mud (Peacham), Old Marsh Upper Symes Mudd	Emerald Ewell Rood Warden Berlin	Coits Half Moon Johnson (Orwell) Mud (Leicester) Chandler Jobs Keiser Little Hosmer North (Brookfield) Bean (Lyndon) South (Brookfield)
Eutrophic	Minards Silver (Georgia)	Little (Franklin) Mile Spruce (Orwell)	Harriman (Newbury) High (Sudbury) Spring (Shrewsbury) Colchester	Burr (Pittsford) Mud (Morgan)-N Toad (Charleston)	Long (Milton) Zack Woods Vallley Great Hosmer Hough, Memphremagog* Round (Milton) Inman	Bliss Tildys Winona
Lake Champlain	Lake Champlain includes parts in different trophic levels.					

*denote exceptions to rules, but best examples in designation.

Component Strengths

The lakes classification is based on high quality data from the statewide lakes and ponds inventory and is a good representation of Vermont's lake and ponds types. The filter for various condition factors uses a separate comprehensive dataset which ensures that the best examples of each type are included.

Component Limitations

The lakes classification does not incorporate biological data as it was not available for all lakes.

Component Priority & Justification

Representative lakes were ranked as highest priority based on the importance of conserving representative lake and pond types. Given

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

References

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For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Kellie Merrell, Vermont Department of Environmental Conservation Lakes & Ponds Management & Protection Section, 802.595.3538, kellie.merrell@vermont.gov

Important Aquatic Habitats & Species Assemblages

Description

This component includes those Vermont lakes, ponds, rivers, and streams that support important aquatic habitats and species assemblages. Important aquatic habitats and lakes and river segments with important species assemblages were selected based on biological data and professional judgment. The selection is primarily based on the occurrence of fish species, although other biological conditions and information was also considered.

Ecological importance

The selected aquatic habitats and river/stream segments represent locations with concentrations of rare species, especially diverse areas, and/or important species assemblages. As such, these waters make an exceptional contribution to Vermont's biological diversity. The ecological importance of each selection is explained in more detail under the selection criteria, below.

Important Aquatic Habitats and Species Assemblages Conservation Goal

To conserve all important aquatic habitats and species assemblages and the ecological condition of the waters, riparian areas, and watersheds that support them.

Component Mapping Goal

To identify and map lakes, ponds, rivers, and streams that support important aquatic habitats and species assemblages based on the best available data and professional judgment.

Source Data and Selection Criteria

Department Databases, VT Fish and Wildlife Dept and VT Dept of Environmental Conservation

Description

The two departments each maintain extensive databases on the location of fish species in Vermont's rivers, streams, lakes, and ponds.

Selection Criteria

The two databases were consulted and combined with the professional judgment/experience of fisheries biologists and aquatic ecologists to select the following lakes, ponds, rivers, and streams.

Lakes and Ponds

a. **Lake Champlain:** due to the influence of biogeography, Lake Chaplain supports native fish and mussel species from two glacial refugia.

b. **Oligotrophic Lakes:** supporting lake trout and/or round whitefish. Great Averill, Little Averill, Beaver, Caspian, Crystal, Echo, Elligo, Seymour, Willoughby

c. **Rutland County Lakes:** supporting or expected to support species assemblages including blackchin shiner, bridle shiner, blacknose shiner, and redfin pickerel.
Austin, Beebe, Black, Breese, Burr, Choate, Doughty, Echo, Halfmoon, High, Hinkum, Hough, Johnson, Mud (Benson), Mudd (Hubbardton), Perch, Roach, Spruce, Sunrise, Sunset, Walker

d. **High elevation ponds**: habitats characterized by simple, cold water obligate aquatic communities. Bourn and Branch (Sunderland), Stratton (Stratton), Lake Pleiad (Middlebury), North Pond (Chittenden), Griffith Lake (Mount Tabor), Big Mud (Mount Tabor), and Little Rock (Wallingford).

Rivers and Streams

a. **Lake Champlain tributaries upstream to the fall line (150 feet elevation):** Due to the influence of biogeography, these waters support native fish and mussel species from two glacial refugia. Unlike the remainder of Vermont waters which were populated only by eastern species, the mid- and lower elevation waters in the Champlain drainage contain both eastern and western species resulting in streams that support greater numbers of species than streams of similar size elsewhere in Vermont. Due to the direct connection with Lake Champlain, these waters also provide habitats necessary for the support of Lake Champlain populations.

   i. Large Rivers

1. Missisquoi River	4. Mallets Creek	7. Otter Creek
2. Lamoille River	5. LaPlatte River	8. Poultney River
3. Winooski River	6. Lewis Creek	9. East Creek

   ii. All other small rivers and streams that drain directly into Lake Champlain.

b. **Large coldwater streams:** Large streams with specific geologic and hydrologic features that support coldwater species assemblages due to the combination of high alkalinity and abundant cold baseflow from groundwater inputs.

   i. Batten Kill from New York-Vermont border upstream on the main stem Batten Kill to elevation 798 feet (East Dorset) and on the West Branch to elevation 926 feet (Dorset Marsh in Dorset).

   ii. Castleton River from Whipple Hollow Road in West Rutland Marsh (West Rutland) to confluence with Poultney River (Fair Haven).

c. **High elevation coldwater streams**: Streams characterized by simple, cold water obligate aquatic communities dominated by native species, especially brook trout and sculpin. While found at lower elevations, above an elevation of 1400ft almost 100% of the stream miles support native coldwater obligate species. These streams will be the refugia for cold water obligate taxa under predicted climate change warming in the next century. All streams above 1,400 feet elevation are included.

d. **Connecticut River**

   i. Upper Connecticut River supports burbot, round whitefish, and coldwater fish communities. For that section of the river shared by New Hampshire and Vermont, this reach is delineated to the north by the state line (River Mile 319.0) and just upstream of Moore Reservoir (River Mile 247.0).

   ii. Lower Connecticut River: River Mile 120.0 (below Bellows Falls power station) and the bypassed river section reported to be the historic upper limit of American shad in river. From this point downriver to the state line the river is habitat for blueback herring and alewife floater.

Component Strengths

The selected lakes, ponds, rivers, and streams are known locations for important aquatic habitats and species assemblages and therefore are important for conservation of biological diversity.

Component Limitations

The dataset is compiled primarily based on fish data and does not include other biota comprehensively. There is not site specific data available for all high elevation streams, but there is high confidence that these streams support cold water obligate species and that they contribute cold water to downstream waters. Fish and mussel data from small Lake Champlain tributaries is incomplete.

Component Priority & Justification

Important aquatic habitats and species assemblages were ranked as highest priority. This is based on the critical contribution of these waters to the conservation of biological diversity and the high confidence in the mapping accuracy.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Rich Kirn, Vermont Fish & Wildlife Department, 802-485-7566, rich.kirn@vermont.gov and Kellie Merrell, Vermont Department of Environmental Conservation, Lakes & Ponds Protection Program, 802.595.3538, kellie.merrell@vermont.gov

Grasslands & Shrublands

Description

Grasslands are open lands dominated by grasses, sedges, and broadleaf herbs, with little or no woody vegetation. Grasslands include wetland natural communities, such as Sedge Meadow, and lands actively managed by people, such as hay fields. Shrublands are areas dominated by low, dense shrub vegetation such as dogwood, willow, tall grasses, and sedges. They are often associated with the margins of grassland habitats and are influenced by human activities such as agriculture or active land management, as well as by natural processes.

Birds that rely on grassland and shrubland habitats for their survival in Vermont include: Upland Sandpiper (endangered); Grasshopper Sparrow (threatened); Sedge Wren (endangered); Vesper Sparrow (uncommon breeder in Vermont); Savannah Sparrow; Bobolink; and Eastern Meadowlark (the last 3 are considered common but with declining populations). American woodcock is also associated with these habitats and is considered a species of greatest conservation need in Vermont's wildlife action plan. Other bird, mammal, reptile and invertebrate species use grasslands and shrublands as well, but the above suite is commonly used for conservation planning purposes because these birds are rare or their populations are declining, and they require grassland and shrubland habitat to survive and reproduce.

Today, most of Vermont's grassland habitats occur in the Champlain Valley and, to a lesser extent, in the Connecticut River Valley and the area around Lake Memphremagog. Other grasslands of various types and sizes scattered across the rest of the state. Most are associated with current or past agricultural practices. There are, however, grasslands that are the result of other human activities and are maintained for specific purposes. These include grasslands associated with airports (commercial and private), landfills, utility rights-of-way, fairgrounds, and industrial complexes. Most of Vermont's grasslands are in private ownership, although the state and federal government own small areas of this habitat. Shrubland habitats are more widely distributed throughout Vermont, are associated with both upland and wetland conditions, and occur broadly on both public and private land.

Three separate input datasets are combined to form BioFinder's Grassland and Shrubland component dataset. The grassland patches identified in this work are distinguished as crop fields, including corn, hay, other crops, and fallow, or suburban pastures, including either agricultural pastures or large non-agricultural (suburban) fields. Together they represent the best available data for this contributor to biological diversity. Spatial data for shrubland habitats is limited and is best captured by extensions of the grassland habitat data and some of the Vermont wetlands data. A more complete assessment of shrubland habitat conditions throughout Vermont is needed to more carefully assess its influence on biological diversity.

Ecological Importance

Grasslands and shrublands, whether of natural origin or resulting from active land management, are critical to the survival of a suite of bird species in Vermont. Most of these species will continue to decline in Vermont if grassland habitat is not maintained.

Since a probable historic high during the agricultural boom of the 1800s, populations of grassland birds have declined substantially in Vermont, primarily as a result of habitat loss. Habitat loss has resulted from forest succession after farm abandonment, changes in current agriculture practices, and residential, commercial, and industrial development. Other potential threats include the extensive use of agricultural pesticides and changes in wintering habitats outside of Vermont.

Conversion of natural grasslands elsewhere in the Northeast and especially the Midwest has led to the decline of grassland birds in their historic natural habitats. This has given Vermont, and the Northeast in general, greater importance for the conservation of grassland birds. The North American Bird Conservation Initiative (NABCI) has designated grassland birds as a priority suite of species in Vermont.

Grassland and Shrubland Conservation Goal

Conserve and manage grassland habitats of adequate size and distribution to support viable populations of all grassland bird species in Vermont. Conserve and manage important areas of shrubland habitats associated with grasslands, wetlands, riparian habitats, and other habitats to support birds and other wildlife that depend upon that type of habitat association.

Component Mapping Goal

To identify the best examples of grassland and shrubland habitat across Vermont.

Data Source and Selection Criteria

1. **Grassland patches in Grand Isle, Chittenden, Franklin, & Addison Counties VT.** F. Sutti, 2011.

   Description
   A modeled product of productive patches of habitat for grassland bird species.

   Selection Criteria
   Champlain Valley grassland patches with priority ranks 3-5 aggregated into 200 hectare units. All Grassland datasets were combined into a single unit for weighting purposes.

2. **Grassland patches in the southern Champlain Valley**, **VT**. K. Puryear, 2004

   Description
   A modeled product of productive patches of habitat for grassland bird species.

   Selection Criteria
   Champlain Valley patches with priority ranks 11-13 aggregated into 200ha.

3. **Expert Panel- Grassland patches near Newport, VT.** Landscape Working Group, Grasslands subcommittee 2012

   Description
   Includes three patches of habitat for grassland bird species selected using aerial photos and expert knowledge of grassland habitat.

   Selection Criteria
   Included all sections of the three patches provided by the subcommittee

Component Strengths

Grassland and shrubland habitats are difficult to model, and their ephemeral nature makes field data quickly out-of-date. The Sutti data includes attributes to screen for the presence of some active agriculture allowing for greater certainty that the model is focused on the desired land cover being present.

This component includes grassland to early shrubland habitats in its focus. This means that the combined dataset achieves a longer lifespan since unmaintained grasslands grow into shrublands. So, even as the species composition changes from grassland birds to shrubland birds the modeled area remains relevant to the target. Given this, we estimate this data to be relevant for 10 years from time of publication (until 2022) but land use changes in the mapped grasslands during this 10-year period may alter their wildlife habitat value significantly

Component Limitations

Grasslands and shrublands in Vermont are inherently ephemeral. Without regular cutting they convert to shrubland and eventually forest. This makes it difficult to model for likely grasslands locations and very few datasets were available for inclusion in BioFinder. The two principal grassland datasets that we used in BioFinder (Sutti and Puryear) are limited to the Champlain Valley. Sutti's model used political boundaries of Franklin, Chittenden and Addison's counties. Puryear's included the remainder of the Champlain Valley biophysical region into Rutland county. There are slight differences in how the two models were put together and thus there is potential for differences between Rutland County and the rest of the Champlain Valley. While there is some concern about the lack of geographic representation from across the state, the Champlain Valley includes an estimated 80% of the overall grassland species diversity in the state. Both of these datasets include lands in row crop which do not support grassland birds. Also, some crops, such as corn and hay, are rotated year-to-year on many farms, so one year the habitat may be potentially good, and another, not.

An expert panel was convened to identify grassland patches outside of the Champlain Valley of the same level of species diversity found in the Sutti and Puryear datasets for inclusion as a separate dataset (See Expert Panel- Grassland patches near Newport, Vermont (2012)). Three additional grassland patches in the Newport area were identified. Other potential patches, especially along the Connecticut River, were thought to include significantly fewer species and thus not included in the third input dataset. Despite these geographic inconsistencies, we believe the three input datasets were the best data available at the time. Future versions would benefit from a more geographically consistent identification of grasslands statewide.

Shrublands are not adequately addressed by any existing datasets given the difficulty in identifying them through remote sensing. None of our input datasets specifically identify shrubland habitat, so they are included in this component to the extent to which grasslands grow into shrublands with new species composition.

Component Priority & Justification

Grassland/Shrubland dataset is ranked priority. This is based on the ephemeral nature of most grassland habitat (both as a result of natural succession and land use changes) and the lack of site specific data and monitoring for most grassland habitats mapped. Even with this low weighting based on data limitations, it is acknowledged that grassland bird species will continue to decline in Vermont if viable grassland habitats are not conserved and managed appropriately.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

References

Puryear, K. 2004. Landscape-level grassland bird conservation in the southern Champlain valley, Vermont. The University of Vermont.

Sutti, F. 2009. Identifying Priority Conservation Areas for Grassland Birds in the Champlain Valley of Vermont. The University of Vermont.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Jens Hilke, Vermont Fish & Wildlife Department, 802-461-6791, jens.hilke@vermont.gov

Rare Species

Description

A rare species of plant or animal is one that has only a few populations in the state and that faces threats to its continued existence in Vermont. The Vermont Fish and Wildlife Department uses a ranking scheme to describe the relative rarity of species in Vermont, using a national Natural Heritage methodology. The range is from S1 (very rare) to S5 (common and widespread). Species are assigned a rarity rank based on the number of known individuals, the population size statewide, and the degree to which the populations are threatened. Rare species are generally considered to be those with twenty or fewer populations statewide, whereas uncommon species are generally considered those with more than 20 but 80 or fewer populations statewide.

Ecological importance

A species may be rare in Vermont for several reasons, including the following: the species is near the edge of the geographic range; the species only occurs in specialized habitats or rare natural communities; or human activities have resulted in a direct loss of the species or the habitat it requires. Rare species, like any species, are important for their intrinsic values – as organisms that have evolved over millennia. Each species is assumed to serve an important role in maintaining ecological integrity. Sometimes the details of this role may not be known until a species is lost or becomes extinct. Rare species, especially populations occurring at the edge of the species' geographic range, provide important genetic diversity which may be especially significant in allowing species to adapt and evolve to changes in the environment, such as climate change.

Rare Species Conservation Goal

To conserve populations of all rare species of plants and animals in Vermont, the habitat they need to survive, the ecological processes that support them, and to conserve landscape connectivity to allow individuals to disperse and populations to shift distribution over time in response to changing environmental conditions.

Component Mapping Goal

To identify and map occurrences of all populations of rare species in Vermont using the best available data.

Source Data and Selection Criteria

1. **Natural Heritage Database**, Vermont Fish and Wildlife Department

   Description

   The Natural Heritage Database contains detailed, geographically-referenced information on Vermont's uncommon, rare, threatened, and endangered species and significant natural communities. The database is periodically updated as new information on species and natural communities becomes available. The data used for BioFinder are current as of March 2012.

   Selection Criteria

   a. All Element Occurrences (An "EO" is a specific record representing a place where the species occurs) in the Natural Heritage Database for species with an S-rank (state rank – describes relative rarity) of S1 (very rare) or S2 (rare). All Element Occurrences for species listed as state Threatened or Endangered. Element Occurrences with very poor mapping accuracy, such as those that are mapped to an entire town boundary, are excluded.

b. All Element Occurrences for S1 and S2 species with EO-rank of H (Historic – there is a lack of recent information verifying the continued existence of the species at a specific location). Element Occurrences with very poor mapping accuracy, such as those that are mapped to an entire town boundary, are excluded.

c. All EOs for species with S-rank of SH (State Historic – the species is missing from the state and known from only historical occurrences, but there is still some hope of rediscovery), except those species that are clearly extirpated from Vermont, those Element Occurrences that need to be eliminated because of very poor mapping accuracy, or other reasons. The following species are specifically excluded

- *Betula × sandbergii*: a sterile hybrid plant species with no unique heritable lineage and known only from a single 1911 collection at Fairfield Pond. (1 EO)
- *Betula × raymundii*: same as above but known from 1983 Colchester Bog specimens (searched for but not found a few times since) and 1914 Stowe specimens (no specific location). (2 EOs)
- Loggerhead Shrike: a bird species no longer present in Vermont (2 EOs)
- Puritan tiger beetle: pre-1932record. Vermont no longer has habitat for this species (1 EO)

2. **Bicknell's Thrush observation data**, Vermont Center for Ecostudies

Description

Vermont Center for Ecostudies maintains point location data on Bicknell's Thrush, a bird species with an S-rank of S2B (very rare during the breeding season). This observational data for Bicknell's Thrush is much more complete than the data for this species in the Natural Heritage Database. The data used for BioFinder are current as of March 2012.

Selection Criteria

All confirmed point locations for Bicknell's Thrush mapped to the full extent of the associated Montane Spruce-Fir Forest polygon as mapped by Natural Heritage Inventory. Montane Spruce-Fir Forest is an accurate representation of the forest habitat used by this rare bird species. Exclude any duplicate Bicknell's Thrush Element Occurrences from the Natural Heritage Database.

3. **Jefferson Salamader data from the Vermont Vernal Pool Mapping Project**, Arrowwood Environmental, Inc. and Vermont Center for Ecostudies

Description

The Vermont Vernal Pool Project is a statewide effort to map the locations of vernal pools. Vernal pools are small seasonal wetlands that typically occur in upland forests and provide critical habitat for breeding amphibians. Vernal pools are mapped using aerial photographs and are subsequently visited with landowner permission to confirm their existence and collect biological and physical data, including the presence of Jefferson Salamander, an S2 species. The data used for BioFinder are current as of March 2012.

Selection Criteria

All vernal pools that have been confirmed by site visits and that are being used by Jefferson Salamander. Each vernal pool is mapped as a 600 foot radius circle to include the pool and the expected life zone of amphibians that breed in the pool and use the surrounding forest for other life stages.

Component Strengths

Rare species records from all three data sources are highly accurate and are based on field inventory. Element occurrence data for rare species are mapped using consistent methodology developed by the Vermont Fish and Wildlife Department and NatureServe. Rare species records are typically considered one of the most important "fine filters" for conserving biological diversity. Bicknell's Thrush observation points are mapped to expected forest habitat which is a more accurate representation of species' needs than the mapped observation points.

Component Limitations

Statewide inventories for rare species are on-going and therefore our knowledge of rare species locations is incomplete, although our understanding is relatively high for some groups, such as vascular plants. Many rare species populations that are mapped in the Natural Heritage Database are mapped as circles, with the circle centered on the expected location of the population and the size of the circle representing uncertainty in the mapping accuracy. For older records with poor mapping accuracy this means that more area is mapped for the species population than it actually inhabits. Populations of rare species and other species change over time in response to shifting environmental conditions and periodic monitoring is required. Site visits are required to identify whether rare species occur on a site. Bicknell's Thrush data is from multiple sources which contributes some uncertainty to the data.

Component Priority & Justification

Rare species were ranked as highest priority due to the critical importance of rare species for conserving biological diversity.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

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Uncommon Species

Description

Uncommon species are defined by the Natural Heritage Inventory of Vermont Fish and Wildlife Department as facing a "moderate risk of extinction or extirpation due to restricted range, relatively few populations or occurrences (often 80 or fewer), recent and widespread declines, or other factors." In contrast, rare species face a higher risk of extirpation and generally have 20 or fewer populations statewide. The Vermont Fish and Wildlife Department uses a ranking scheme to describe the relative rarity of species in Vermont, using a national Natural Heritage methodology.

Ecological importance

Uncommon species of plants and animals are restricted in their distribution because of limited suitable habitat, either from natural causes or due to habitat loss and fragmentation associated with development. Some uncommon species in Vermont may be at or near the edge of their geographic range. Uncommon species are an important part of Vermont's natural communities and contribute to biological diversity at the genetic and species levels. It is important to keep track of uncommon species as they may become rare or more common as environmental conditions change.

Uncommon Species Conservation Goal

To conserve viable populations of all uncommon plant and animal species in Vermont, the habitat they need to survive, the ecological processes that support them, and landscape connectivity to allow individuals to disperse and populations to shift distribution over time in response to changing environmental conditions. Uncommon species are less at risk than rare species, but conserving all species is critical to conserving biological diversity. Understanding trends in uncommon species and taking appropriate conservation action is important in preventing uncommon species from becoming rare.

Component Mapping Goal

To identify and map all of Vermont's documented uncommon species populations using the best available data.

Source Data and Selection Criteria

Natural Heritage Database, Vermont Fish and Wildlife Department

Description

The Natural Heritage Database contains detailed, geographically-referenced information on Vermont's uncommon, rare, threatened, and species and on Vermont's significant natural communities. The database is periodically updated as new information on species and natural communities becomes available. The data used for BioFinder are current as of March 2012.

Selection Criteria

All uncommon species records in the Natural Heritage Database. These include all records for species with S-rank (state ranks – describes relative rarity) of S3 (uncommon) or S3S4 (uncommon – split rank), with the exception of D-ranked S3 and S3-S4 records (ranks A-D describe the quality of records and a D-rank implies "not viable"). Records with very poor mapping accuracy, such as those that are mapped to an entire town boundary, are excluded.

Component Strengths

Uncommon species records from Natural Heritage Inventory are based on detailed site surveys and data collected by consistent methods. More recent records have high spatial accuracy.

Component Limitations

Inventories of uncommon species of plants and animals are incomplete, especially for many invertebrate animals and bryophytes (non-vascular plants). Many uncommon species populations that are mapped in the Natural Heritage Database are mapped as circles, with the circle centered on the expected location of the population and the size of the circle representing uncertainty in the mapping accuracy. For older records with poor mapping accuracy this means that more area is mapped for the species population than it actually inhabits.

Component Priority & Justification

Uncommon species were ranked as priority. This is based on the high importance of all species in their contribution to biological diversity, but the relatively moderate risk of extirpation of these species, compared to rare species. The priority ranking also reflects the relatively incomplete set of occurrence records for uncommon species in the Natural Heritage Database.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

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Rare Natural Communities

Description

A natural community is an interacting assemblage of plants and animals, their physical environment, and the natural processes that affect them. As these assemblages of plants and animals repeat across the landscape wherever similar environmental conditions exist, it is possible to describe these repeating assemblages as natural community types. The Vermont Fish and Wildlife Department uses a ranking scheme that is part of the national Natural Heritage methodology to describe the relative rarity of natural community types in Vermont. The range is from S1 (very rare) to S5 (common and widespread). Examples of common natural community types include Northern Hardwood Forest (S5) and Alder Swamp (S5).

S1 and S2 (rare) natural community types are considered rare for BioFinder. Natural communities are rare because the physical and environmental conditions that support the communities are rare. This may be the result of natural conditions such as restricted distribution of a bedrock type or edge of climatic range, or the result of habitat loss or fragmentation from development or other human activities. Examples of rare natural community types include Subalpine Krummholz (S1), Red Maple-Black Gum Swamp (S2), and Pitch Pine Woodland Bog (S1), all of which are naturally rare because their landscape positions are rare, and also Mesic Clayplain Forest (S2), which was once extensive but became rare in the 19th century because of large-scale conversion to agricultural use.

Ecological importance

Natural communities represent the distribution of plant and animal species in response to current environmental conditions and natural processes. Although the species composition of natural communities may shift over time in response to changing climate, it is believed that the locations of high quality natural communities represent physical landscape settings that will continue to support important natural communities into the future. Rare natural communities typically include rare species and occur in environmental settings that are rare. Natural communities are commonly referred to as one of the "coarse filters" for conserving biological diversity. This is because there are relatively few natural community types (89 types are currently recognized by Vermont Fish and Wildlife Department) compared to the thousands of plant and animal species, and one approach to conserve most species is to conserve high quality examples of all natural community types across their natural range of distribution. By this approach, natural communities act as a "coarse filter" for conserving species.

Uncommon natural communities typically include rare species and occur in environmental settings that are uncommon. The mapped locations of the uncommon natural communities used in BioFinder represent the best know examples in the state.

Common natural communities are important ecologically because they form the natural matrix of the Vermont landscape, provide habitat for innumerable species and support ecological processes such as natural disturbance, water filtration, and carbon sequestration. Natural communities are commonly referred to as one of the "coarse filters" for conserving biological diversity. This is because there are relatively few natural community types (89 types are currently recognized by Vermont Fish and Wildlife Department) compared to the thousands of plant and animal species, and one approach to conserve most species is to conserve high quality examples of all natural community types across their natural range of distribution. By this approach, natural communities act as a "coarse filter" for conserving species

Rare Natural Community Conservation Goal

To conserve, enhance, and restore high quality examples of all natural community types across their geographic range of distribution and representing all physical settings (soil, bedrock, elevation, etc.) where they occur. Effective conservation should maintain or restore the ecological processes that support the communities and their component species and a network of connected lands, waters, and riparian areas to allow ecological exchange between communities, including the ability of component species to shift over time in response to changing environmental conditions.

Component Mapping Goal

To identify and map all of Vermont's documented natural communities using the best available data.

Source Data and Selection Criteria

Natural Heritage Database, Vermont Fish and Wildlife Department

Description

The Natural Heritage Database contains detailed, geographically-referenced information on Vermont's uncommon, rare, threatened, and species and on Vermont's significant natural communities. The database is periodically updated as new information on species and natural communities becomes available. The data used for BioFinder are current as of March 2012.

Selection Criteria

Rare: All natural communities Element Occurrences in the Natural Heritage Database with S-rank of S1 and S2. An Element Occurrence (EO) is a specific record representing a place where the community occurs.

Component Strengths

Natural community Element Occurrences from Natural Heritage Inventory are based on detailed site surveys and data collected by consistent methods. Inventories for rare and uncommon natural community types are more complete than for common types. Natural communities represent critical coarse-filter elements for conserving biological diversity and overall natural heritage.

Component Limitations

Statewide natural community inventories are on-going and therefore our knowledge of natural community locations is incomplete. Inventories for rare communities are more complete than for uncommon and common communities. Of uncommon communities, inventories for S3 communities are more complete than for S4 community types. A field assessment is always needed to identify whether rare natural communities occur on a site.

The majority of mapped examples of common natural communities are on state-owned land. Statewide inventory of Northern Hardwood Forest, the most widespread natural community type in Vermont, is especially incomplete.

Component Priority & Justification

Rare natural communities were ranked highest priority due to the critical natural of rare natural communities for conserving biological diversity.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

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Uncommon Natural Communities

Description

A natural community is an interacting assemblage of plants and animals, their physical environment, and the natural processes that affect them. As these assemblages of plants and animals repeat across the landscape wherever similar environmental conditions exist, it is possible to describe these repeating assemblages as natural community types. The Vermont Fish and Wildlife Department uses a ranking scheme that is part of the national Natural Heritage methodology to describe the relative rarity of natural community types in Vermont. The range is from S1 (very rare) to S5 (common and widespread). Examples of common natural community types include Northern Hardwood Forest (S5) and Alder Swamp (S5).

S3 (uncommon) and S4 (uncommon to widespread) natural community types are considered uncommon for BioFinder. Examples of uncommon natural community types include Montane Spruce-Fir Forest (S3), Dry Oak-Hickory-Hophornbeam Forest (S3), Boreal Outcrop (S4), Northern White Cedar Swamp (S3), and Silver Maple-Ostrich Fern Riverine Floodplain Forest (S3). All of these are naturally uncommon, since their soils are uncommon, but Sliver Maple-Ostrich Fern Riverine Floodplain Forest has been made more uncommon by the conversion of many floodplain areas to agriculture.

Ecological importance

Natural communities represent the distribution of plant and animal species in response to current environmental conditions and natural processes. Although the species composition of natural communities may shift over time in response to changing climate, it is believed that the locations of high quality natural communities represent physical landscape settings that will continue to support important natural communities into the future. Rare natural communities typically include rare species and occur in environmental settings that are rare. Natural communities are commonly referred to as one of the "coarse filters" for conserving biological diversity. This is because there are relatively few natural community types (89 types are currently recognized by Vermont Fish and Wildlife Department) compared to the thousands of plant and animal species, and one approach to conserve most species is to conserve high quality examples of all natural community types across their natural range of distribution. By this approach, natural communities act as a "coarse filter" for conserving species.

Uncommon natural communities typically include rare species and occur in environmental settings that are uncommon. The mapped locations of the uncommon natural communities used in BioFinder represent the best know examples in the state.

Common natural communities are important ecologically because they form the natural matrix of the Vermont landscape, provide habitat for innumerable species and support ecological processes such as natural disturbance, water filtration, and carbon sequestration. Natural communities are commonly referred to as one of the "coarse filters" for conserving biological diversity. This is because there are relatively few natural community types (89 types are currently recognized by

Vermont Fish and Wildlife Department) compared to the thousands of plant and animal species, and one approach to conserve most species is to conserve high quality examples of all natural community types across their natural range of distribution. By this approach, natural communities act as a "coarse filter" for conserving species

Natural Community Conservation Goal

To conserve, enhance, and restore high quality examples of all natural community types across their geographic range of distribution and representing all physical settings (soil, bedrock, elevation, etc.) where they occur. Effective conservation should maintain or restore the ecological processes that support the communities and their component species and a network of connected lands, waters, and riparian areas to allow ecological exchange between communities, including the ability of component species to shift over time in response to changing environmental conditions.

Component Mapping Goal

To identify and map all of Vermont's documented natural communities using the best available data.

Source Data and Selection Criteria

Natural Heritage Database, Vermont Fish and Wildlife Department

Description

The Natural Heritage Database contains detailed, geographically-referenced information on Vermont's uncommon, rare, threatened, and species and on Vermont's significant natural communities. The database is periodically updated as new information on species and natural communities becomes available. The data used for BioFinder are current as of March 2012.

Selection Criteria

Rare: All natural communities Element Occurrences in the Natural Heritage Database with S-rank of S1 and S2. An Element Occurrence (EO) is a specific record representing a place where the community occurs.

Uncommon: All natural communities Element Occurrences in the Natural Heritage Database with S-rank of S3 and S4.

Common: All natural community Element Occurrences in the Natural Heritage Database with S-rank of S5.

Component Strengths

Natural community Element Occurrences from Natural Heritage Inventory are based on detailed site surveys and data collected by consistent methods. Inventories for rare and uncommon natural community types are more complete than for common types. Natural communities represent critical coarse-filter elements for conserving biological diversity and overall natural heritage.

Component Limitations

Statewide natural community inventories are on-going and therefore our knowledge of natural community locations is incomplete. Inventories for rare communities are more complete than for uncommon and common communities. Of uncommon communities, inventories for S3 communities are more complete than for S4 community types. A field assessment is always needed to identify whether rare natural communities occur on a site.

The majority of mapped examples of common natural communities are on state-owned land. Statewide inventory of Northern Hardwood Forest, the most widespread natural community type in Vermont, is especially incomplete.

Component Priority & Justification

Uncommon natural communities were ranked as priority. This is based on the high importance of all high quality natural communities in their contribution to biological diversity but the relative abundance of these community types compared to rare communities. This also reflects that inventory of S4 community types is incomplete.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to natural community components, contact Eric Sorenson, Vermont Fish & Wildlife Department, 802-476-0126, eric.sorenson@vermont.gov

Common Natural Communities

Description

A natural community is an interacting assemblage of plants and animals, their physical environment, and the natural processes that affect them. As these assemblages of plants and animals repeat across the landscape wherever similar environmental conditions exist, it is possible to describe these repeating assemblages as natural community types. The Vermont Fish and Wildlife Department uses a ranking scheme that is part of the national Natural Heritage methodology to describe the relative rarity of natural community types in Vermont. The range is from S1 (very rare) to S5 (common and widespread). Examples of common natural community types include Northern Hardwood Forest (S5) and Alder Swamp (S5).

Common Natural Communities include all natural community Element Occurrences in the Natural Heritage Database with S-rank of S5.

Ecological importance

Natural communities represent the distribution of plant and animal species in response to current environmental conditions and natural processes. Although the species composition of natural communities may shift over time in response to changing climate, it is believed that the locations of high quality natural communities represent physical landscape settings that will continue to support important natural communities into the future. Natural communities are commonly referred to as one of the "coarse filters" for conserving biological diversity. This is because there are relatively few natural community types (89 types are currently recognized by Vermont Fish and Wildlife Department) compared to the thousands of plant and animal species, and one approach to conserve most species is to conserve high quality examples of all natural community types across their natural range of distribution. By this approach, natural communities act as a "coarse filter" for conserving species.

Common natural communities are important ecologically because they form the natural matrix of the Vermont landscape, provide habitat for innumerable species and support ecological processes such as natural disturbance, water filtration, and carbon sequestration. Natural communities are commonly referred to as one of the "coarse filters" for conserving biological diversity. This is because there are relatively few natural community types (89 types are currently recognized by Vermont Fish and Wildlife Department) compared to the thousands of plant and animal species, and one approach to conserve most species is to conserve high quality examples of all natural community types across their natural range of distribution. By this approach, natural communities act as a "coarse filter" for conserving species

Natural Community Conservation Goal

To conserve, enhance, and restore high quality examples of all natural community types across their geographic range of distribution and representing all physical settings (soil, bedrock, elevation, etc.) where they occur. Effective conservation should maintain or restore the ecological processes that support the communities and their component species and a network of connected lands, waters, and riparian areas to allow ecological exchange between communities, including the ability of component species to shift over time in response to changing environmental conditions.

Component Mapping Goal

To identify and map all of Vermont's documented natural communities using the best available data.

Source Data and Selection Criteria

Natural Heritage Database, Vermont Fish and Wildlife Department

Description

The Natural Heritage Database contains detailed, geographically-referenced information on Vermont's uncommon, rare, threatened, and species and on Vermont's significant natural communities. The database is periodically updated as new information on species and natural communities becomes available. The data used for BioFinder are current as of March 2012.

Selection Criteria

Common: All natural community Element Occurrences in the Natural Heritage Database with S-rank of S5.

Component Strengths

Natural community Element Occurrences from Natural Heritage Inventory are based on detailed site surveys and data collected by consistent methods. Inventories for rare and uncommon natural community types are more complete than for common types. Natural communities represent critical coarse-filter elements for conserving biological diversity and overall natural heritage.

Component Limitations

Statewide natural community inventories are on-going and therefore our knowledge of natural community locations is incomplete. Inventories for rare communities are more complete than for uncommon and common communities. Of uncommon communities, inventories for S3 communities are more complete than for S4 community types. A field assessment is always needed to identify whether rare natural communities occur on a site.

The majority of mapped examples of common natural communities are on state-owned land. Statewide inventory of Northern Hardwood Forest, the most widespread natural community type in Vermont, is especially incomplete.

Component Priority & Justification

Common natural communities were ranked priority. This is based on the high importance of all high quality natural communities in their contribution to biological diversity, but the low level of inventory that has been completed for common community types and the overall low threat to these common community types.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

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Wildlife Road Crossings

Description

Habitat Connectivity is a complex process that functions at different scales for different species. Generally speaking, connecting habitat is represented by land that links larger patches of habitat within a landscape, allowing the movement, migration, and dispersal of animals and plants. Wildlife Road Crossings are locations where wildlife are likely to cross roads. The dataset is the result of an assessment of structural components (i.e., where there is forest and/or other natural vegetation on both sides of a road) to predict the ease of movement for a variety of wildlife species. While this assessment is not specific to particular species, it offers a generalized sense of where the greatest variety of species is likely to move based on the assumption that wildlife.

Ecological Importance

Wildlife road crossings are a critical and vulnerable component of the network of connecting lands. These areas of habitat fragmentation are locations where wildlife species are most likely to cross roads, based on remote assessment of structural connectivity features. Movement of animals from one habitat patch to another is the most common function associated with connecting habitat. This function is particularly important for wide-ranging animals, such as bobcats and black bears, or for animals that require a great deal of space to meet their daily life needs, such as barred owls or otter. Although connecting habitat is often associated with wide-ranging mammals, it is equally important for animals with relatively small ranges. Spotted salamanders, for example, use connecting habitat in spring to move from their hibernation sites to breeding pools. The value of connecting habitat is a function of both seasonal and spatial patterns of wildlife behavior. For example, connecting habitat may allow black bears to access important food resources during a specific time of year (seasonal), or it may prevent isolation of bear populations by allowing free exchange of breeding adults (spatial). Ultimately, connecting habitat can ensure that the habitat, movement, migration, and behavior requirements of most native plants and animals are conserved across a broad landscape. The broader ecological value of connecting habitat is to join fragmented pieces of habitat, thereby reducing the deleterious effects of habitat fragmentation and population isolation. Linking small or otherwise isolated habitat patches may reduce the risk of local population extinctions by ensuring immigration, recolonization, reproduction, and exchange of genes for some plant and animal species. While conserving corridors has great merit, do not assume that conserving threads of vegetative cover within a developing landscape will maintain an area's ecological values and biological diversity. Nor will corridors alone meet the habitat needs of all of an area's plant and animal species. Only in conjunction with the conservation of large areas of undeveloped land with diverse habitat conditions, will vegetative corridors assist in supporting ecosystem functions and related public benefits.

Wildlife Road Crossing Conservation Goal

Conserve wildlife road crossings wherever possible, especially in fragmented landscapes. Wildlife Road Crossings are of critical importance in this network as they are the most threatened by future development.

Component Mapping Goal Statement

To map locations of potential wildlife road crossings statewide based on structural connectivity features.

Input Datasets (s) & Selection Criteria

Linkage Ratings, Habitat Block project. Sorenson & Osborne, in prep.

Description

Linkage Ratings is a dataset created by Vermont Fish & Wildlife Department using the Habitat Block dataset (Sorenson & Osborne, in prep.). A Linkage Ratings is an assessment of the structural connectivity across roads—the expected permeability of the road to crossing. Ratings were assigned to all known Vermont roads (except logging roads) on a scale of 1-5 with one being best and five worst. Ratings utilize a "cost-grid," a tool to help predict locally significant wildlife crossing areas, by identifying road segments where favorable habitat occurs on both sides of the road. Forested uplands and forested wetlands are considered the most favorable habitats (i.e., provide the least cost—resistance—for wildlife movement).Road segments with these land cover types on both sides receive the highest linkage rating. Road segments with favorable habitat on only one side, and areas in or near developed areas receive relatively lower linkage ratings.

Selection Criteria

First, we chose habitat blocks that are 200-acres or larger. Using GIS software, blocks were expanded, regrouped and then shrunk 80m from original polygon size to identify nearby connections. Then the local linkage score from Sorenson & Osborne was used. All roads class 4 or higher were selected from the linkage ratings dataset. Within that selection, linkage scores of 3, 4 or 5 were used. We intersected the expanded blocks and the 3,4,5 road sections to find important road sections that have 200ac or larger blocks on both sides of the road. Road sections were buffered by 100' to show the area of influence.

Source Data Strengths

This dataset provides our best look at local-scale movement areas. While areas such as the Champlain Valley of Vermont are not considered important for regional scale movement between the Adirondacks and the Green Mountains, a network of patches of intact forest and small connecting lands between them still exist. Though fragmented habitat, they nonetheless provide connectivity to help wildlife populations persist into the future. This dataset is the best we have for addressing fine scale connectivity.

Component Limitations

Field surveys to document wildlife movement have not been performed in most of these areas. Wildlife road crossings were selected based on the presence of adjacent natural cover (e.g., forest, wetlands and waters). This dataset does not rank crossing areas based on ecological importance. For example, a wildlife road crossing on I-89 may be significantly more important to the overall connectivity network than a rural road in that the interstate is one of the state's most significant barriers to wildlife movement. Under the time limitations of this project we could not discriminate between a crossing of this most significant barrier and the crossing of a small rural road. We recommend that future efforts to refine this dataset incorporate a ranking factor. More work needs to be done to flesh out the concept of riparian wildlife crossings. The methodology here of buffering streams and rivers and selecting the bisected road sections has promise, but is not filtered based on land cover and so casts too wide a net. As with all features included in BioFinder, we recommend site-specific surveys prior to making any land-use decision.

Component Priority & Justification

Wildlife Road Crossings was divided into highest priority & priority areas based on the spatial relations to highest priority connectivity blocks. Crossings between highest priority connectivity blocks are highest priority, while crossings with priority or unassigned blocks are priority.

References

Sorenson, E. and J. Osborne. 2014. Vermont Habitat Blocks & Wildlife Corridors, an analysis using geographic information systems. Vermont Fish & Wildlife Department. Draft report.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Jens Hilke, Vermont Fish & Wildlife Department, 802-461-6791, jens.hilke@vermont.gov

Vernal Pools—Confirmed

Description

Vernal Pools are small (generally less than one acre), ephemeral pools that occur in natural basins within upland forests. Vernal pools typically have no permanent inlet or outlet streams and have very small watersheds. These temporary pools generally last only a few months and then disappear by the end of summer, although some pools may persist in wet years. During dry periods, vernal pool depressions may be recognized by the sparse vegetation, stained leaves marked by seasonal high water, and the soils that have many more wetland characteristics than the surrounding upland soils. The periodic drying prevents the establishment of fish populations, but supports a specialized assemblage of species that typically includes amphibians (such as spotted salamanders and woodfrogs), specialized insects (such as caddis flies), mollusks (fingernail clams), and other invertebrates (fairy shrimp). Vernal pools typically lack trees but are shaded by trees growing in the surrounding upland forest. The vegetation that grows in vernal pools is highly variable in composition and abundance, although most pools have only sparse vegetation. Vernal pools are defined by the physical and hydrologic characteristics of the basin and by the animal species associated with the pool, including mole salamanders, wood frogs, and invertebrates.

Vernal pools are currently being mapped throughout Vermont as part of the Vermont Vernal Pool Mapping Project (Vermont Center for Ecostudies and Arrowwood Environmental, Inc.). All vernal pools included in this mapping component are those that have been confirmed by site visits. However, 71 vernal pools that were confirmed by site visits and include the rare Jefferson salamander are not included in this component and are instead included under the rare species component.

Ecological importance

Vernal pools are best known as critical breeding habitat for mole salamanders (spotted salamander, blue-spotted salamander, and Jefferson salamander), eastern four-toed salamander, and wood frog. These species are considered vernal pool indicator species, meaning they cannot reproduce without access to a vernal pool. All of these species migrate to vernal pools for spring breeding from adjacent upland forests where they spend the majority of their life cycles. Eggs are laid in the pools and amphibian larvae develop and mature there and then move to the adjacent forest. Studies indicate that the majority of the amphibians using a pool for breeding are found within 600 feet of the pool during the non-breeding season (Semlitsch 1998). A closed forest canopy, abundant coarse woody debris, and a lack of artificial barriers to salamander movement are important habitat features to maintain in the 600 feet of forest adjacent to the vernal pool. Vernal pools are also important for other species, including fairy shrimp, fingernail clams, spring peepers, American toad, and several plant and wildlife species. Vernal pools and the species that rely on them are particularly vulnerable to hydrologic changes to their small watersheds. For example development and climate driven changes in runoff volume and pool duration may render them less suitable amphibian breeding habitat.

Vernal Pool Conservation Goal

To conserve, enhance, and restore high quality examples of vernal pools across their geographic range of distribution and representing all physical settings (soil, bedrock, elevation, etc.) in which they occur. Effective conservation should include the 600 foot upland forest zone around pools that provide amphibian habitat, the pools' watersheds, and networks of connected lands, waters, and riparian areas to allow ecological exchange between vernal pools over time.

Component Mapping Goal

To identify and map all field verified vernal pools and the associated 600 foot upland forest zone adjacent to pools using the best available data.

Source Data and Selection Criteria

Vermont Vernal Pool Mapping Project Data Set, Vermont Center for Ecostudies and Arrowwood Environmental, Inc

Description

Vermont Vernal Pool Mapping Project data set.

Selection Criteria

All vernal pools that have been field verified and are included in the Vermont Vernal Pool Mapping Project data set. Any duplicates between the Vermont Vernal Pool Mapping Project dataset and the Natural Heritage Inventory (NHI) dataset will be identified and deleted from the NHI dataset. A 600-foot radius buffer is assigned to all pools to include the upland habitat zone.

Component Strengths

This dataset includes 985 vernal pools that have been mapped and confirmed by site visits over the past five years. This new data is spatially accurate and includes detailed information on the condition of each pool, the type and condition of the surrounding forest, and the presence of amphibian species.

Component Limitations

A statewide inventory is in progress and many more vernal pools exist that have not been confirmed by site visits.

Component Priority & Justification

Confirmed vernal pools were ranked as highest priority. This weighting is based on the critical breeding habitat that vernal pools provide for many species of amphibians. It is also based on the spatial accuracy and high quality of this confirmed vernal pool dataset.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Steve Faccio, Vermont Center for Ecostudies, 802-649-1431, sfaccio@vtecostudies.org

Vernal Pools—Potential

Description

Vernal Pools are small (generally less than one acre), ephemeral pools that occur in natural basins within upland forests. Vernal pools typically have no permanent inlet or outlet streams and have very small watersheds. These temporary pools generally last only a few months and then disappear by the end of summer, although some pools may persist in wet years. During dry periods, vernal pool depressions may be recognized by the sparse vegetation, stained leaves marked by seasonal high water, and the soils that have many more wetland characteristics than the surrounding upland soils. The periodic drying prevents the establishment of fish populations, but supports a specialized assemblage of species that typically includes amphibians (such as spotted salamanders and woodfrogs), specialized insects (such as caddis flies), mollusks (fingernail clams), and other invertebrates (fairy shrimp). Vernal pools typically lack trees but are shaded by trees growing in the surrounding upland forest. The vegetation that grows in vernal pools is highly variable in composition and abundance, although most pools have only sparse vegetation. Vernal pools are defined by the physical and hydrologic characteristics of the basin and by the animal species associated with the pool, including mole salamanders, wood frogs, and invertebrates.

Vernal pools are currently being mapped throughout Vermont as part of the Vermont Vernal Pool Mapping Project (Vermont Center for Ecostudies and Arrowwood Environmental, Inc.). All potential vernal pools in this mapping component are those that have not yet been confirmed by site visits but for which there is high or medium-high mapping confidence that they exist.

Ecological importance

Vernal pools are best known as critical breeding habitat for mole salamanders (spotted salamander, blue-spotted salamander, and Jefferson salamander), eastern four-toed salamander, and wood frog. These species are considered vernal pool indicator species, meaning they cannot reproduce without access to a vernal pool. All of these species migrate to vernal pools for spring breeding from adjacent upland forests where they spend the majority of their life cycles. Eggs are laid in the pools and amphibian larvae develop and mature there and then move to the adjacent forest. Studies indicate that the majority of the amphibians using a pool for breeding are found within 600 feet of the pool during the non-breeding season (Semlitsch 1998). A closed forest canopy, abundant coarse woody debris, and a lack of artificial barriers to salamander movement are important habitat features to maintain in the 600 feet of forest adjacent to the vernal pool. Vernal pools are also important for other species, including fairy shrimp, fingernail clams, spring peepers, American toad, and several plant and wildlife species.

Vernal Pool Conservation Goal

To conserve, enhance, and restore high quality examples of vernal pools across their geographic range of distribution and representing all physical settings (soil, bedrock, elevation, etc.) in which they occur. Effective conservation should include the 600 foot upland forest zone around pools that provide amphibian habitat, the pools' watersheds, and networks of connected lands, waters, and riparian areas to allow ecological exchange between vernal pools over time.

Component Mapping Goal

To identify and map all potential vernal pools and the associated 600 foot upland forest zone adjacent to pools that have not been field verified but for which there is high to medium-high mapping confidence (Vermont Vernal Pool Project).

Source Data and Selection Criteria

Vermont Vernal Pool Mapping Project Data Set, Vermont Center for Ecostudies and Arrowwood Environmental, Inc

Description

Vermont Vernal Pool Mapping Project data set.

Selection Criteria

All potential vernal pools identified by the Vermont Vernal Pool Project with a high (H) or medium-high (MH) mapping confidence ranking. A 600-foot radius buffer is assigned to all vernal pools to include the upland habitat zone.

Component Strengths

This dataset includes 1,557 vernal pools that have been mapped with high to medium-high confidence by the Vermont Vernal Pool Project. Although these pools have not been confirmed by site visits, the confidence in their mapping makes it very likely that they are vernal pools.

Component Limitations

This set of vernal pools has not been visited and although it is very likely that they are vernal pools, this has not been confirmed and there is no other ecological data available for the pools. The statewide inventory of vernal pools is underway and more pools will be confirmed.

Component Priority & Justification

Potential vernal pools were also ranked highest priority. This is based on the critical breeding habitat that vernal pools provide for many species of amphibians, but care should be taken given that these vernal pools have not be confirmed by site visits.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

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Wetlands

Description

Wetlands are vegetated ecosystems characterized by abundant water. Wetlands include the vegetated, shallow-water margins of lakes and ponds and he seasonally flooded borders of rivers and streams. They occur in an amazing diversity of topographic settings across the landscape, including basins, seepage slopes, and wet flats. All wetlands have three characteristics in common. First, all are inundated by or saturated with water during varying periods of the growing. Second, they contain wetland or hydric soils, which develop in saturated conditions and include peat, muck, and mineral soil types. Finally, wetlands are dominated by plants that are adapted to life in saturated or inundated soils. As a group, these plants are referred to as hydrophytic vegetation. There are several types of wetlands that are commonly recognized. Swamps are wetlands dominated by woody plants, either trees or shrubs. Marshes are wetlands dominated by herbaceous plants. Fens are peat-accumulating open wetlands that receive mineral-rich groundwater. Bogs are also peat-accumulating wetlands but are isolated from groundwater or surface water runoff by deep peat and therefore receive most of their water and nutrients from precipitation. Vernal pools are small, isolated, seasonally inundated wetlands typically surrounded by upland forests. Vermont's wetlands range in size from vernal pools and seeps that may be a few hundred square feet or less to vast swamps and marshes occupying thousands of acres along Otter Creek and Lake Champlain.

Ecological importance

Few natural systems have been studied as much for their ecological functions as have wetlands. Wetlands store large volumes of water and attenuate downstream flooding, a function that is likely to increase in importance in Vermont as climate change brings more frequent and larger storm events. Wetlands help maintain surface water quality by trapping sediments and removing nutrients and pollutants from surface waters before that water reaches streams or lakes. Many wetlands are associated with groundwater discharge and form the headwaters of many cold water streams, another function that is likely to increase in importance with the expected warming and reduction is snowpack associated with climate change. Wetlands are well known for the critical wildlife habitat they provide for many species of birds, mammals, reptiles, amphibians, and insects, but some wetlands also provide critical spawning and nursery habitat for fish species. Although wetlands occupy only about five percent of the land area in Vermont, they provide necessary habitat for the survival of a disproportionately high percentage of the rare, threatened, and endangered species in the state. Examples of wetland dependant rare species include Calypso orchid, Virginia chain fern, marsh valerian, sedge wren, spotted turtle, and four-toed salamander.

Wetlands Conservation Goal

To conserve the full diversity of wetland types across their geographic ranges. Effective conservation should include appropriate upland buffer zones, the ecological processes that support wetlands (especially hydrology), and a network of connected lands, waters, and riparian areas to allow ecological exchange between wetlands, including the ability of component species to shift over time in response to changing environmental conditions.

Component Mapping Goal

To identify and map all wetlands that are expected to provide significant ecological functions.

Source Data and Selection Criteria

Vermont Significant Wetland Inventory (VSWI), VT Department of Environmental Conservation

Description

All wetlands mapped by the Vermont Significant Wetland Inventory (VSWI). The VSWI maps are based on the National Wetlands Inventory maps produced by the U.S. Fish and Wildlife Service, but have been updated periodically by the Vermont Department of Conservation and the Vermont Natural Resources Board.

Selection Criteria

All wetlands in the dataset.

Component Strengths

The VSWI maps are a well-known dataset based on National Wetlands Inventory maps and updated periodically for Vermont based on additional inventory and work by Vermont Department of Conservation and the Vermont Natural Resources Board. The maps are generally very accurate in identifying wetland presence, although the boundaries are not necessarily precise. Studies and on-going regulatory review by the Department of Environmental Conservation have shown that most wetlands mapped on VSWI provide ecological functions at a significant level.

Component Limitations

Not all wetlands with significant ecological functions are included on the VSWI maps. The VSWI maps do not include attribute information describing the wetland type present at a site. Site visits are always needed to identify whether a wetland is present on a site and to determine the actual boundary of the wetland.

Component Priority & Justification

Wetlands are assigned highest priority. This is based on the high level of ecological functions provided by wetlands, the large number of plant and animal species that are dependent on wetland habitat for survival, and the high accuracy of the VSWI maps for identifying wetland presence.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component summaries can be found at www.BioFinder.vt.us. For more information specific to this component, contact Laura Lapiere, Vermont Department of Environmental Conservation, Wetlands Division, laura.lapiere@vermont.gov

Mast Production Areas

Description

Mast is the fruit and seeds of shrubs and trees that are eaten by wildlife. Hard mast refers to nuts (especially those of beech and oak trees), whereas soft mast refers to berries and fruits of a number of species (such as black cherry, raspberry, blackberry, and apple). While most forested areas contain at least a few mast producing trees and shrubs, forests producing significant concentrations of mast are much less common. In general, hard mast production areas of beech and oak that are used by wildlife represent a small fraction of the landscape.

A beech or oak Mast Production Area representing important wildlife habitat exhibits bear scarring on at least 15-25 tree trunks (most readily identifiable on beech) and/or show some evidence of use by bears (e.g., bear nests in crown of tree). These Mast Production Areas are disproportionately important to myriad wildlife species and crucial to the survival of Vermont's black bear population. For example, red and gray squirrels rely on beech nuts and acorns for their survival and reproductive success. And since these animals are prey for fisher, coyote, fox, owls, hawks, and other predators, the influence of Mast Production Areas can be seen throughout the food chain.

Ecological Importance

Significant mast production areas are generally recognized as a very important wildlife food source, both because of the concentrated nature of the available food in these areas and because of the high energy content of the food, especially for beech nuts and acorns. Mast production areas are used by at least 170 species of wildlife in Vermont, including deer, black bear, turkey, blue jays, and cedar waxwings. Hard mast production areas of beech and oak are absolutely essential for the survival and reproduction of black bear in Vermont. Studies have documented that the availability of hard mast in the fall affects the minimum reproductive age of bears, productivity rates, and cub survival, and that female bears may "skip" reproduction after poor mast years. (Elowe and Rogers 1989)

Mast Production Areas Conservation Goal

To conserve high quality, functioning mast production areas across Vermont, representing the variety of forest types and regions of the state. Effective conservation should strive to maintain mast production areas in unfragmented forest habitat where development and other human activities are least likely to adversely affect wildlife use and would provide a network of connected lands, waters, and riparian areas to allow movement of wildlife species between mast production areas and other necessary habitats and to allow for ecological exchange between unfragmented habitat blocks.

Component Mapping Goal

To map documented hard mast production areas using the best data currently available.

Source Data and Selection Criteria

Mast Production Areas database, Vermont Fish and Wildlife Department

Description

Hard mast production areas mapped by Vermont Fish and Wildlife Department includes 277 mast production areas as of May 2012. Mast production areas are mapped as points, but the size of the habitat is included in the attribute data for 193 of the 277 mapped stands. The average size of these 193 areas is 65 acres and for consistency all 277 mast production areas are mapped in BioFinder as circles with area of 65 acres.

Selection Criteria

All mast production areas in the database

Component Strengths

Hard mast production areas are known to be very important food sources for many species of wildlife. The mast stand data provides some information on associated forest type and species providing hard mast (primarily beech).

Component Limitations

There has not been a statewide inventory of functioning mast production areas, so the data represents a subset of actual mast production areas. The attribute data includes estimates of acreage for about 70 percent of the mapped mast production areas but these areas are mapped as points not delineations of the functioning mast production areas. The current condition and wildlife use of mapped mast production areas is not known as they are not periodically monitored.

Component Priority & Justification

Mast production areas were ranked priority. This is a critical habitat condition for many species of wildlife, but care must be taken in using this data given the inaccuracies in the spatial locations.

For this version of BioFinder, most Species and Natural Community Scale elements were lumped into either Highest Priority or Priority in their entirety based on what the Steering Committee felt was their relative ecological importance given only the two options. Agency of Natural Resources staff are currently re-examining each of these elements and identifying areas *within each component* that are highest priority and priority. This further prioritization will reclassify these data in coming years and will do much to increase our understanding of places with the highest contribution to biological diversity.

For more information

A complete report on BioFinder development, methods and findings, including all 21 component abstracts can be found at www.BioFinder.vt.us. For more information specific to this component, contact John Austin, Vermont Fish & Wildlife Department, 802-476-0197, john.austin@vermont.gov