Lakes Region Conservation Plan 2017 Update

Mount Major in Alton, NH. Photo by Jerry and Marcy Monkman, Ecophotography

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Mapping, Analysis & Technical Report
Prepared by Dan Sundquist

GreenFire GIS

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Squam Lakes Conservation Society

Newfound Lake Region Association

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Introduction

Reader Guidance

The following report is technical in nature and covers many topics that may be unfamiliar to the reader. Every effort has been made to simplify terms, concepts and inter-relationships among the data and various aspects of the study methodology. **Bold-face** wording is used to emphasize the first use of new terms, concepts and key points, or to emphasize a point; footnotes and web links are provided where the reader may wish to follow up source materials for more detailed study.

This report is divided into five sections:

- The **Introduction** provides a brief overview of the Lakes Region update project initiative and highlights of the original 2011 planning effort;
- The **2017 Mapping Update** section describes the results of the co-occurrence mapping with new data;
- **Integrating Climate Change Resilience Data** analyzes data recently released by The Nature Conservancy and addresses how the various data can be integrated into the 2017 Lakes Region plan;
- The section on the **Shoreland Conservation Zone** describes the complete redesign of the original 2011 data; and,
- The **Conclusion** collects key points of this study in a summary, and offers recommendations for use of the updated plan.

Background

In 2010, the Society for the Protection of NH Forests (Forest Society) convened a group of land trusts, state agencies, and the regional planning commission for the Lakes Region of New Hampshire to begin the process of establishing a strategic conservation plan for the region. This effort was part of a series of similar, interlocking regional conservation plans in the state, including the Quabbin-to-Cardigan partnership, the Coastal Watershed Plan for New Hampshire led by The Nature Conservancy, and the Merrimack Region Conservation Plan in the south-central portion of the state. The Lakes Region plan was the last of these landscape-scale planning efforts, and was finalized in 2011.

All of these plans utilized a unique consensus-building process (Delphi process) and an array of natural resource features important in each region to work towards a "shared vision" plan for conserving key tracts of land. Each plan was based on co-occurrence mapping of natural resource features with weighted values generated as part of the Delphi process; weighting varied among the several stakeholder groups participating in the planning process. **Importantly, climate change resilience data was not yet available for consideration by the stakeholder groups.**

In August, 2016, The Nature Conservancy's Eastern Regional Office released a ground-breaking report on resilient and connected landscapes accompanied with robust GIS datasets for use in conservation planning (see more detailed discussion in a later section of this report titled **Integrating Climate Change Resilience Data**). This science-based analysis and data has now provided a solid platform from which to consider climate change impacts in long-range conservation planning.

With this in mind, the Lakes Region Conservation Trust, one of the original plan partners, reached out to all organizations and agencies with land conservation interests in the Lakes Region, to re-convene the 2010 partnership with a special interest in adding climate change resilience to the plan components. It also happens that new data had become available in 2015 for the NH Wildlife Action Plan, a key element of the 2011 plan, so there was a need to update the co-occurrence mapping for that plan. With support from the Forest Society, the NH Chapter of The Nature Conservancy, and the NH Fish and Game Department Wildlife Action Program, a new planning effort was laid out to update the 2011 plan.

Overview of the 2011 Lakes Region Plan

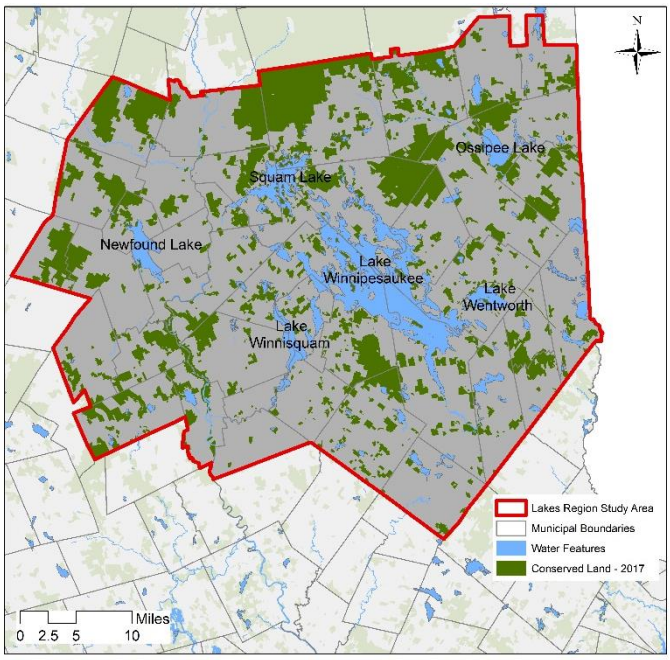
It is not possible within the limits of this report to recap the entire planning process and milestones of the 2011 Lakes Region plan. Rather, the reader is encouraged to review the final plan documentation at the following link to the Forest Society website:

https://forestsociety.org/regional-initiatives

This landing page contains information on all the regional conservation plans cited above, with a link directly to the 2011 Lakes Region plan. Scroll down to the report PDF file.

Study Area

The Lakes Region spans 41 municipalities and more than 1,660 square miles of territory in central New Hampshire, about 20% of the total land area of the state.



The centerpiece of the region is Lake Winnipesaukee, the largest lake in the state, surrounded by other large lakes including Squam Lake, Winnisquam Lake, Newfound Lake, Ossipee Lake, Lake Wentworth, and many other related water bodies totaling 224 lakes and ponds, and containing more than half of all water area in N.H.

A little more than 198,000 acres, or 20% of the study area, are currently conserved in the Lakes Region, including the southern reaches of the White Mountain National Forest to the north, large tracts in the Ossipee Range to the east and the Belknap Range south of Lake Winnipesaukee, and scattered but significant tracts in the Newfound Lake watershed.

2011 Plan Components

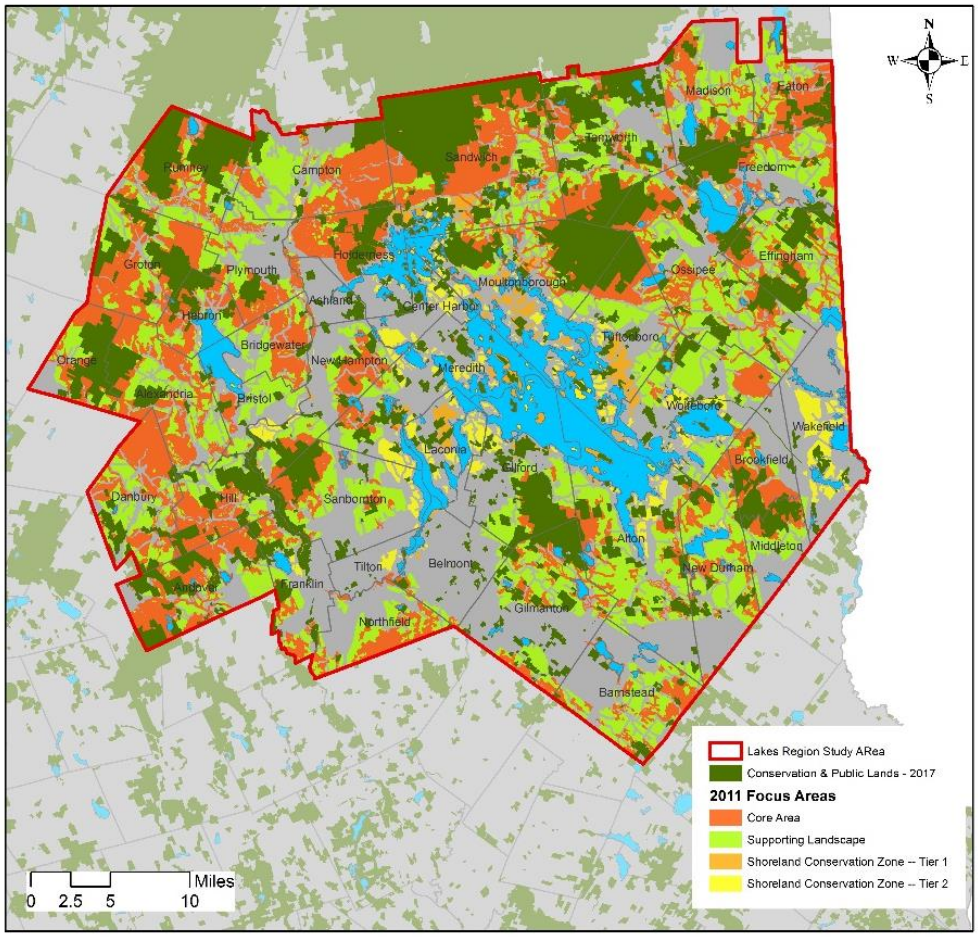
As noted above, the 2011 Lakes Region conservation plan relied upon a range of natural resource features important to maintaining and enhancing water quality in the region's water bodies and rivers. This data was merged into a co-occurrence map that identified areas of higher aggregate scores determined in the Delphi process. The list of natural resource features and weighted scores can be found in the next section of the report titled **2017 Mapping Update.**

A rather complicated protocol was established to translate the raw co-occurrence mapping into strategic conservation focus areas (see 2011 technical report at link above). This involved merging large forest blocks, NH Wildlife Action Plan habitat ranking data, and high quality stream watersheds to form conservation focus areas (CFA). These CFA were refined into two categories:

- **Core CFA** containing the highest scoring areas of the co-occurrence mapping and therefore the broadest aggregate of natural resource features being considered in the plan; and,
- **Supporting Landscapes** with above-average scores, but intended primarily to serve as buffers that protect the integrity of the Core CFA.

A third category of focus area - the **Shoreland Conservation Zone** - was also generated to address the areas immediately surrounding the lakes which did not score as highly in the co-occurrence mapping due to natural resource fragmentation by development. This zone was comprised of larger blocks of forested land in two tiers, reflecting the presence/absence of Core CFA features.

For reference purposes, the map below shows the 2011 Lakes Region plan CFA and Shoreland Conservation Zone. It may be helpful to compare this map with the 2017 CFA mapping later in this report, but note that significant changes in the Lakes Region plan have emerged in the updating process, not the least of which is the addition of climate change resilience data, so the 2011 map is of historical interest only in tracking the evolution of conservation planning in the region.



2017 Mapping Update

Overview

Several steps were necessary to update the 2011 Lakes Region conservation planning maps before integration with the 2016 TNC climate change resilience data. First, two data layers used in the 2011 co-occurrence mapping were replaced with more recent and better data; these include the NHWAP habitat ranking data and the NHDES drinking water protection areas.

Next, GIS processing was done to generate a new version of the natural resources co-occurrence mapping, using the same importance values determined by stakeholders in 2011. Then the updated co-occurrence map was further analyzed to locate areas of higher priority for conservation based on total scores found in the new co-occurrence map (see "hot spots" analysis below). Finally, the raw hot spots data was further refined into three tiers of conservation focus areas, as discussed below.

This report addresses only the planning process and GIS-related steps used to update the Lakes Region conservation plan. However, it relies upon a great deal of research, data, and GIS technique from the 2011 planning effort. More information on the process and methods used to develop the 2011 Lakes Region Strategic Conservation Plan can be found at this link: https://forestsociety.org/sites/default/files/LakesRegionPlan_TechReport.pdf

Co-Occurrence Mapping

As an initial foundation for the 2011 Lakes Region conservation plan, a **co-occurrence map** of 25 natural resource data layers was generated to reveal where resources of conservation concern are co-located. The co-occurrence map was based on weighted values for each resource feature, with the values determined by a stakeholder group of private land conservation organizations and public agency representatives. The **importance values** are listed in the table on the next page, in rank order of scoring.

Since 2011, two of the data layers have been updated: NH Wildlife Action Plan Habitat Rankings (2015) and Drinking Water Protection Areas[1] (updated annually). Therefore, in order to maintain a high level of accuracy in the co-occurrence mapping, both of these data layers

[1] The NHWAP habitat ranking data is managed by the NH Fish & Game Department and is updated every five years. The NH Department of Environmental Services maintains the drinking water protection data with changes as needed on a regular basis.

have been coded in the GIS and the co-occurrence map has been updated to reflect the new information using the previous importance values.

Factor	Mean Value
Riparian & Shoreland Buffers	12.00
Blocks >10,000	7.86
High-yield sand/gravel aquifers	7.86
NWI wetlands & Hydric Soils	7.29
Blocks 1,000 - 5,000	7.14
Blocks 5,000 - 10,000	6.71
Steep slopes >25%	6.71
WAP Tier 1: Best in NH	6.71
WAP Tier 2: Best in Eco-region	5.43
EPA reference reach	4.71
Low density rural watersheds	3.71
Top 15% of Tier 1 watersheds	3.29
Blocks 500 - 1,000	3.00
Lower-yield aquifers	3.00
WAP Tier 3: Supporting Landscape	2.57
Floodplain forest complexes	2.43
Top 30% of Tier 2 watersheds	2.14
Species of interest habitat	1.86
Highly erodible soils	1.57
Blocks 250 - 500 acres	1.43
Marsh complexes	1.14
Peatlands complexes	0.71
Wellhead protection areas	0.43
Impaired waters	0.29
Favorable gravel well sites	0.00

NHWAP Habitat Ranking Data

The NHWAP habitat ranking data represents the NH Fish and Game Department's best modeling estimate relative to the quality of existing wildlife habitat statewide. This modeling effort uses a broad palette of bio-physical inputs developed by the department, as well as new data produced by science-based studies by others. The habitat ranking data is subdivided into three tiers:

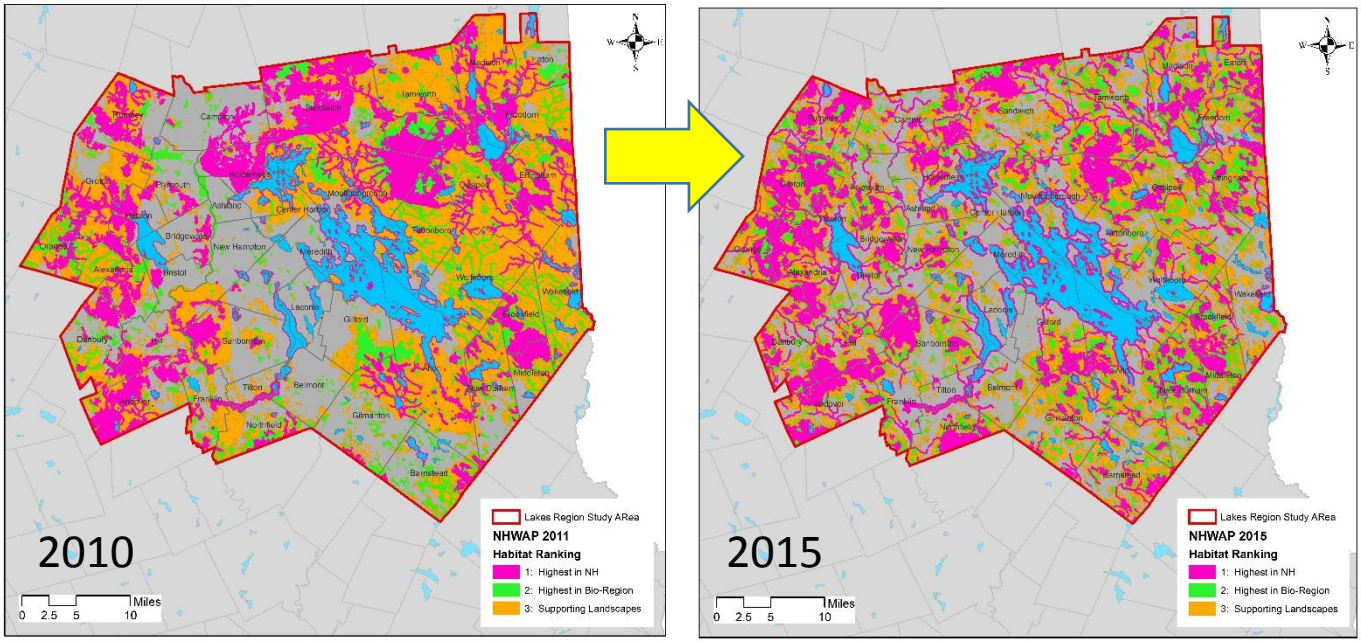
- Tier 1: Best Habitat in New Hampshire
- Tier 2: Best Habitat in the Ecological Region[2]
- Tier 3: Supporting Landscapes[3]

The maps below show the NHWAP habitat ranking data for both 2010 and 2015. Note the difference in the extent and distribution of the three tiers from one year to the next. Better data inputs and predictive modeling has typically resulted in a finer degree of mapping of each

[2] Several distinct ecological regions exist in NH, each with its own distinctive bio-physical and habitat occurrences. The Lakes Region planning area shares part of two such ecological regions.

[3] Supporting landscapes are intended to provide buffers to protect the integrity of Tiers 1 and 2.

tier. Note also how many river corridors and lake shorelines have been elevated to Tier 1 status.



Since the NHWAP tiers scored relatively high in terms of importance values in 2011, we can expect that the 2015 NHWAP data layers will produce a significant change in some locations within the original co-occurrence mapping.

Drinking Water Protection Area Data

NHDES maps hydro-geologically based protection areas around every public water supply in NH. Most of these are wellheads, but some significant water supplies depend upon surface water intakes on large reservoirs. The two maps on the next page illustrate the 2011 and 2017 data for drinking water protection areas[4]. Looking closely at the maps, subtle differences in the location and size of certain drinking water protection areas can be detected. There are new polygons in places in the 2017 version, and some 2011 polygons have been eliminated.

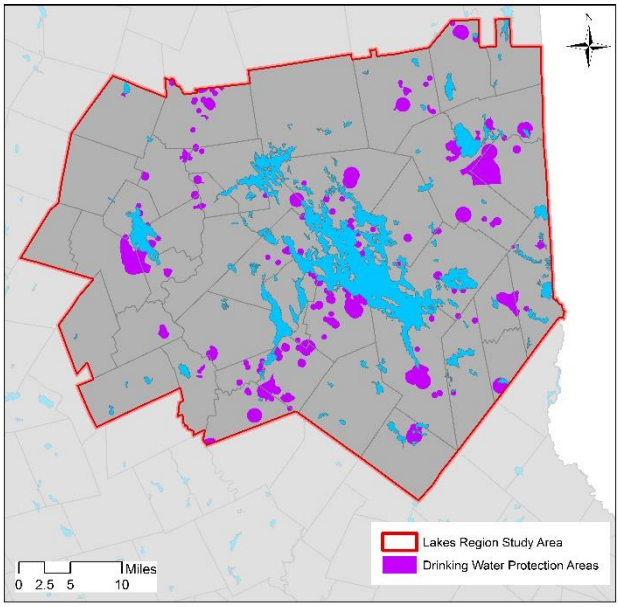
Because the drinking water protection areas ranked relatively low in score (0.43 in the table above), we should not expect to see significant change in the co-occurrence map update. However, the 2017 data is included in the overall update for the sake of accuracy and as a resource feature that may influence localized scoring in the co-occurrence map.

[4] Only NHDES "C-class" community water supply features are used in this study.

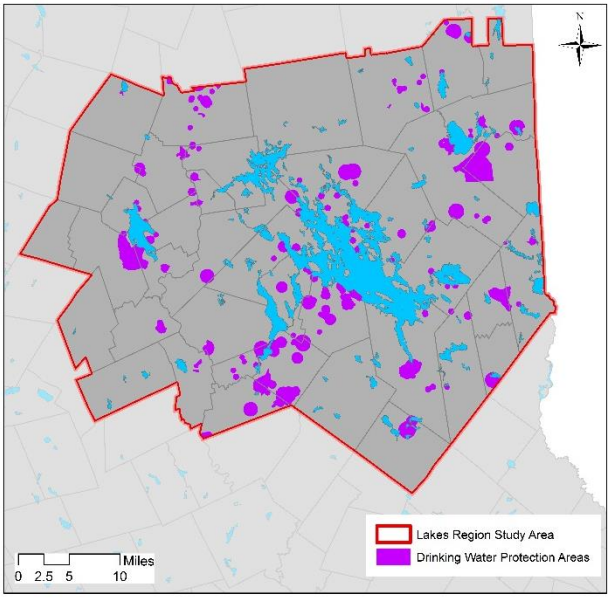
Updated Co-Occurrence Mapping

Using the importance value scores in the table above, the co-occurrence mapping has been updated by adding all 25 geo-referenced data layers in a manner identical to the original 2011 study. The results of both the 2011 and 2017 co-occurrence analysis are shown in the two maps on the next page. Darker colors in both maps indicate higher-scoring areas and therefore higher priority for strategic conservation efforts. Lighter colored areas are lower scoring overall, and gray areas did not score in the mapping due to absence of any natural resource features being considered.

At first glance, both maps are fairly similar, but closer inspection reveals new, higher-scoring areas in the 2017 map. Several of these areas are highlighted with red circles in the 2017 map. Changes in the co-occurrence mapping affect the subsequent planning step of identifying conservation focus areas, addressed below. **Larger versions of each co-occurrence map are provided at the end of this report section for more detailed reference.**



2011



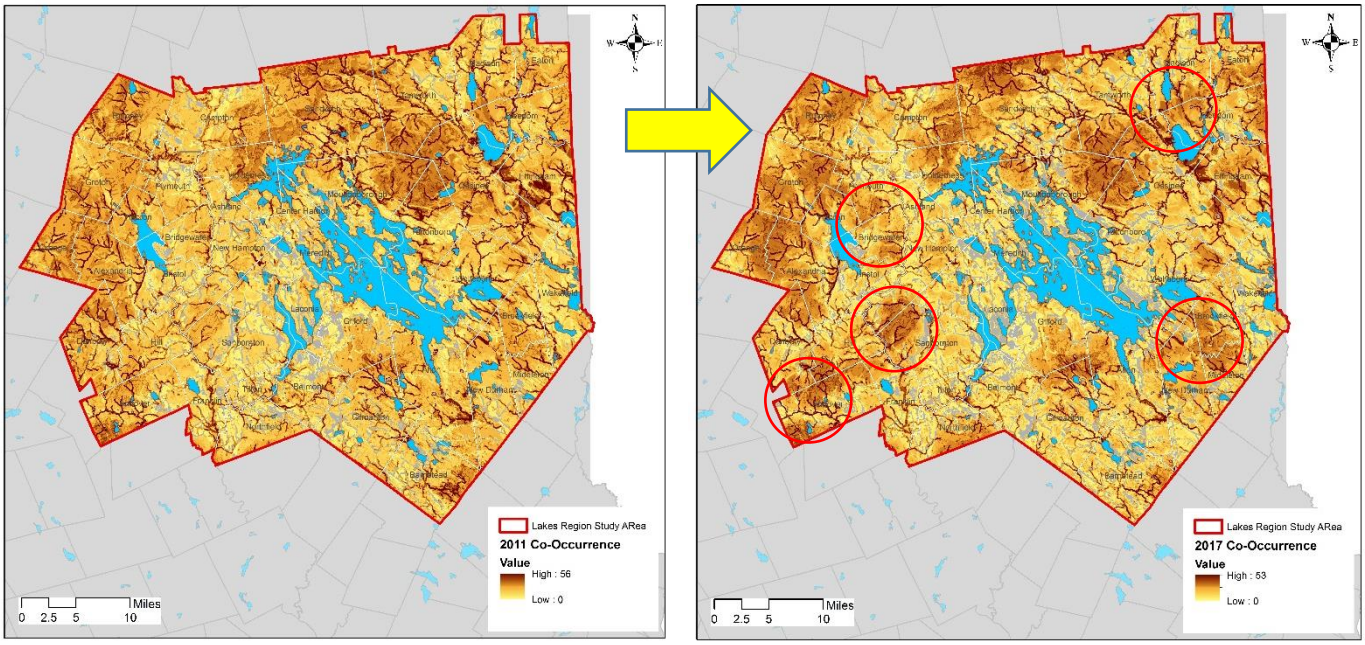
2017

Identifying Preliminary Conservation Focus Areas

The 2011 Lakes Region conservation plan used an elaborate protocol for deciding and delineating conservation focus areas, based on the results of the co-occurrence mapping at the time. The method stems from an early model for delineating focus areas developed by the NH Chapter of The Nature Conservancy for a strategic conservation plan for the coastal region of

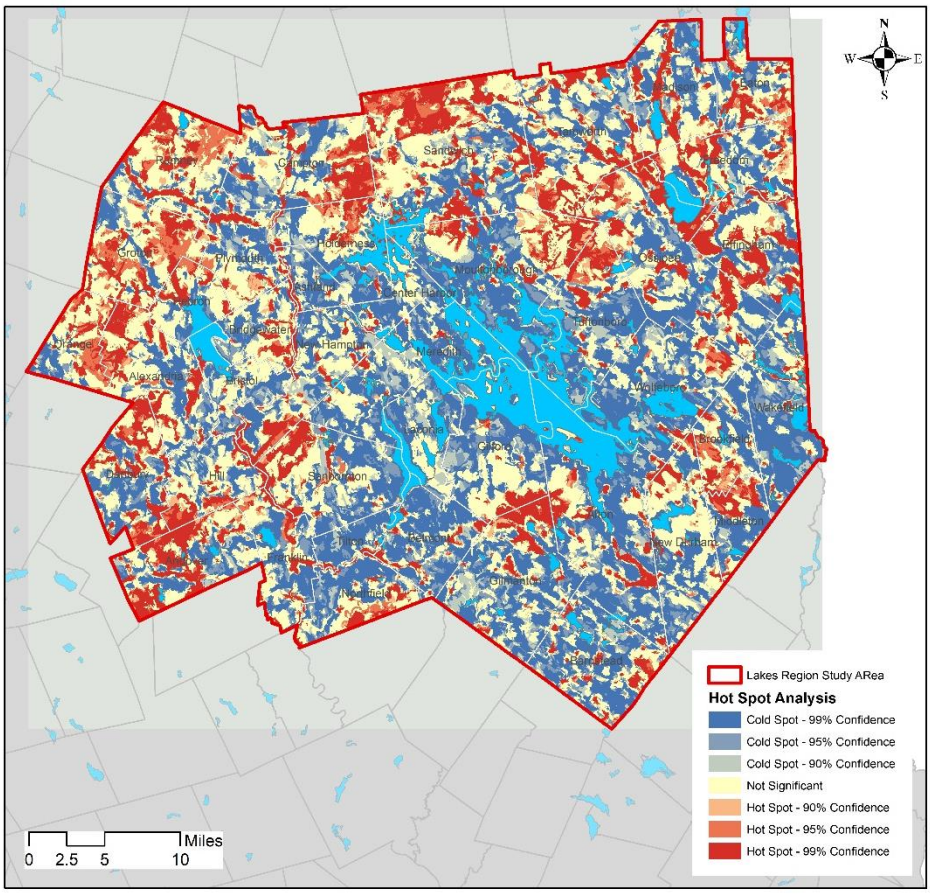
NH (2006). The building blocks of this protocol included forest blocks greater than 100 acres, NHWAP habitat ranking Tier 1 and 2 polygons, and high quality stream watersheds.

The 2017 update uses a new, and more accurate method of delineating conservation focus areas: GIS processing and analysis of "hot spots" based on the scoring within the co-occurrence map. The 2011 post-processing of the co-occurrence map used an analysis of scores that averaged[5], and therefore generalized, the complex features scoring within the co-occurrence map. The hot spots method uses a probability-based approach by analyzing neighboring grid cells, in this case for a 1,000' search radius. The results of the hot spots analysis are shown in the map on the next page.



2011 2017

[5] Specifically, a focal mean analysis was performed on all 30m x 30m grid cells within the co-occurrence map which averaged grid scores for a circular "neighborhood" of 25 cells.



Raw Hot Spots Analysis

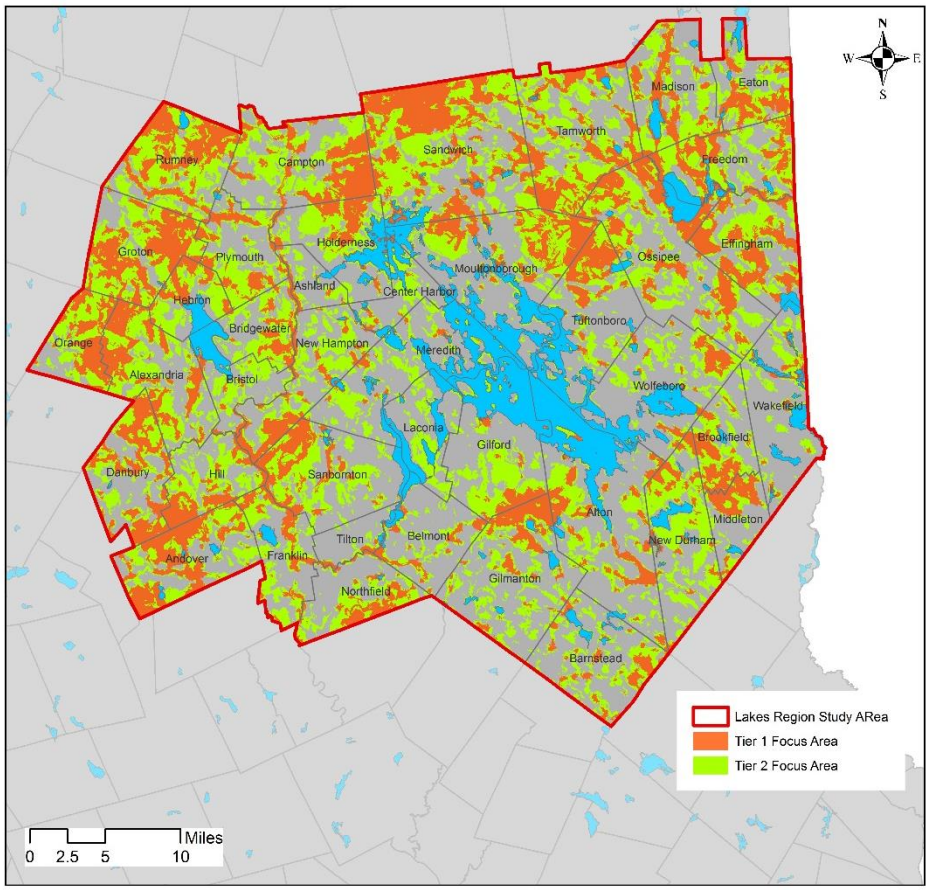
As can be seen in the map legend, the hot spots analysis determines the relative confidence (probability) of both hot spots and cold spots. Hot spots correspond to clusters of higher-scoring grid cells in the co-occurrence map; cold spots indicate areas of typically lower-scoring cells.

For the purposes of the 2017 Lakes Region conservation plan update, the hot spots analysis has been classified into two tiers of conservation focus areas:

- All hot spot classes with 90% confidence level and above are grouped into Tier 1 conservation focus areas (highest scoring areas and highest conservation priority).
- The “not significant” hot spot class becomes Tier 2 supporting landscape (Tier 1 buffers).

It is important to note that the “not significant” hot spot classification is a statistical artifact of the GIS processing, in a sense representing more mid-range co-occurrence values where grid cells are somewhat more scattered or fine-textured in the overall scheme. Compare the 2017 co-occurrence mapping to the “not significant” hot spot locations to verify that important, relatively high-scoring natural resource features exist in these areas.

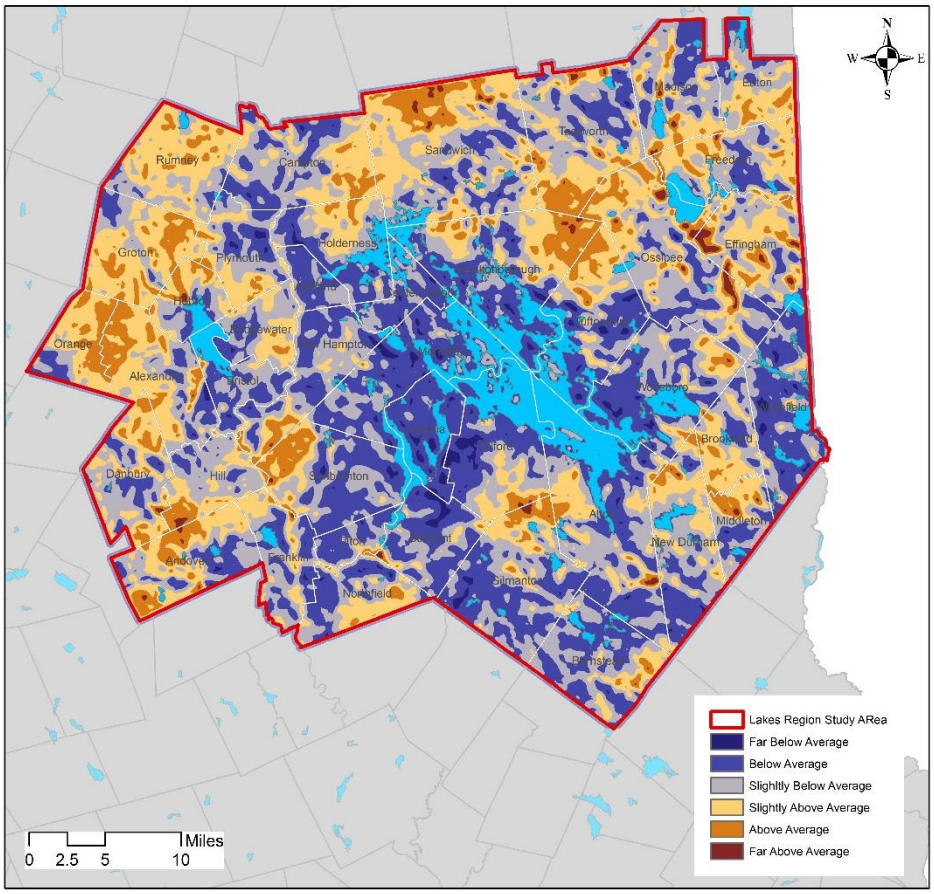
The map below shows the 2017 Lakes Region conservation focus areas distilled from the hot spots analysis (Tier 1 focus areas in orange, Tier 2 supporting landscapes in bright green). These tiers represent a preliminary step towards a more refined delineation of the CFA discussed below.



Preliminary Hot Spots Delineation

As a check on this approach, we can compare the hot spots analysis with a focal mean analysis of the co-occurrence map (the averaging method used in the 2011 focus area delineation, and replicated here using the 2017 co-occurrence values). The map on the next page shows the results of the focal mean analysis. As mentioned above, this dataset appears much more generalized due to the nature of the mathematical analysis, but it does reveal areas where the co-occurrence mapping has averaged grid cell scores in gradations above an average (mean) for the entire analysis area.

The key point is both methods generate similar locations of the “above average” classifications indicating areas of higher conservation priority. The hot spots analysis, however, is a finer-grained rendition of the general location of these areas, and more detailed in relation to the actual natural resource features underlying the analysis.



Focal Mean Analysis

Refining the Conservation Focus Areas

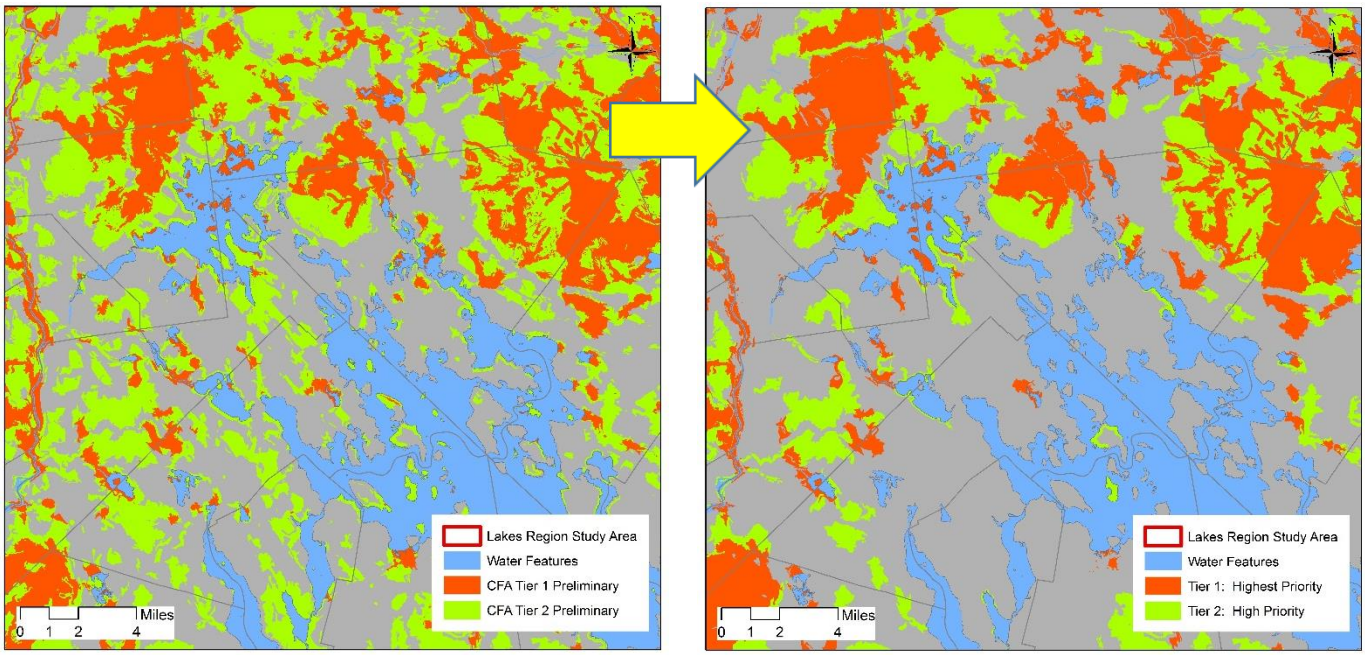
The distilled hot spots analysis discussed above represents the most precise locations of consistently high values of co-located natural resource features considered in the co-occurrence mapping. However, the patterns of the two preliminary CFA tiers are very complex and somewhat fragmented. One of the basic tenets of conservation biology is to identify core conservation areas that are "blocky" in shape, and surrounded by a second tier of supporting landscapes that act as a buffer to protect the integrity of the core area. Therefore, a further step in generalizing the data is necessary to generate the focus area "blockiness" and to consolidate the supporting landscapes into meaningful buffer zones.

The criteria and assumptions used to refine the preliminary Tier 1 and 2 CFA are as follows:

1. **All hot spot polygons less than 100 acres in size in both tiers were removed** to simplify the extent and distribution pattern of the data. A threshold of 25 acres was tested first, but it was found to leave many scattered, small "islands" of data across the study area.

2. **All "holes" in both tiers were removed.** These holes are areas of slightly lower hot spot scoring, and therefore "sinks" in the numerical data. This helps to simplify the CFA polygons and reduce complexity overall without losing the intent of the preliminary CFA ranking.
3. **Tier 2 polygons (preliminary) were further enhanced by selecting for a grid code value[6] of 9 or higher**, based on a calculation of the standard deviation of the Tier 2 grid codes for the entire study area. This refinement ensures that the highest scoring areas are elevated in importance, and helps to consolidate the pattern of the Tier 2 data.
4. **Finally, all water bodies and developed land was removed** from a merged CFA dataset of both Tiers using the 2011 version of the National Land Cover Database.

The two detail maps below show the difference between the preliminary and the refined CFA for a portion of the Lakes Region study area. The differences are subtle, but a close inspection reveals where "holes" are filled, and where lower-scoring areas (value less than 9) have been removed.

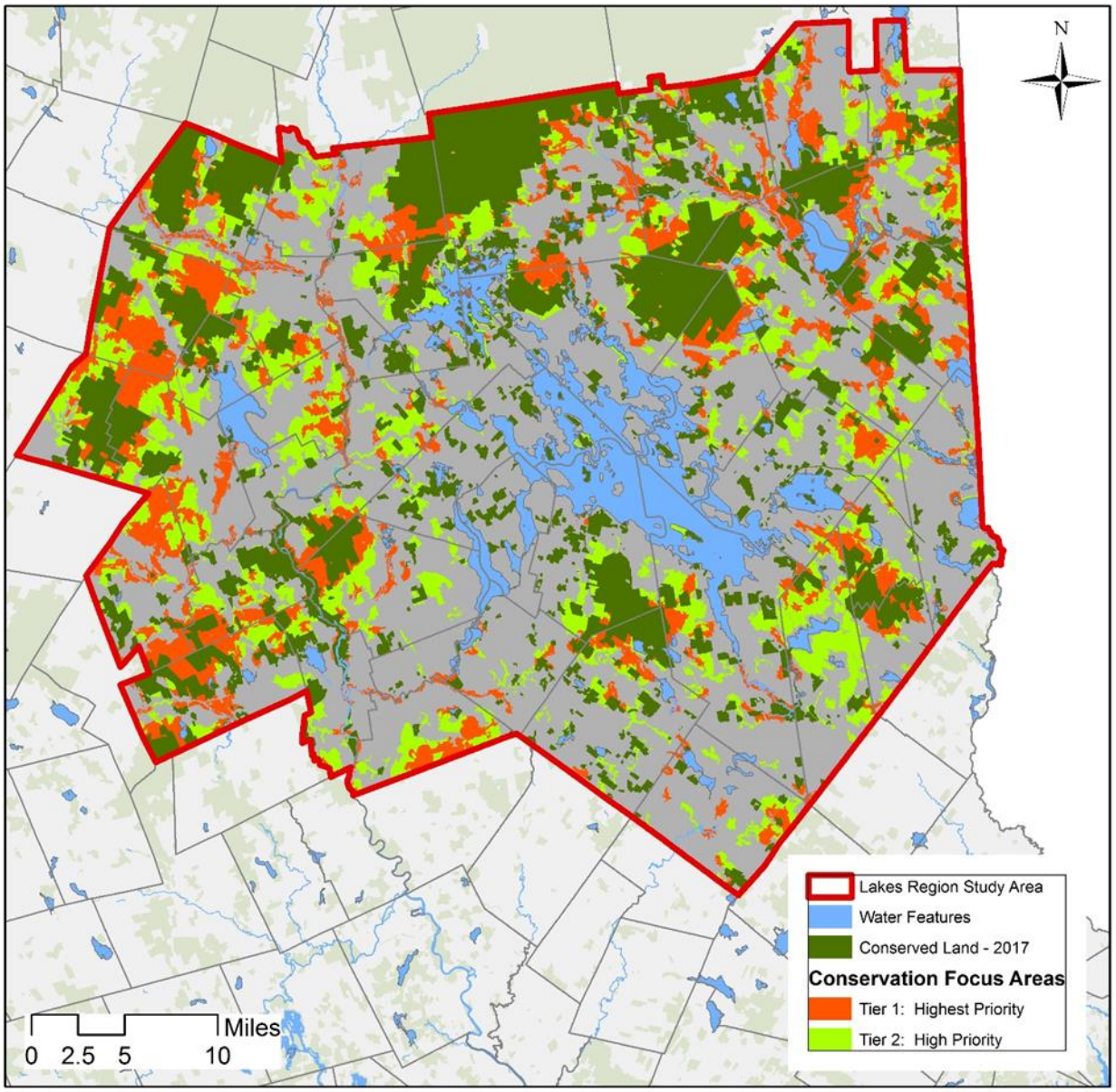


Preliminary CFA

Refined CFA

[6] The hot spots data carries with it the original co-occurrence map grid codes (values). A histogram was compiled for the preliminary Tier 2 data to determine the mean value (16) and the standard deviation (7).

The map below shows the updated and refined Lakes Region conservation plan focus area tiers with existing conservation and public lands[7] overlaid in dark green. Here, it is the conservation focus areas that appear outside the conserved land tracts that are of primary concern to private and public conservation entities.



Note how the bright green Tier 2 CFA tend to work as buffer zones around and adjacent to Tier 1 core conservation focus areas. Keeping in mind that Tier 2 CFA are only slightly lower scoring than the Tier 1 areas, note also several large areas of contiguous Tier 2 areas which, in a sense, also identify key areas for conservation activities. There is a cluster of these large Tier 2 CFA

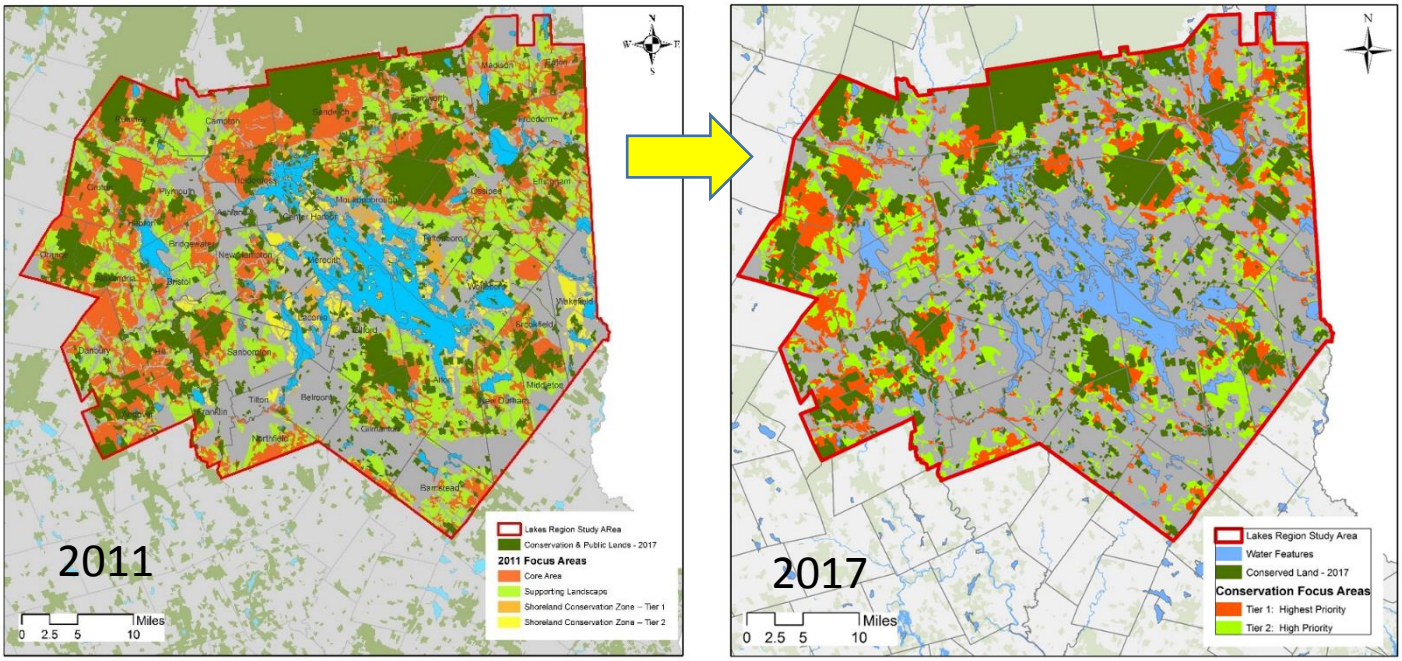
[7] Based on 2017 data from GRANIT. Some recently conserved land may not appear in the map.

west of Lake Winnipesaukee bordering the Newfound Lake region, and another significant area to the east surrounding Merrymeeting Lake in New Durham.

The table below summarizes the acreage and percent of regional land area contained in each CFA tier, as well as the current status of land protection in those tiers. Taken together, Tiers 1 and 2 total to about 43% of the study area, which is a reasonable target for strategic land protection planning.

Summary of Lakes Region CFA - 2017				
CFA Tier	**Total Acres**	**Percent Total Land Area**	**Acres Protected**	**Percent Protected**
1	217,415	22.4%	88,846	40.9%
2	201,216	20.8%	60,537	30.1%
	418,631	**43.2%**	**149,383**	**35.7%**

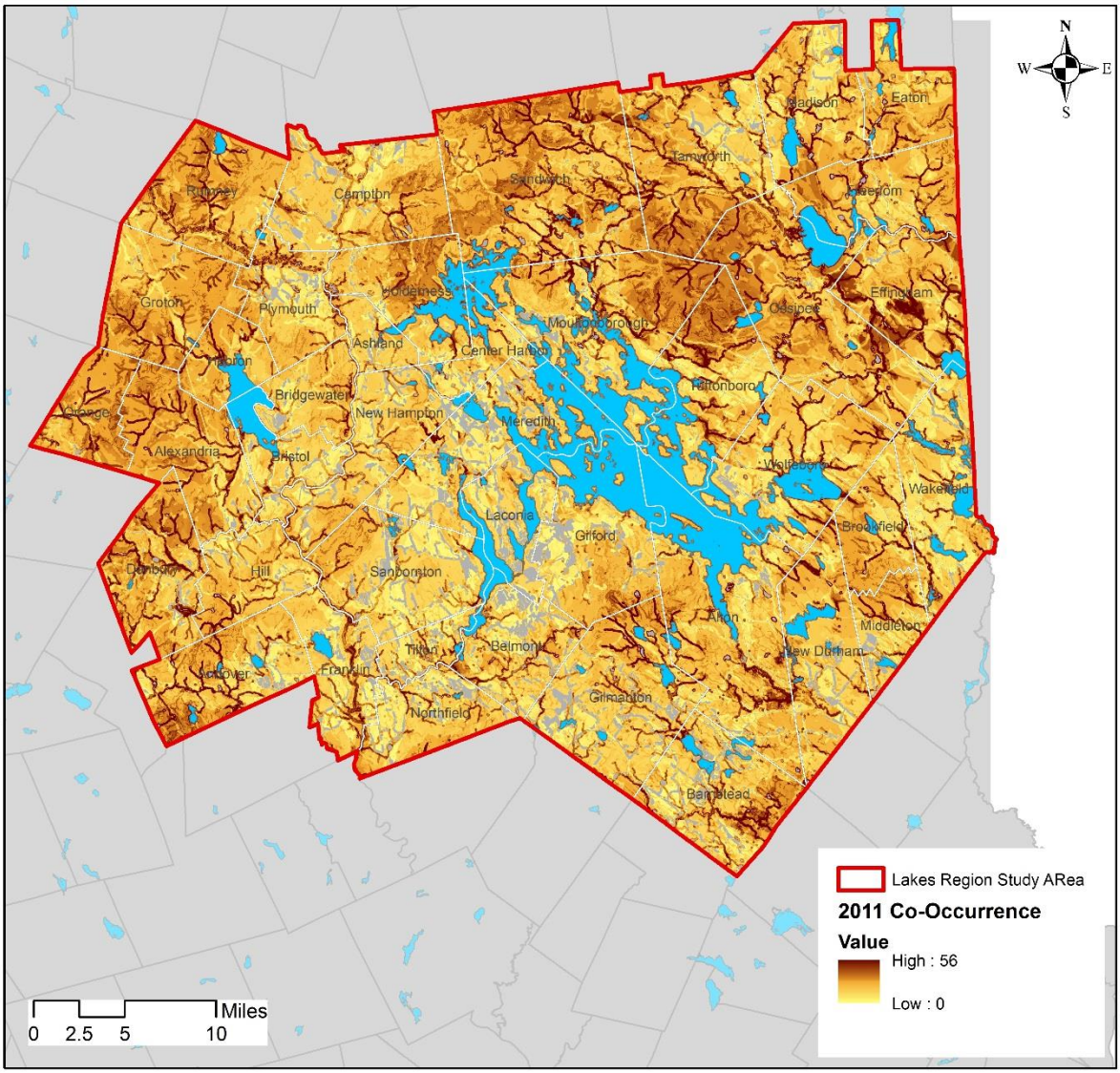
The two maps below show the 2011 Lakes Region conservation focus areas versus the 2017 refined focus areas derived from the hot spots analysis. Keep in mind that the 2011 focus areas are comprised of on-the-ground features such as forest blocks, stream watershed, and the boundaries of habitat ranking tiers. The 2017 focus areas are derived only from the hot spots statistical analysis, but in fact are built from multiple natural resources data layers (also on-the-ground features) and their assigned importance values. Therefore, the 2017 focus areas embrace <u>more</u> than the three focus area building blocks used in 2011, and are arguably more realistic and accurate in delineation of true conservation priorities. The 2017 plan can also be thought of as more intensive and precise. **In fact, the 2017 plan has about 196,200 acres <u>less</u> conservation focus area than the 2011 plan.**



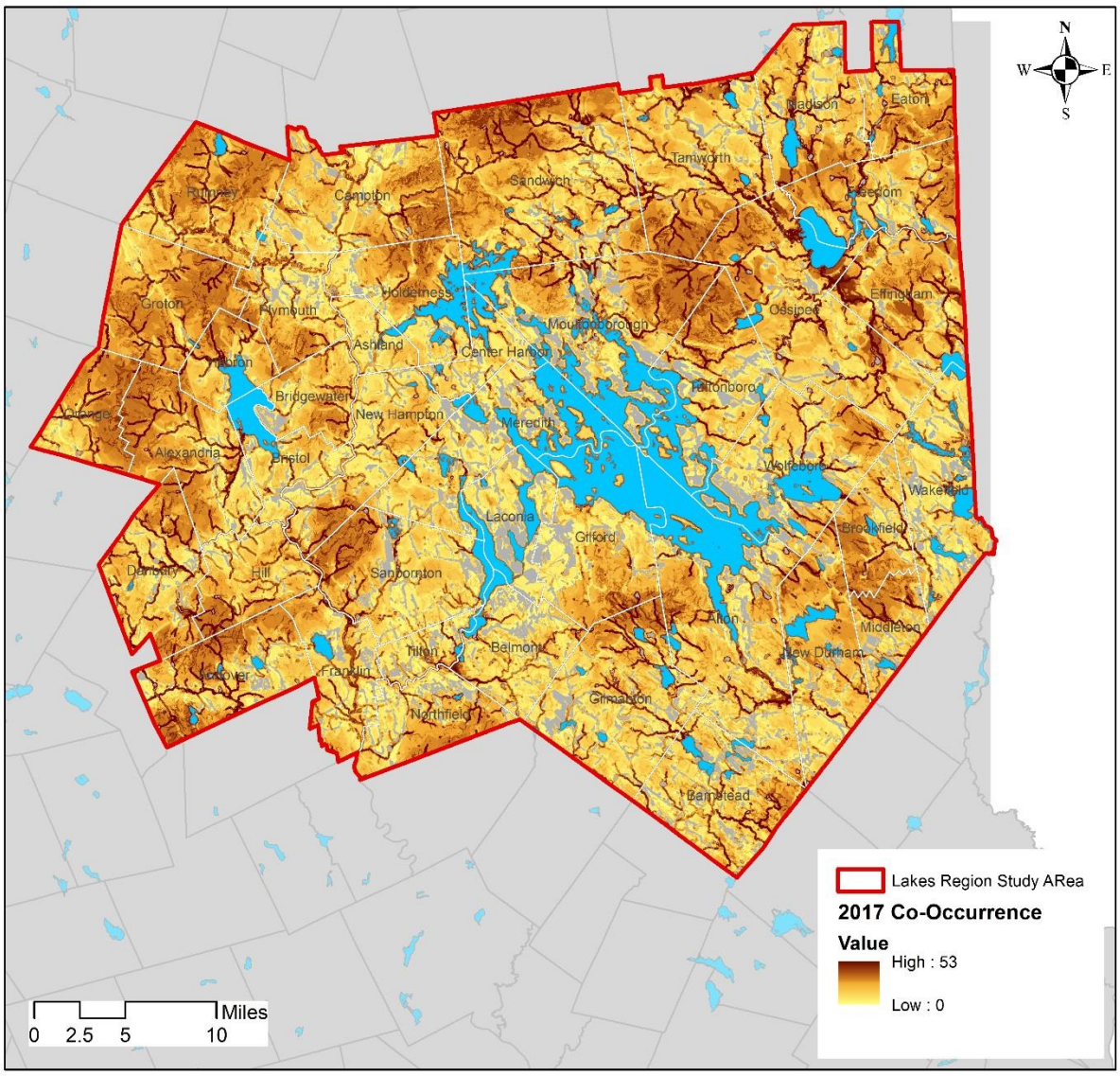
Summary

The key points of the updating process and results above are as follows:

- New and better data has been incorporated into the Lakes Region plan, including significantly different NHWAP habitat ranking data.
- The co-occurrence map and higher-scoring areas in that map have changed, largely due to the 2015 NHWAP data.
- The method used to identify and delineate conservation focus areas is radically different from the protocol used in 2011, and ensures more accurate location of actual high-scoring locations.
- Classification of the 2017 “hot spots” analysis into two tiers of conservation focus areas (CFA) has resulted in a similar but more intensive and detailed array of focus areas when compared to the 2011 results.



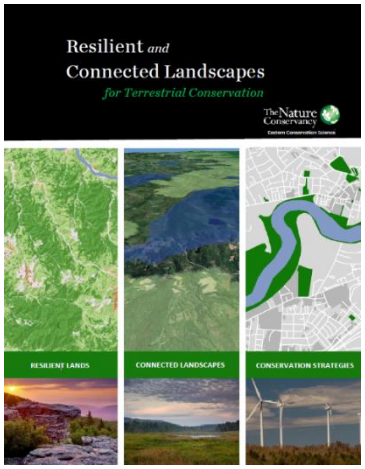
2011 Co-Occurrence Map



2017 Co-Occurrence Map

Integrating Climate Change Resilience Data

Introduction



A large body of cutting-edge scientific information on climate change resilience was released by the TNC Eastern Regional office in August, 2016. Titled *Resilient and Connected Landscapes for Terrestrial Conservation*, this report integrated resilience, diversity, and permeability to identify a connected network of sites that represent the full range of geophysical settings and connectivity needed to support the continued rearrangement of plant and animal species in response to climate change.

Since it is not within the scope of this report to delve into the details of the data and the complex modeling conducted by TNC, the report on this study can be found at the following link:

https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/Downloads.aspx

Each aspect of the study – geophysical settings, diversity metrics, and connectivity – are complete studies in their own right, but they contribute to and are integrated into the final climate change resilience mapping. The complexity of the climate change resilience data is further distilled down into a key dataset: the **8-class prioritization** mapping. This data utilizes various combinations of diversity metrics and regional flow modeling to delineate broad areas with similar characteristics. More information on how this data was developed can be found at the following link, which takes the reader to a special "story map":

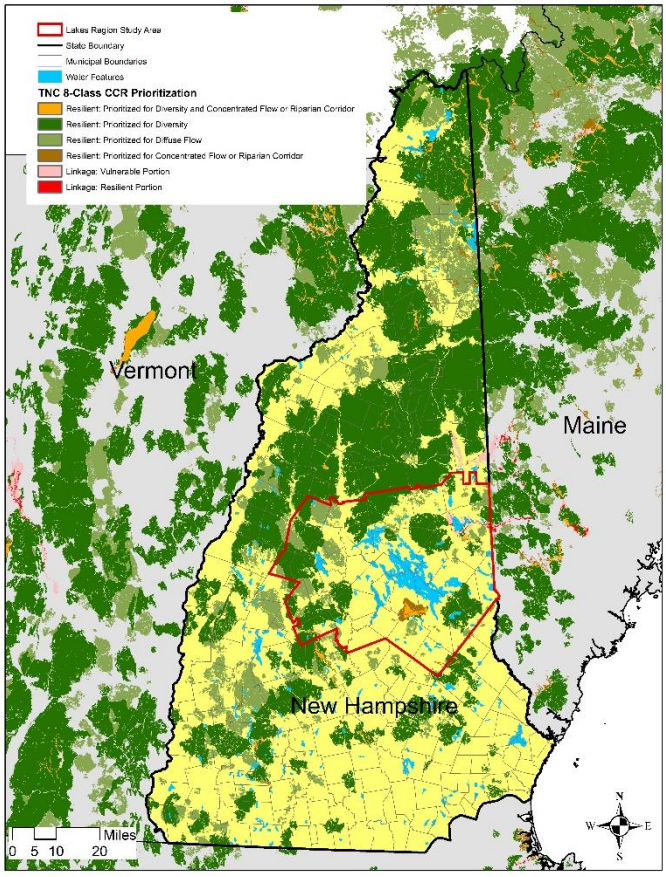
https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/Maps.aspx

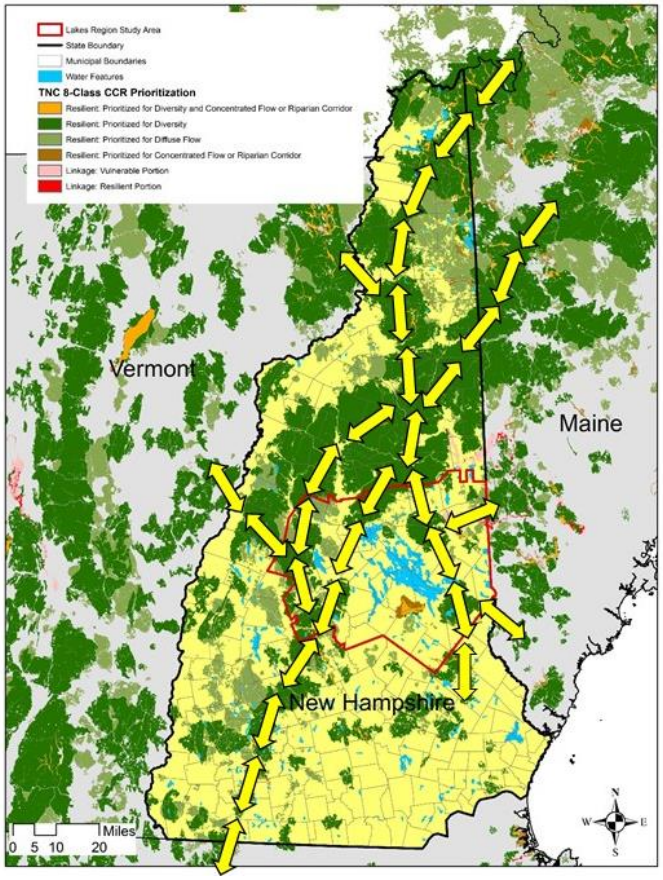
By clicking on the numerical buttons at the top of the map, one can view a short narrative and map addressing each step of the process used to create the 8-class prioritization data used in the Lakes Region conservation plan update. The map window is scalable to the Lakes Region study area by using the +/- toggle.

Regional Context

The two maps on the next page show elements of the 8-Class Prioritization data centering on New Hampshire and framed by Vermont and Maine. Two elements, or classes of data, have been removed from the mapping for clarity: **Non-Resilient** areas which are developed more intensively for human uses, and **Resilient: Not Prioritized**. At the scale of this mapping, the

latter data category is not important; rather it is the “island geography” of the other priority areas that are key, especially from the perspective of connectivity across the larger region.





The map on the left shows the 8-Class data reduced to six classes. Keep in mind that no ranking is implied in this data; it is simply different combinations of diversity and connectivity (flows) data. Note how New Hampshire is dense with data from the White Mountain National Forest north, and also along the highlands east of the Connecticut River, including a portion of the Lakes Region study area. Note also how south-central New Hampshire and the Seacoast Region display only isolated occurrences of the 8-class data. This is due to the more developed character of southeast N.H. with its major cities and suburbs fragmenting the natural landscape and impeding wildlife species movements, presently and into the future.

It should also be pointed out how the major lakes in the Lakes Region study area tend to act as barriers to species movement, partly due to size but also because the areas are intensively developed.

The map to the right shows the same data, but has arrows overlaid to highlight probable major species movement connections and corridors north/south[8] across New Hampshire and into

[8] While species movement is generally assumed to be south-to-north due to climate change, double-ended arrows are used in this illustration to emphasize flow schematically. Also, in some locations, flows may be southerly to

neighboring Vermont and Maine. This map emphasizes the importance of the western and eastern portions of the study area as movement corridors, and also demonstrates the unique dividing effect of the major lakes in the center of the study areas.

More detailed information appears later in this report with a focus on the Lakes Region study area itself, which resolves into a more complex pattern of internal and external movement options.

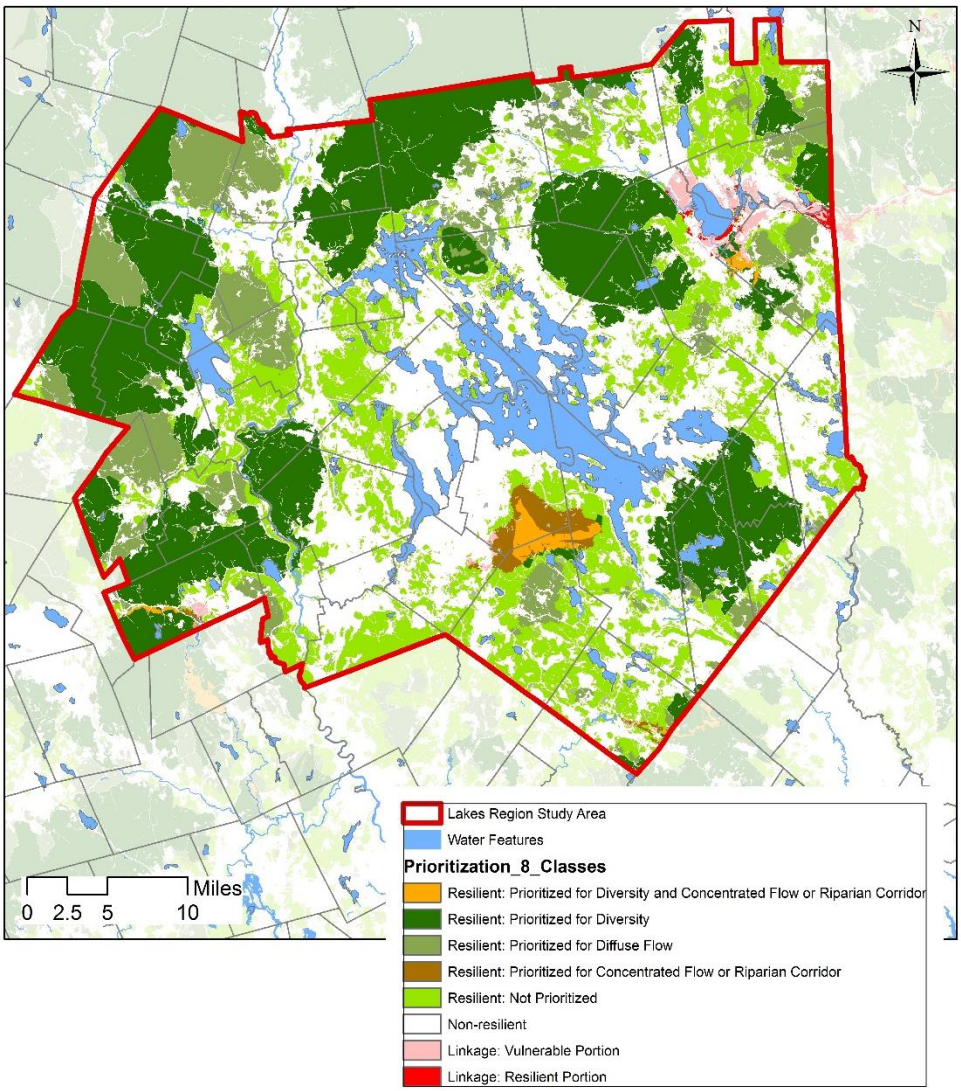
Refining Climate Change Resilience Data

In order to intelligently integrate the TNC 8-Class Prioritization data into the Lakes Region study area, a GIS-oriented team[9] was formed to provide guidance based on both local knowledge and science, as well as decisions on which of the broad range of TNC resilient and connected landscapes data to utilize. Under the mentorship of TNC staff, the team quickly decided the key dataset to use in integrating climate change resilience science into the Lakes Region plan is the **8-class Prioritization** data, discussed above.

The following map shows this data for the entire Lakes Region study area, here displaying all eight data categories, including the **Resilient: Not Prioritized** data (light green) not shown in the regional context maps above.

some extent to reach higher elevations which are also important to species habitat rearrangement at a more local scale.

[9] This team included Dr. David Patrick, Director of Land Conservation at the TNC/NH Chapter, Pete Steckler, GIS & Conservation Project Manager at TNC/NH, Emily Preston, NH Fish & Game Department, Wildlife Action Program, and David White, Lakes Region Conservation Trust Board Member and project manager.



Remember that these data categories do not imply any ranking, although the dark green areas tend to convey more importance in the graphics.

Much of the study area is dominated by two data categories: **Resilient: Prioritized for Diversity** (dark green), and **Resilient: Prioritized for Diffuse Flow** (gray-green). These areas tend to correspond with large existing blocks of natural land cover or sparsely developed landscapes. There are four more localized and special data categories:

- **Resilient: Prioritized for Diversity and Concentrated Flow** (orange);
- **Resilient: Prioritized for Concentrated Flow** (brown); and,
- **Linkage: Vulnerable Portion** (pink), and
- **Linkage: Resilient Portion** (red).

The first two data categories are located in the Belknap Mountains, south of Lake Winnipesaukee, with a very small occurrence found along the Smith River in southwest

corner of the study area. The linkage category is focused mainly around Ossipee Lake and the Pine River corridor leading into Maine in the northeastern portion of the study area.

It is important to note, then, that the Lakes Region exhibits both broad-ranging and highly localized climate change resilience data.

Six elements of the **8-Class Prioritization** dataset were selected by the GIS advisory team as most important to climate change resiliency within the study area, as follows:

- Resilient Areas: Prioritized for Confirmed Diversity and Concentrated Flow
- Resilient Areas: Prioritized for Confirmed Diversity
- Resilient Areas: Prioritized for Diffuse Flow
- Resilient Areas: Prioritized for Concentrated Flow
- Linkage Zones: Vulnerable Portion
- Linkage Zones: Resilient Portion

The six elements listed above have been merged into a single overlay dataset to signal those locations within the Lakes Region study area that are critical to conserve for climate change reasons.

This approach sets aside the **Non-Resilient** portions of the region as well as the **Resilient: Not Prioritized** areas. The latter may be preserved as a reference dataset in the updated plan, but at this point these areas do not meet the same level of CCR importance as the areas/zones noted above due to the optimization model used by TNC in the 2016 release of the data package and analysis. However, TNC is working toward more localized CCR data and analysis that will be relevant in the next year, and it is thought that the non-prioritized resilient areas may be elevated in importance at the end of that study, although the physical areas covered may change somewhat.

A second decision made by the GIS team relates to how the 6-Class Prioritization data should be integrated into the Lakes Region plan. **It was agreed that this data will be used as a separate reference overlay in conjunction with the conservation focus areas derived from the co-occurrence analysis.** There are several reasons for this decision:

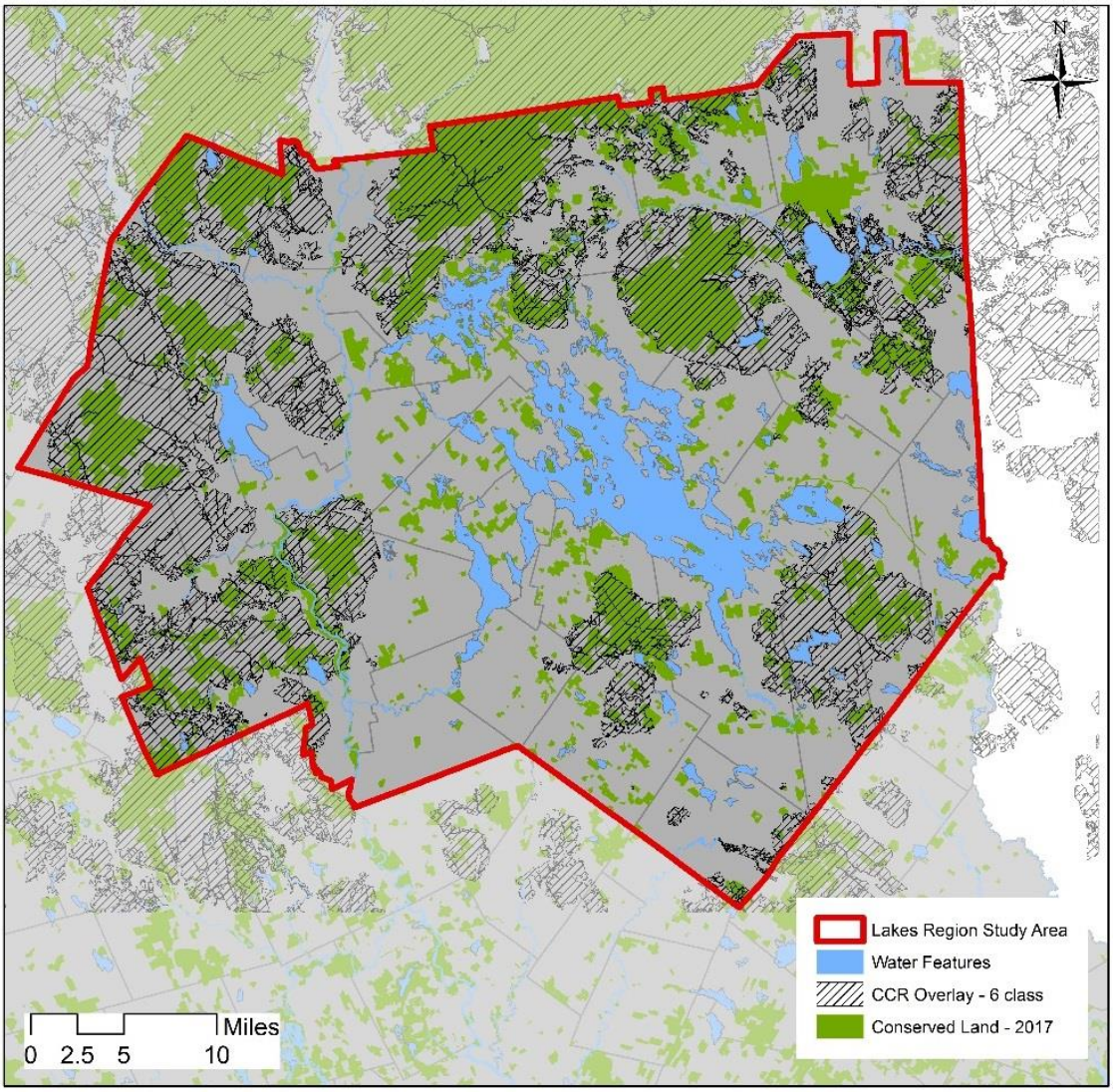
- The 6-class climate change resilience data cannot be added to the co-occurrence data since the Delphi process weighting of natural resource features (importance values) established by the original Lakes Region stakeholder group cannot be changed. It has been more expedient to carry forward the importance values as they were decided in 2011.

- The nature of the data inputs and the scale of the modeling in the co-occurrence mapping versus the climate change resilience data is widely different, and uses differing assumptions. The first is the "shared vision" of the 2011 Lakes Region plan stakeholders and is based on a range of natural resource features. The second utilizes different data inputs than the co-occurrence mapping, and the outputs are based on complex GIS modeling rather than on-the-ground features, for the most part. The former is regional in scale (1,660 square miles) and detail, while the TNC study spans the entire eastern United States and Atlantic Canada.
- The TNC climate change resilience data is a dynamic dataset, subject to new data inputs and modeling. Specifically, TNC has begun a discussion of how to scale down the results of the 2016 study results to regional-scale components that depend more on true eco-regional inputs, precisely what is being explored early on in this update of the Lakes Region plan. Thus, the climate change resilience overlay concept leaves the opportunity for new and more relevant data to be added to the Lakes Region plan, hopefully in the near future.

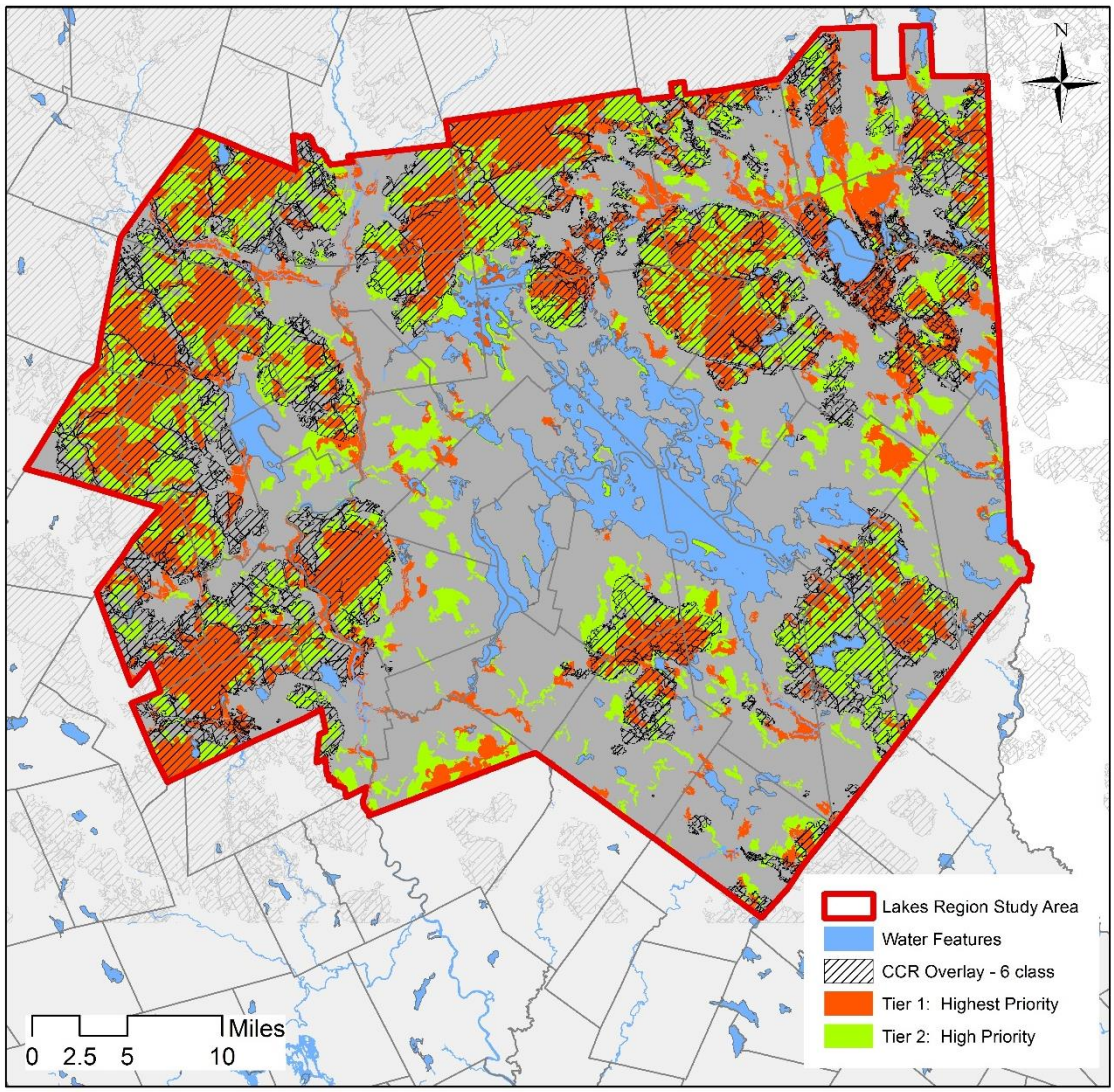
The following map displays the 6-class prioritization data (black cross hatch overlay) with existing conservation and public lands. The six classes are combined into a single working overlay in this case, mainly because each of the six classes has its own character and function, and none of the six are ranked in any way.

Note that significant areas within the overlay data are already conserved; that factor, in combination with large blocks of forest and other natural land cover, has contributed to these important climate change resilient areas. Note also how the 6-class overlay occupies the periphery of the Lakes Region study area for the most part, begging the question of how to connect the prioritized areas to facilitate species movement patterns. This is addressed in more detail later in the sub-section titled **Enhanced Connectivity** below.

In 2017, the 6-class climate change resilience overlay totals 385,470 acres within the Lakes Region study area, with about 140,800 acres, or about 36.5%, presently conserved.


N
Lakes Region Study Area
Water Features
CCR Overlay - 6 class
Conserved Land - 2017
Miles
0 2.5 5 10

The map below shows the relationship between the 6-class merged data and the Lakes Region conservation focus areas derived from the “shared vision” co-occurrence analysis and hot spots analysis.



Note the strong correlation between the Tier 1 and 2 CFA with the CCR overlay in most locations across the study area. This match-up points to an over-arching conservation plan strategy in the region where both datasets tend to leverage each other in terms of high-level priority.

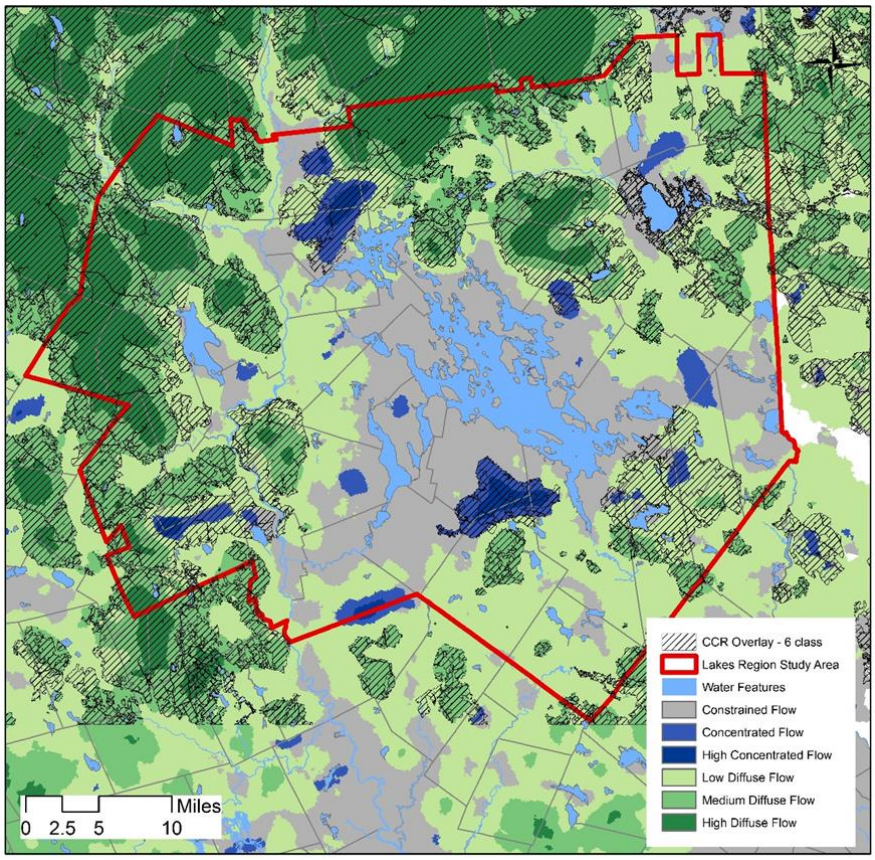
The 6-class CCR prioritization overlay provides a science-based, rational foundation for integrating climate change considerations into the Lakes Region plan. However, large gaps are evident in the mapping, raising concern for landscape-scale connectivity.

Granted, Lake Winnipesaukee and the developed land uses surrounding it act as barriers to connectivity, but the "island geography" of the overlay suggests corridors north and south, especially in the western portion of the study area, as well as more east/west into Maine and towards the NH Seacoast region.

Enhancing Connectivity

Regional Flows Analysis

An important component of the TNC 2016 climate change resilience study includes a distillation of regional flow patterns, working from the details developed in the analysis of **local connectedness**. The map below shows the regional flows data with the 6-class CCR prioritization data overlay.



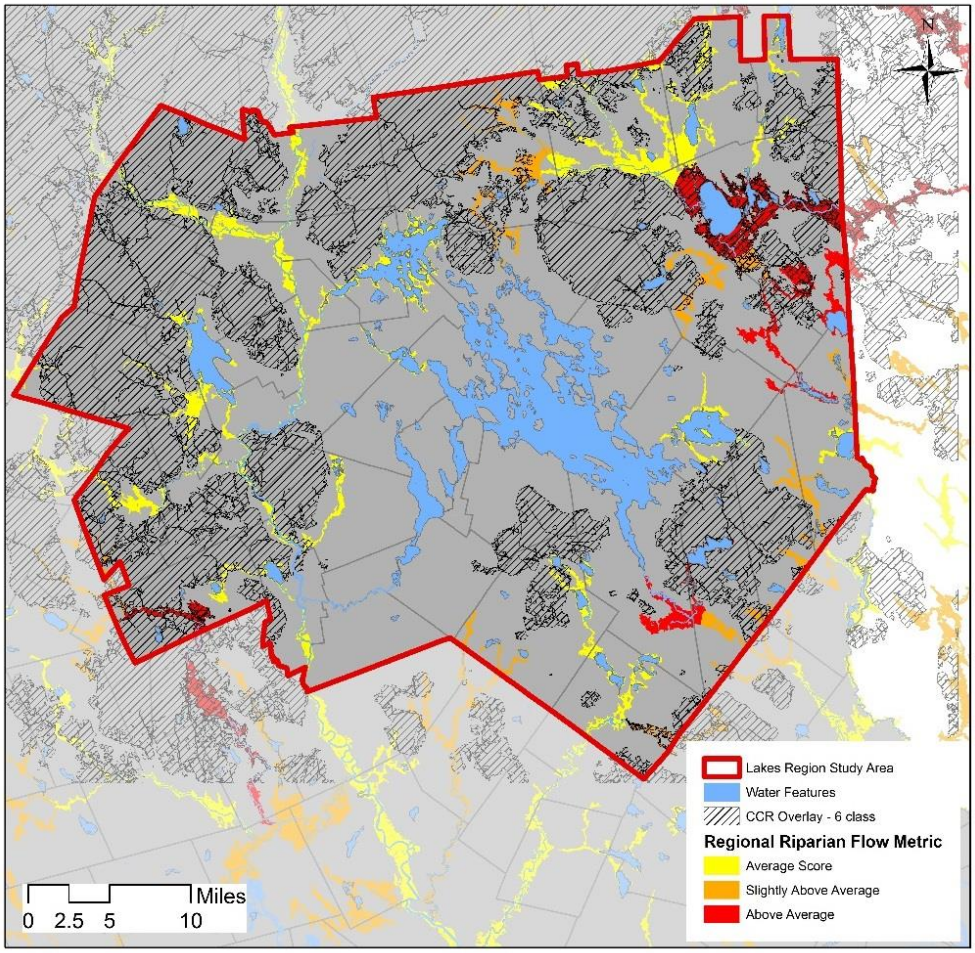
Parsing out the various classifications in the legend and comparing these to the 6-class overlay, various elements have more importance to enhancing CCR connectivity within the study area, as follows:

- Both **High Diffuse Flow** and **Medium Diffuse Flow** zones correlate strongly with the 6-class overlay zones. In fact, the fact that these two flow classes offer the best option for species movement due to climate change is already embraced in the original 8-Class Prioritization analysis by TNC.
- **Low Diffuse Flow** zones tend to fall outside the 6-class overlay with the significant exception of a large area centered on the Moose Mountain Range in the southeastern portion of the Lakes Region study area. Other, smaller areas of Low Diffuse Flow within the 6-class overlay can be found in the western portion of the study area around Newfound Lake and along the Maine border. Low Diffuse Flow zones offer the best option for regional connectivity among the "islands" of the 6-class overlay, but can be refined using forest blocks and TNC's riparian corridor data used in the 2016 study (see more detail below).
- **High Concentrated Flow** and **Concentrated Flow** zones occur in smaller, localized areas within the study area. Several of these flow zones fall within the 6-class overlay, but a few significant instances are outside the overlay and appear to be critical linkages in the total scheme. Examples of the latter include an east/west corridor along the Northfield/Canterbury town boundary in the south, another corridor traversing the northwest corner of Wolfeboro in the east, and another corridor north of Ossipee Lake. There are also three small "islands" in Bristol, Laconia, and Sanbornton in the west-central portion of the study area. Each of these concentrated flow zones can be thought of as "pinch points" in the CCR connectivity data, and should be elevated in importance in terms of crafting a well-connected CCR data array.

Riparian Corridor Analysis

Another key dataset of the TNC resilient and connected landscapes study focuses on the importance of broad riparian corridors as climate change movement vectors. The map below displays the Lakes Region riparian flow data, stratified by TNC by ecoregion and size, using the classification ratings that apply within the study area (there are only three classes; the far-above average class does not exist in the Lake Region, and all below average ratings are dropped in this map).

Note that the highest rating (above average in red) occurs in a 6-class overlay zone associated with the Ossipee Lake/Pine River linkage zone discussed earlier, but there are several areas in red outside the 6-class overlay. Two of these include the Branch River in Brookfield and Milton, and the South River drainage from Province Lake along the Maine border. Another is found along the Merrymeeting River in Alton and New Durham.



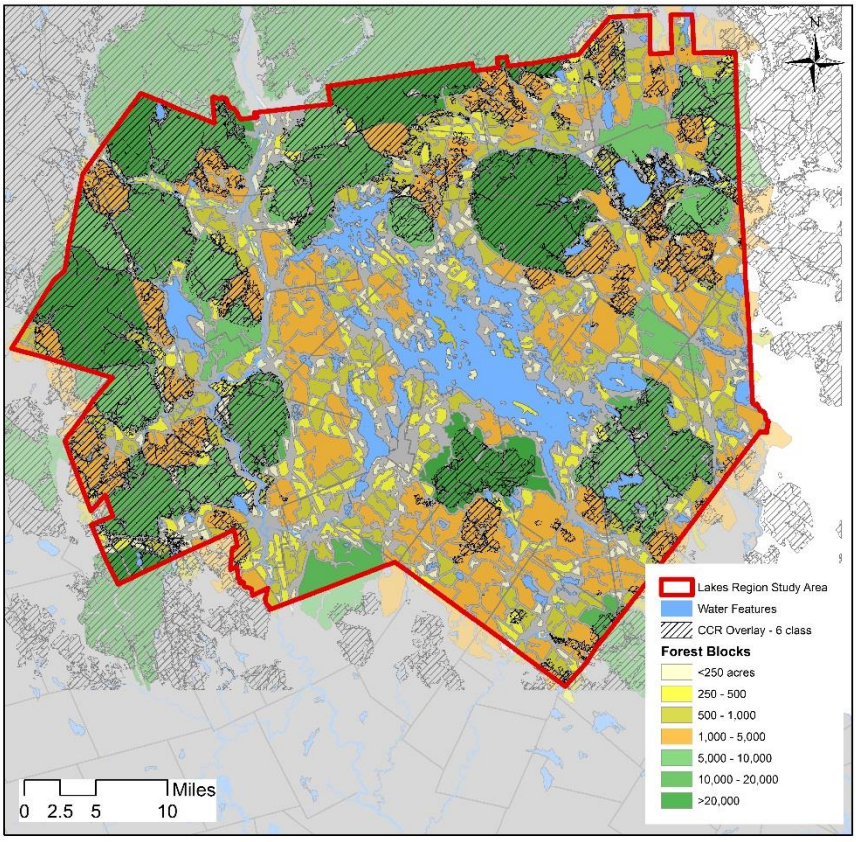
The average and slightly above average riparian flow ratings (yellow and orange, respectively) occur almost entirely outside the 6-class overlay, and suggest potential connectivity zones, especially when considered in conjunction with other data described in this section (see also discussion below on combining these data).

Forest Blocks Analysis

Large, contiguous blocks of forest land cover can provide ample natural open space for plant and animal species to migrate in response to climate change. The term "forest block" should be understood to include other, non-forest land cover embedded within the blocks, including wetlands, talus and ledge areas, and other small patch habitat features. Forest blocks in this study are defined by travelled roadways, large water features, and non-forest land cover such as agricultural and developed land uses.

The map below shows the current extent and distribution of forest blocks across the Lakes Region study area with the 6-class prioritization overlay. The size classification

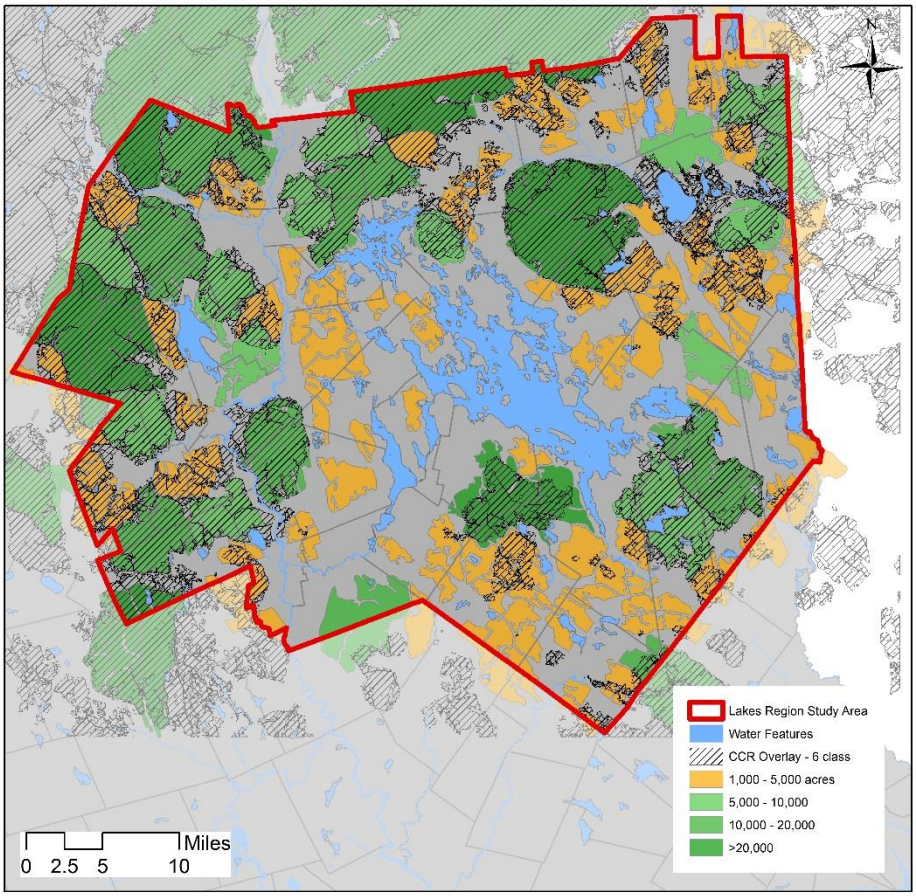
scheme is designed to reveal the patterns of both smaller and larger forest blocks, with the lower threshold being 50 to 250 acres. The map uses a split color scheme to show the pattern of the smaller forest blocks versus the larger acreages. The 1,000 to 5,000 acre blocks are shown in orange, and will be discussed later.



Note how the larger forest blocks (green) are closely correlated with the 6-class overlay data, except in a few locations near Ossipee Lake, along the Maine border, in the Newfound Lake region, and along the southern border of the study area. These "outlier" blocks are all larger than 5,000 acres in size, and correspond to the concentrated regional flows data discussed earlier. These large, outlier blocks could be included into the climate change resiliency overlay as "steppingstones" across areas, providing linkages not highlighted in the TNC CCR modeling of the 8-class prioritization dataset.

However, relying on forest blocks greater than 5,000 acres in size to fill "gaps" in connectivity does not generate seamless continuity at regional scale. Therefore, it is worth considering the 1,000 to 5,000 acre size class to help consolidate the features needed to strengthen continuity. These forest blocks are shown in orange in the next

map, along with the major structural patterns provided by forest blocks larger than 5,000 acres.



Note how the 1,000 to 5,000 acre blocks add potential connectivity to the 6-class overlay in many locations within the Lakes Region study area, especially west and east of the lakes, and south from the Belknap Range into the Seacoast region. They also correlate with the 6-class overlay features in several areas (black hatching over orange blocks).

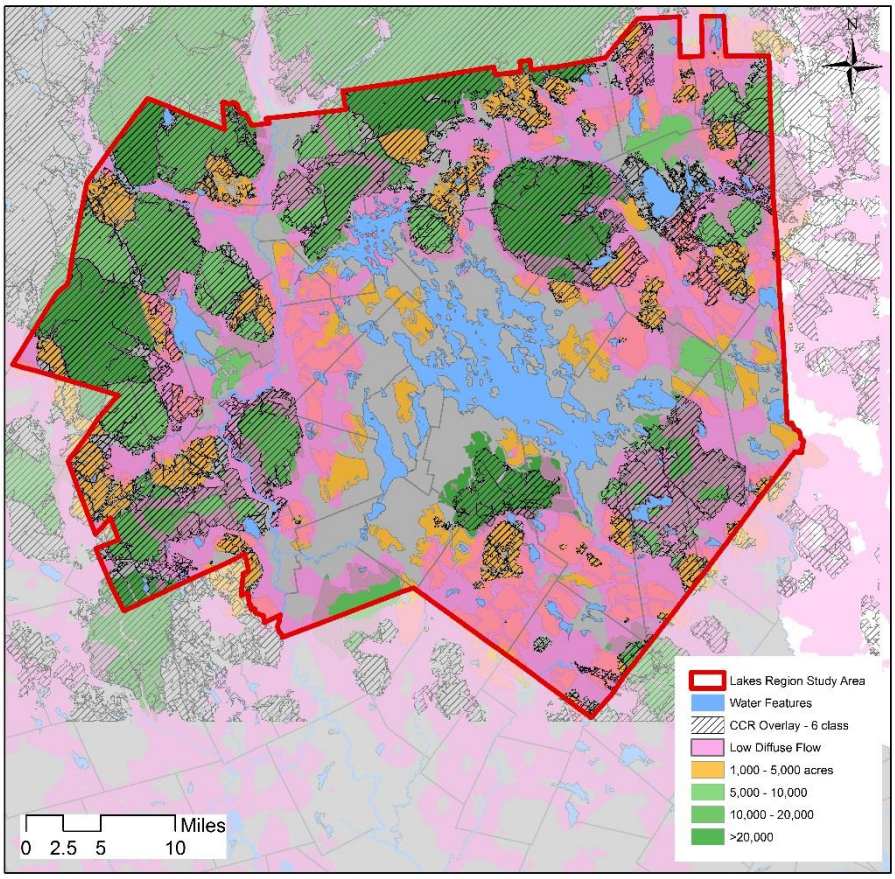
The average size of the 1,000 to 5,000 acres forest blocks is about 2,000 acres, and 49 blocks in this size class range from 2,000 to 5,000 acres, making these blocks more significant in terms of fostering ecological structure, function and processes.

Aggregation of Connectivity Features

It is tempting, given all the data discussed above, to simply aggregate all the features into an enhanced climate change resiliency overlay, with an emphasis on local or

regional connectivity, but "reverse engineering" the data by comparing it to the original 8-class prioritization dataset is worthwhile. Recall the **Low Diffuse Flows** element of the regional flows data discussed above; this feature tends to correlate with the **Resilient: Not Prioritized** areas of the original 8-class which were set aside in developing the more focused 6-class overlay.

The map below shows the forest blocks with the **Low Diffuse Flows** areas (pink) across the study area. Many of the forest blocks, or portions of them, occur within the low diffuse flows area; this is especially true west of the lakes, and in a broad swath of land extending from the White Mountain National Forest to the north, south and east through the Ossipee Range to the Moose Mountains Range, and south of the Belknap Range. However, there are significant land areas within forest blocks greater than 1,000 acres that extend beyond the Low Diffuse Flows zones.

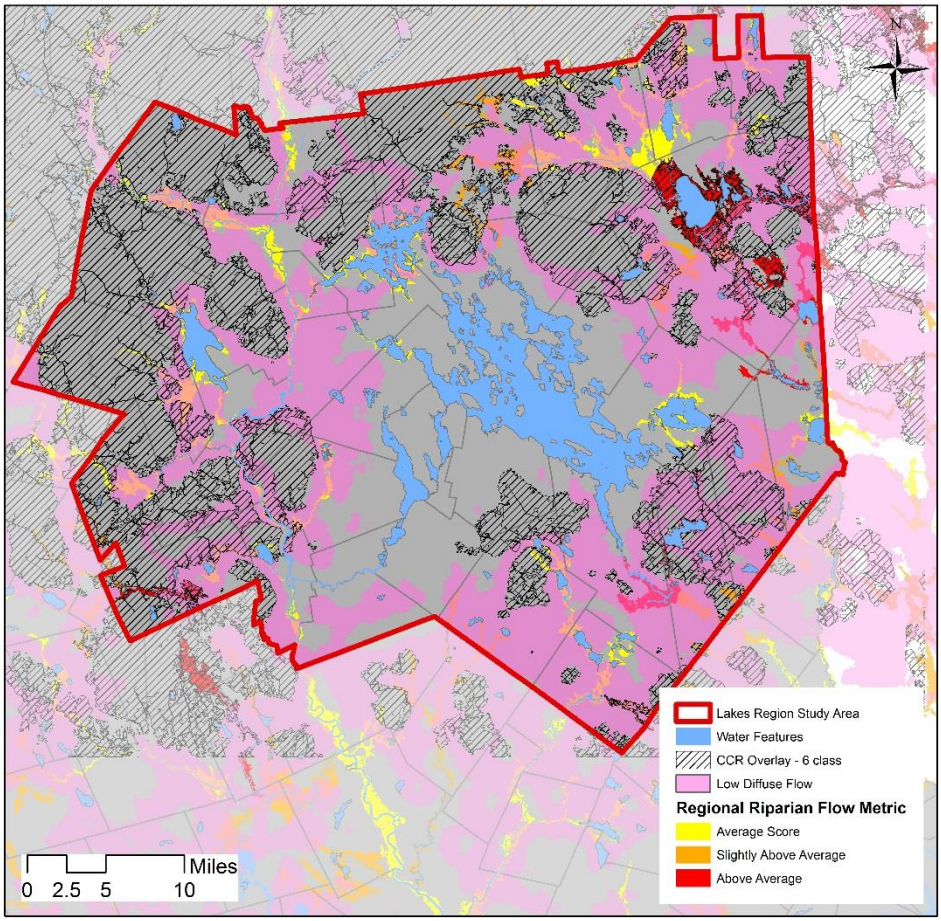


From a climate change resiliency perspective, it may be best to rely on the TNC low diffuse flows modeling, but retain the forest blocks data as a reference dataset since they are also important to the "shared vision" co-occurrence based conservation priorities of the Lakes Region conservation plan. **Thus, where large forest blocks occur**

in coincidence with the low diffuse flow zones, they should be elevated in land protection strategy.

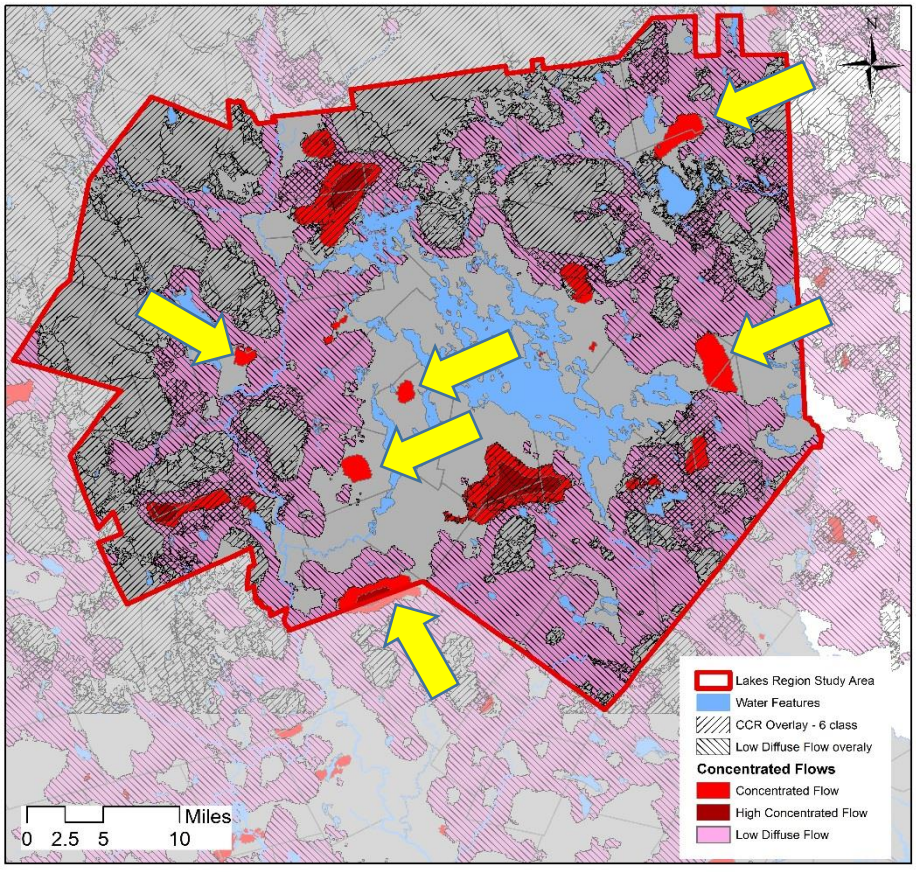
The TNC **riparian corridor zones** have a similar inside/outside relationship with the low diffuse zones, as shown in the following map. Note how some of the above average riparian areas (red) match elements of the 6-class overlay, as can be seen in the Ossipee Lake area, but others are outside that overlay (discussed in more detail previously). The other two riparian classes (slightly above average and average) also occur inside and outside the 6-class overlay; the most notable of those outside the overlay are seen north of Ossipee Lake, connecting to the large low diffuse flow area south of the White Mountain National Forest.

Since riparian zones are critical to the (home range) movement of many species, it is worth incorporating those areas into an enhanced connectivity scheme.



Finally, we need to return to the **Regional Flows** data to be sure critical connecting features are included in the master climate change resilience scheme for the Lakes Region. The map on the next page shows the combination of the 6-class overlay and the low diffuse flows zones along with the two Concentrated Flows classes taken from the regional flows data (red).

Several of these critical concentrated flow areas are already embedded within the 6-class overlay, as already noted, but several are outside both the 6-class and low diffuse flows (see yellow arrows in map). Three of these concentrated flow features appear to be critical to connectivity along the eastern third of the study area. Three others appear as isolated areas in the western third of the study area, and are not likely as important to connectivity but could be preserved in a master scheme.



Summary of Analysis

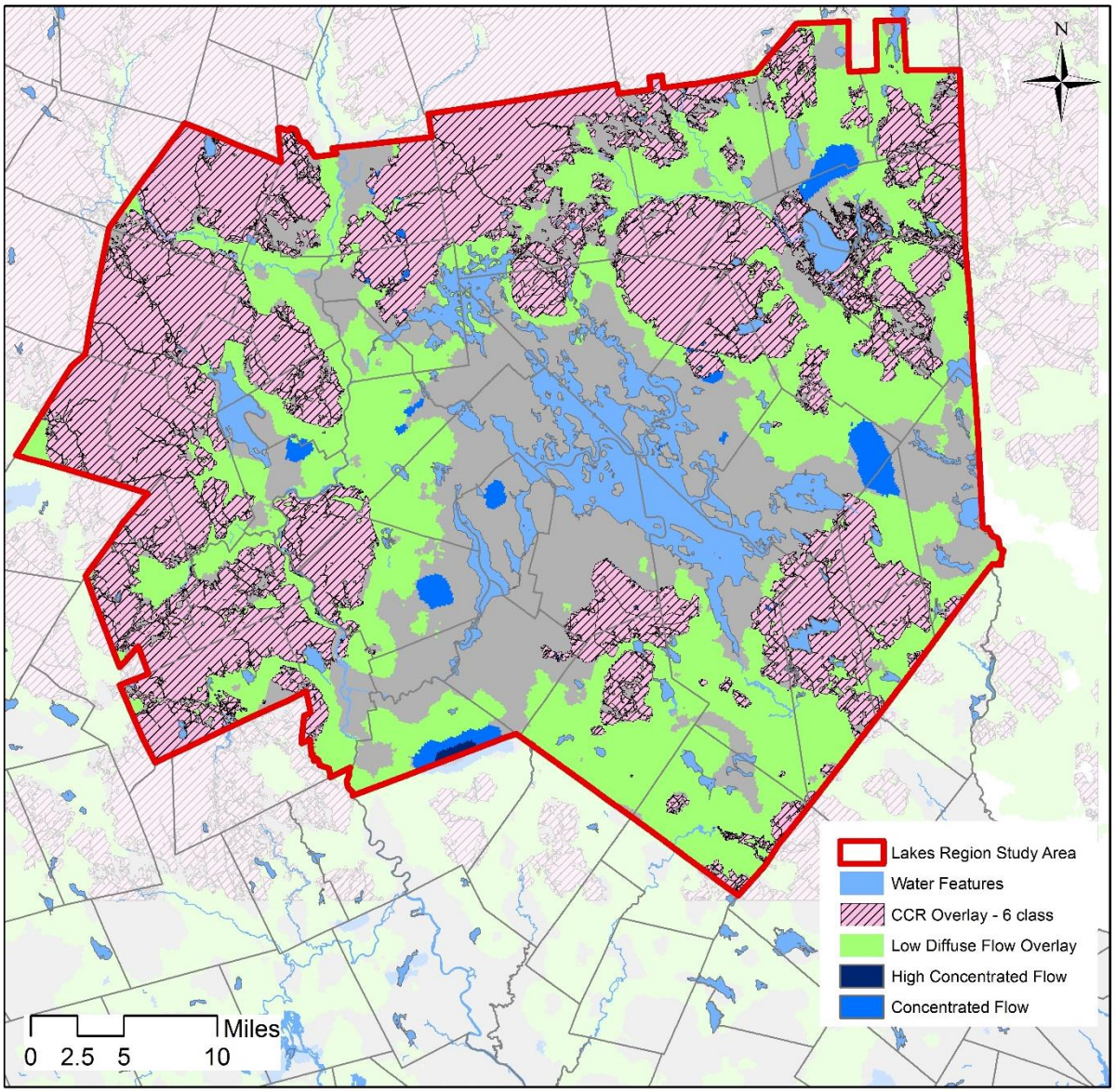
The following points can be concluded from this analysis:

- The 6-class CCR prioritization data provides a science-based foundation for a climate change resiliency overlay to be used in conjunction with the Lakes Region conservation focus areas which flow from the co-occurrence mapping and "shared vision" of conservation priorities of the partner organizations and agencies.
- Forest blocks data show that most of the more significant natural land cover blocks occur in areas of Low Diffuse Flows. Therefore, the low diffuse flows modeling of the 2016 TNC resilient and connected landscapes study will suffice as a secondary aspect of the 6-class overlay, providing strategic connectivity zones across the Lakes Region study area.
- TNC riparian corridors data from the 2016 study occur both inside and outside the 6-class overlay and the low diffuse flow zones. Those areas outside both features can be added as another secondary aspect of the 6-class overlay.
- Several critical concentrated flow zones occur outside the 6-class overlay and low diffuse zones, and three of those features provide linkages that do not occur in combinations of 6-class priorities, riparian corridors, or low diffuse flow areas. At a minimum, the three concentrated flow zones in the eastern third of the study area should be included with the final master climate change resiliency data.

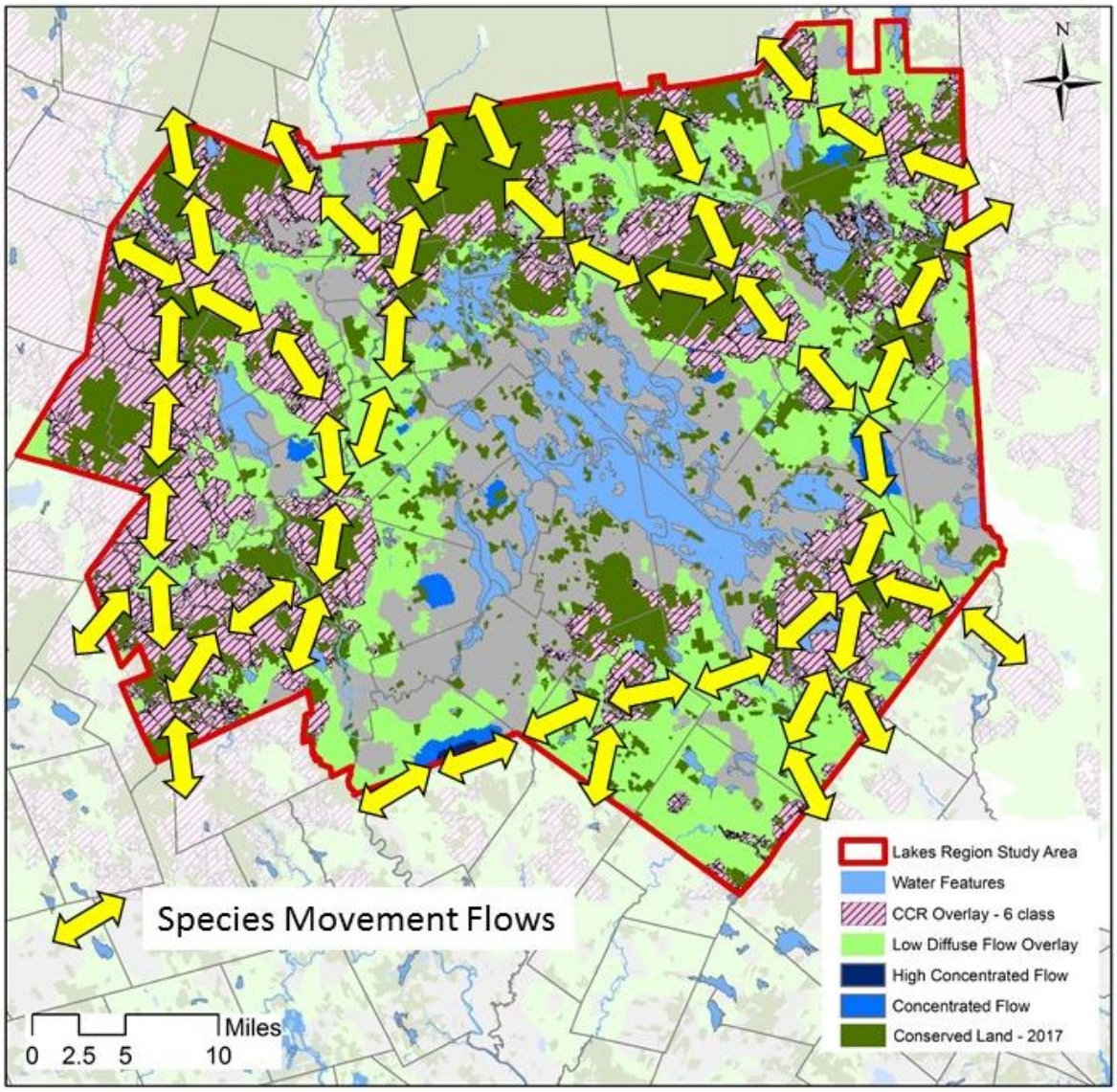
With these points in mind, the GIS advisory team considered whether to combine all these connectivity elements with the 6-class prioritization data in a single overlay to be used in conjunction with the co-occurrence-based conservation focus areas, or to possible classify the various datasets into tiers reflecting relative priority. After discussion among the GIS advisory team, it was decided to resolve all the climate change resilience and connectivity data into three inter-related components:

- The 6-classes of TNC prioritization data where the focus of conservation efforts will focus on retaining the integrity of those areas by preserving natural land cover as extensively as possible;
- The low diffuse flow zones where conservation priorities will focus on connectivity elements such as large forest blocks and TNC riparian flow zones, as well as keeping these relatively undeveloped areas in a natural condition; and,
- The concentrated flows zones outside the 6-class priority areas and outside the low diffuse flow zones, which are critical species movement "pinch points" that link various elements of the two components above.

The map below illustrates the final climate change resilience 3-component conservation priority scheme for the Lakes Region.



The next map shows the same CCR data, but with conservation and public lands overlaid to emphasize the areas that are not now protected. The yellow arrows are also added to highlight probable species movement patterns, and to aid in targeting future CCR-oriented conservation efforts in the region. The yellow arrows are placed with knowledge of the various connectivity elements discussed above, and with regard to the location of significant tracts of conserved land that serve as permanent anchor points in the total scheme.



Compare this map with the previous species movement map in the **Regional Context** sub-section above to understand how analyzing climate change resilience data and species flows at regional scale helps to augment the available CCR conservation strategies and to more precisely guide localized tactics and conservation targets.

Shoreland Conservation Zone

Background

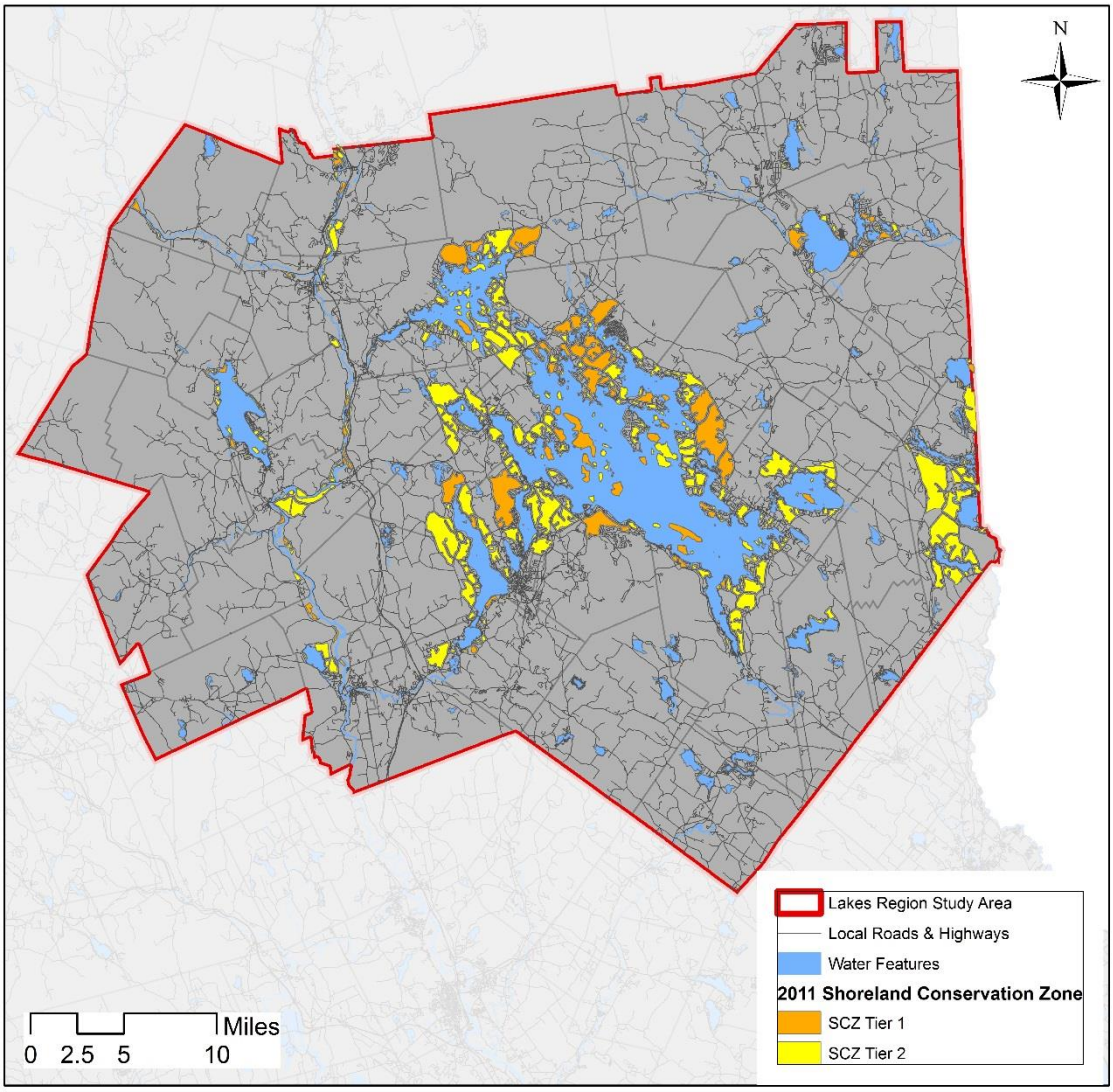
The 2011 Lakes Region Conservation Plan included a special adjunct to the core and supporting landscapes conservation focus areas termed the **Shoreland Conservation Zone**. This involved a number of forest blocks in close proximity to the major lakes and along rivers, selected to help identify conservation priorities close to shoreland areas. The reason for this was that the co-occurrence mapping at the time did not generate significant conservation focus areas in the heart of the Lakes Region, and concern was raised that conservation opportunities are known to exist close to the lakes in a number of undeveloped areas.

The strategy used in developing the 2011 shoreland conservation zone included:

- Forest blocks greater than 10 acres within 1,000 feet of lakes greater than 500 acres in size were selected as a framework for the zone;
- Blocks with core conservation focus areas were classified as Tier 1: High Priority;
- All other blocks were classified as Tier 2: Lower Priority; and,
- Supporting landscape blocks adjacent to rivers and certain lake and pond shorelines were added to the Tier 1 and 2 forest blocks.

See the discussion of the 2011 Lakes Region conservation focus area core area and supporting landscape areas in the **Introduction** of this report for more detail.

The 2011 shoreland conservation zone is shown in the map on the next page. Note the limited land area involved in this version of the shoreland conservation zone, closely clustered near the major lakes. It is comprised of 394 forest blocks ranging in size from 10 to about 1,880 acres in size, and totaling about 47,595 acres of land area. It is important to recognize that this array of forest blocks is a product of the complex protocol used for delineating forest blocks in the 2011 plan. As part of the 2017 update of the Lakes Region conservation plan, a new and enhanced version of the shoreland conservation zone has been generated, and is detailed in the following pages.



Refining the Shoreland Conservation Zone

In 2017, new and better natural resources data, particularly NHWAP habitat ranking and habitat type data, have allowed for improved characterization of significant ecological features within the forest block framework of the shoreland conservation zone. This, in turn, has helped to rank the forest blocks according to a new scheme based on the number of natural resource features found in each block.

The 2017 modeling of the shoreland conservation zone includes the following:

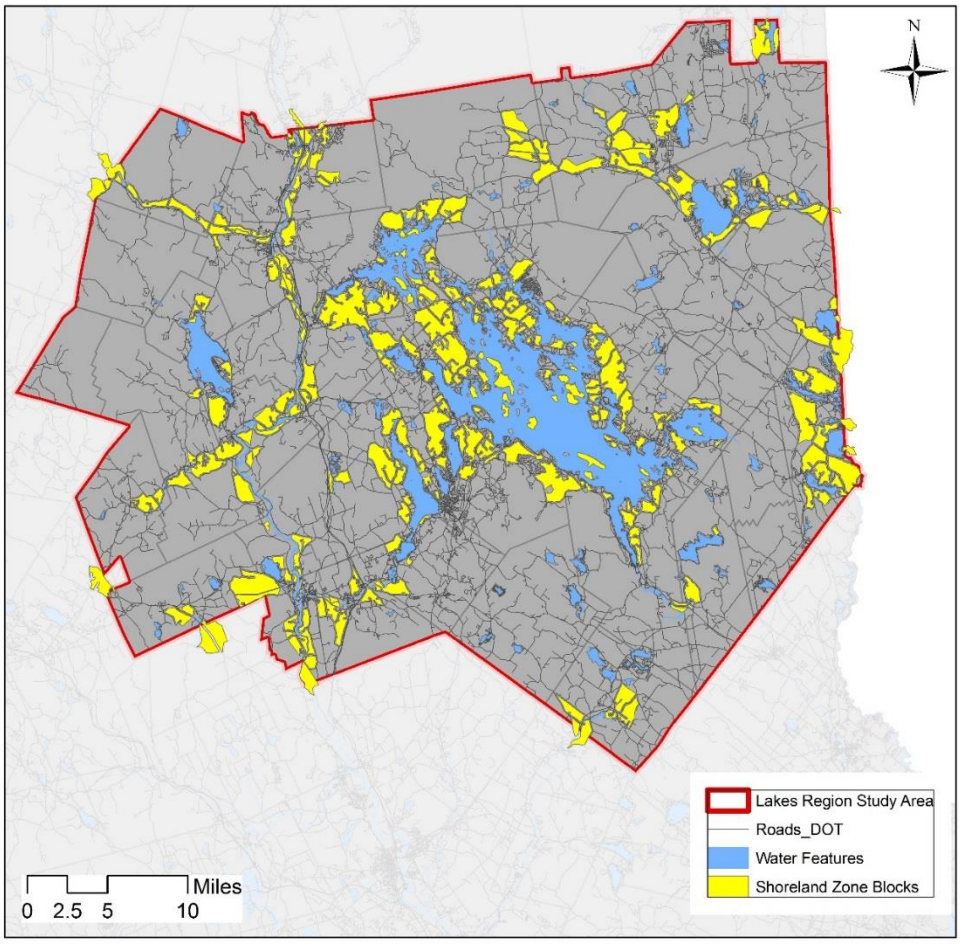
- **Forest blocks greater than 50 acres in size and within 1,000 feet of lakes greater than 500 acres or major river shorelines**[10] were selected as a base framework for the shoreland zone; the

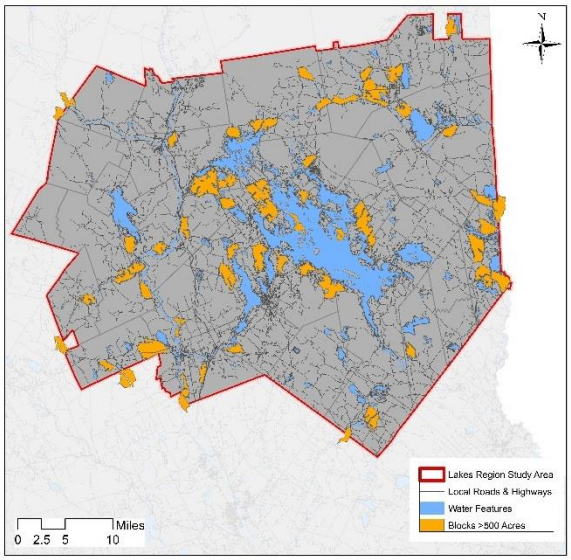
[10] Forest blocks that contain significant (more than 50% area) of Tier 1 and 2 CFA were culled from this selection even though part of the block is within the 1,000 proximity buffer of the lakes. However, several forest blocks ranging up to more than 3,000 acres that are close to lakes were retained, principally west and south of Lake Winnipesaukee.

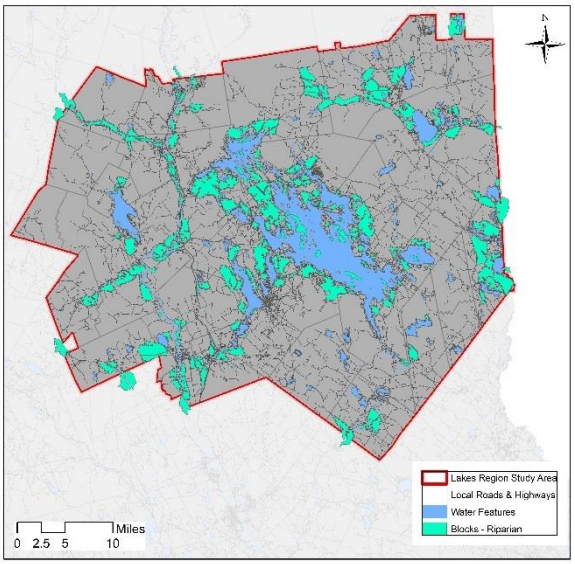
lower threshold of block size was raised to 50 acres from the 10 acres used in 2011 as a more efficient land protection criterion.

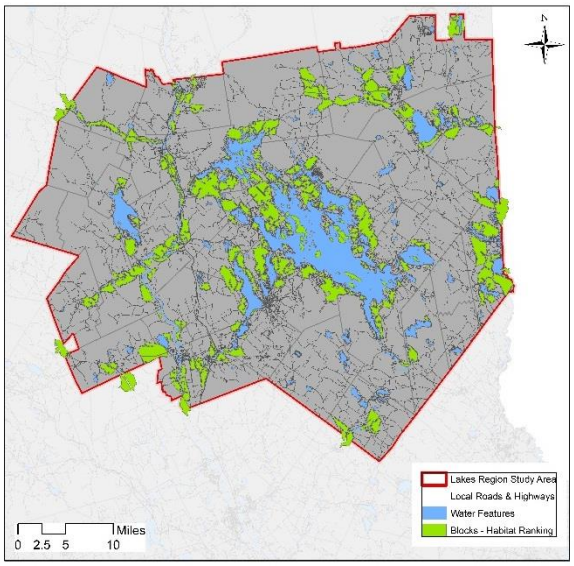
- Blocks with **riparian corridors** directly connected to the lakes or rivers were coded within the entire forest block framework; this elevates the importance of water quality which is the guiding principle of the Lakes Region plan.
- Blocks with NHWAP **habitat ranking** of Tier 1, 2, or 3 were similarly coded.
- Blocks with uncommon NHWAP **habitat types** were also coded; these habitat types include various wetlands (wet meadow, peatlands, northern swamps, etc.), grasslands, cliff and talus communities, as well as extensive floodplain forests and pitch pine barrens in the Ossipee region.
- Blocks including or adjacent to **existing protected lands** were coded, with the idea of expanding and linking conserved lands in these blocks.
- Blocks containing **2017 conservation focus areas of Tier 1 or 2** were coded.
- Blocks **greater than 500 acres** in size were also coded as more important to conserve since larger blocks help preserve ecological function, structure and processes.

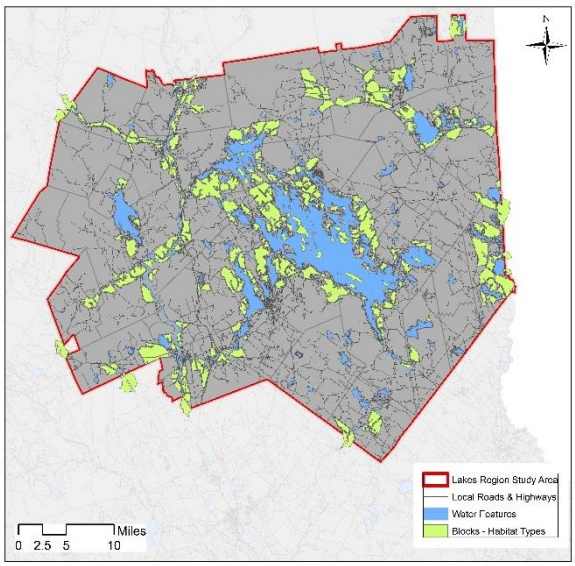
The map below shows the forest block framework developed for the 2017 Shoreland Conservation Zone, followed by a series of six maps highlighting (in blue) the blocks containing the above features.

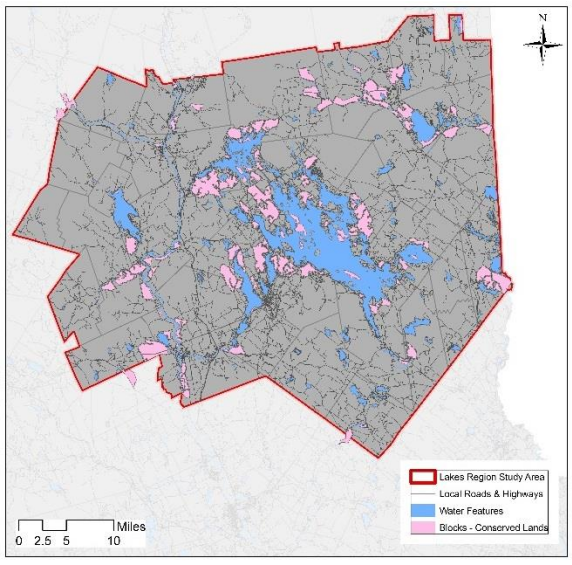


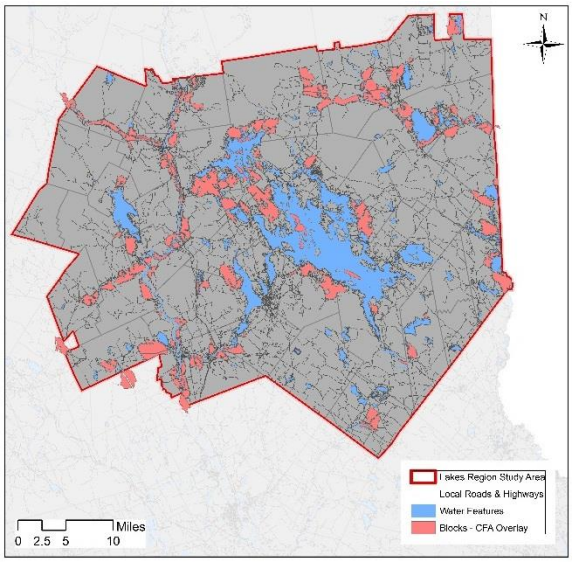

N
Lakes Region Study Area
Local Roads & Highways
Water Features
Blocks >500 Acres
Miles
0 2.5 5 10


N
Lakes Region Study Area
Local Roads & Highways
Water Features
Blocks - Riparian
Miles
0 2.5 5 10

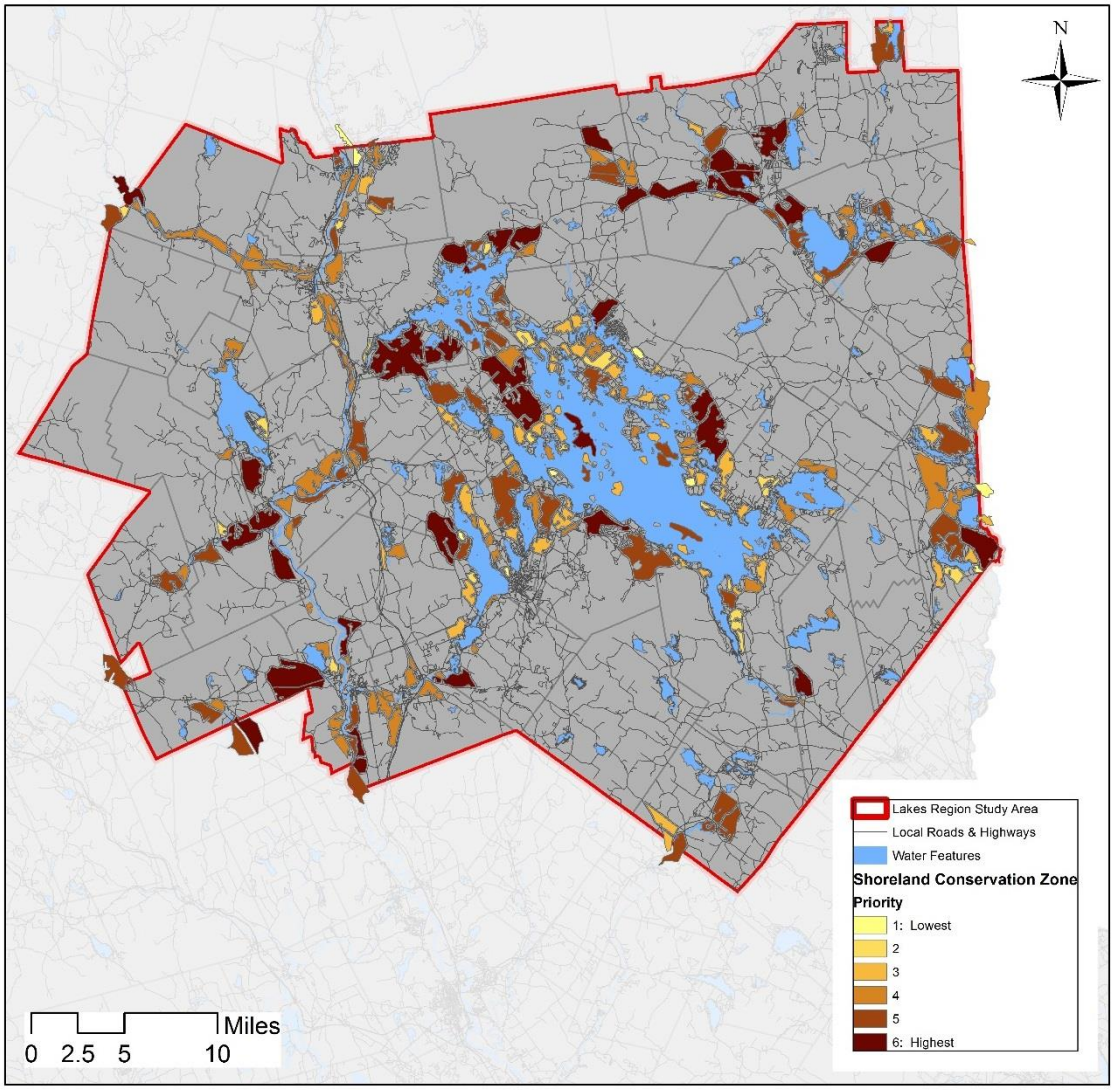

N
Lakes Region Study Area
Local Roads & Highways
Water Features
Blocks - Habitat Ranking
Miles
0 2.5 5 10


N
Lakes Region Study Area
Local Roads & Highways
Water Features
Blocks - Habitat Types
Miles
0 2.5 5 10


N
Lakes Region Study Area
Local Roads & Highways
Water Features
Blocks - Conserved Lands
Miles
0 2.5 5 10


N
Lakes Region Study Area
Local Roads & Highways
Water Features
Blocks - CFA Overlay
Miles
0 2.5 5 10

The coded blocks were then processed in the GIS to identify the number of aspects noted above contained within each block. The map below shows the shoreland conservation zone blocks classified from 1 to 6 where higher values reflect higher co-location of the modeling inputs by block (see bulleted list above).



Summary

Coupled with the modeling of the conservation focus areas from the hot spots analysis addressed in previous sections of this report, the 2017 approach to identifying and ranking forest blocks within the shoreland conservation zone has generated a more robust and useful scheme to guide land protection decision-making. The new shoreland zone contains 539 forest blocks covering about 256,200 acres. Some of that acreage involved small occurrences of the 2017 Tier 1 and 2 conservation focus areas, but for the most part there is little "double counting" between the CFA and the shoreland zone. With the new scheme, shoreland forest blocks are coded not only to reflect size value (>500 acres), but the presence of ecological significant features such as NHWAP habitat rankings and habitat types, riparian corridors leading to major water bodies, and proximity to existing conserved lands are also included in the characterization.

It is not possible within the scope of work for this update to develop a profile of these conservation-related values as attributes for the 539 blocks, but an ArcGIS map package focusing on the shoreland conservation zone does allow a GIS operator to examine individual blocks or clusters of blocks to learn why certain blocks rank higher than others.

Obviously, opportunistic land protection will take precedence in the shoreland conservation zone forest blocks. However, strategic land protection campaigns could be launched selectively in the larger and higher-scoring areas, or these blocks can be included in broader strategic campaign targets that include nearby areas of Tier 1 and 2 conservation focus areas in the 2017 Lakes Region conservation plan update.

Conclusion & Recommendations

Conclusion

The update of the Lakes Region Strategic Conservation Plan has been a major undertaking of many collaborators, with special thanks to the Lakes Region Conservation Trust who took on the project and convened the regional conservation partners to focus on improving the 2011 plan. This would not have happened were it not for the keen interest of the LRCT and its board members to see climate change addressed in the 2017 plan, and in turn it could not have happened without the state-of-the-art climate change science released by The Nature Conservancy's Eastern Regional Office in 2016.

It should be recognized that this effort to integrate climate change resilience into a regional land conservation plan is the first of its kind in New Hampshire at the time of this writing. Climate change data has been included in other recent conservation planning projects in the state, most notably in the development of the Moose Mountains Regional Greenways conservation action plan (2017), and in planning studies by the The Monadnock Conservancy. Of course, climate change is a major issue and strategic focus of The Nature Conservancy and relatedly, the NH Fish and Game Department's ongoing refinement of the NH Wildlife Action Plan. But this update of the Lakes Region plan is the first full-scale integration of climate change resilience science and data into a regional conservation plan in New Hampshire.

The Lakes Region plan update also provides a template for other regional plans that have used the natural resource co-occurrence model as a basis for developing a "shared vision" by a regional group of stakeholders. Historically, this approach has been the end product of the planning process once conservation focus areas are identified, and it has strong value in the way stakeholder perspectives and resource values are democratically incorporated into the plan. The update of the Lakes Region plan demonstrates how climate change resilience and connectivity data can be managed as a parallel track of critical conservation data in any conservation plan that seeks to serve both local importance values and climate change resilience.

Recommendations

It is worth posing a few recommendations here as part of the learning process that this project entailed, and considering next steps in implementing the plan.

1. **It must be recognized that the 2017 Lakes Region conservation plan is only a snapshot in time and needs to be periodically updated.** Key datasets such as the NH Wildlife Action Plan habitat types and habitat ranking are under constant study and refinement, and new data will become available that will change the complexion of co-occurrence mapping and therefore the delineation of conservation focus areas. The same is true of climate change resilience and connectivity data which The Nature Conservancy continues to refine. The next year or two will bring new insights and more detail at regional scale, so a provisional plan to further update the Lakes Region plan should be considered.
2. **An engagement and outreach plan for the updated Lakes Region conservation plan should be considered** to extend the effectiveness of the plan and to educate conservation partners and regional land use decision-makers about the importance of climate change resilience to conservation and community planning. The plan does little good filed away for reference; it needs to be put to work. Suggestions include:
    - Presentations at key conferences such as Saving Special Places and the autumn conference by the NH Association of Conservation Commissions;
    - Hosting local workshops with conservation partners in the Lakes Region;
    - Alliance with NH Cooperative Extension to help outreach the plan;
    - Transforming this report into a short (4-page) highlights-oriented, lay language flyer to be distributed widely as an educational effort; and,
    - Offering packaged web-based information, including this report, large format mapping, GIS map packages, and narrated Powerpoint presentations.
3. **Leading strategic conservation planning sessions with regional partners to focus strategically on key geographic areas**. The plan tends to draw attention to either or both the conservation focus areas and the climate change resilience priority zones, but this narrowed vision may be at odds with a subtle aspect of the climate change resilience data, viz., the importance of land protection in those locations that are still rural and natural, but subject to development in the near future. This is especially true in the Resilient: Not Prioritized (Low Diffuse Flows) areas identified in the TNC data. The potential for strategic conservation campaigns is as important as protecting key tracts in the conservation focus areas or the higher priority climate change resilience zones.
4. **Celebrate the success of the 2017 Lakes Region plan in communicating recent and future land protection projects.** This pertains to both the conservation focus areas (the regional "shared vision") as well as climate change resilience. The Spencer Creek/Beebe River project in Campton and the recent Kimball Hill project in Groton are recent success stories in this regard. Each conservation partner in the Lakes Region might also consider developing an organizational "score card" of its past land protection projects in light of the new plan.