Vermont Land Trust

Forest Project Prospecting: Developing a GIS Model to Identify Conservation Priorities

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Productivity Inputs

- **Elevation**
- **Landforms**
- **USDA Plant Hardiness Zones**
- **Geology**
  - **Bedrock – Surficial Union**

Formula: ([Landforms] * 0.3) + ([Elevation] * 0.2) + ([Geology] * 0.4) + ([USDA Hardiness Zones] * 0.1)

Other Inputs

- **Development Pressures**
  - **Town Population Growth (1990-2004)**
  - **Building Density**
  - **Town Average Parcel Size**
- **Proximity to Conserved Lands**
- **Slope**
- **Forest Contiguity/Fragmentation Measure**
- **Adjusted County Harvest**
  - **County Harvest per Forested Acre**
  - **Conserved Lands Protection Level**

Formula: ([Development Pressures] * 0.375) + ([Distance to Cons. Land] * 0.125) + ([Forest Fragmentation Measure] * 0.125) + ([Slope] * 0.2) + ([Adjusted County Harvest] * 0.175)

Biology Inputs

- **Tier One**
  - **TNC Matrix Blocks**
  - **TNC Portfolio Sites**
- **Tier Two**
  - **Non-game and Natural Heritage**
  - **Priority Aquatic Features**
  - **Clayplain Forest**
- **Tier Three**
  - **Representative Landscapes**
  - **Complementary Landscapes**

Formula: ([TNC Matrix Blocks] * 0.25) + ([TNC Portfolio Sites] * 0.25) + ([NNHP] * 0.125) + ([Priority Aquatic Features] * 0.125) + ([Clayplain Forest] * 0.125) + ([Complementary Landscapes] * 0.0625) + ([Representative Landscapes] * 0.0625) + [Forested Areas]

All Inputs Formula:

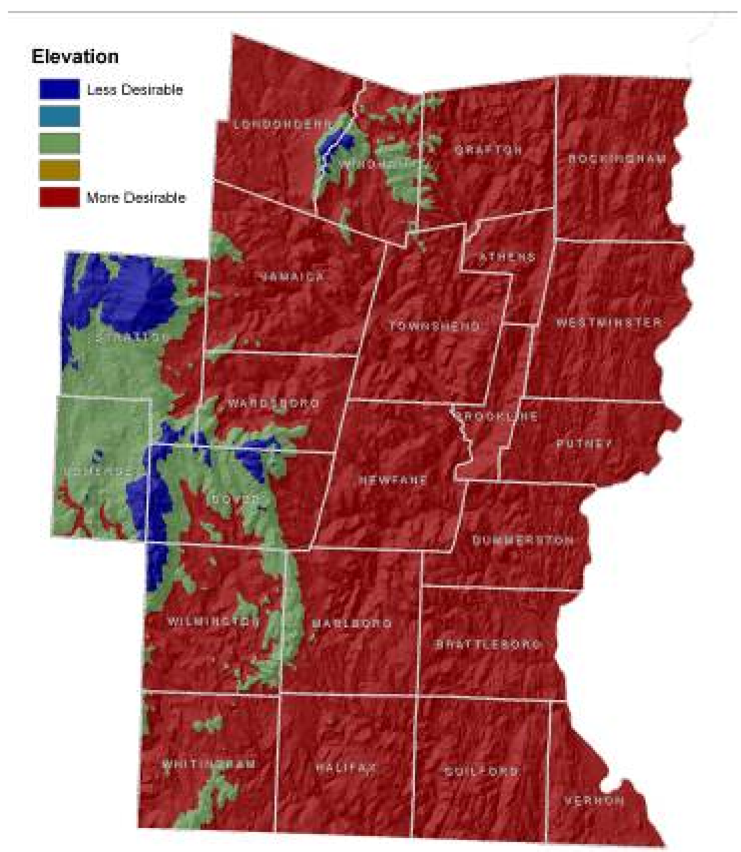
([Productivity Layer] * 0.5) + ([Other Inputs Layer] * 0.375) + (Biology Layer] * 0.125)

Forest Cover
The State of Vermont contains about 6.1 million acres, including about 200,000 acres covered by lakes and ponds. Using land cover/land use data developed by UVM using 1994 and 2002 Landsat Thematic Mapper 30 meter satellite imagery and National Land Cover Data, we calculate that 4.5 million acres, or 76%, of the land in Vermont as being forested. Windham County, with approximately 420,000 acres, is 82% forested.

Elevation
Recognizing that elevation influences natural community types and productivity, lower elevations were weighted more heavily than higher elevations. Generally following the transition zones of natural communities, the elevation breaks are as follows:

Elevation	Weight
70’ - 1,950’	5
1,950’- 2,500’	4
> 2,500’	3

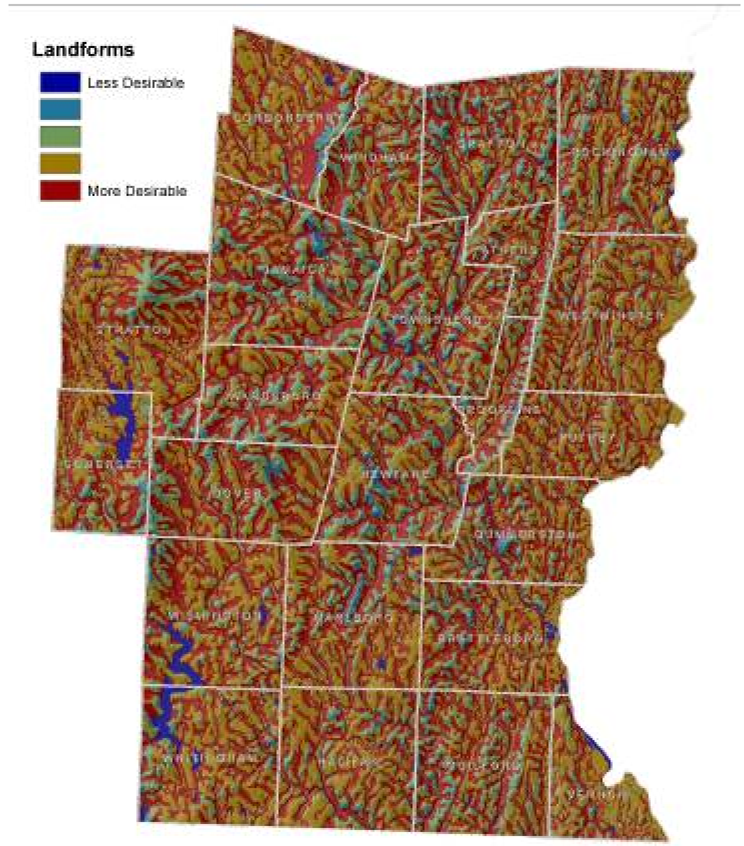
Eighty-eight percent of Vermont is below 1,950 feet. Ninety-seven percent of Vermont is below 2,500 feet.



Landforms

A site's position in the landscape, whether it is perched on top of a steep ridge, or nestled at the bottom a toe slope, influences nutrient availability, and therefore productivity. Working from a digital elevation model, UVM identified 16 distinct landforms. Ranking, in terms of forest productivity, is as follows:

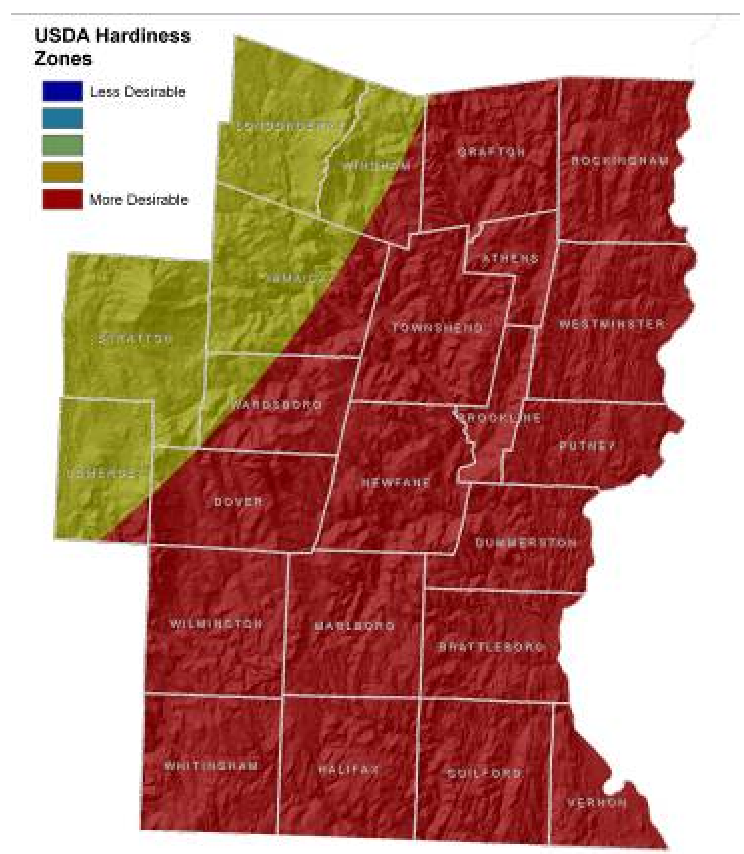
Landform	Weight
Valley or toe slope; lower side slope/gentle draw; cove; flat in valley; bench	5
Slight convexity; low rounded summit/ridge; flats	4
Flat summit/ridge top; wetland; sloped crest; upper side slope/rounded ridge	3
Steep slope; slope crest/ ridge; moderately steep	2
Water, cliff	0



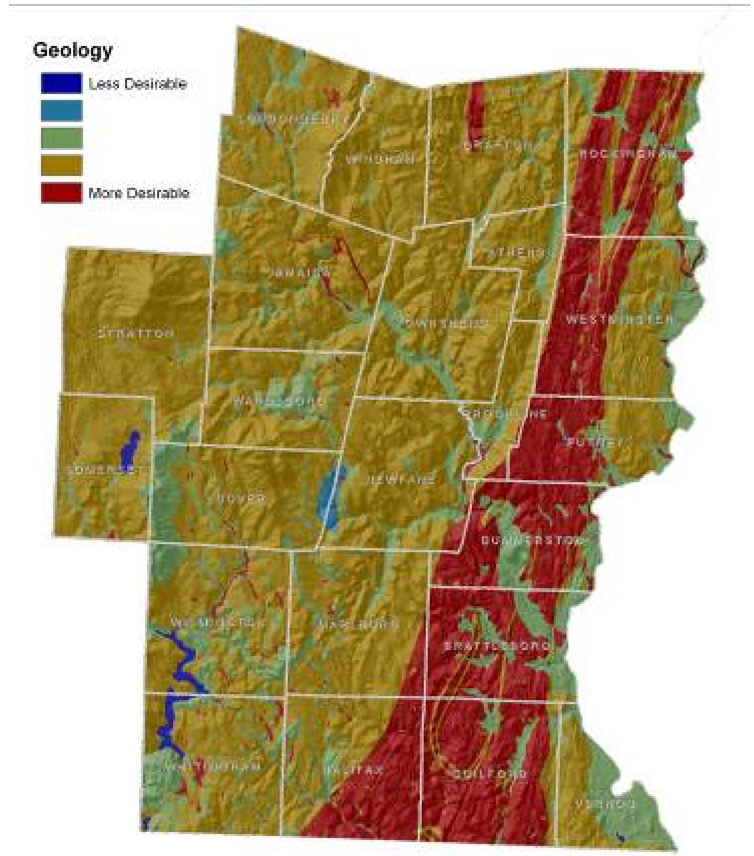
USDA Hardiness Zones

Climate, more specifically temperature and growing season, affects species distribution and productivity. Four zones cover Vermont, ranging from Zone 3b in the northeast (avg. annual min. temp of -30 to -35° F) to Zone 5a in the south (avg. annual min. temp of -15 to -20° F). Obviously, this data is much coarser than other inputs, but combining Hardiness Zones with Elevation and Landforms captures, to some degree, the effect of microclimates on productivity. Hardiness Zones are weighted as follows:

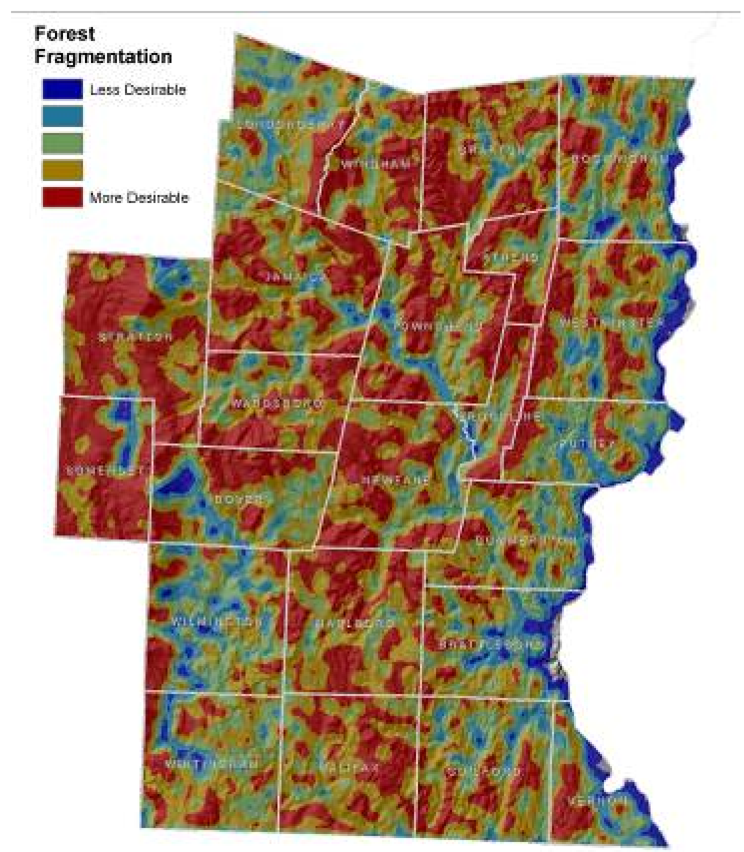
Hardiness Zones	Weight
5a (-15 to -20° F)	5
4b (-20 to -25° F)	4
4a (-25 to -30° F)	3
3b (-30 to -35° F)	2



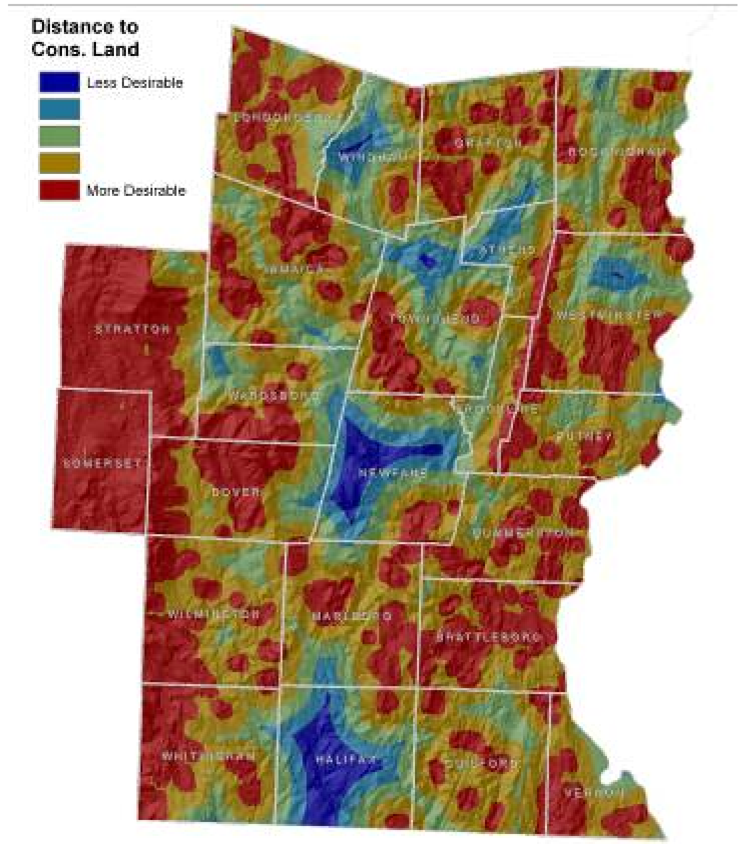
Geology
Soils, and the underlying bedrock geology, play a large role in the productivity of a site. Where close to the surface, a carbonate-rich bedrock like limestone, can have a positive influence on productivity. On the other hand, where surficial deposits of clay, silt, sand or gravel are thick, they essentially mask the effects of the underlying bedrock. Lacking statewide detailed soils data, we combined available bedrock geology data with surficial geology data, creating 94 unique combinations. The cumulative effects on productivity for each combination of bedrock and surficial geology were considered, and weighted accordingly.



Forest Fragmentation
Based on the assumption that bigger is better, and that large contiguous forest blocks are more likely to contribute, for the long term, to a productive working landscape than small 'patchwork' islands of forest surrounded by agriculture and developed areas. Additionally, large forest blocks tend to be less expensive per acre than more fragmented blocks closer to development pressures. The Forest Fragmentation input is created using a neighborhood analysis. Each forested pixel counts all the other forested pixels in its vicinity, or neighborhood. Areas with the highest totals are part of a less fragmented landscape, and are weighted more.



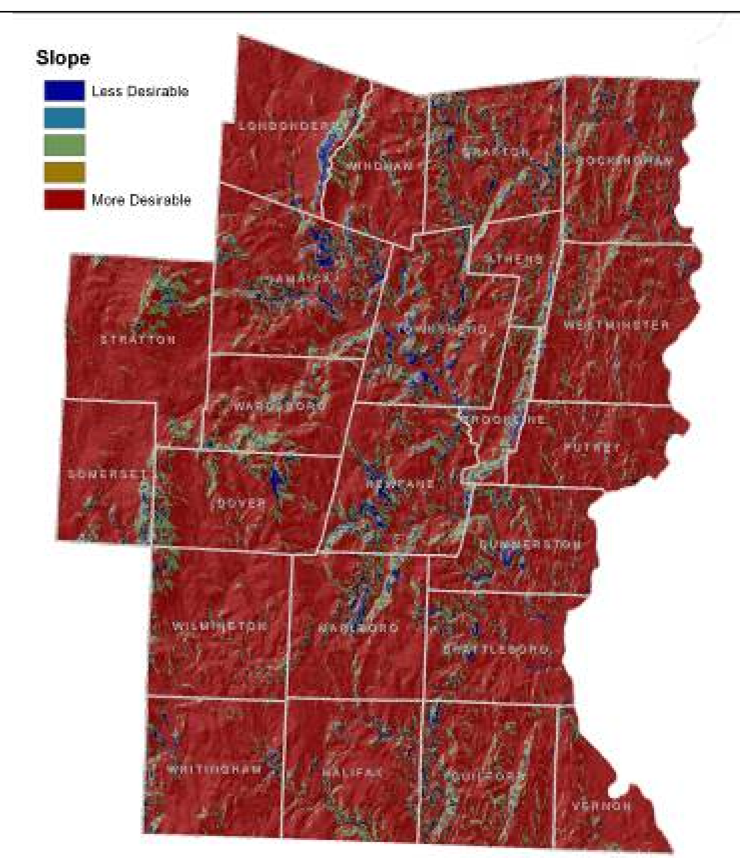
Proximity to Conserved Lands
Recognizing that development leads to fragmentation and an increased likelihood of abutter conflict, we weighted areas closest to publicly and privately conserved lands more than areas with little, if any conserved land. Building large blocks of conserved land maximizes the area to perimeter ratio, reducing the number of potential abutters. Large blocks of forest that will stay in production for the long term, may also provide some stability for the local forest economy.



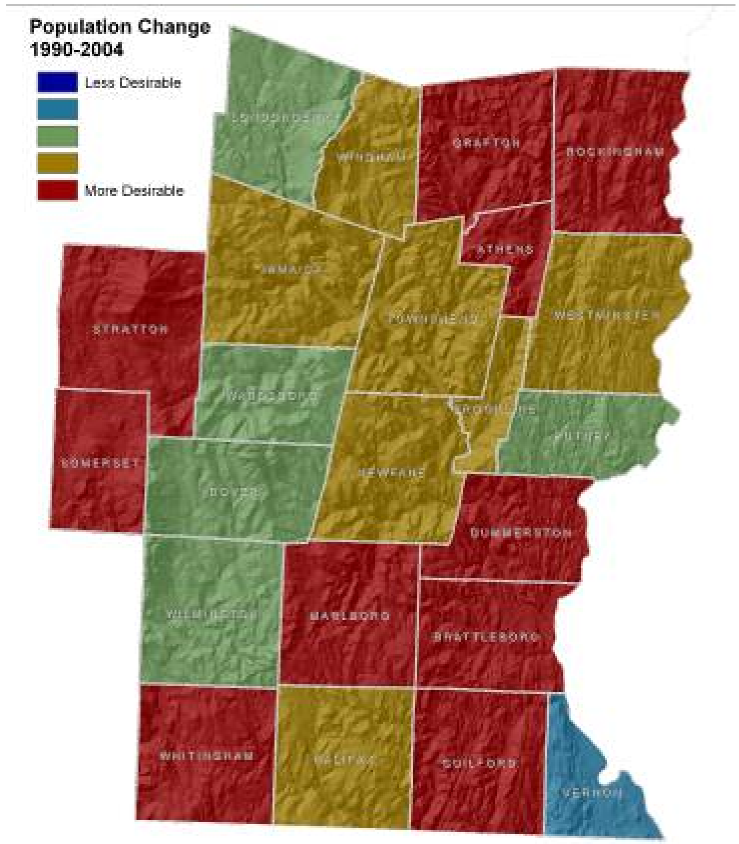
Slope
Slope is one of the main factors in determining whether a logging a site is physically and economically feasible. Slope classes are weighted as follows:

Slope (Percent)	Weight
0 - 25	5
25 - 40	3
> 40	1

Eighty-two percent of the state is less than 25 percent slope. Ninety-six percent of the state is less than 40 percent slope.

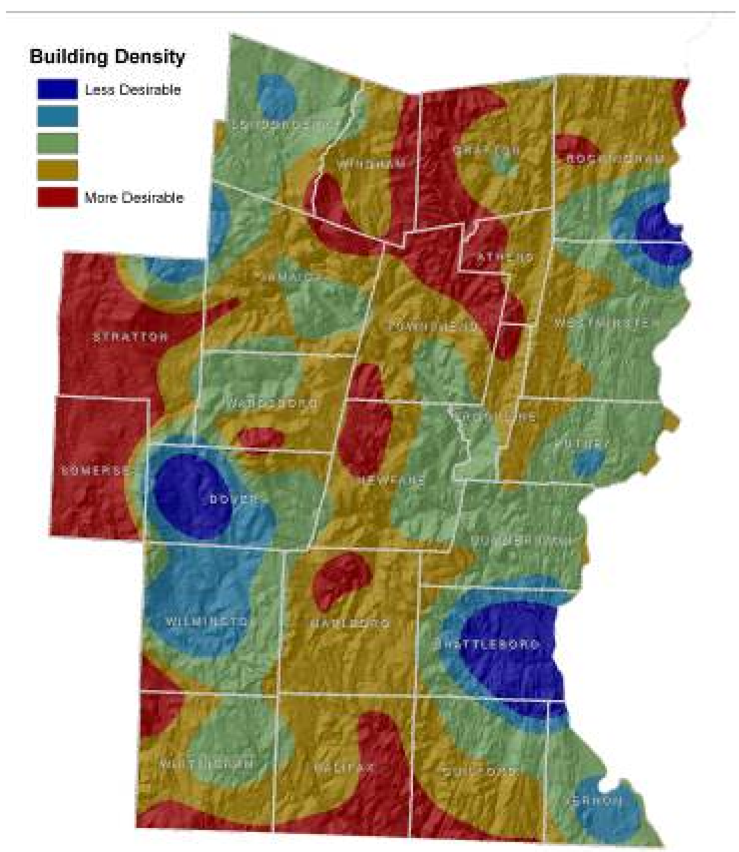


Population Change
Simply put, more people translates into increased development pressure on the forest land base. We looked at population growth per acre by town from 1990 to 2004. Growth rates ranged widely, with a general trend of population declines in traditional population centers like Burlington, Rutland, Brattleboro and Bennington and population increases in so-called ‘bedroom communities,’ areas within commuting distance of population centers, like Hinesburg, Hubbardton, Putney and Shaftsbury. Towns with lower population growth per acre from 1990-2004 were weighted more.



Building Density
Similar to average parcel size and population growth, building density is an indicator of development pressure on the forest land base and the forest economy. As the number of buildings in an area increases, the cost of owning and operating in the area are also likely to increase. Along with more buildings, whether they are a primary residence, second home, or even a seasonal cottage or camp, comes the increased likelihood of abutter conflict. Complaints from neighbors not accustomed to log trucks and skidders are likely to send most timber investors to more rural areas over time. Areas were weighted as follows:

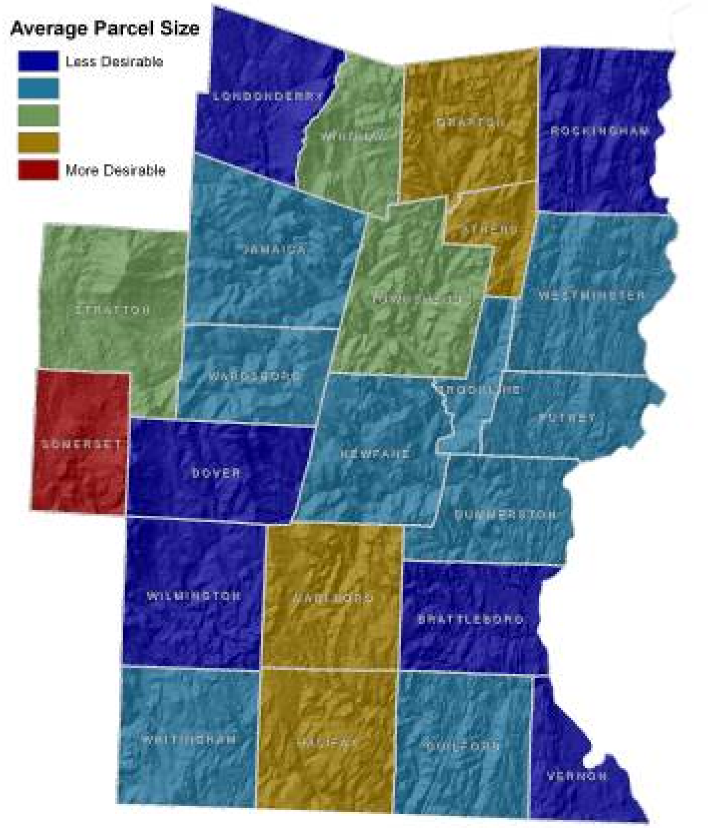
Buildings/km^2	Weight
0-5	5
5-10	4
10-20	3
20-40	2
> 40	1



Average Parcel Size

Related to population growth and building density, average parcel size is an indicator of development trends. Decreases in average parcel size translate into decreases in forest cover. Analyzing each town's Grand List, we found average parcel sizes ranging from a third of an acre in Rutland to over 5,800 acres in Averys Gore. Towns with larger average parcel sizes were weighted more. The complete weighting scheme is as follows:

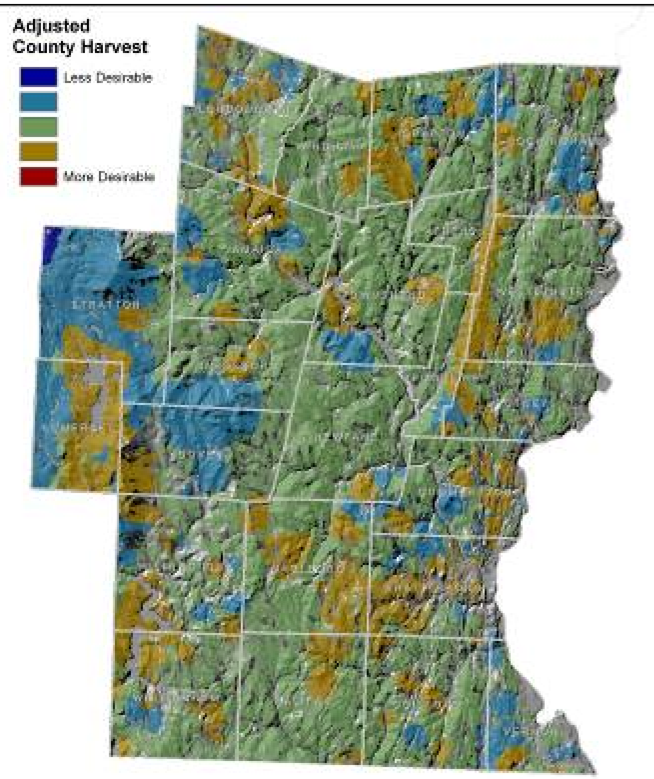
Average Parcel Size (acres)	Weight
>45	5
35-45	4
25-35	3
15-25	2
0-15	1



Adjusted County Harvest

We started with the available harvest data, then calculated the harvest per forested acre for each county, yielding the following results:

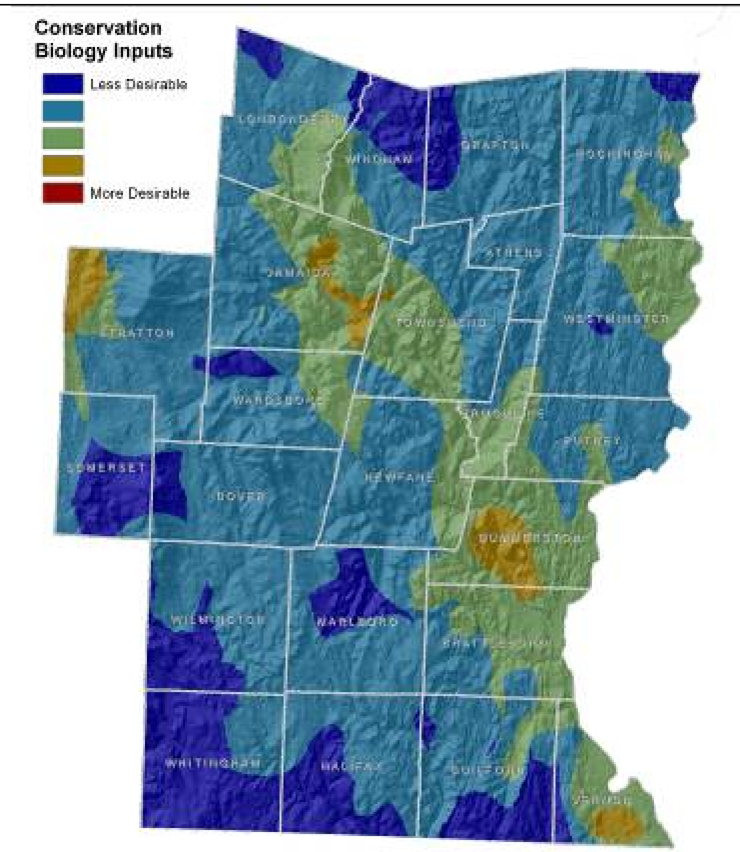
County	Cords/Forest Acre	Rank
Caledonia	0.351	1
Essex	0.341	2
Orleans	0.331	3
Orange	0.279	4
Lamoille	0.231	5
Franklin/GI	0.196	6
Windsor	0.173	7
Rutland	0.146	T-8
Washington	0.146	T-8
Windham	0.135	10
Addison	0.102	11
Bennington	0.100	12



Harvest amounts were then re-allocated within each county based on the amount, and protection level of conserved lands. Federal Wilderness Areas, or designated State Natural Areas do not contribute to county harvest totals. Conversely, other conserved lands, like those protected by a Forest Legacy Easement, or a VLT 'working forest' most likely contribute more than the county average.

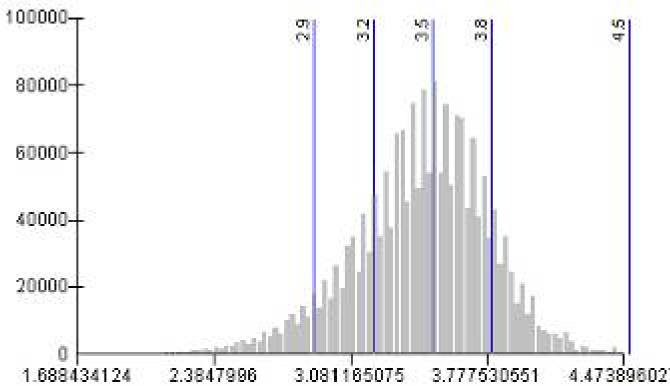
Conservation Biology Inputs

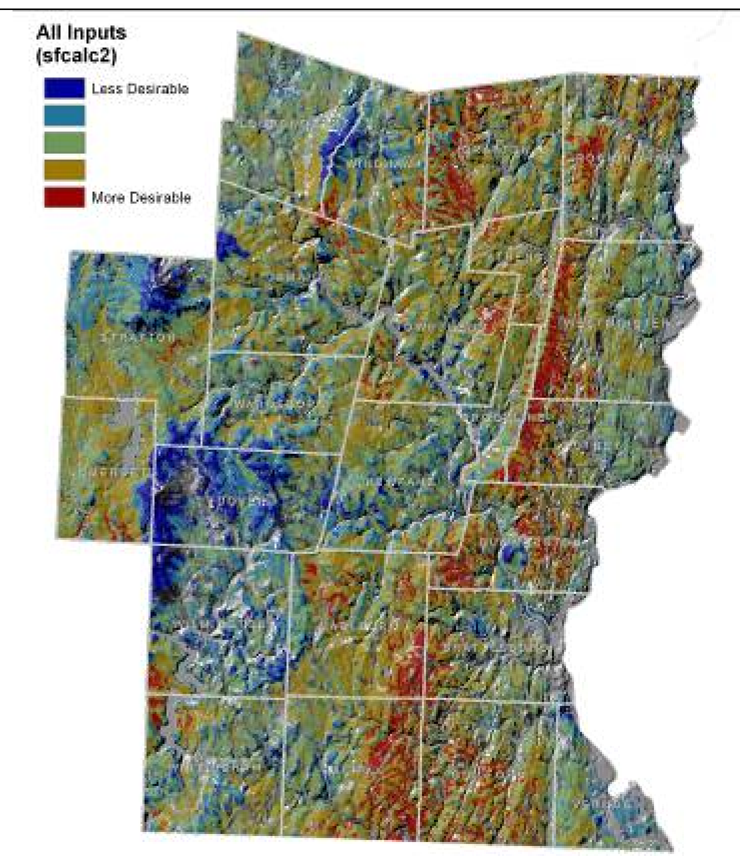
Used as input to the model, or as a separate ancillary data layer, the conservation biology layer can be used to target those large forest blocks that also include significant ecological features. The input layer depicted here is the cumulative result of adding all the individual conservation biology inputs, which include; TNC Matrix Blocks, TNC Portfolio Sites, Non-game and Natural Heritage Sites, Priority Aquatic Features; Representative Landscapes and Complementary Landscapes.



Total Weighted Scores

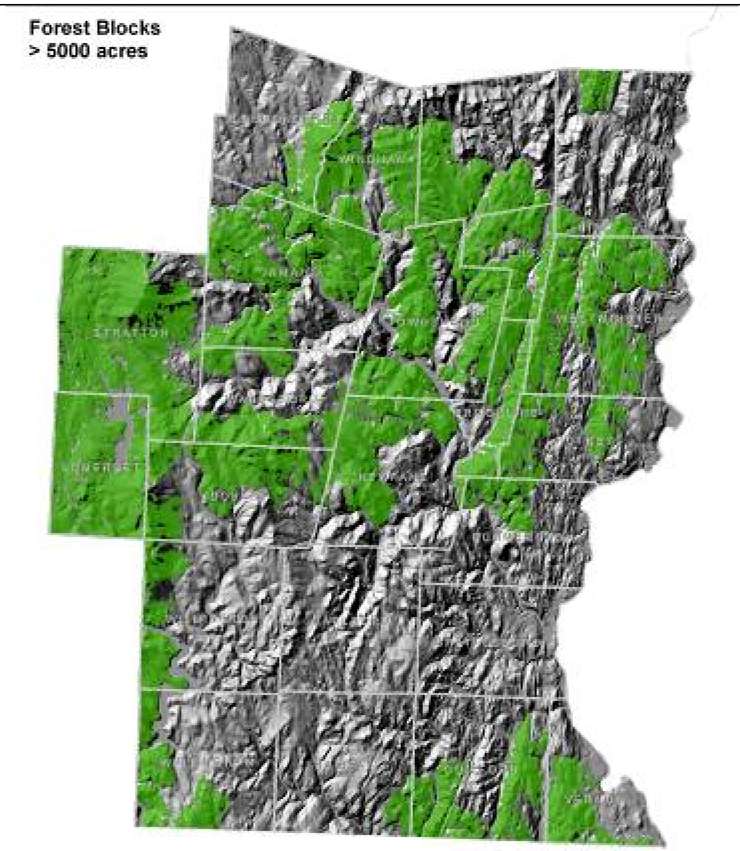
Using the following formula, *([Productivity Layer] * 0.5) + ([Other Inputs Layer] * 0.375) + (Biology Layer] * 0.125,* to weight each of the main input layers, every forested pixel is assigned a final score. The average score, statewide, is 3.45, minimum score is 1.69 and the maximum score is 4.47, and distribution follows a typical bell curve.





Forest Blocks
Using the Forest Cover layer, we can create areas of contiguous forest, or blocks, that can be analyzed individually or collectively. Defined in most cases by roads, the blocks range in size from just a few acres up to a block on the former Champion lands of 139,000 acres. Statewide, there are almost 575 forest blocks that are over 1,000 acres. By establishing a acreage threshold, in this case 5000 acres, we can begin to narrow our focus. Additional block size and counts are:

Forest Block Size (acres)	Count
>1,000	574
>2,000	299
>5,000	118
>10,000	64
>50,000	10
>100,000	2



Forest Block Weighted Scores
Combining an acreage threshold, again using 5,000 acres, with the average Total Weighted Score for each forest block begins to identify priorities at the county, regional, and state level.