Thank you to our sponsor!

51st New Hampshire Association of Conservation Commissions Annual Business Meeting
November 6, 2021

NH WILDLIFE CORRIDORS

Sandra Houghton
Nongame & Endangered Wildlife Program
New Hampshire Fish and Game Department

Katie Callahan
GIS Coordinator
DoIT-NH Fish and Game Department

WILDLIFE CORRIDOR

A habitat linkage that joins 2 or more areas of wildlife habitat, allowing for fish passage or the movement of wildlife from one area to another.

RSA 207:1 XXXVI.






Habitat Stronghold

Habitat stronghold: A high-quality habitat that supports the ability of wildlife to be more resilient to increasing pressures on species due to climate change and land development.

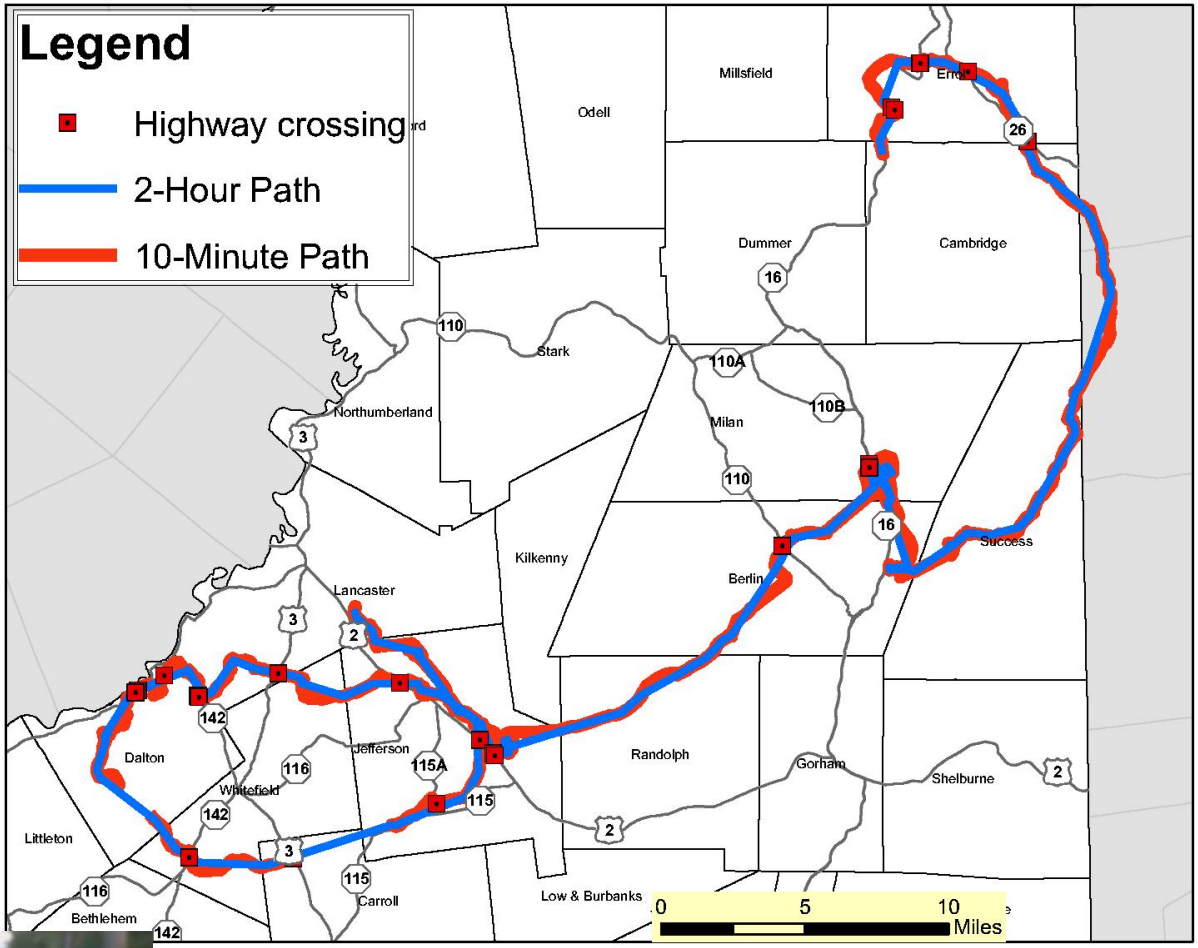
RSA 207:1 XIII-a.

Animals move

For food, breeding, shelter, seasonal migrations, or dispersing to a new territory.

One bear
Three weeks
142 miles
(299 km)

23 highway crossings



Catherine Callahan and Nancy Comeau, 2010. Estimating Fine-Scale Movement Patterns of Black Bear using GPS Telemetry. Masters Thesis. Plymouth State University. Plymouth, NH

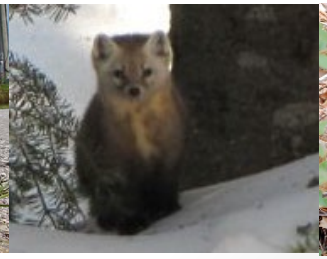
The loss of wildlife corridors may result in:

- Direct mortality
- Barriers to dispersal
- Habitat fragmentation

At greatest risk are:

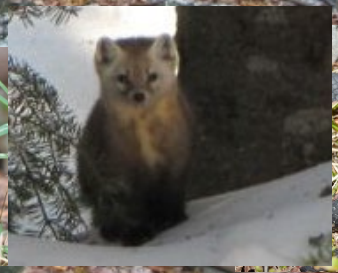
- Slow-moving species (e.g., reptiles and amphibians)
- Species that depend on high adult survivorship (e.g. turtle species)
- Species that are long range dispersers (e.g. bobcats, American martens)
- Species with scarce populations (e.g. timber rattlesnakes)




Riparian Corridors

Ridgeline/Forested Corridors



NH Wildlife Connectivity Model - project objectives

To create a model for identifying wildlife connectivity zones at multiple scales

To make information on New Hampshire's wildlife connectivity zones available to land use planners

2006, Revised 2008 (traffic volume), 2010, 2016, **2020**

NH Wildlife Connectivity Model

Originally funded in 2006 by a grant from the NH GIS Conservation Collaborative

NH Fish & Game and NH Audubon

With assistance from taxonomic experts across northern New England

Used in NH Wildlife Action Plan

Habitat Condition assessments

Updated every 5 years

NH Wildlife Connectivity Model

Pixel = smallest unit of area in a raster GIS map (current model 10m x 10m or approx. 1,076 sq.ft. or 0.025 acre)

Factor = attribute such as land cover, distance to road, distance to riparian, slope, ridgelines

Cost = a pixel attribute that represents the relative difficulty (resistance) of moving through the pixel. Opposite of **Permeability**

Cost distance = sum of costs associated with a string of pixels between two areas

Least-cost modeling = identifies area with low relative resistance, based on weighted combination of factors

Corridor = a continuous swath of land estimated to be the most permeable route for one or more species to use for travel

NH Wildlife Connectivity Model
Focal species

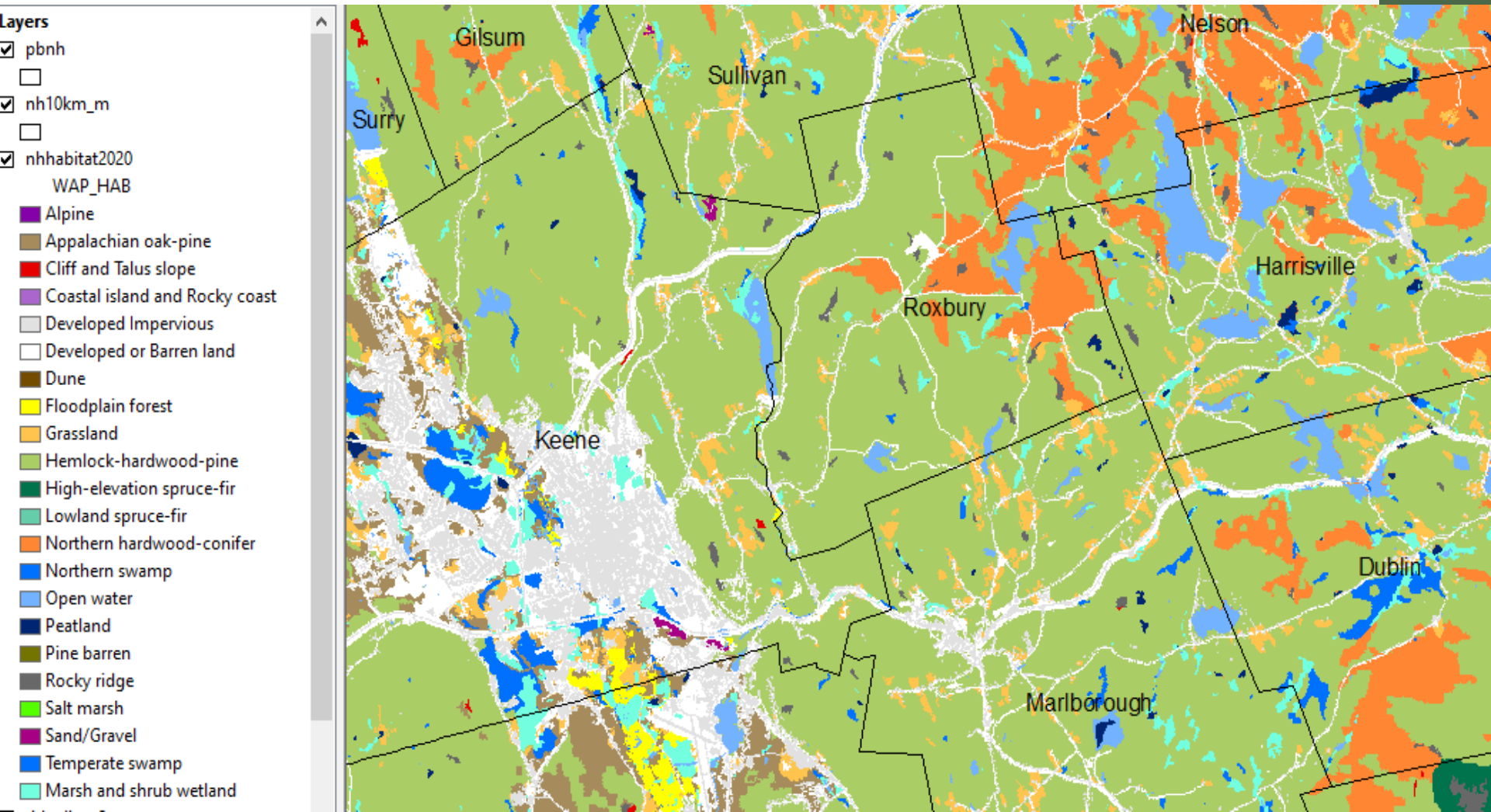
Habitat generalists (G), habitat specialists (S),
area sensitive (A), and barrier sensitive (B) species
were included to capture the range of response to habitat
and variation in dispersal behavior:

Blanding's turtle (B)
Spotted turtle (B)
Wood turtle (B)
Eastern hognose (S,B)
Black racer (B)
Snowshoe hare (S)
New England cottontail (S)
Porcupine (G,B)
Mink (S)
Otter (S)
Long-tailed weasel (G)
Fisher (G)
American marten (S,A)
Bobcat (A)
Canada lynx (S,A)
Black bear (G)

NH Wildlife Connectivity Model
Landscape factors

- Land cover
- Distance to road
- Distance to riparian area
- Slope
- Ridgeline (modifier)

NH Wildlife Connectivity Model land cover

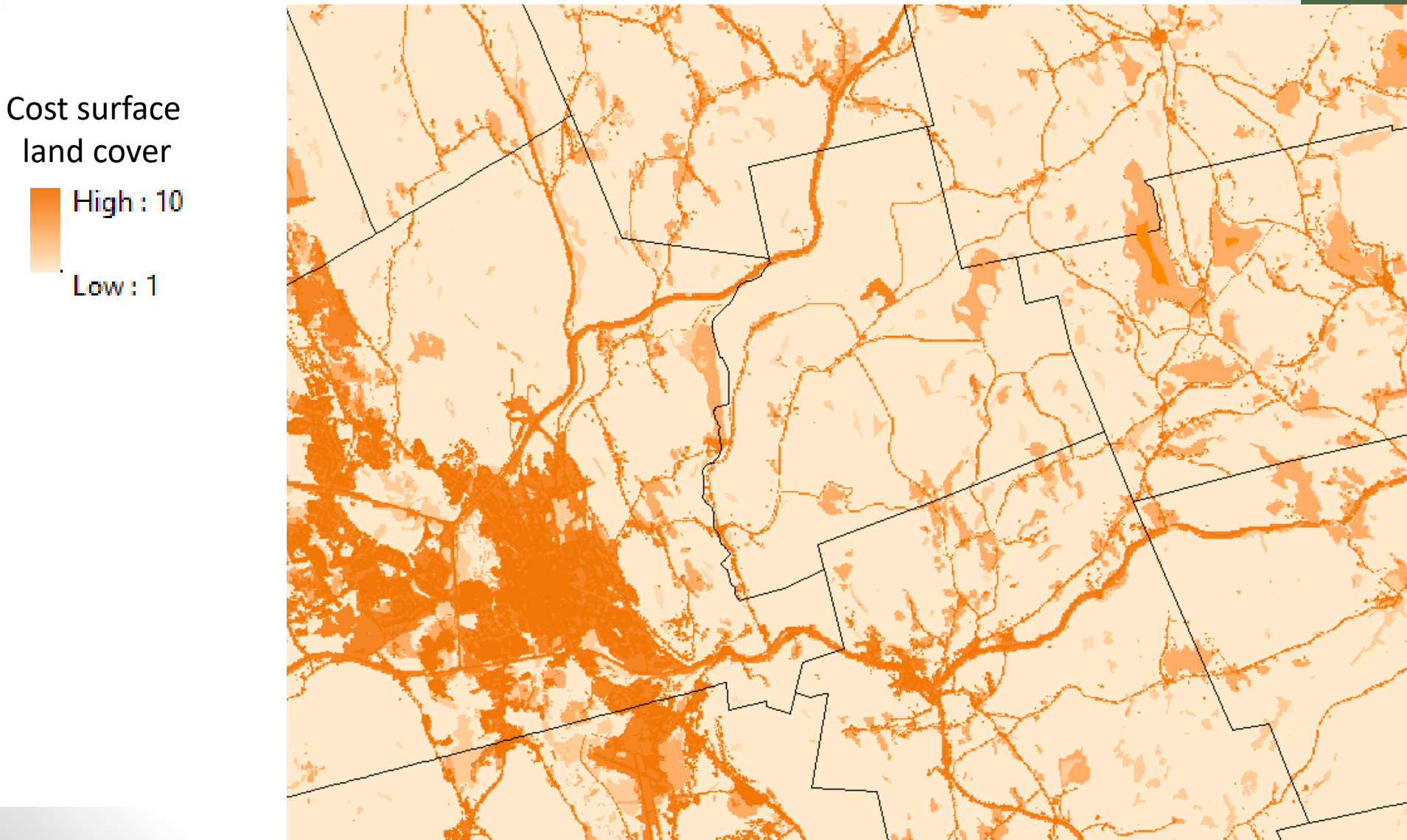


NH Wildlife Connectivity Model land cover

Each factor is assigned a relative cost 1 = low cost, highly permeable
10 = high cost, least permeable

NHLC/NLCD	WAPHAB	MARTEN	BEAR	RACER	BLANDINGS	BOBCAT	LYNX	FISHER	HOGNOSE	WEASEL	MINK	NEC	OTTER	PORCUPINE	SSH	SPOTTEDTUR	WOODTURTLE
Dev Med	Developed or Barren land	8	8	8	10	8	8	8	8	8	8	8	8	8	8	9	10
Dev High	Developed Impervious	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Orchards	Grassland	9	5	1	3	5	5	5	3	5	3	4	3	3	3	3	3
Hardwoods	Appalachian oak-pine	4	1	1	2	1	2	2	3	1	3	5	2	1	2	2	2
Softwoods	High-elevation spruce-fir	1	1	2	3	1	1	2	3	1	3	6	2	1	1	3	3
Softwoods	Lowland spruce-fir	1	1	2	3	1	1	2	3	1	3	6	2	1	1	3	3
Mixed forest	Hemlock-hardwood-pine	2	1	1	2	1	1	2	3	1	3	5	2	1	1	2	2
Mixed forest	Northern hardwood-conifer	2	1	1	2	1	1	2	3	1	3	5	2	1	1	2	2
Mixed forest	Pine barren	2	1	1	2	1	1	2	3	1	3	5	2	1	1	2	2
Alpine	Alpine	2	8	10	10	7	2	7	10	9	9	10	10	10	4	10	10
Open water	Open water	8	5	9	7	7	7	7	9	7	2	9	1	10	7	7	7
For Wet	Northern swamp	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	2
For Wet	Temperate swamp	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	2
For Wet	Floodplain forest	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	2
Open Wet	Wet meadow/shrub wetland	9	3	2	1	5	5	3	4	3	1	3	1	8	5	1	2
Open Wet	Peatland	9	3	2	1	5	5	3	4	3	1	3	1	8	5	1	2
Tidal Wet	Salt marsh	10	7	4	5	7	10	9	10	7	1	9	1	10	10	5	10
Cleared	Sand/Gravel	4	2	1	2	5	5	5	3	5	5	1	5	5	5	2	2
Bedrock-veg	Cliff and Talus	2	2	1	2	2	2	2	3	2	3	5	3	3	3	2	2
Bedrock-veg	Rocky ridge	2	2	1	2	2	2	2	3	2	3	5	3	3	3	2	2
Sand dune	Dune	10	8	1	4	5	10	5	1	5	5	3	5	8	9	4	4
	Coastal island	10	8	1	4	5	10	5	1	5	1	5	1	10	9	4	10

NH Wildlife Connectivity Model land cover



NH Wildlife Connectivity Model traffic volume

Cost surface
Traffic volume

High : 10

Low : 0

Maine Audubon

Traffic Volumes:

Road Type	**Vehicles/day**
Subdivision road with 10 houses (10 trips/day/house)	**100**
Rural/suburban road – a few vehicles in a couple minutes; then nothing for 15-30 minutes	**450**
State Road – regularly see cars, but a minute or so with no cars; you can cross road at will	**4,000**
State Highway – cars not bumper to bumper, but flow regularly; wait for a brake in traffic to cross	**16,000**
Interstate	**35,000 +/-**

Traffic Thresholds

Vehicles/day	**Species Impacts**
100-500	Start for carnivores, amphibians, reptiles
500-1500	Significant for amphibians, reptiles, start for birds
3000-6000	Significant for amphibians, reptiles, ungulates, carnivores, birds
10,000+	Nearly complete barrier most species, major avoidance birds

Charry, B., & Jones, J. (2009). Traffic Volume as a Primary Road Characteristic Impacting Wildlife: A Tool for Land Use and Transportation Planning. UC Davis: Road Ecology Center.

NH Wildlife Connectivity Model
Resistance curves

- Logistic functions that describe the cost of movement across landscape

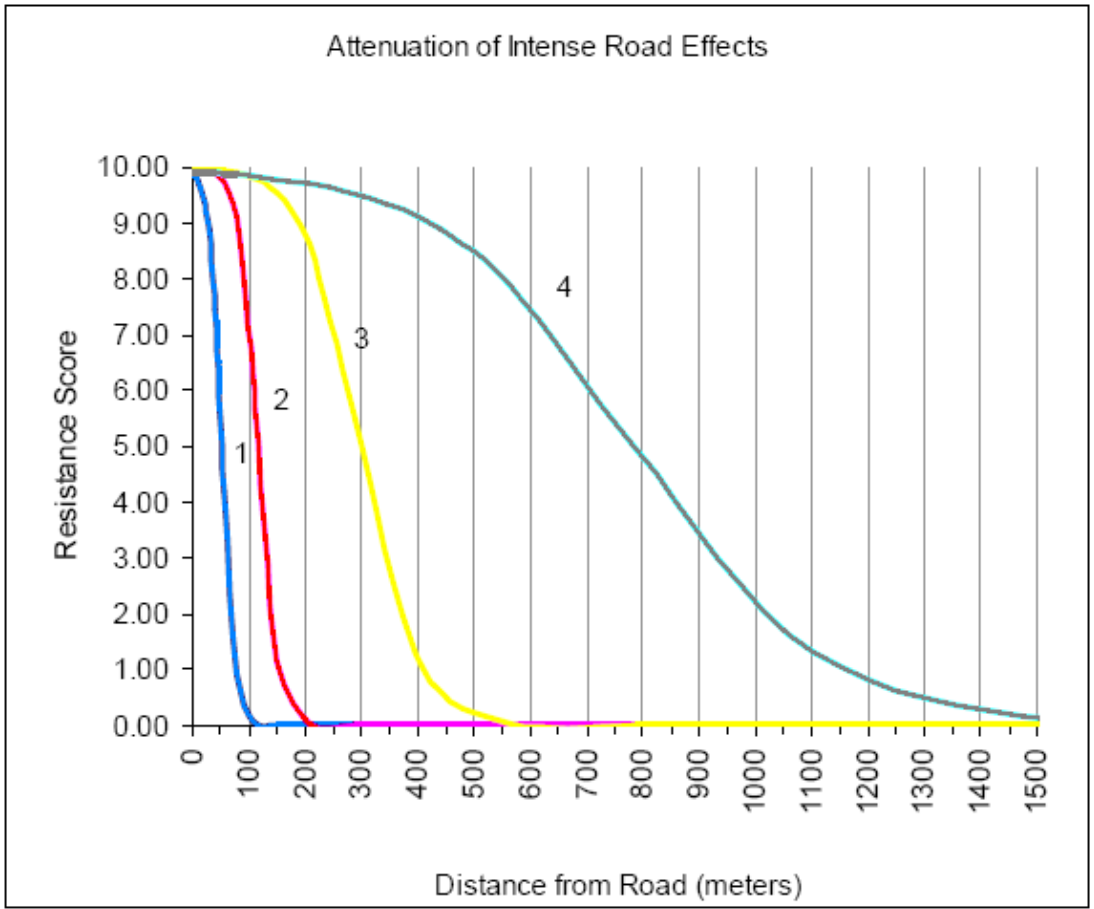
- Functions are based on
  - Maximum possible effect
  - Half life of effect
  - Rate of change in effect

COST = (max cost / (1+ (half life * EXP(-attenuation rate * distance)))

NH Wildlife Connectivity Model

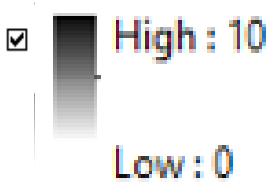
DISTANCE TO ROAD				
Interstate & Arterial	H2	H3	H1	H1
Collector & Paved Local	M3	M2	M1	M1
Unpaved & Private; Railroad	L1	L1	M1	M1
TrafficVolume6 (10,000+)	tv6_h3	tv6_h3	tv6_h1	tv6_h1
TrafficVolume5 (6,000-9,999)	tv5_h3	tv5_h3	tv5_h1	tv5_h1
TrafficVolume4 (3,000-5,999)	tv4_h3	tv4_h3	tv4_h1	tv4_h1
TrafficVolume3 (500-2,999)	tv3_m3	tv3_m2	tv3_h1	tv3_h1
TrafficVolume2 (100-499)	tv2_m2			
TrafficVolume1 (< 100)	tv1_l1			
Railroads (turtles addl' cost)				
DISTANCE TO RIPARIAN				
	R4			
SLOPE (percent)				
	S4			

Score 1 – 10
1 low resistance
10 high resistance



NH Wildlife Connectivity Model traffic volume

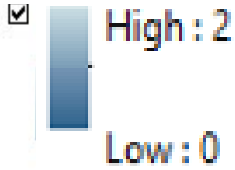
Cost surface
Traffic volume

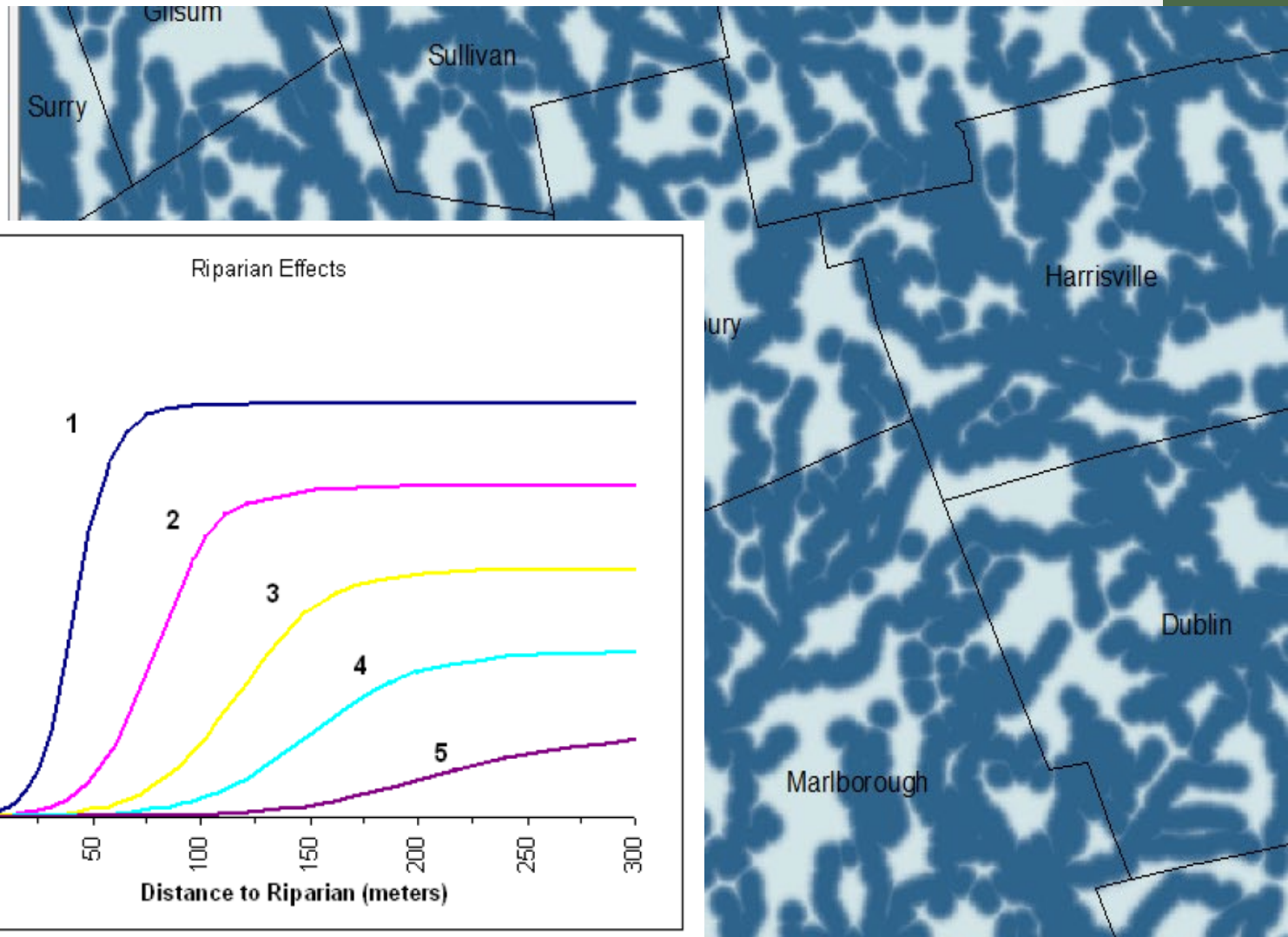


NH Wildlife Connectivity Model riparian

Cost surface

Riparian areas



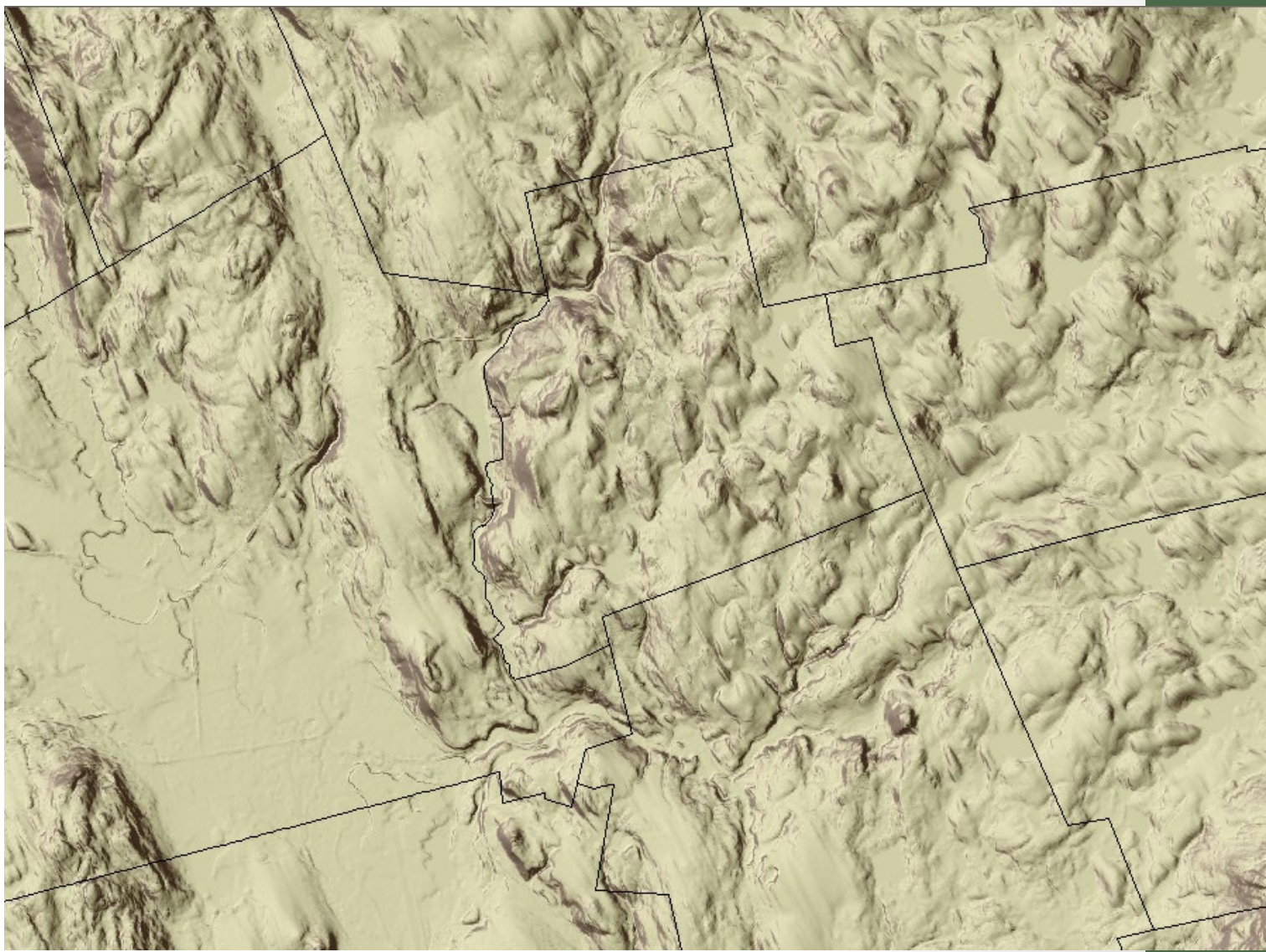


NH Wildlife Connectivity Model slope

Cost surface slope

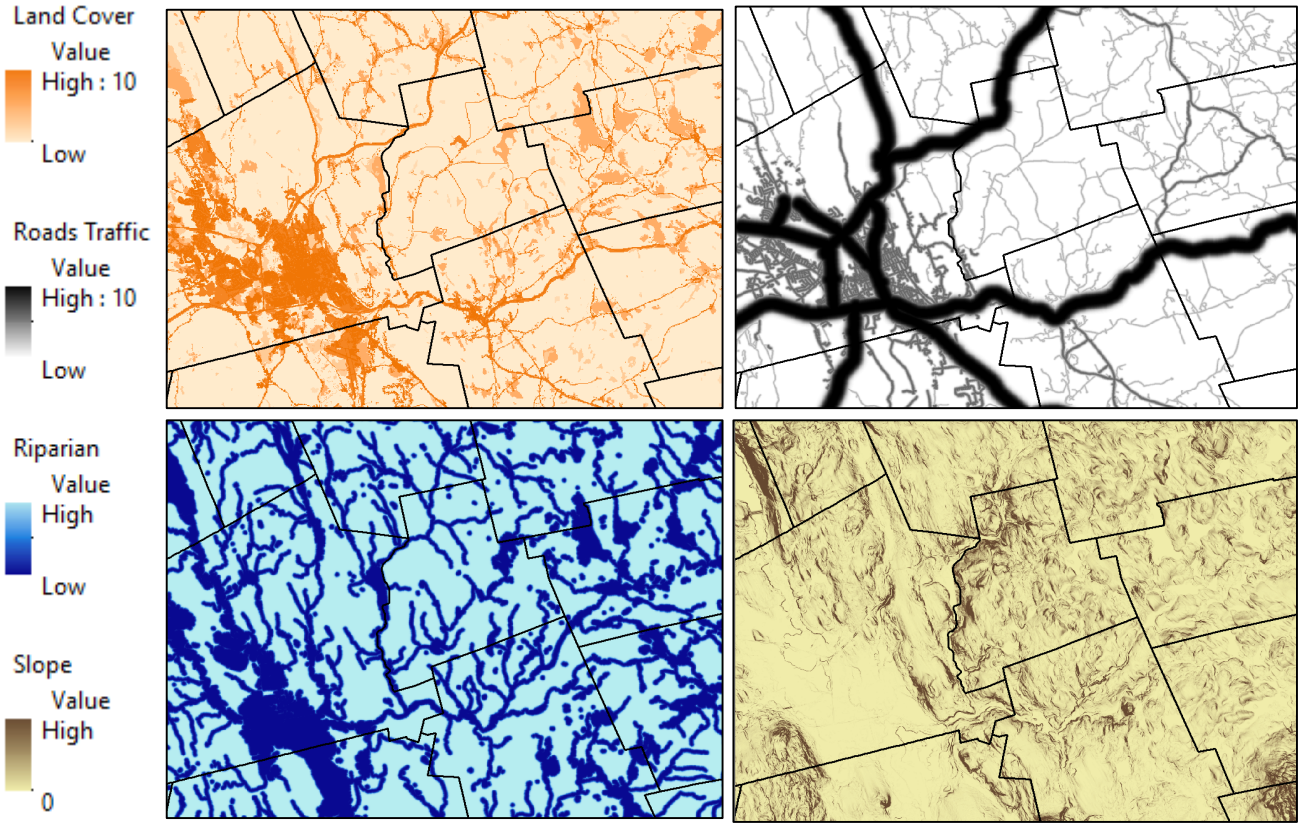
High : 10

Low : 0



NH Wildlife Connectivity Model

Step 4: weighted sum



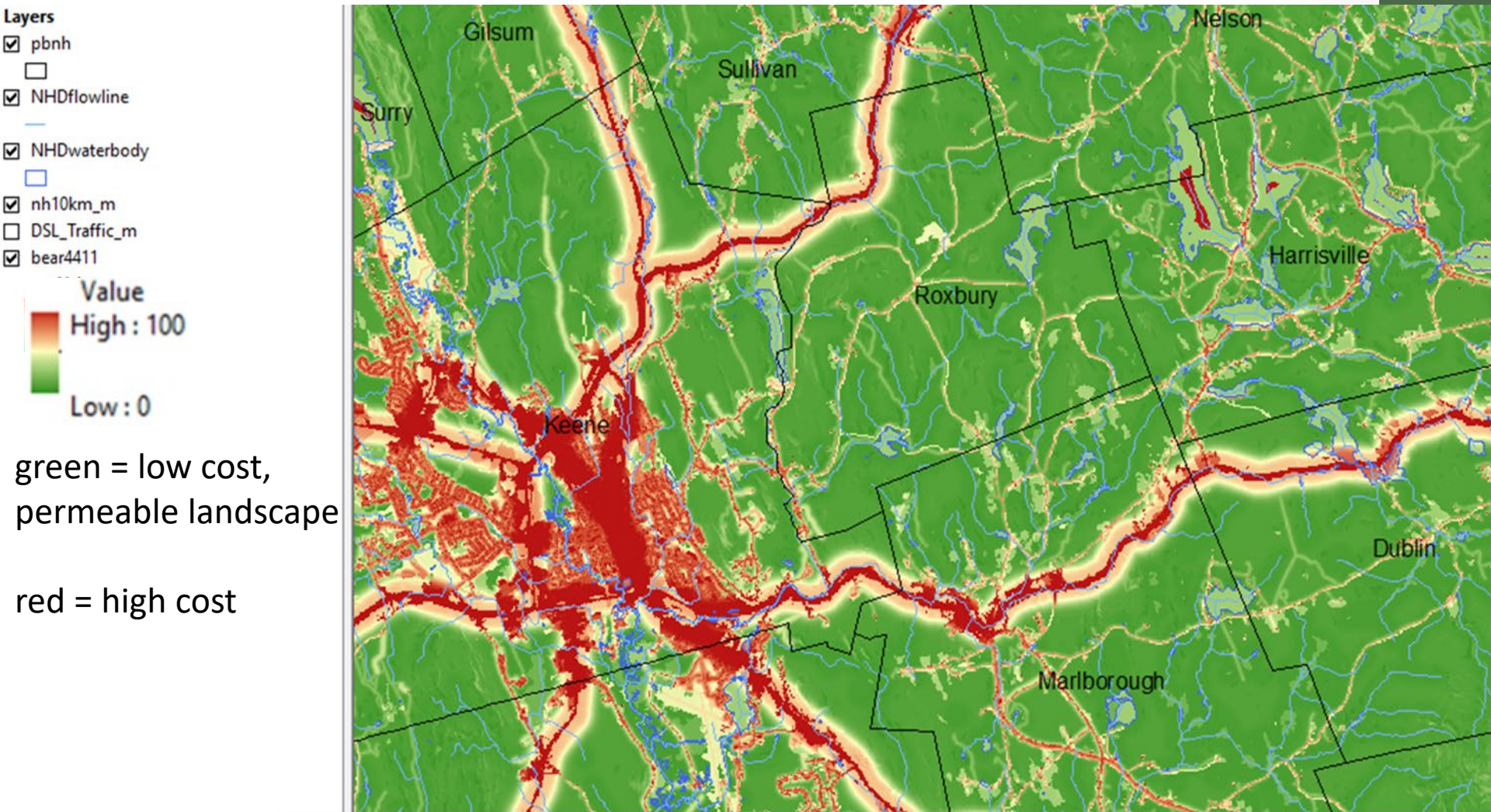
Relative (riparian dependent species relative influence in blue font, 3-3-3-1 weight)

Influence:		Factor:
40%	**30%**	Land cover (NH Wildlife Action Plan habitat derived from 2016 NOAA C-CAP land cover data)
40%	**30%**	Distance to road (all roads classified by traffic volume based on UMass DSL traffic metric)
10%	**30%**	Distance to riparian areas (NHD water, NWI wetlands, and floodplains)
10%	**10%**	Slope (derived from USGS 10m digital elevation model)

NH Wildlife Connectivity Model

Variable	American Marten	Black Bear	Black Racer	Blandings Turtle	Bobcat	Canada Lynx	Fisher	Hognose Snake	LT Weasel	Mink	NEC	Otter	Porcupine	SSH	Spotted Turtle	Wood Turtle
RELATIVE INFLUENCE (weight)																
Land Cover	4	4	4	3	4	4	4	4	3	3	4	3	4	4	3	3
Road	4	4	4	3	4	4	4	4	3	3	4	3	4	4	3	3
Riparian	1	1	1	3	1	1	1	1	3	3	1	3	1	1	3	3
Slope	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LAND COVER (2020 NH Wildlife Action Plan habitat updated with NOAA C-CAP land cover; based on 2016 conditions/imagery)																
Developed or Barren land	8	8	8	10	8	8	8	8	8	8	8	8	8	8	9	10
Developed Impervious	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Grassland	9	5	1	3	5	5	5	3	5	3	4	3	3	3	3	3
Appalachian oak-pine	4	1	1	2	1	2	2	3	1	3	5	2	1	2	2	2
High-elevation spruce-fir	1	1	2	3	1	1	2	3	1	3	6	2	1	1	3	3
Lowland spruce-fir	1	1	2	3	1	1	2	3	1	3	6	2	1	1	3	3
Hemlock-hardwood-pine	2	1	1	2	1	1	2	3	1	3	5	2	1	1	2	2
Northern hardwood-conifer	2	1	1	2	1	1	2	3	1	3	5	2	1	1	2	2
Pine barren	2	1	1	2	1	1	2	3	1	3	5	2	1	1	2	2
Alpine	2	8	10	10	7	2	7	10	9	9	10	10	10	4	10	10
Open water	8	5	9	7	7	7	7	9	7	2	9	1	10	7	7	7
Open water > 1/4 mile wide	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Northern swamp	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	2
Temperate swamp	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	2
Floodplain forest	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	2
Wet meadow/shrub wetland	9	3	2	1	5	5	3	4	3	1	3	1	8	5	1	2
Peatland	9	3	2	1	5	5	3	4	3	1	3	1	8	5	1	2
Salt marsh	10	7	4	5	7	10	9	10	7	1	9	1	10	10	5	10
Sand/Gravel	4	2	1	2	5	5	5	3	5	5	1	5	5	5	2	2
Cliff and Talus	2	2	1	2	2	2	2	3	2	3	5	3	3	3	2	2
Rocky ridge	2	2	1	2	2	2	2	3	2	3	5	3	3	3	2	2
Dune	10	8	1	4	5	10	5	1	5	5	3	5	8	9	4	4
Coastal island	10	8	1	4	5	10	5	1	5	1	5	1	10	9	4	10
DISTANCE TO ROAD (Data source: Umass Designing Sustainable Landscapes: traffic metric "DSL_roadtraffic_2020_v5.0" March 2020)																
TrafficVolume6 (10,000+)	tv6_h3	tv6_h3	tv6_h1	tv6_h1	tv6_h3	tv6_h4	tv6_h2	tv6_h1	tv6_h2	tv6_h2	tv6_h1	tv6_h2	tv6_h1	tv6_h1	tv6_h1	tv6_h1
TrafficVolume5 (6,000-9,999)	tv5_h3	tv5_h3	tv5_h1	tv5_h1	tv5_h3	tv5_h4	tv5_h2	tv5_h1	tv5_h2	tv5_h2	tv5_h1	tv5_h2	tv5_h1	tv5_h1	tv5_h1	tv5_h1
TrafficVolume4 (3,000-5,999)	tv4_h3	tv4_h3	tv4_h1	tv4_h1	tv4_h3	tv4_h4	tv4_h2	tv4_h1	tv4_h2	tv4_h2	tv4_m2	tv4_h2	tv4_h1	tv4_m2	tv4_h1	tv4_h1
TrafficVolume3 (500-2,999)	tv3_m3	tv3_m2	tv3_h1	tv3_h1	tv3_m2	tv3_m3	tv3_m2	tv3_h1	tv3_m2	tv3_m2	tv3_m2	tv3_m2	tv3_h1	tv3_m2	tv3_h1	tv3_h1
TrafficVolume2 (100-499)	tv2_m2	tv2_m2	tv2_m1	tv2_m1	tv2_m2	tv2_m3	tv2_m1	tv2_m1	tv2_m1	tv2_m1	tv2_m1	tv2_m1	tv2_m1	tv2_m1	tv2_m1	tv2_m1
TrafficVolume1 (< 100)	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1	tv1_l1
Railroads (railroads and rail trai	rr_l1	rr_l1	rr_l1	**rr_m1**	rr_l1	rr_l1	rr_l1	rr_l1	rr_l1	rr_l1	rr_l1	rr_l1	rr_l1	rr_l1	**rr_m1**	**rr_m1**
DISTANCE TO RIPARIAN (USFWS NWI wetlands and National Hydrography data, 2020)																
	R4	R5	R5	R4	R4	R5	R4	R5	R4	R3	R4	R3	R5	R5	R3	R2
SLOPE (percent slope derived from USGS 10-meter digital elevation model, 2020)																
	S4	S5	S4	S1	S4	S4	S4	S1	S4	S4	S2	S4	S3	S2	S1	S1
RIDGELINE MODIFIER (derived from USGS 10-meter digital elevation model, 2020)																
	Yes	**Yes**			**Yes**	**Yes**	**Yes**									
	American **Marten**	Black **Bear**	Black **Racer**	Blandings **Turtle**	Bobcat	Canada **Lynx**	**Fisher**	Hognose Snake	LT Weasel	Mink	**NEC**	Otter	Porcupine	SSH	Spotted Turtle	Wood Turtle

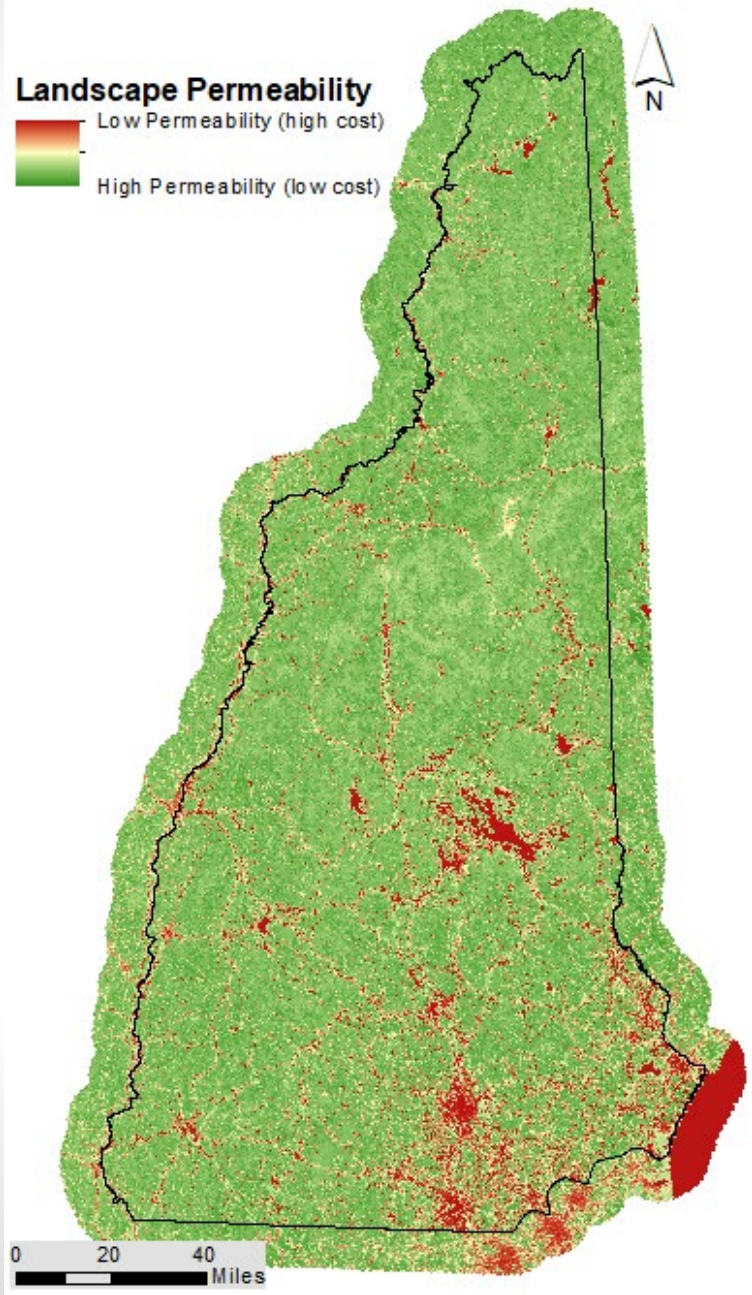
NH Wildlife Connectivity Model
Species cost surface: black bear

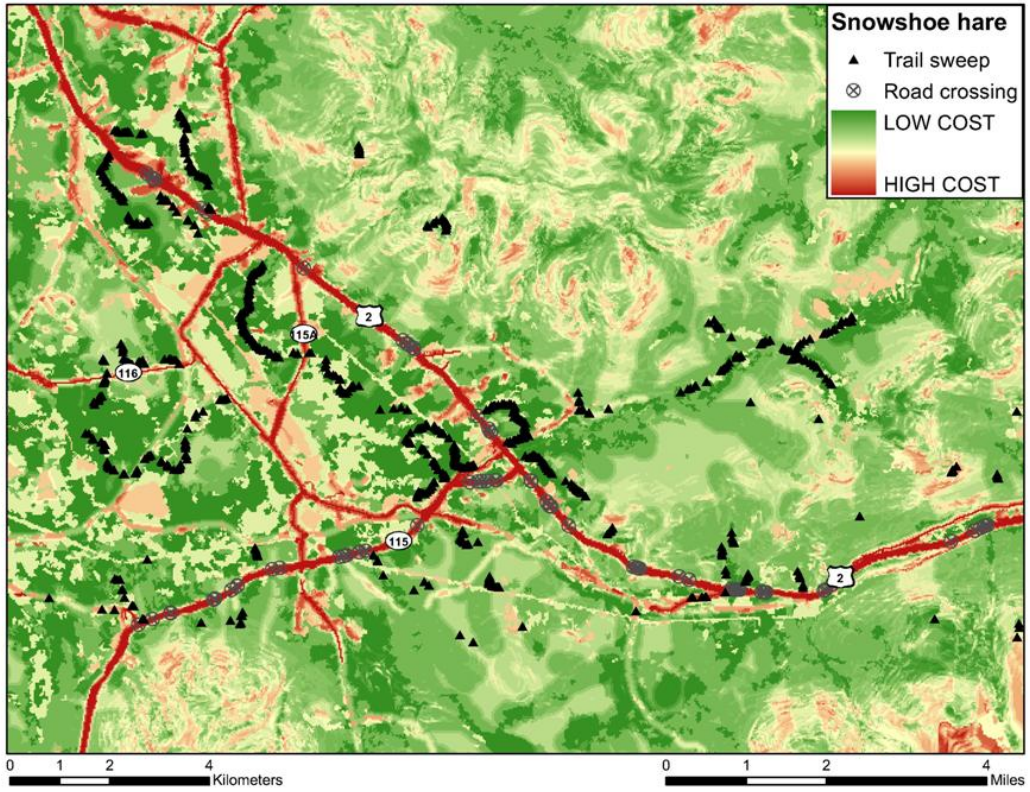


green = low cost, permeable landscape

red = high cost

NH Wildlife Connectivity Model





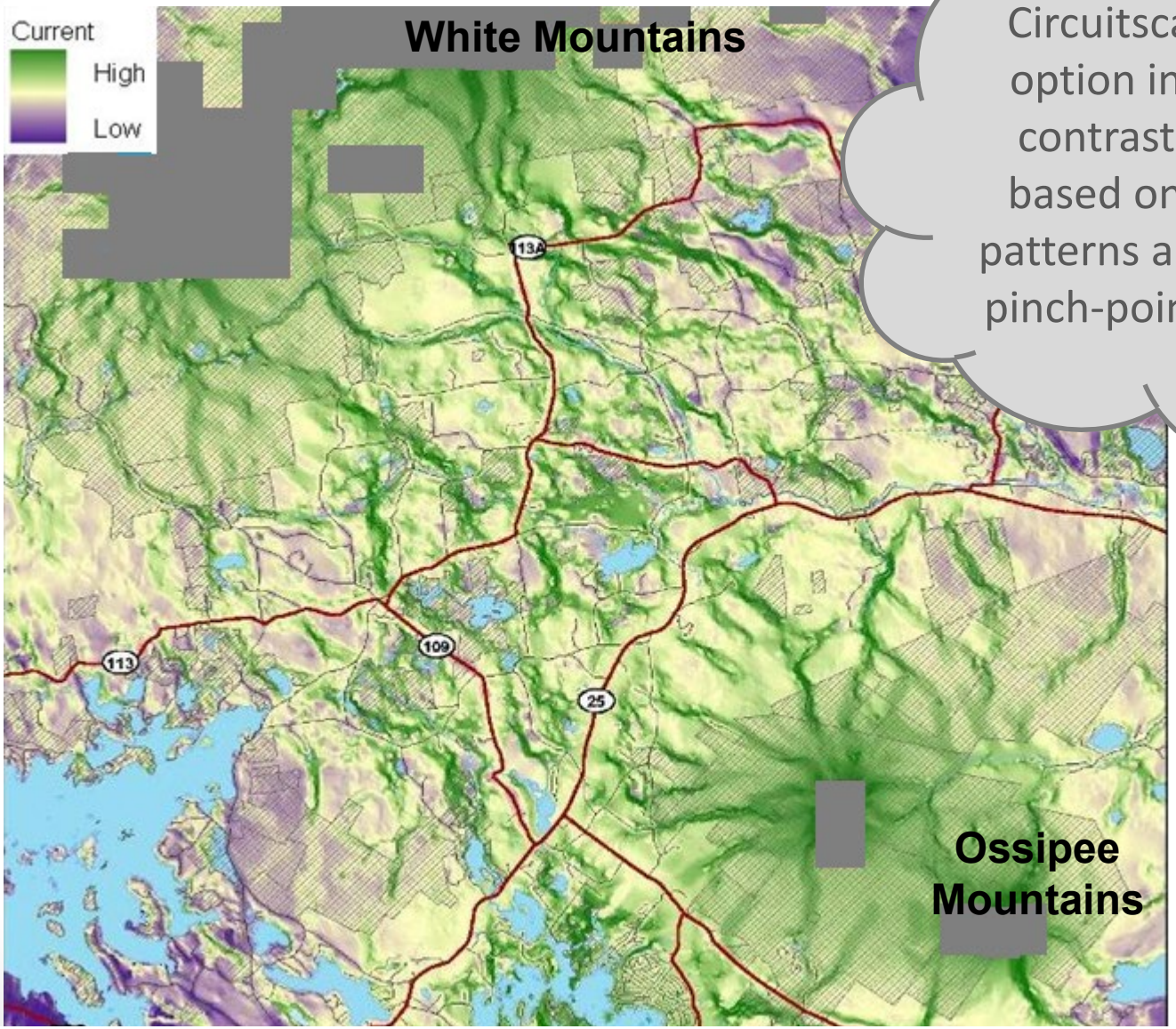
Connectivity → to Corridors Option 1

CIRCUITSCAPE

Open-source program that uses circuit theory, with theoretical basis in random walk theory, to predict connectivity in heterogeneous landscapes for individual movement, gene flow, and conservation planning.

McRae, B.H., and Shah, V.B. 2009.
Circuitscape User Guide. ONLINE.
The University of California, Santa Barbara.
Available online: http://www.circuitscape.org

Corridors: Option 1



Circuitscape is a better option in areas of low-contrast, because it is based on random walk patterns and may identify pinch-points of dispersal.

CIRCUITSCAPE identifies ALL areas that contribute to connectivity.

Corridors: Option 2

Connect THE Coast

LINKING WILDLIFE ACROSS NEW HAMPSHIRE'S SEACOAST AND BEYOND

Final Report: 10/31/2019

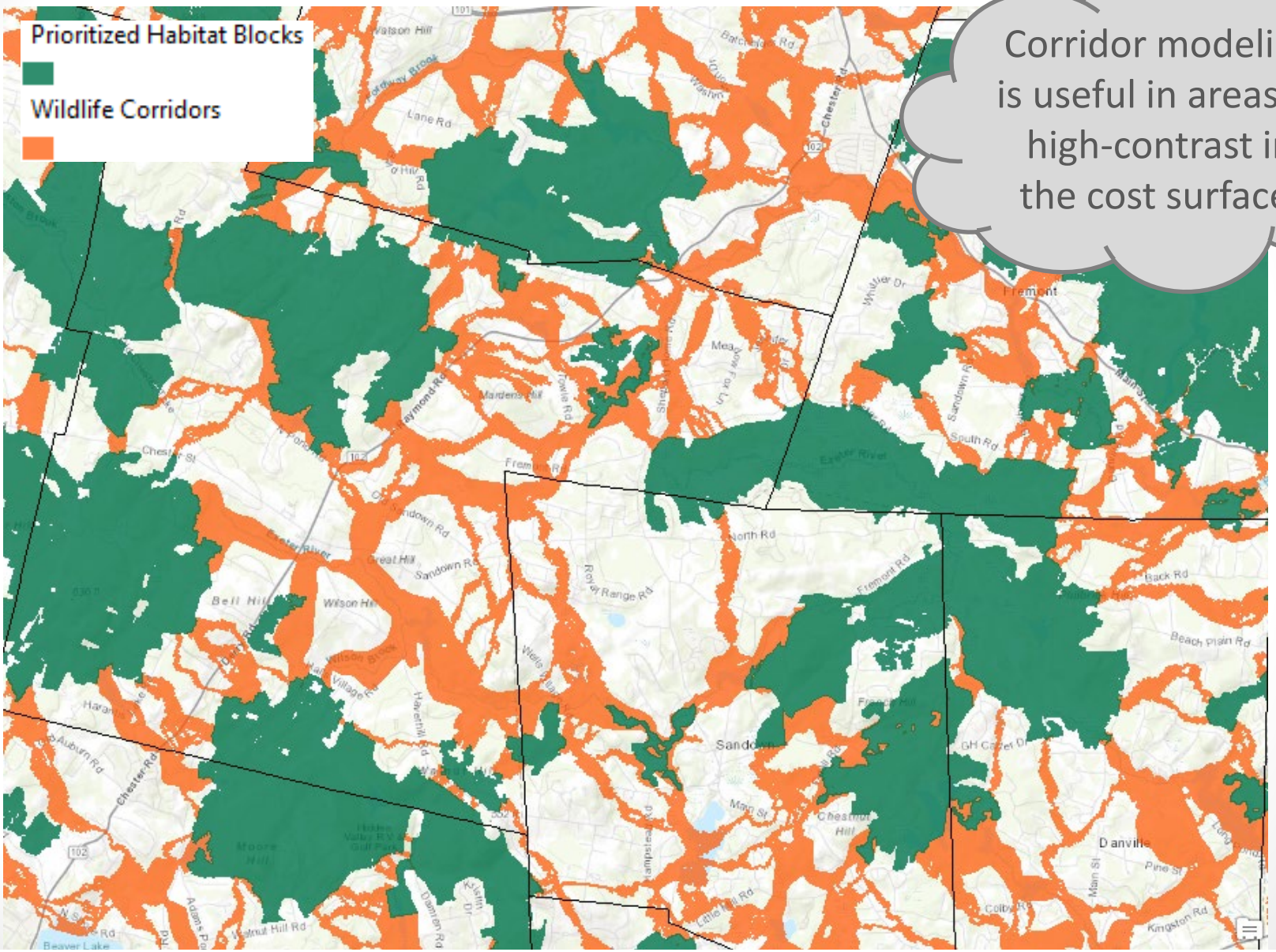
Authors: Peter Steckler and Dea Brickner-Wood

The Nature Conservancy
New Hampshire

GREAT BAY
RESOURCE PROTECTION PARTNERSHIP

Corridor modeling is useful in areas of high-contrast in the cost surface.

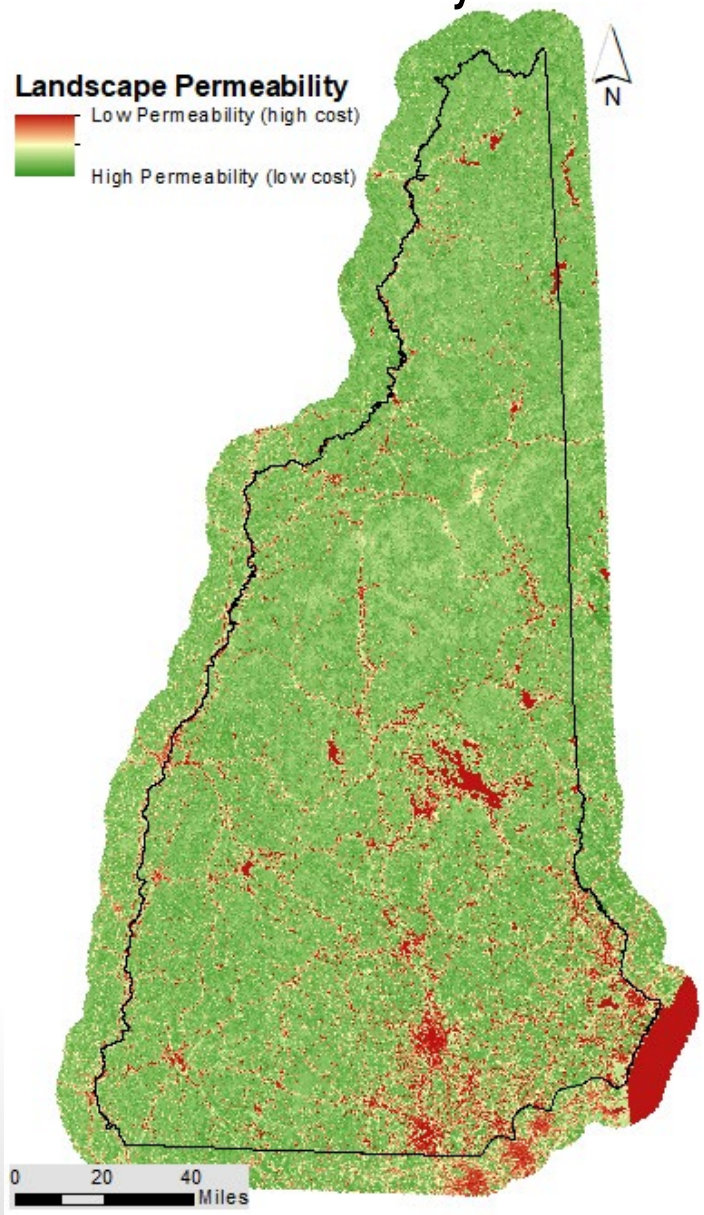
NH Wildlife Corridors



Corridor modelling identifies the least-cost option between habitat blocks.

NH Wildlife Corridors

Wildlife connectivity



Wildlife corridors

NH Wildlife Corridors

Nodes (Prioritized Habitat Blocks)

NH Transportation and Wildlife workgroup, following TNC's Connect-the-Coast:

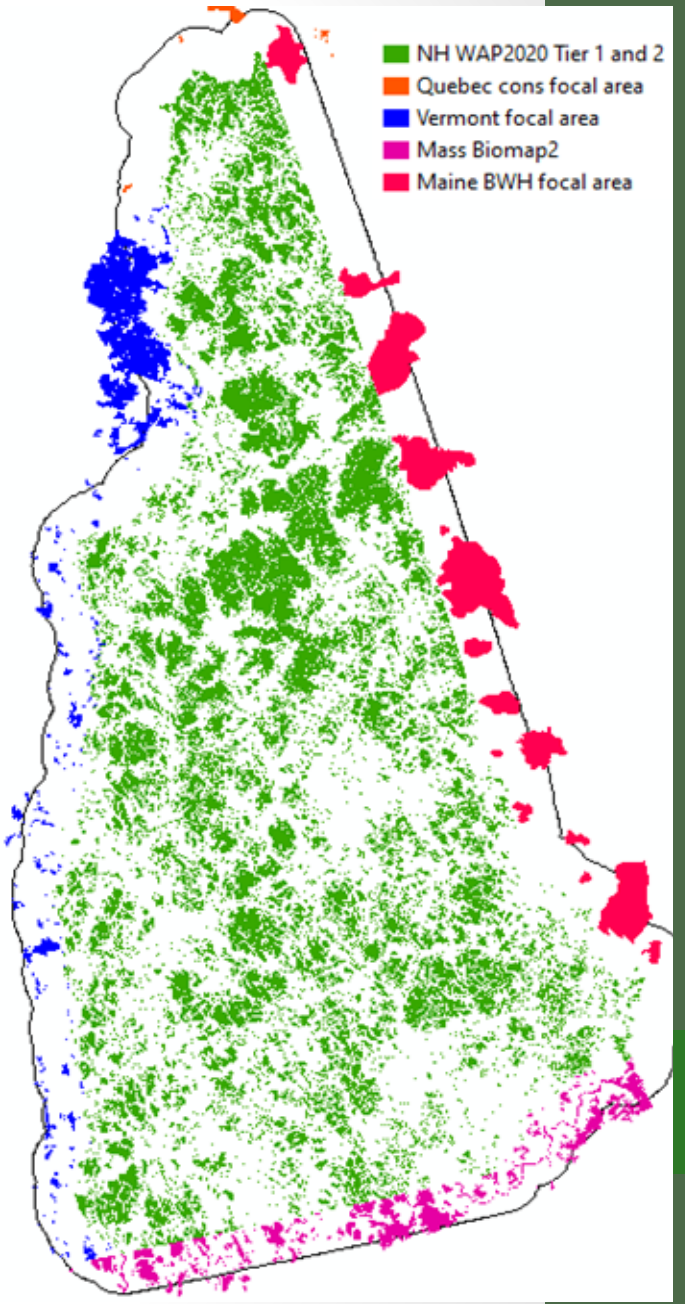
Nodes = prioritized habitat blocks defined using WAP Tier 1 and 2 top-ranked habitat areas merged and selected >= 50 Acres

Added focal areas for species of concern

even if smaller than 50 acres

Similar areas included for Quebec, Maine, Massachusetts and Vermont

…out to 10 km

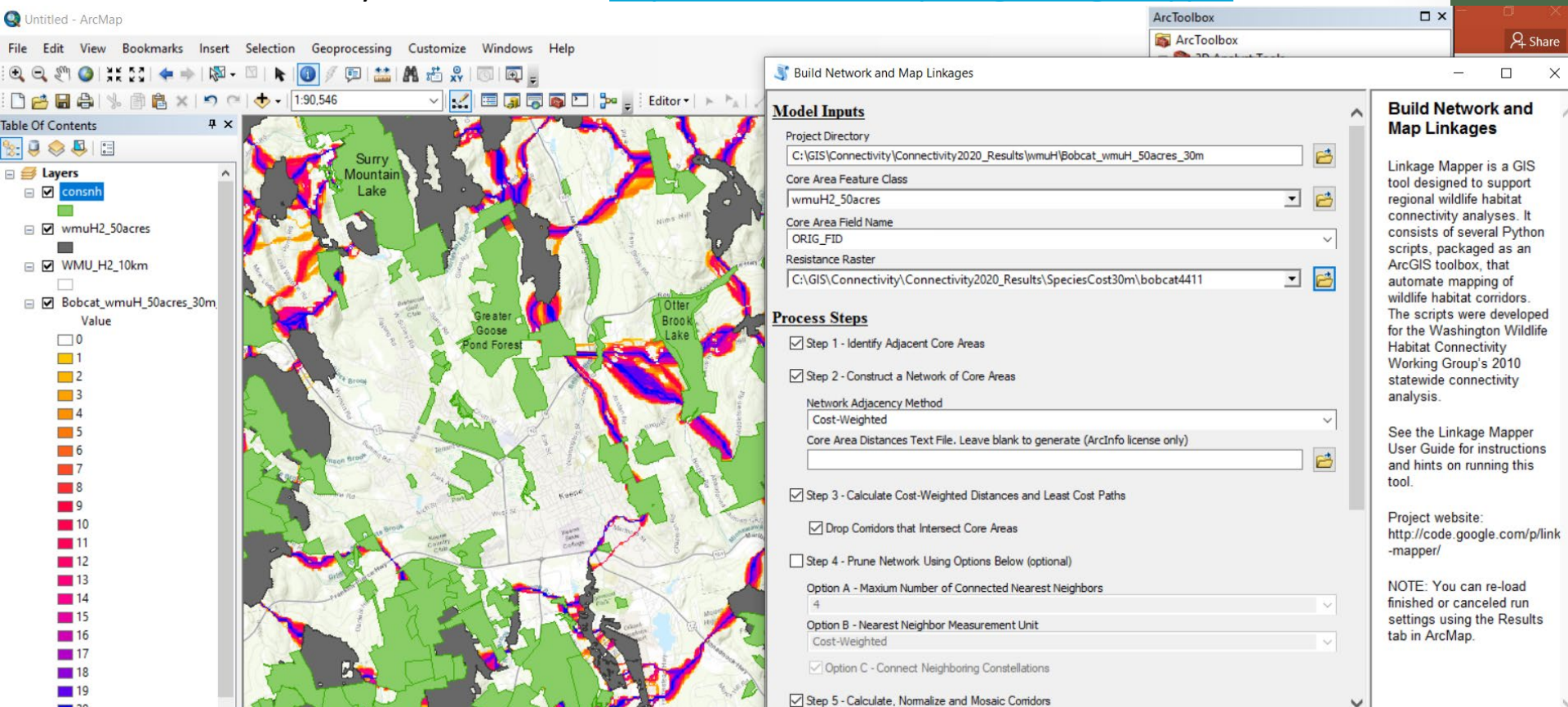


NH Wildlife Corridors

GIS software toolbox

Linkage Mapper supports regional wildlife habitat connectivity analyses.
It consists of six tools that automate mapping and prioritization of wildlife habitat corridors.
It is comprised of open source Python scripts, shared in an ArcGIS toolbox.

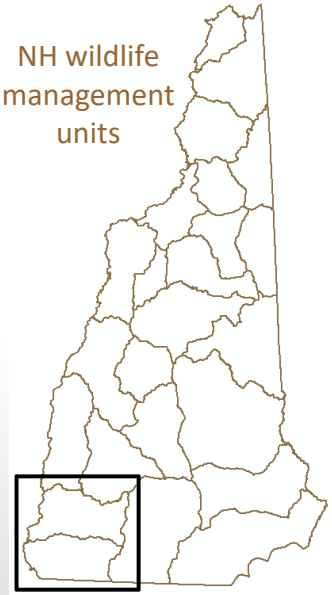
McRae BH, Kavanagh DM. 2011. Linkage Mapper Connectivity Analysis Software.
The Nature Conservancy. Available from http://www.circuitscape.org/linkagemapper

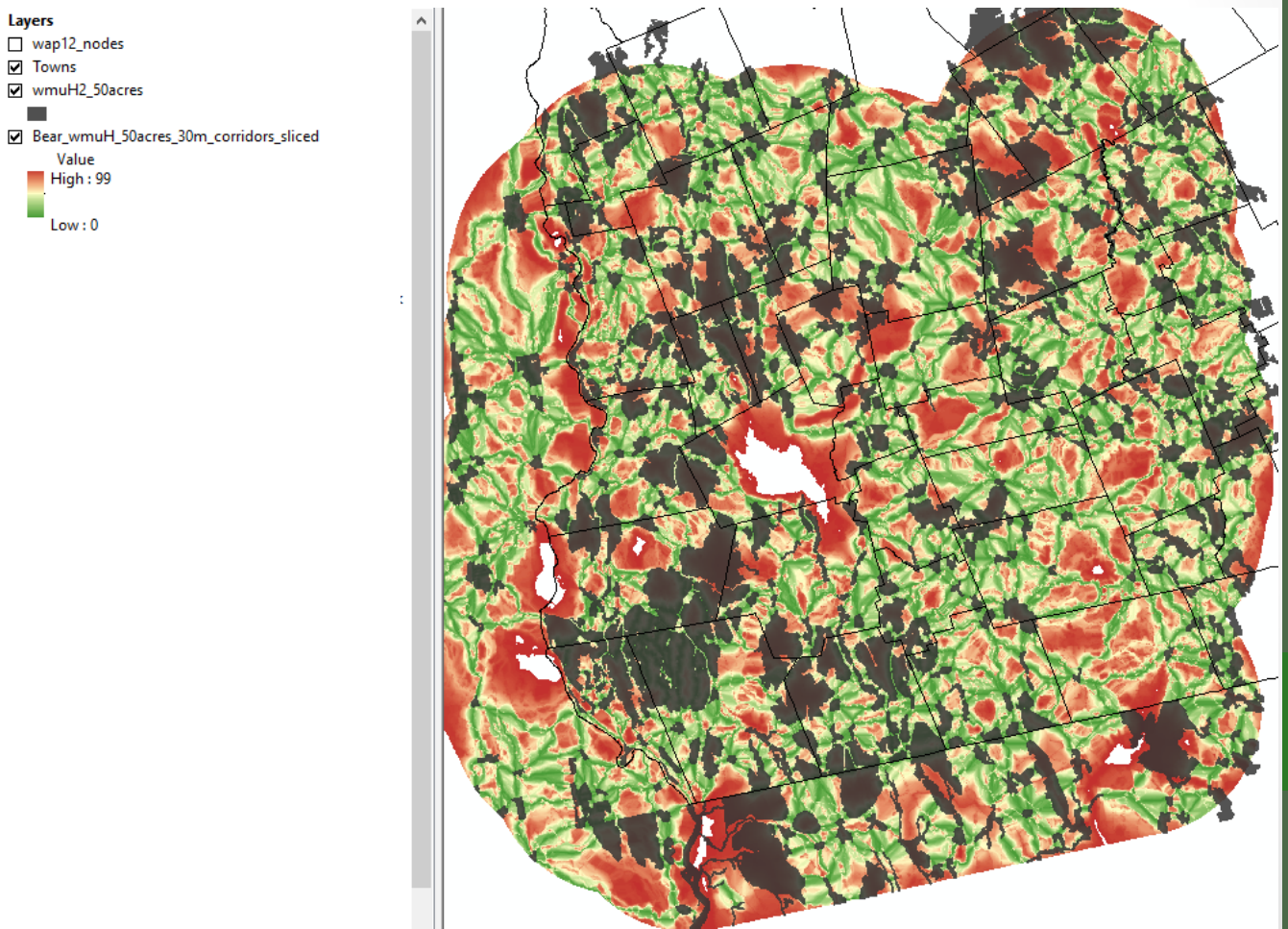


Corridor results – 8 months later!

Following TNC's Connect-the-Coast process:

1.) For each species, take the corridor output from the Linkage Mapper tool and slice into 100 equal parts

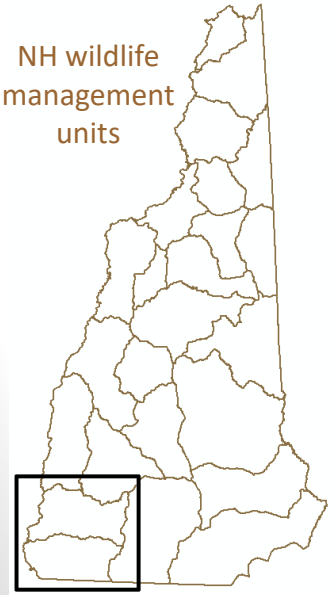


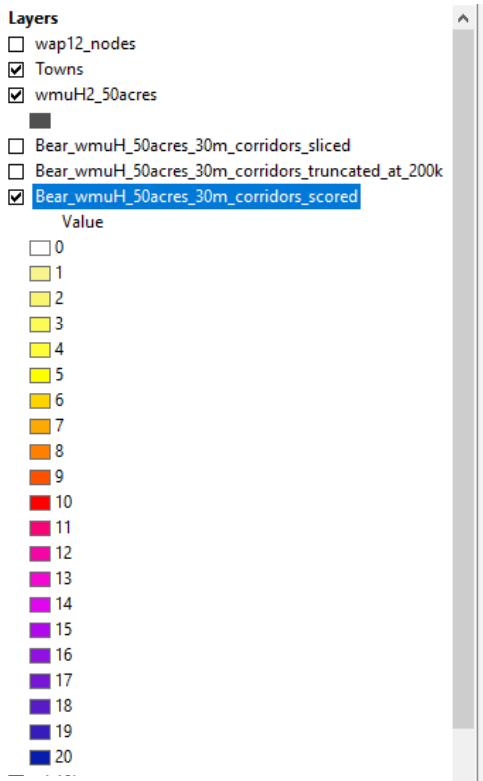


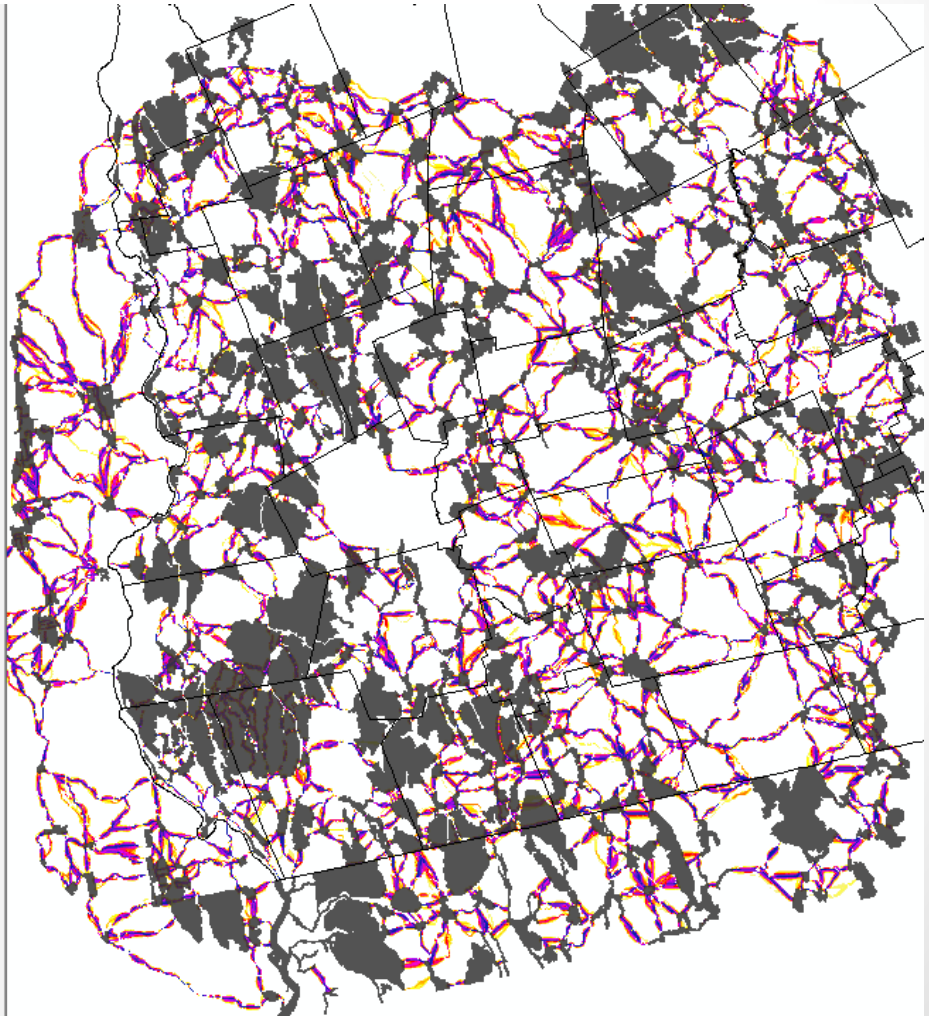
2.) Score the best corridor slices 1 through 20

The corridor slices are reclassified using a weighted index score so that the least costly 1% grid cells were assigned a value of 20, 2% a value of 19, 3% a value of 18, and so on
until the 20% grid cells were assigned a value of 1 point.

All grid cells greater than 20% were excluded

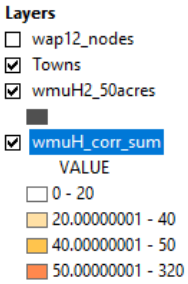


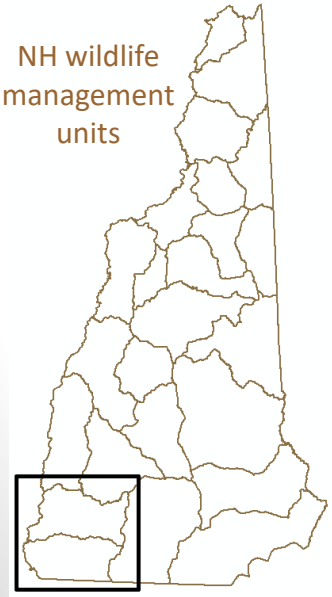


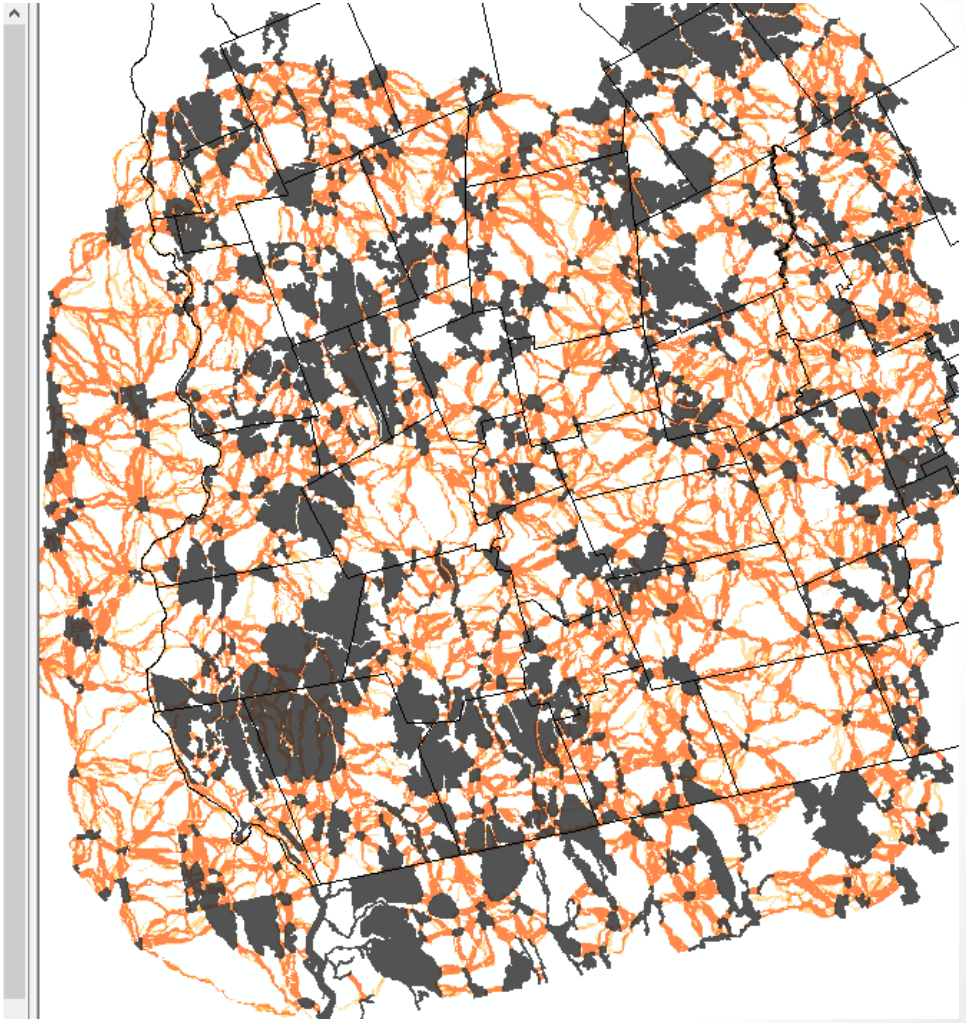


3.) Sum the scored corridors of all sixteen species

Sum the scores and pick a threshold → emphasize riparian corridors







NH Wildlife Corridors

ArcGIS process to create NODES:

- WAP habitat Tiers 1 and 2 (highest ranked in the state or highest ranked in biological region, respectively) were combined and dissolved, then areas less than 50 acres removed
- All nodes trimmed by 100-meter buffer of UMass annual daily traffic rate roads
- Isolated patches of nodes fragmented by road buffer were removed
- Lake nodes trimmed to remove water wider than ¼ mile, so model ran from edge
- Add-ins: wood turtle focal areas, Blanding's turtle priority wetlands 2+ acres, and New England cottontail priority areas were added to the nodes

NH Wildlife Corridors and Prioritization (following TNC's Connect-The-Coast workflow):

- Linkage Mapper tool run for each of the 16 species cost surfaces, 30-meter pixel size
- Maximum Euclidean distance set at 30,000 to limit long-distance corridors
- Truncated 200K outputs were sliced (equal area, 100)
- Sliced output raster data layers were then reclassified using a weighted index score: o Least costly 1% = score 20, 2% = score 19, 3% = score 18, … 20% = score 1 point

- All grid cells greater than 20% travel cost were deemed less permeable landscape and not prioritized
- The reclassified (scored) values for each species were then summed (cell statistics)
- Pixels with combined score sum >= 160 (mean) became the preliminary wildlife corridors
- Riparian corridors are then prioritized by adding pixels with a max. riparian score > 17
- Secondary wildlife corridors then identified (max. score for any species > 15)

NH Wildlife Corridors: validation

78% agreement with wildlife-GPS collar data

81% agreement with wildlife-snow track surveys from winters 2014-2019 (north central-to northern NH)

85% agreement with Black racer and Wood turtle telemetry locations

87% agreement with NHB animal occurrences (all species, high precision locations, past 25 years)

NH Wildlife Corridors

To be determined

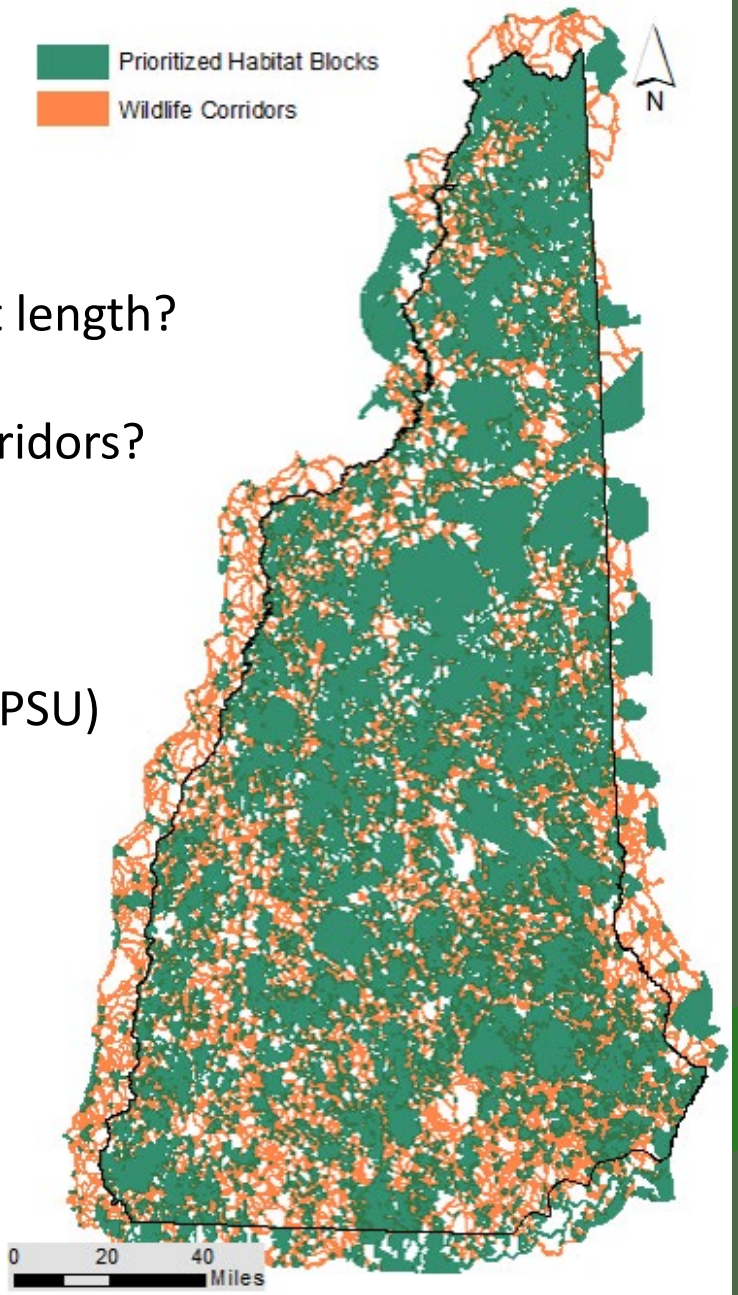
- How wide do corridors need to be per unit length?
- What human activities are okay within corridors?

Underway – Fall 2021

- Wildlife Vehicle Collisions review (NHDOT/PSU)

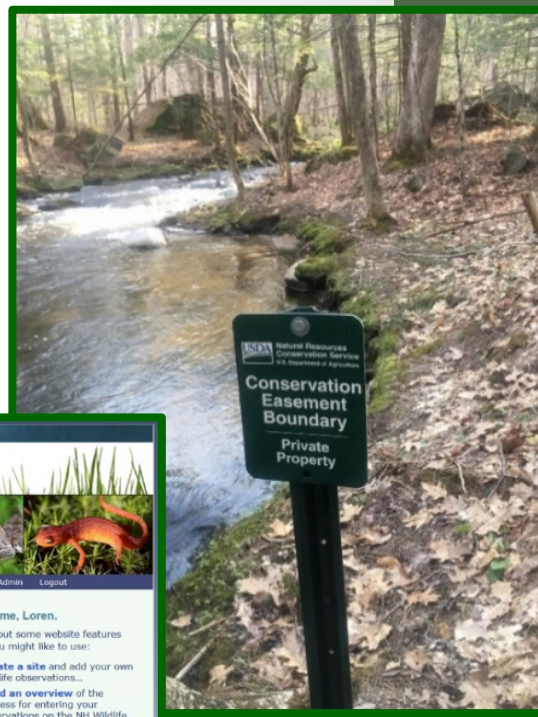
Next steps

- Designate priority road segments
- Develop a transportation and wildlife guidance document



Actions for communities

- Learn and share
- Document and report wildlife sightings
- Conserve Land
- Land use planning
- Promote road solutions
- And more…



For more information

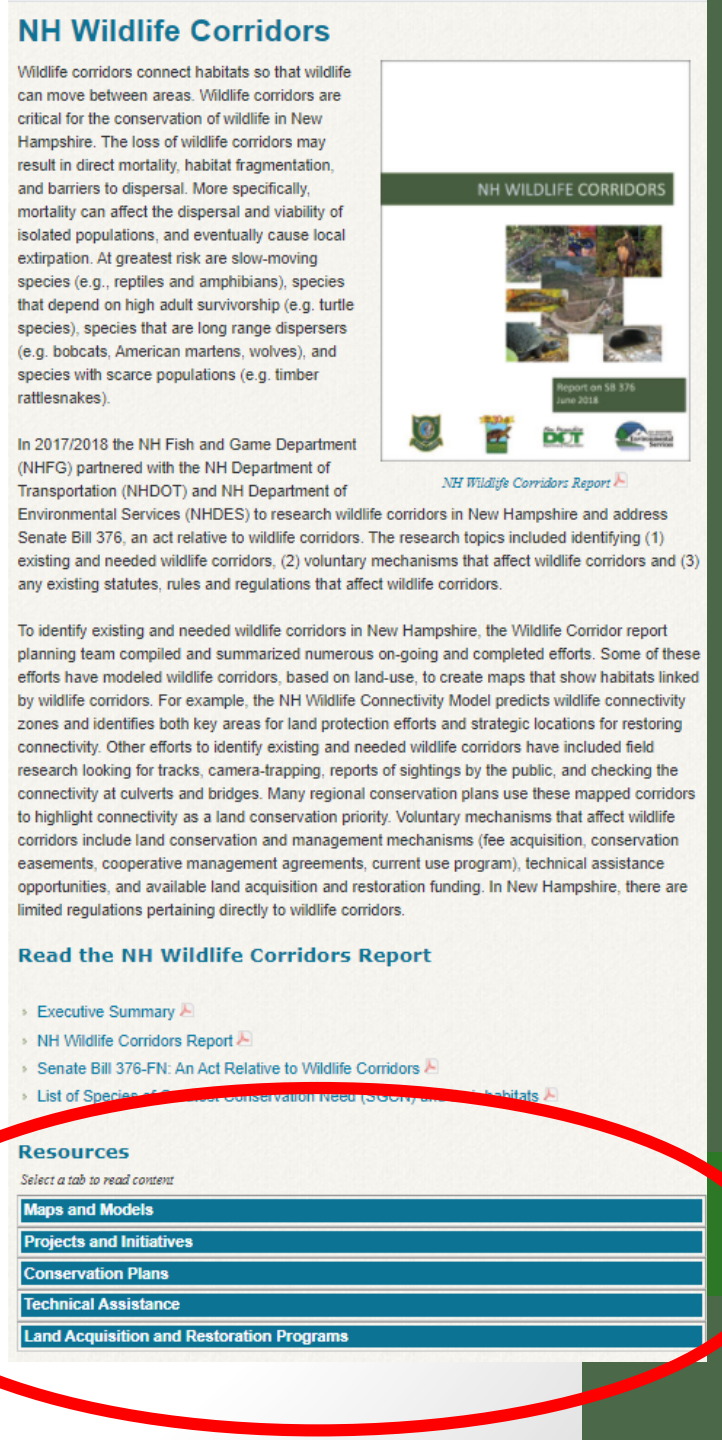
https://www.wildlife.state.nh.us/nongame/corridors.html

Resources Include

- **Maps and Models**
- **Projects and Initiatives**
- **Conservation Plans**
- **Technical Assistance**
- **Land Acquisition and Restoration Programs**

Wildlife corridors map

nhfg.maps.arcgis.com



NH Wildlife Corridors

Wildlife corridors connect habitats so that wildlife can move between areas. Wildlife corridors are critical for the conservation of wildlife in New Hampshire. The loss of wildlife corridors may result in direct mortality, habitat fragmentation, and barriers to dispersal. More specifically, mortality can affect the dispersal and viability of isolated populations, and eventually cause local extirpation. At greatest risk are slow-moving species (e.g., reptiles and amphibians), species that depend on high adult survivorship (e.g. turtle species), species that are long range dispersers (e.g. bobcats, American martens, wolves), and species with scarce populations (e.g. timber rattlesnakes).

NH Wildlife Corridors Report

In 2017/2018 the NH Fish and Game Department (NHFG) partnered with the NH Department of Transportation (NHDOT) and NH Department of Environmental Services (NHDES) to research wildlife corridors in New Hampshire and address Senate Bill 376, an act relative to wildlife corridors. The research topics included identifying (1) existing and needed wildlife corridors, (2) voluntary mechanisms that affect wildlife corridors and (3) any existing statutes, rules and regulations that affect wildlife corridors.

To identify existing and needed wildlife corridors in New Hampshire, the Wildlife Corridor report planning team compiled and summarized numerous on-going and completed efforts. Some of these efforts have modeled wildlife corridors, based on land-use, to create maps that show habitats linked by wildlife corridors. For example, the NH Wildlife Connectivity Model predicts wildlife connectivity zones and identifies both key areas for land protection efforts and strategic locations for restoring connectivity. Other efforts to identify existing and needed wildlife corridors have included field research looking for tracks, camera-trapping, reports of sightings by the public, and checking the connectivity at culverts and bridges. Many regional conservation plans use these mapped corridors to highlight connectivity as a land conservation priority. Voluntary mechanisms that affect wildlife corridors include land conservation and management mechanisms (fee acquisition, conservation easements, cooperative management agreements, current use program), technical assistance opportunities, and available land acquisition and restoration funding. In New Hampshire, there are limited regulations pertaining directly to wildlife corridors.

Read the NH Wildlife Corridors Report

- Executive Summary
- NH Wildlife Corridors Report
- Senate Bill 376-FN: An Act Relative to Wildlife Corridors
- List of Species of [illegible] Conservation Need (SGCN) and [illegible] habitats

Resources

Select a tab to read content

- Maps and Models
- Projects and Initiatives
- Conservation Plans
- Technical Assistance
- Land Acquisition and Restoration Programs