Resilient and Connected Landscapes

for Terrestrial Conservation in Vermont

Mark Anderson PhD. Director of Conservation Science, TNC Eastern US

Thank you to over 150 Scientists

Resilient Land

Connected Landscapes

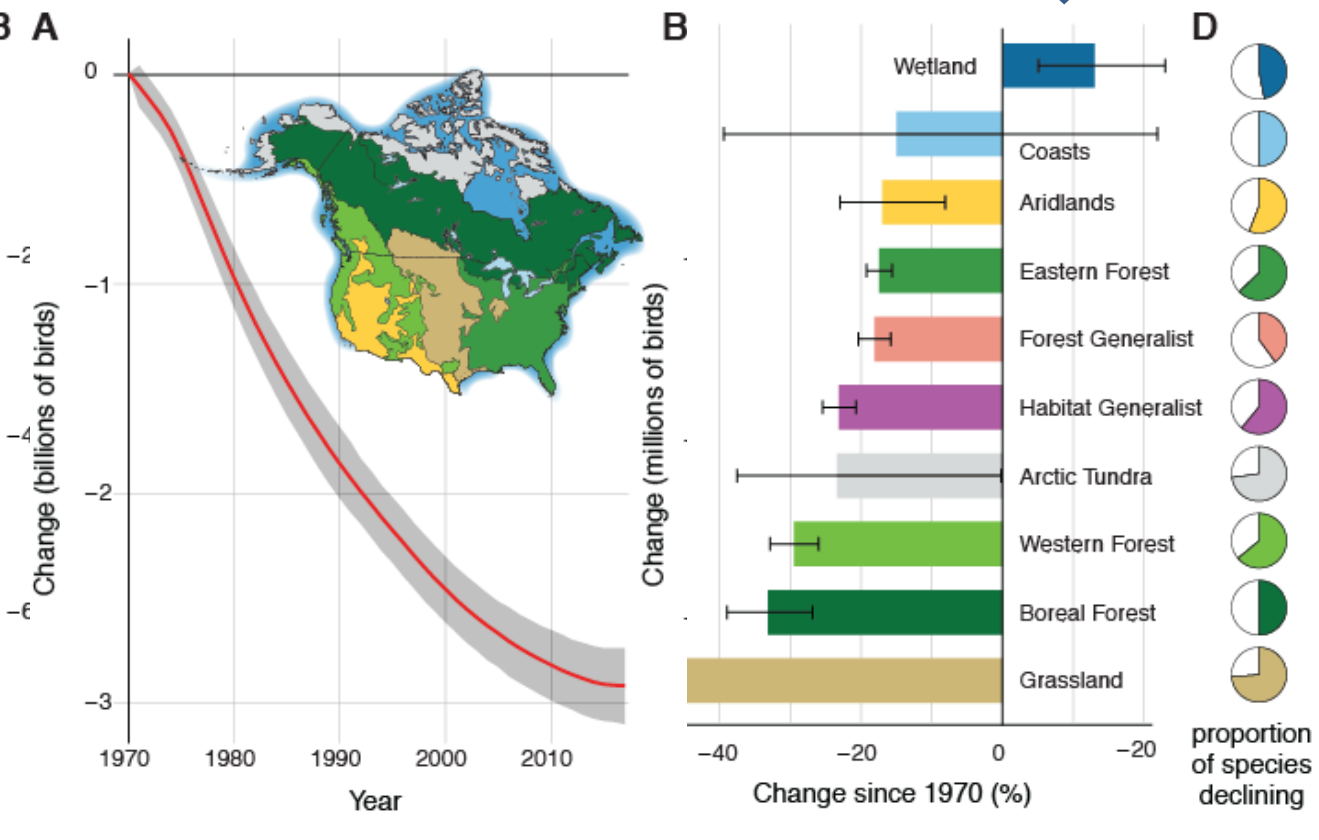
Confirmed Diversity

Mark Anderson PhD. Director of Conservation Science, TNC Eastern US

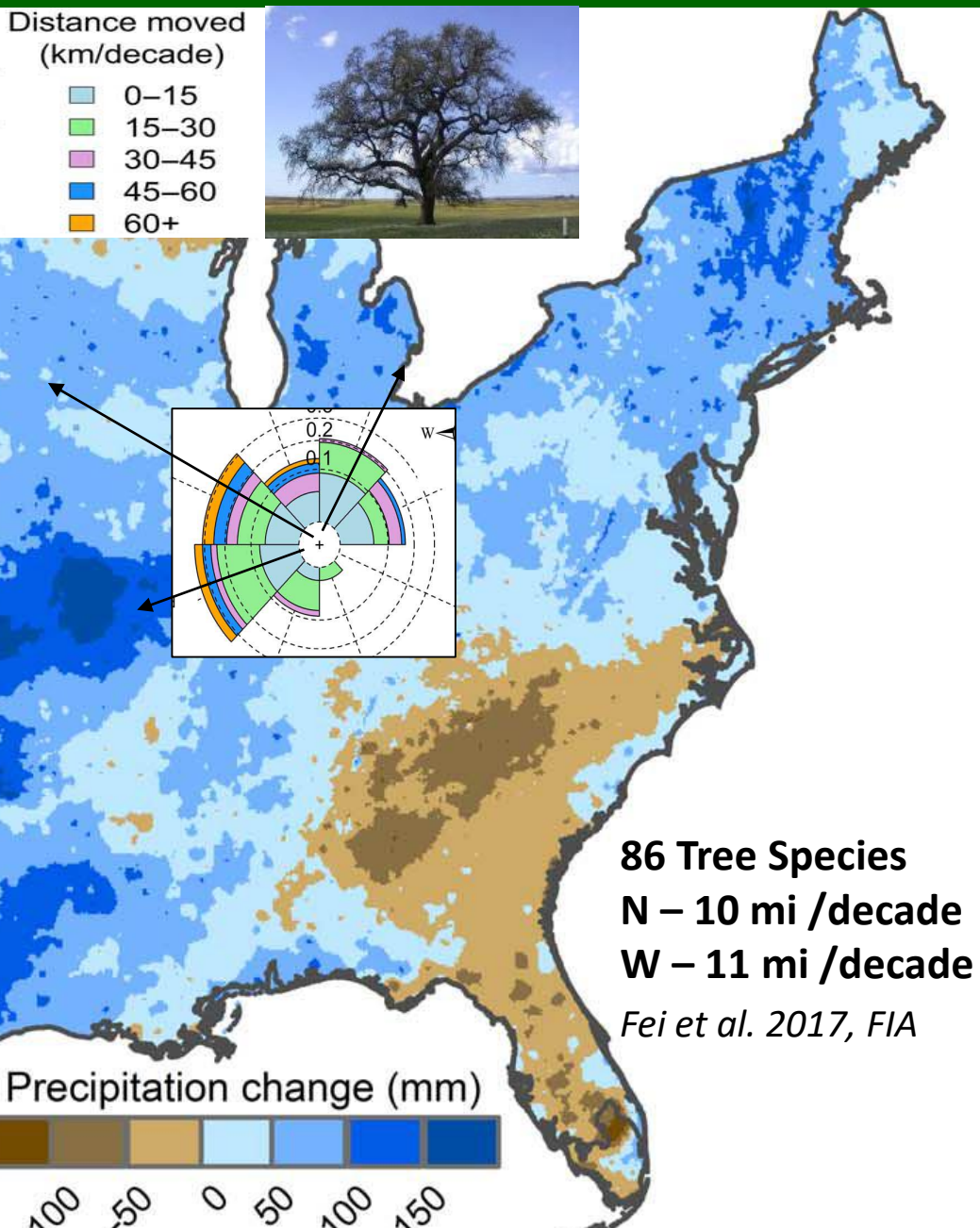
Abundance Crisis

Mammals : Global biomass down 82%
Amphibians: 30% now T &E
Butterflies: Abundance down 35%/ 40 yr
NA Birds: Abundance down 29%
or 3 Billion birds since 1970

Wetland Birds Up: Thanks to Adaptive Harvest Management and billions $ on wetland protection and restoration



Nature is Dynamic



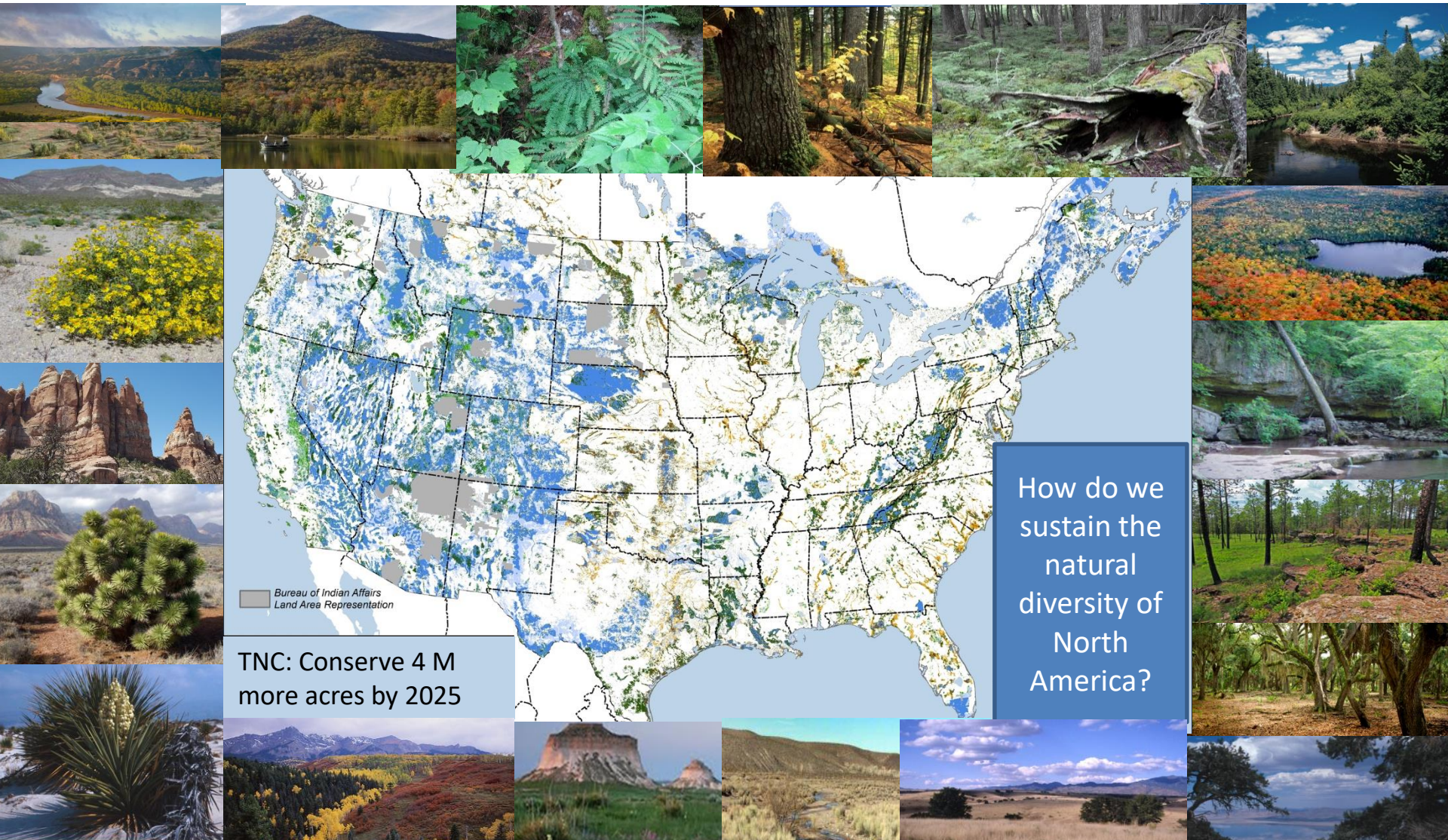
Chen et al. 2015, Science

86 Tree Species
N – 10 mi /decade
W – 11 mi /decade
Fei et al. 2017, FIA

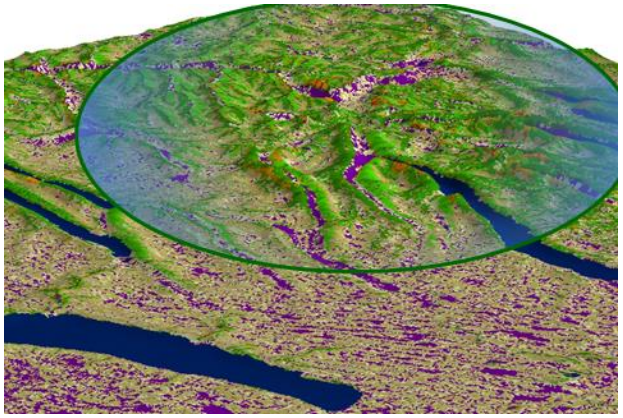
Median residence times range from **200-700** years (overall **500** years) and are shorter during times of warming *McGuire et al. in prep*

Conserve Resilient Land and Water

Conserve a network of resilient sites and connecting corridors that will sustain North America's natural diversity by allowing species to adapt to climate impacts and thrive.

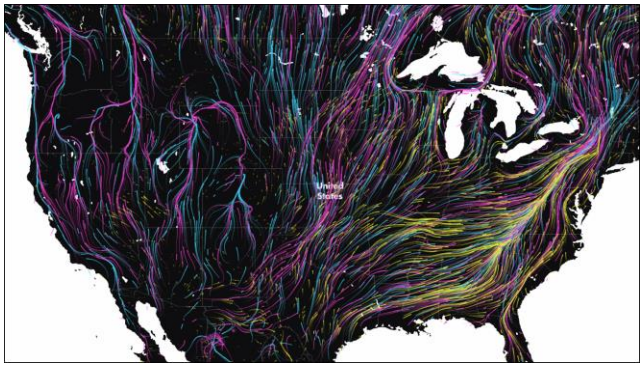


Key Ingredients



Resilient Sites

Land with many connected *microclimates* representing all physical environments



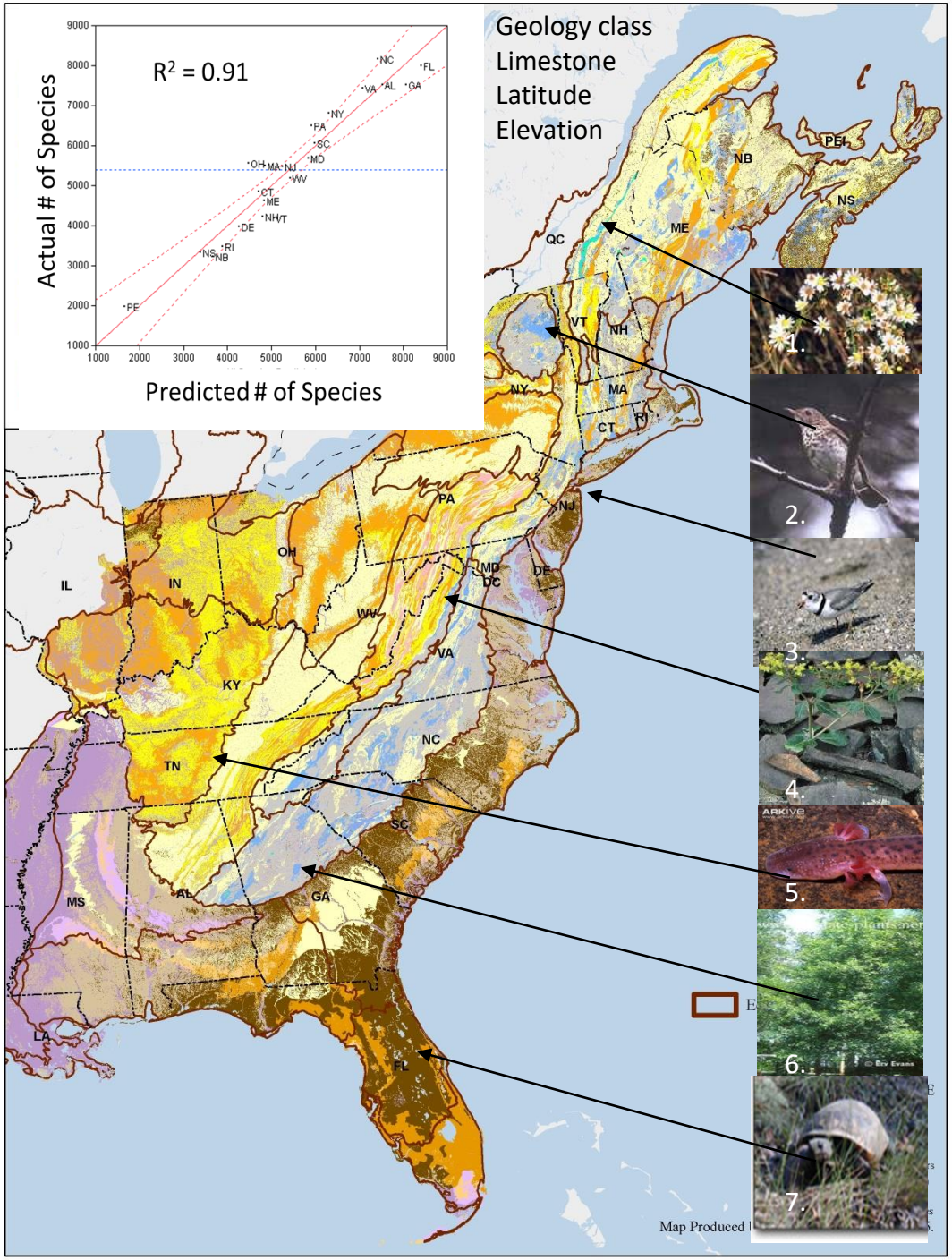
Permeable Landscape

A *connected* landscape that allows movement and facilitates range shifts

Resilient Systems

Intact habitats, unique communities and rare species populations

Conserving Nature's Stage

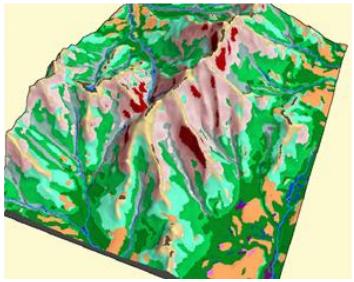


Representative Land

Biological diversity is highly correlated with **Land Properties** (Geology, Soil, Elevation, Topography, Hydrology)

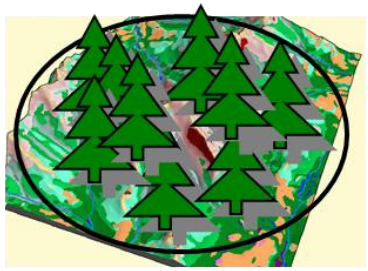
Many Microclimates

Create climate options

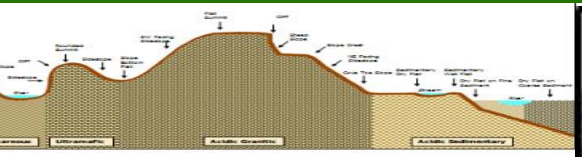


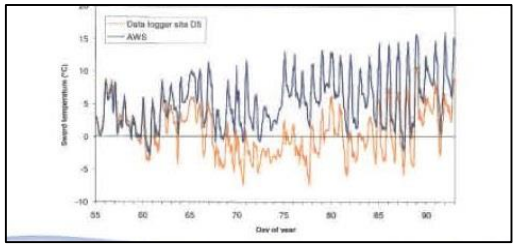
Locally Connected

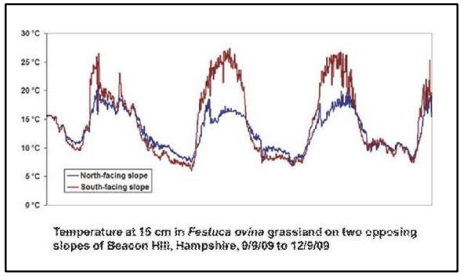
Allows species to move



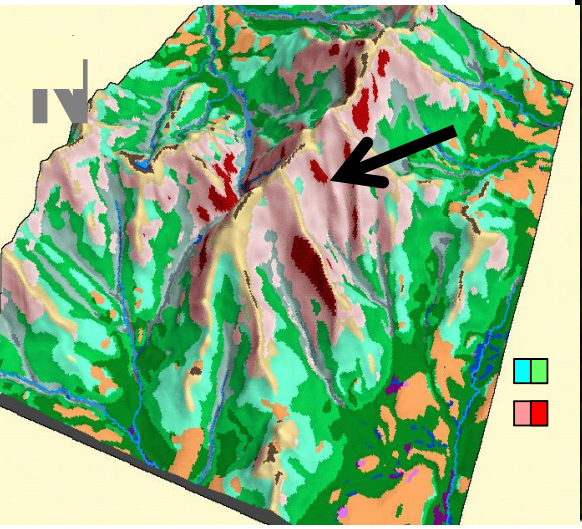
Climate Resilience: Microclimates

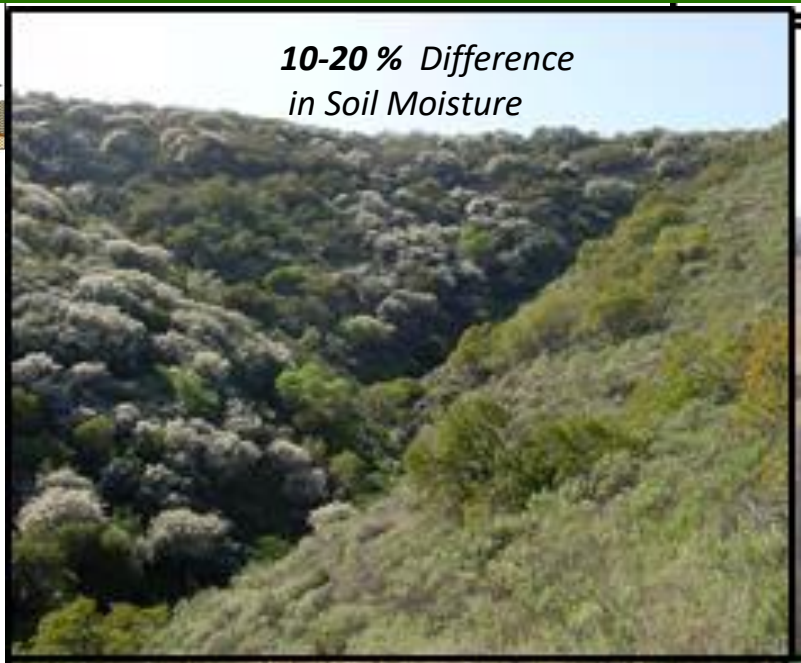




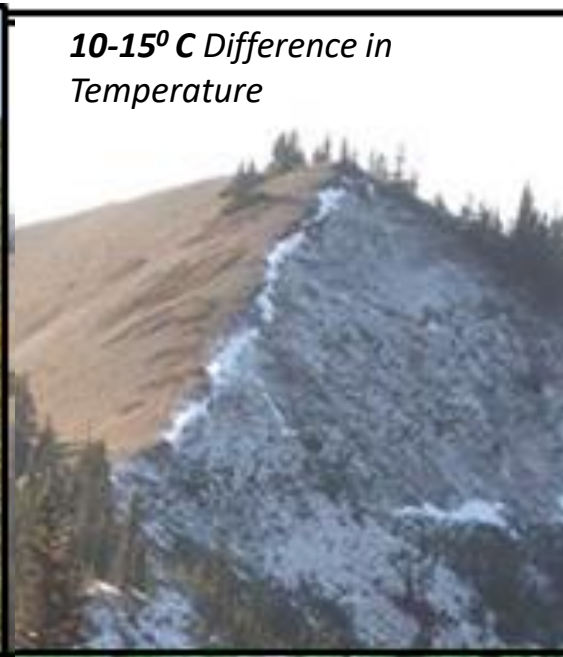


Temperature at 15 cm in *Festuca ovina* grassland on two opposing slopes of Beacon Hill, Hampshire, 9/9/09 to 12/9/09





10-20 % *Difference in Soil Moisture*

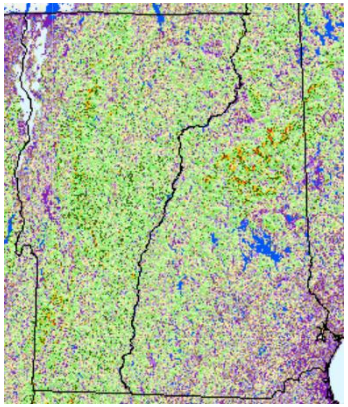


10-15⁰ C *Difference in Temperature*

Climate Resilience: Microclimates

- Far Above Average
- Above Average
- Slightly Above Average
- Average
- Slightly Below Average
- Below Average
- Far Below Average

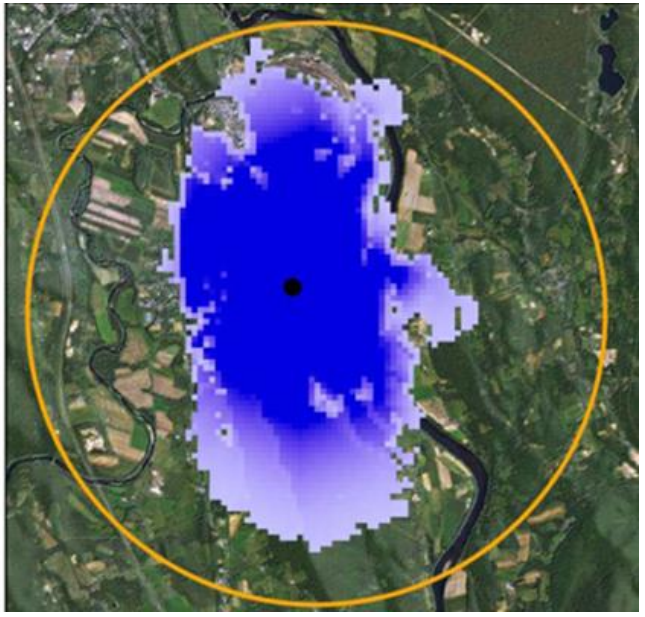
Relative to **Ecoregion** and **Geophysical Setting**



Climate Resilience:
Local Connectedness

Category	Weight
Developed	
-Low intensity	8
-Mid intensity	9
-High intensity	20
-Mine	9
Roads/Linear	
-Major	20
-Minor	10
-Unpaved	+1
-Transmission	9
-Pipelines	9
-Railroads	9
Agriculture	
-Corn/Soy	9
-Other Ag	7
-Hay Pasture	3
-Forestry (indust.)	4
Energy	
-Oil & Gas	7+
-Wind	+1
-Solar	

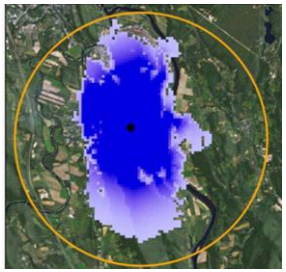
Natural	Weight
All Vegetation Types	1
Barrens	1
Water (by size)	1-3*



Vermont: Local Connectedness

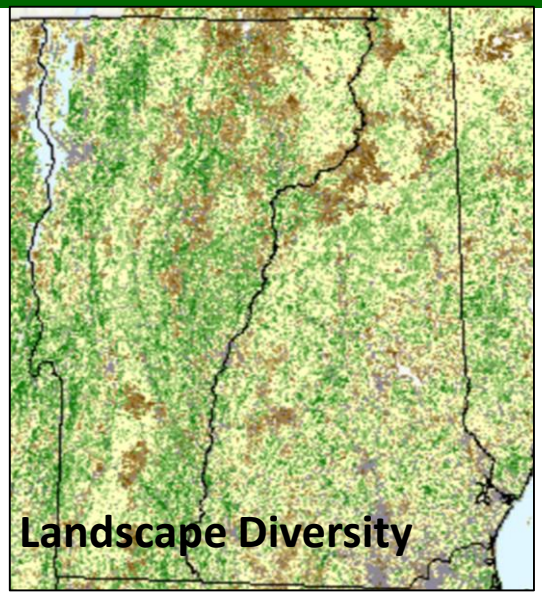
- Far Above Average
- Above Average
- Slightly Above Average
- Average
- Slightly Below Average
- Below Average
- Far Below Average

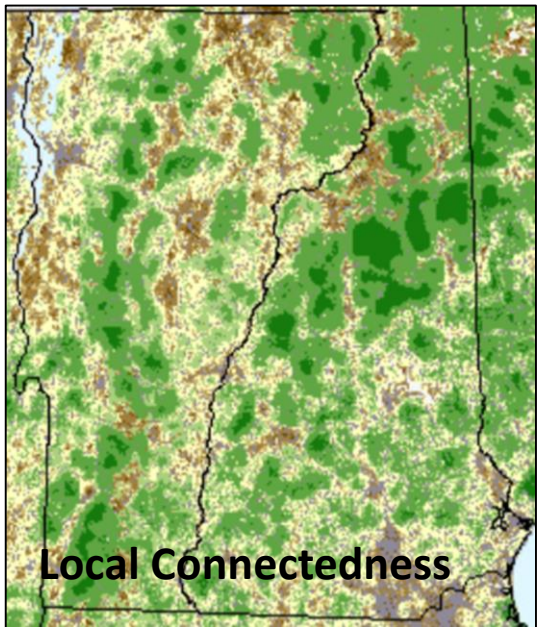
Relative to **Ecoregion** and **Geophysical Setting**



Vermont: Resilient Land

Site Resilience by Ecoregion





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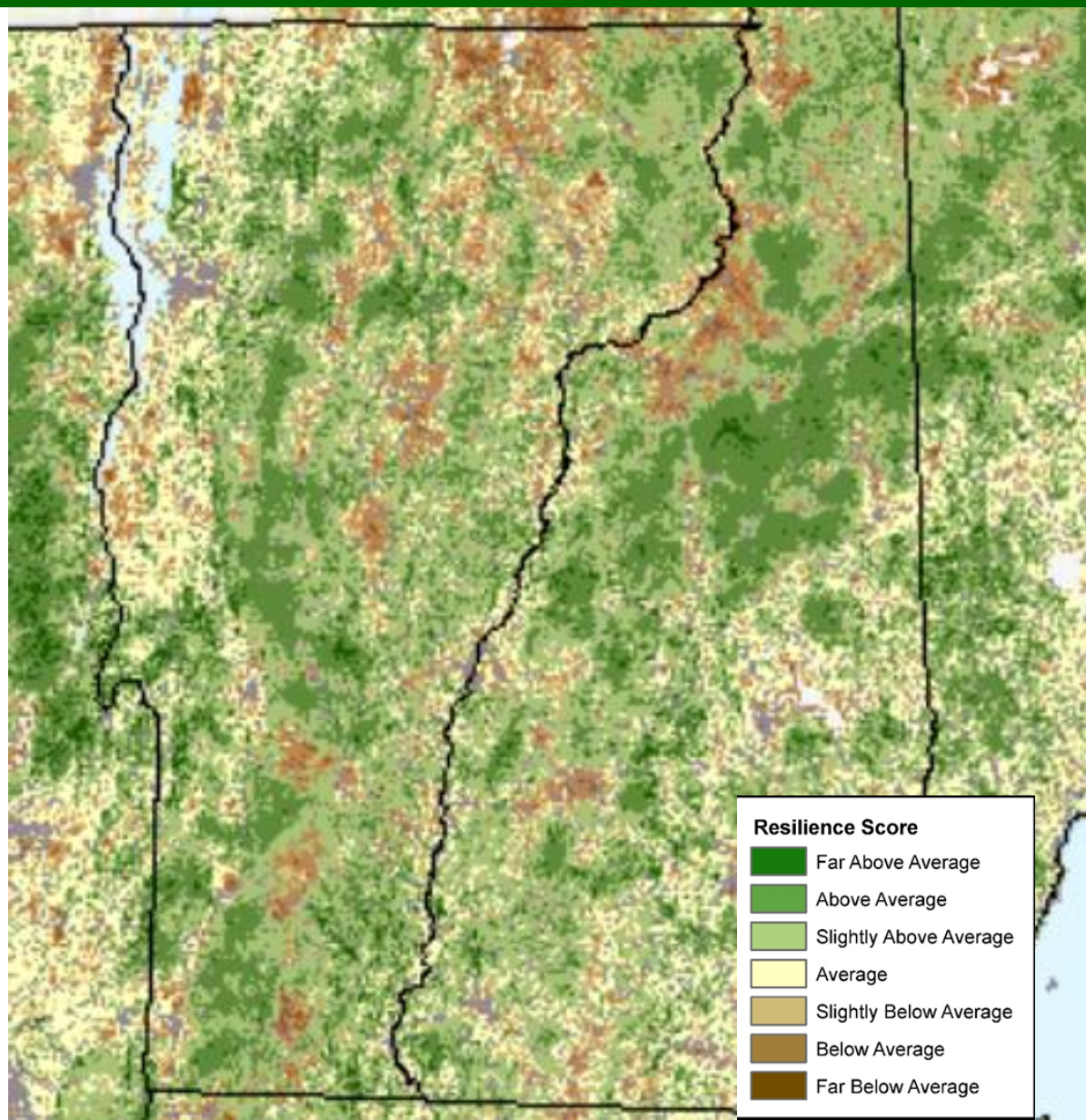
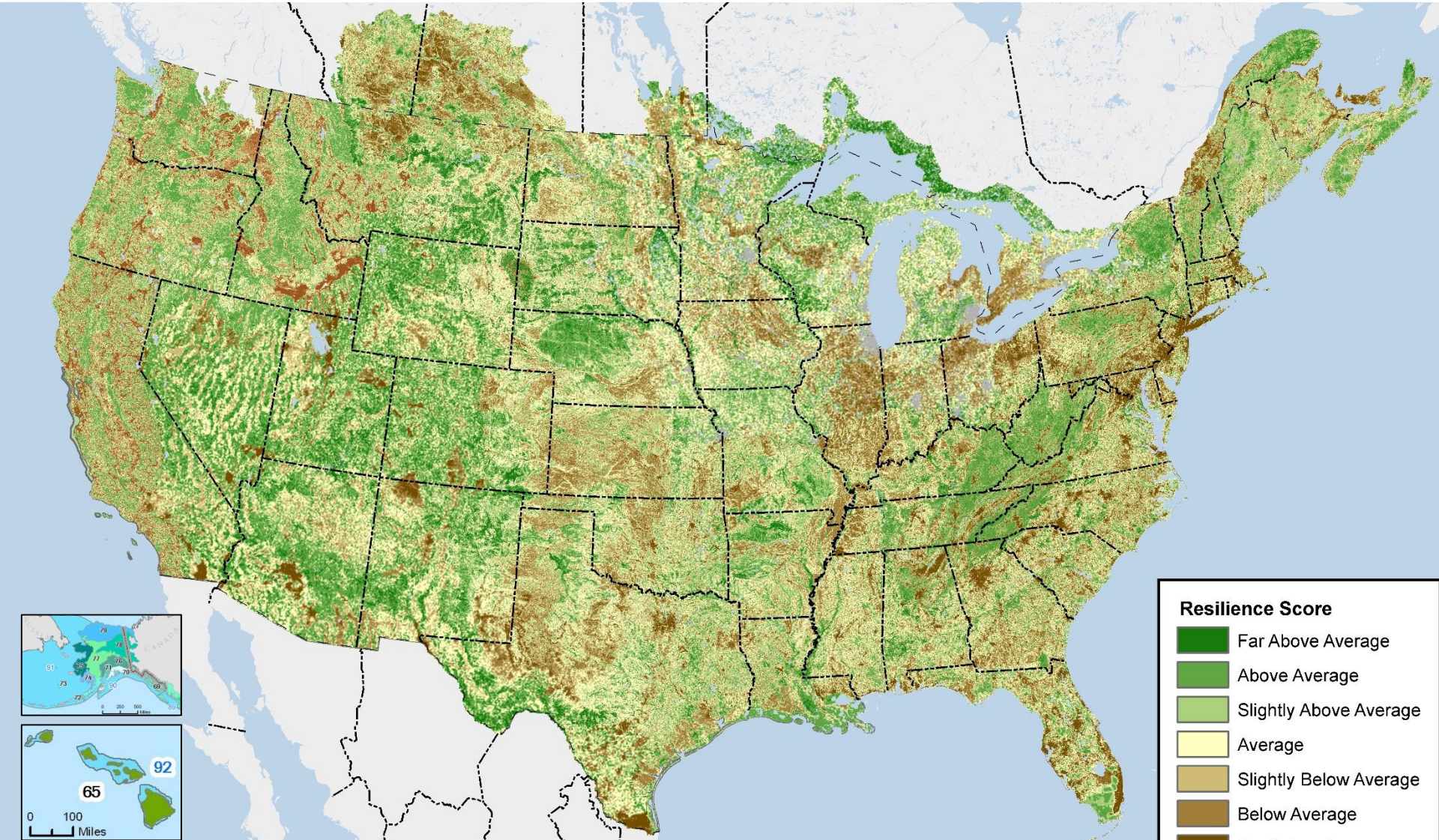
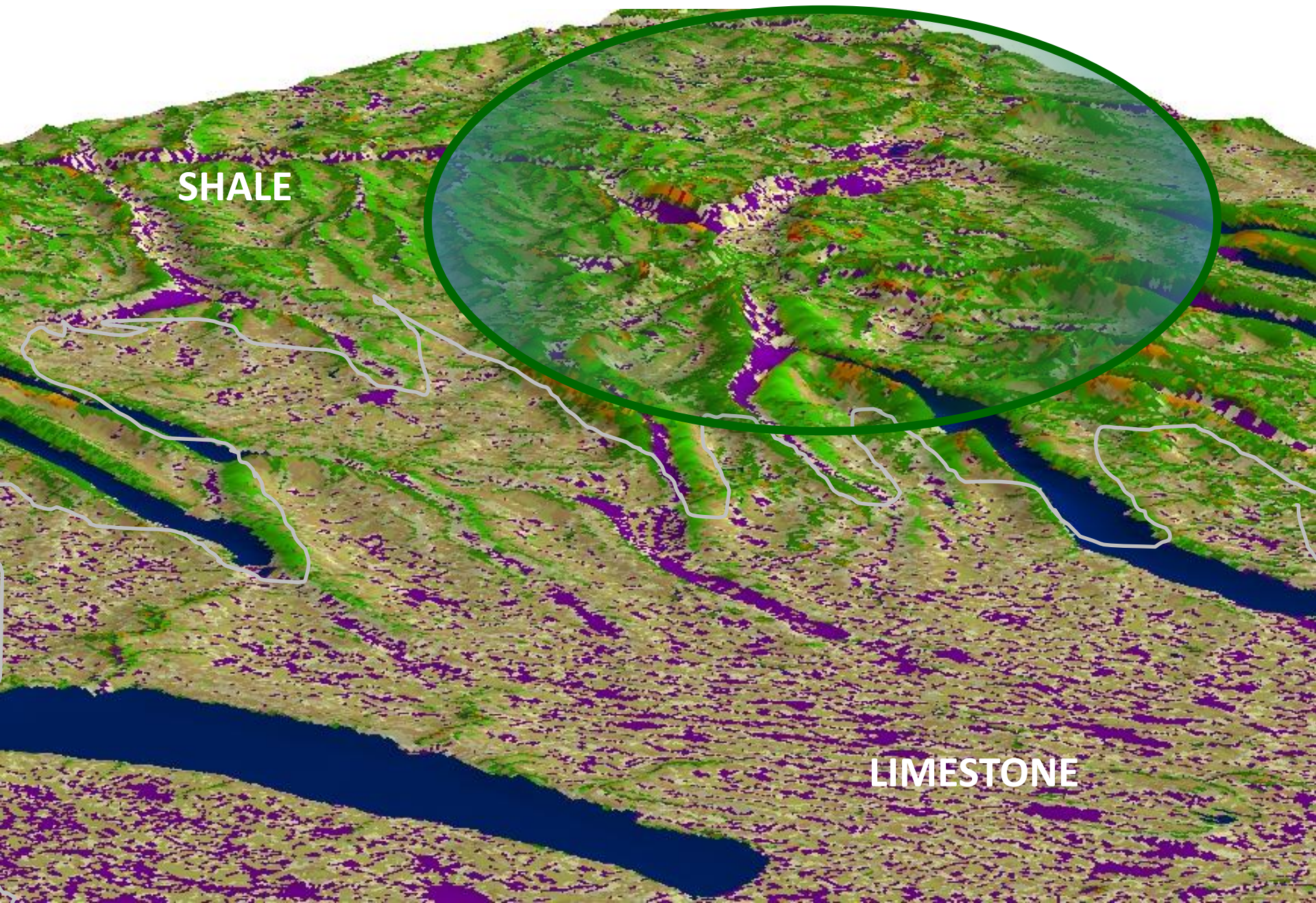


Resilient Land Map

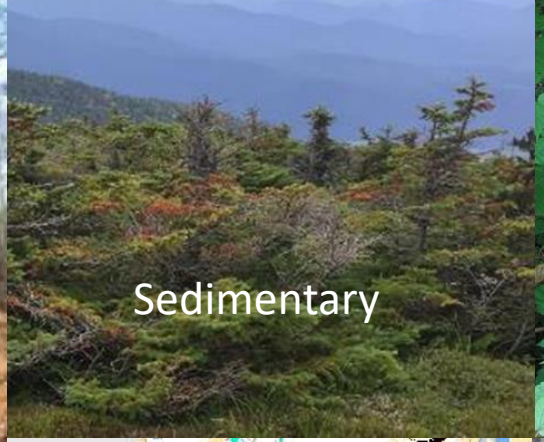
Green = Land with the most microclimates in a connected landscape relative to their ecoregion and setting



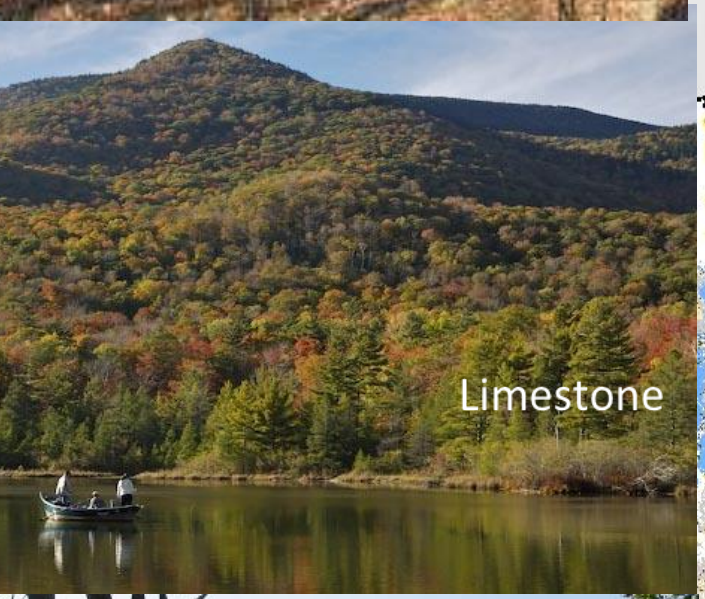
Complex and Connected = Many Options

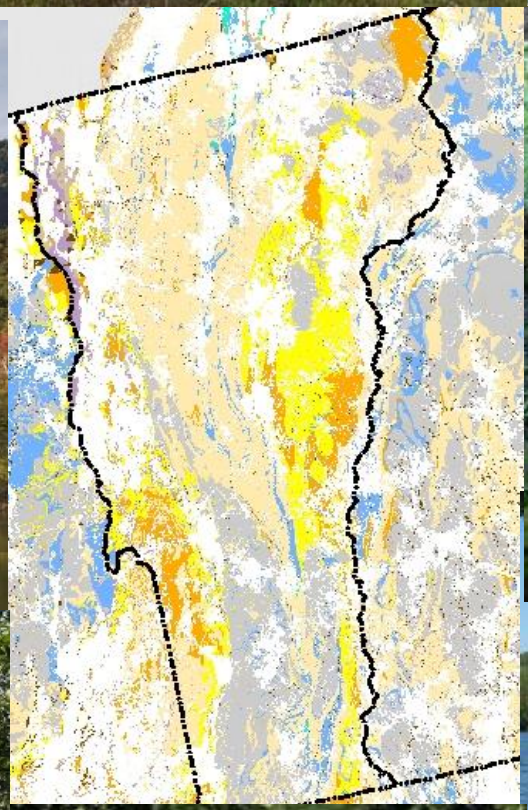



Clay


Sedimentary

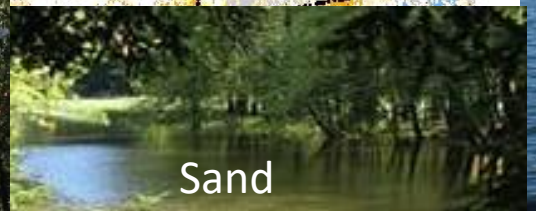

Ultra-Mafic


Limestone



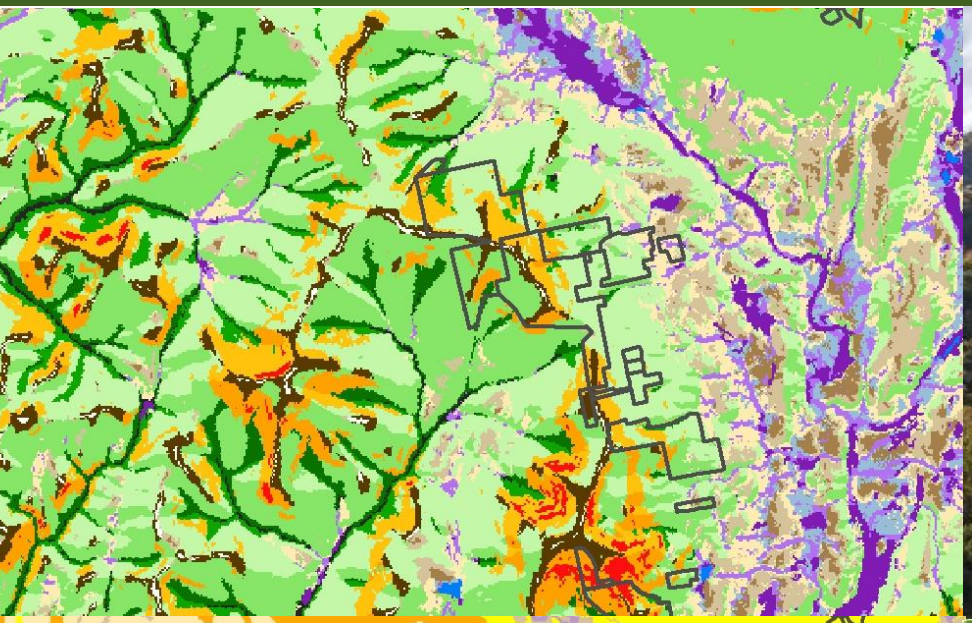

Limestone

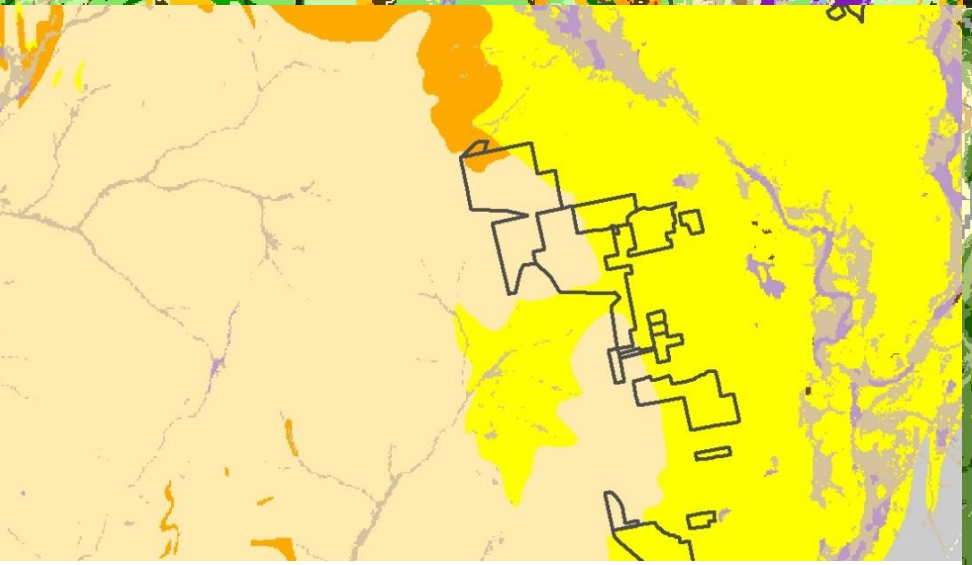

Mod
Calcareous


Sand


Granitic

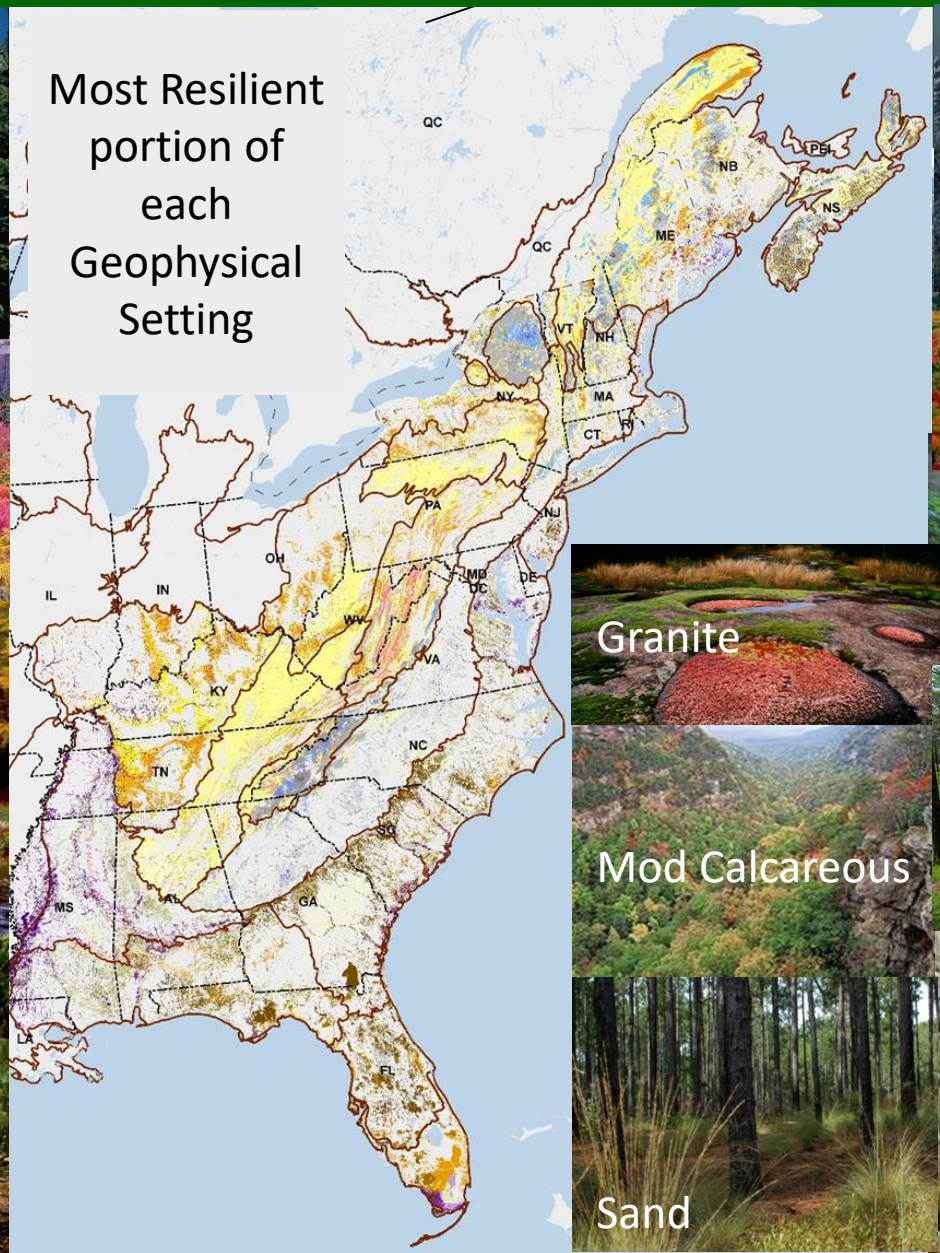
Acidic Sedimentary/ Calcareous: Equinox Highlands

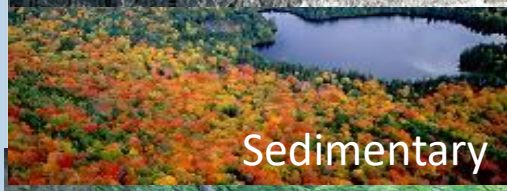


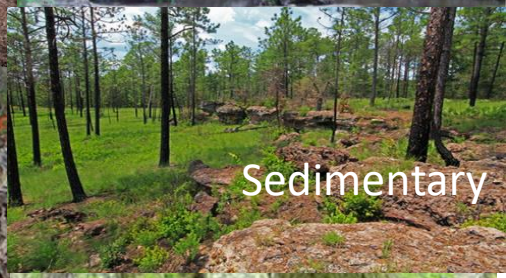


Representation & Resilience

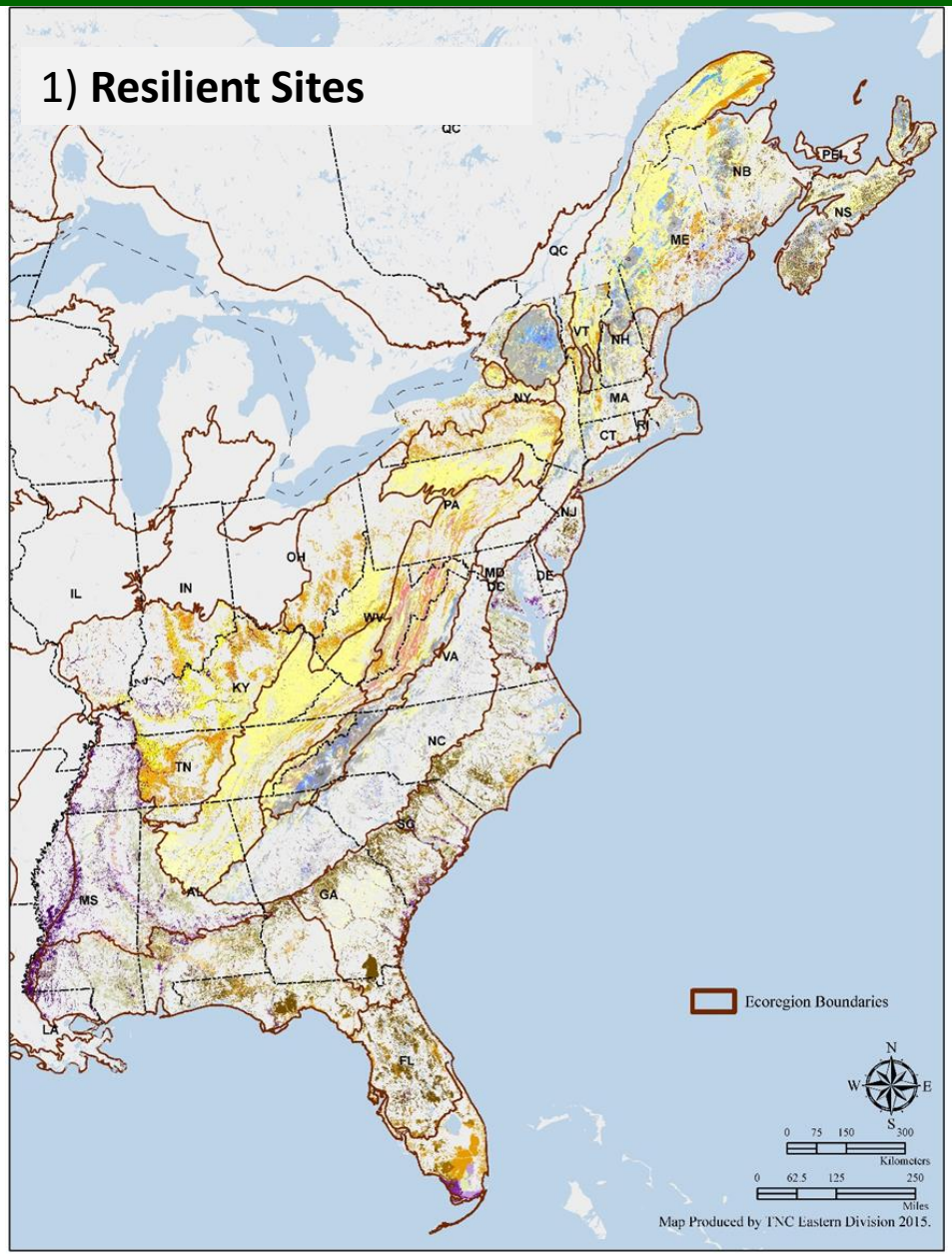
About 33% of each Geophysical Environment in each Ecoregion

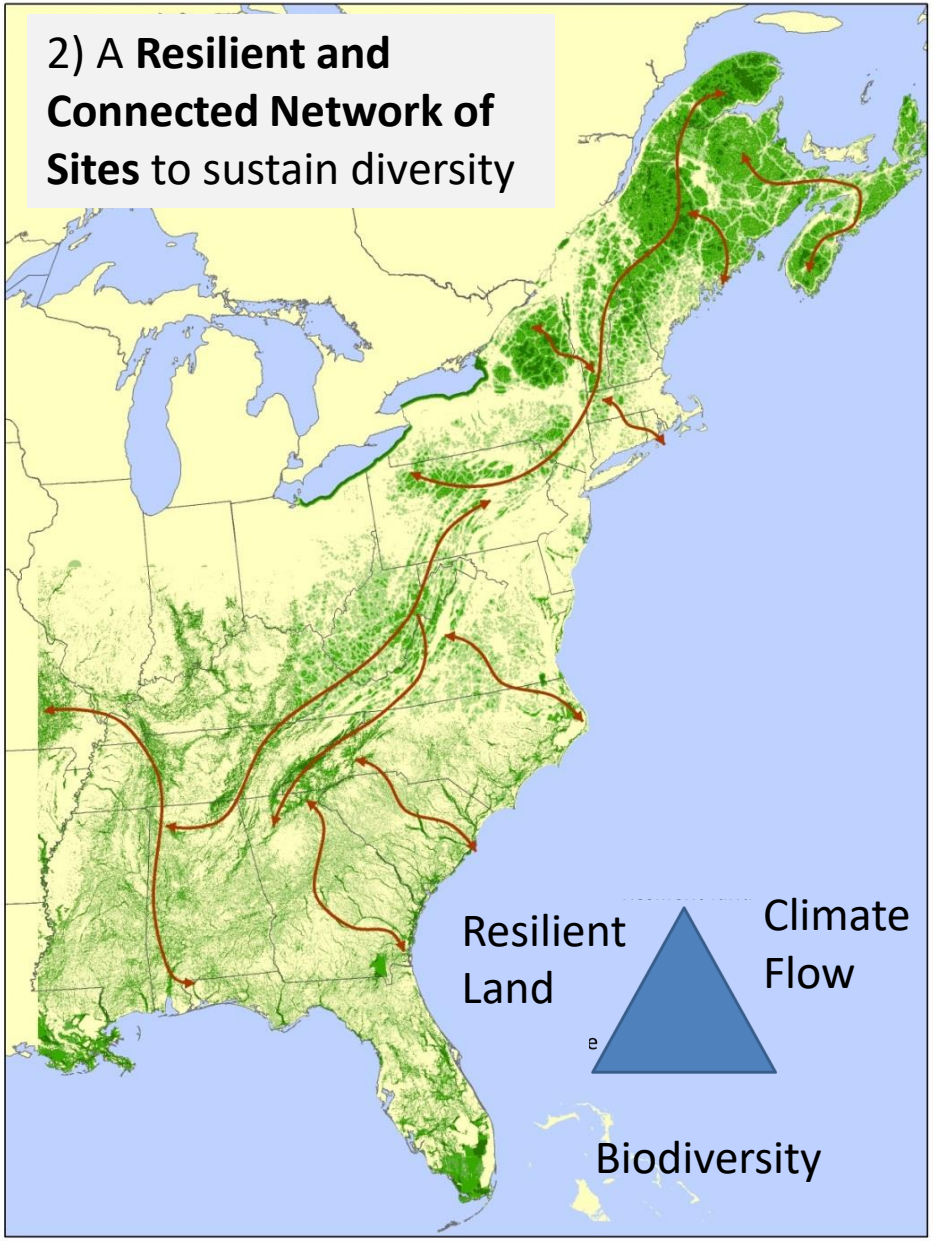






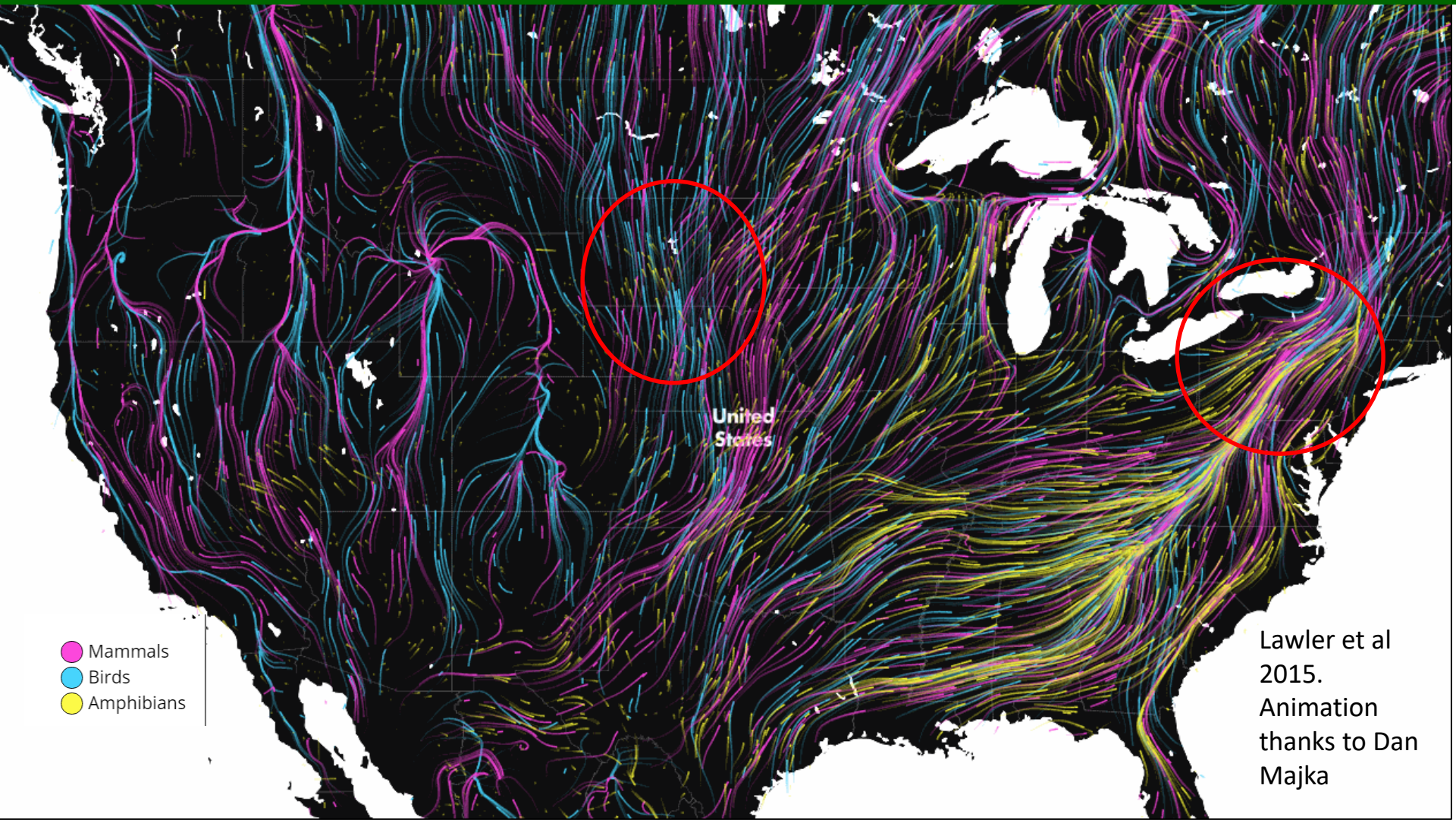
Maintaining a Permeable Landscape





Climate Flow

The Gradual Movement of Populations in Response to Climate Change



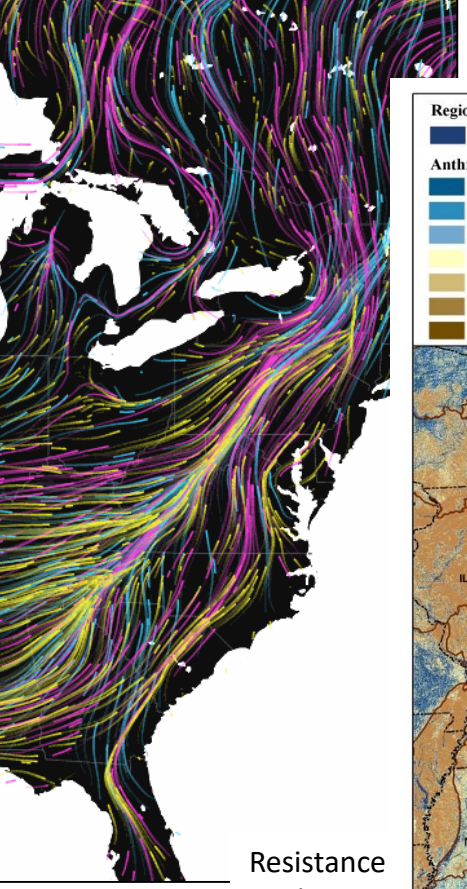
The gradual movement of populations across the landscape in response to climate change

Current Rates: 11 mile per decade North **36 feet** per decade Upslope

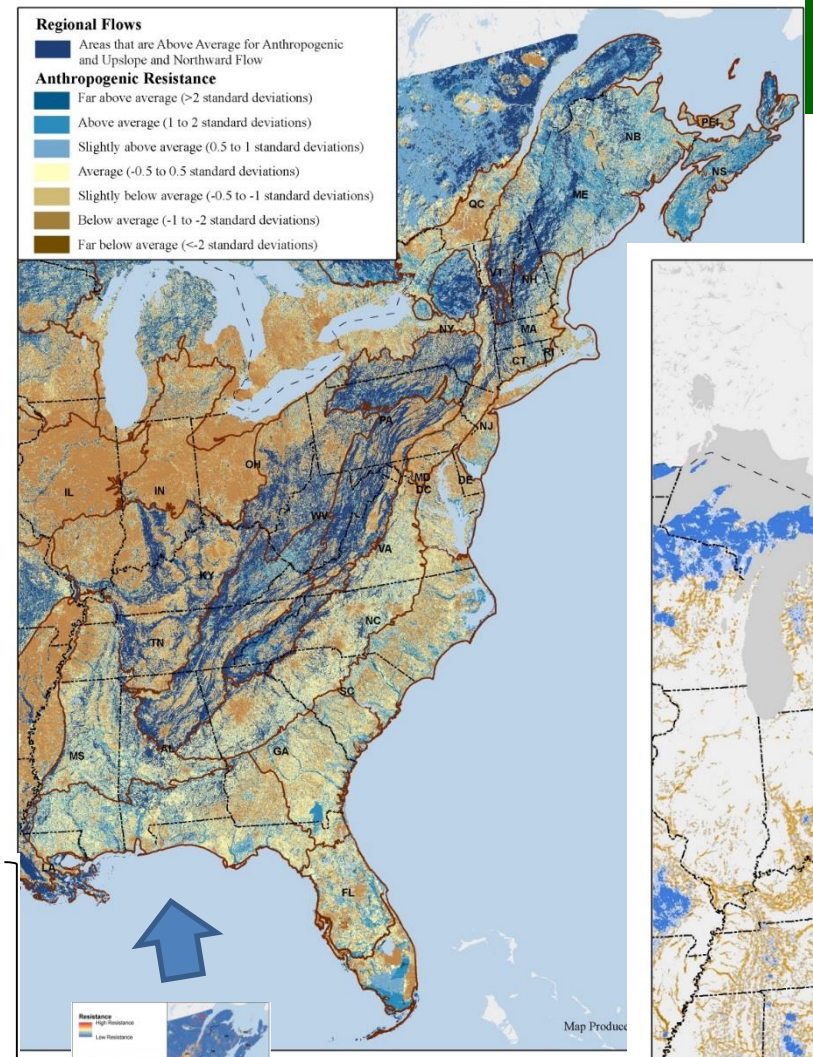
Climate Flow

(wall to wall Circuitscape)

Thanks to
Brad McRae

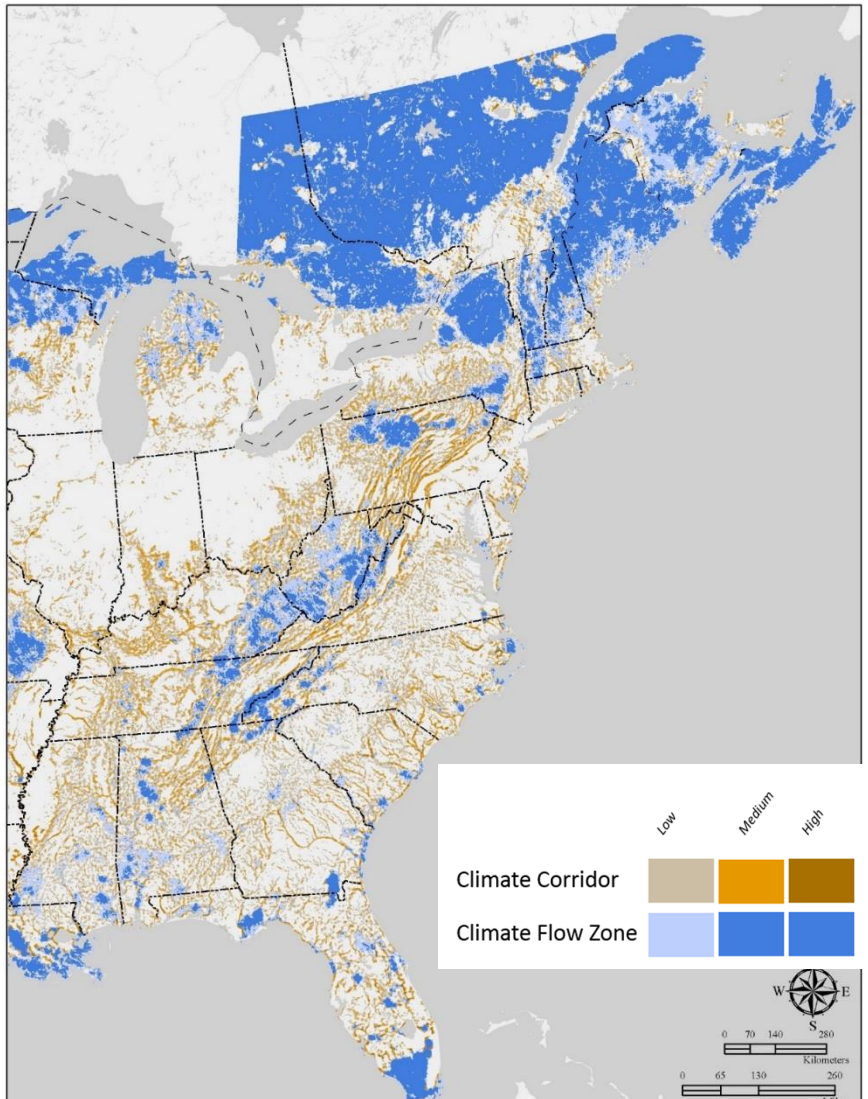


Resistance Grid

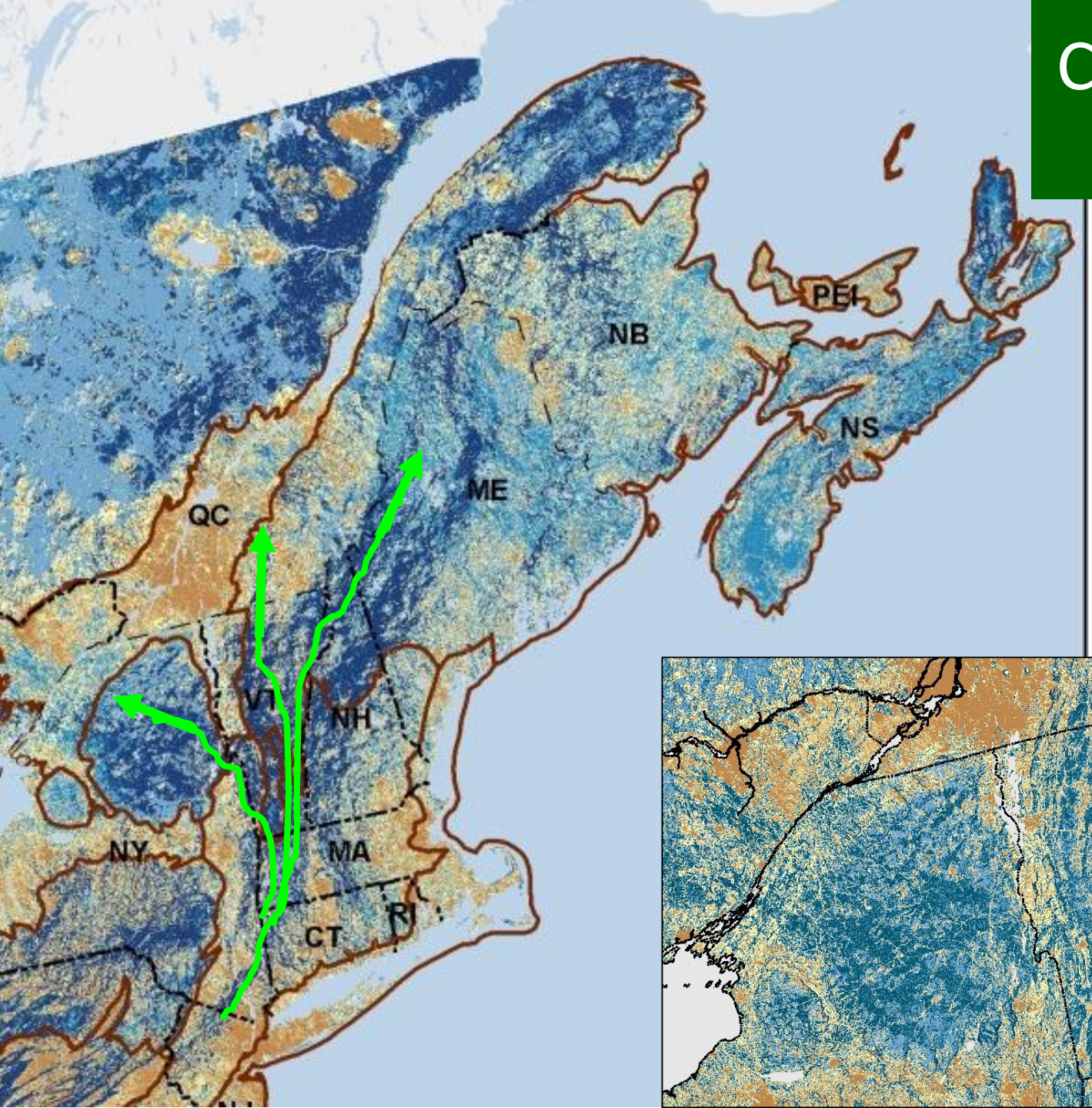


Category	Weight
Developed	
-Low intensity	8
-Mid intensity	9
-High intensity	20
-Mine	9
Roads/Linear	
-Major	20
-Minor	10
-Unpaved	+1
-Transmission	9
-Pipelines	9
-Railroads	9
Agriculture	
-Corn/Soy	9
-Other Ag	7
-Hay Pasture	3
-Forestry (indust.)	4
Energy	
-Oil & Gas	7+
-Wind	+1

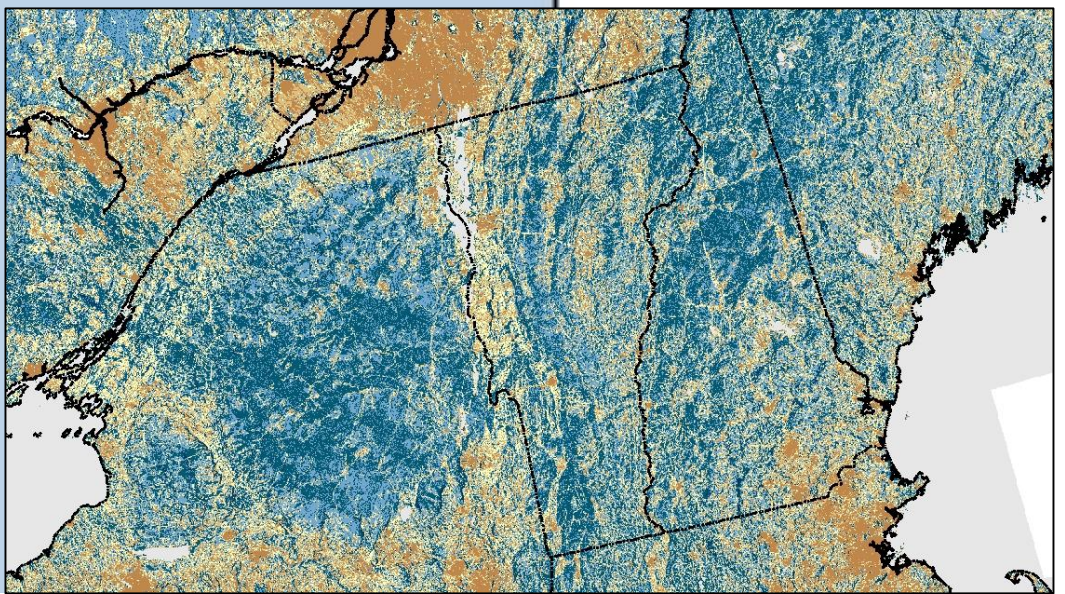
Based on same Resistance Grid as Local Connectedness



Climate Flow
Vermont

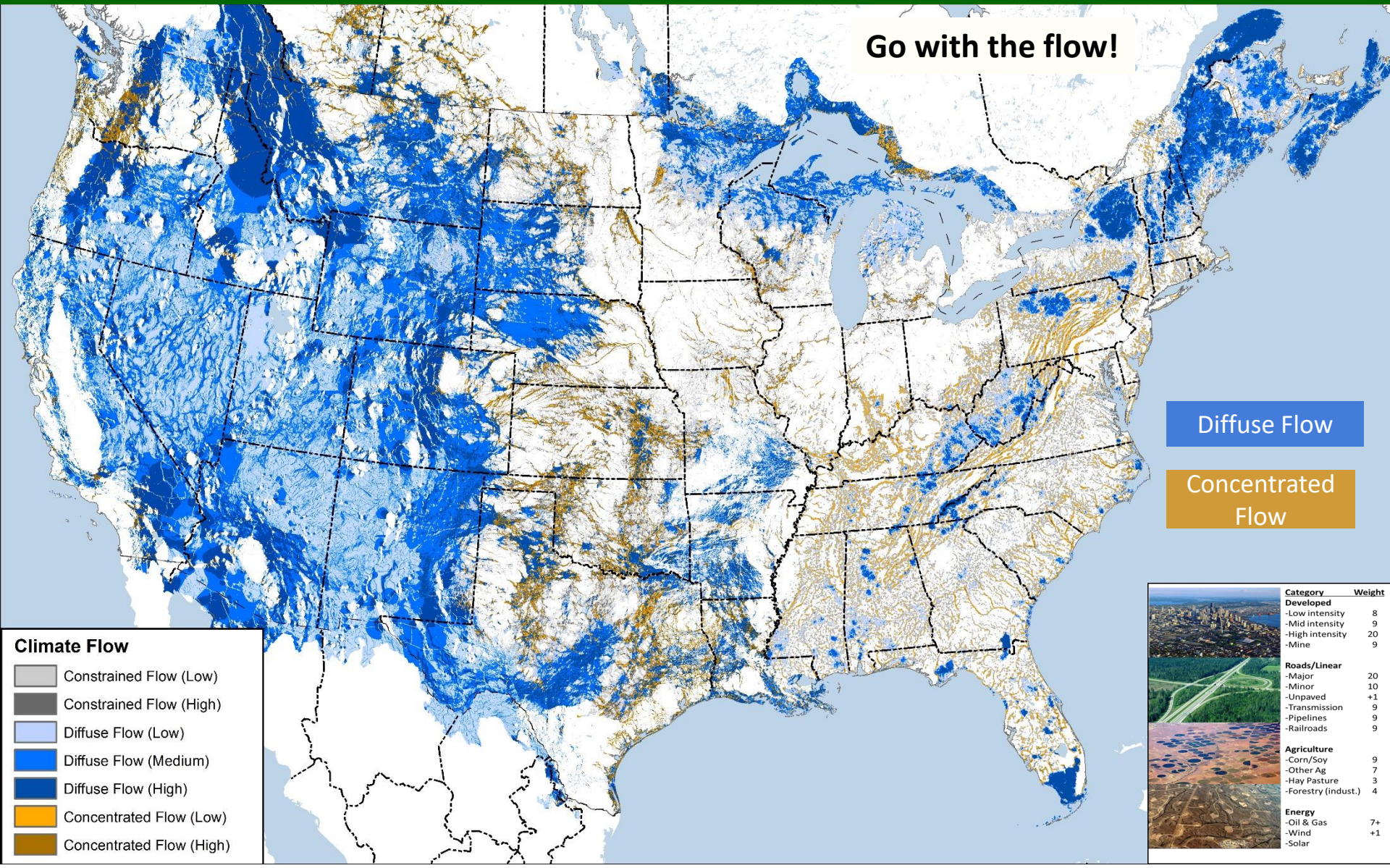


Where does flow get channeled into pinch points?



Climate Flow

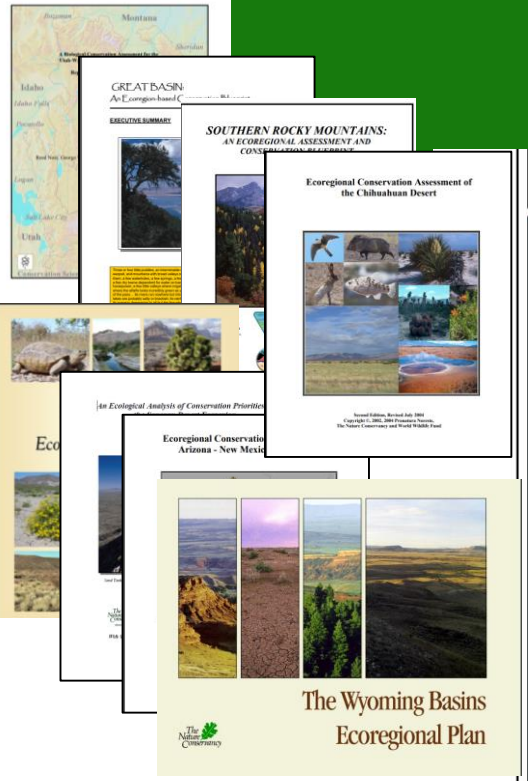
The gradual movement of species populations in response to a changing climate

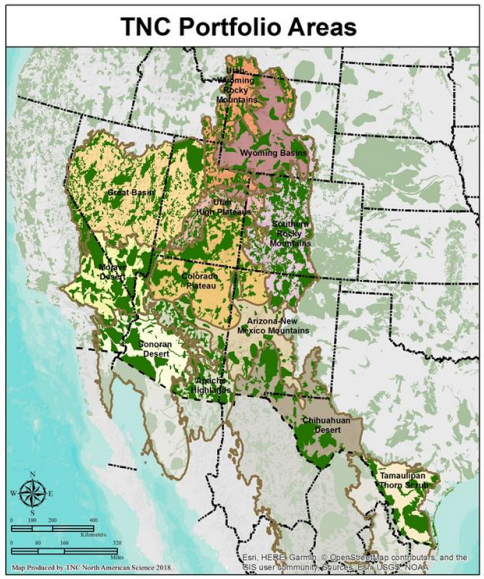


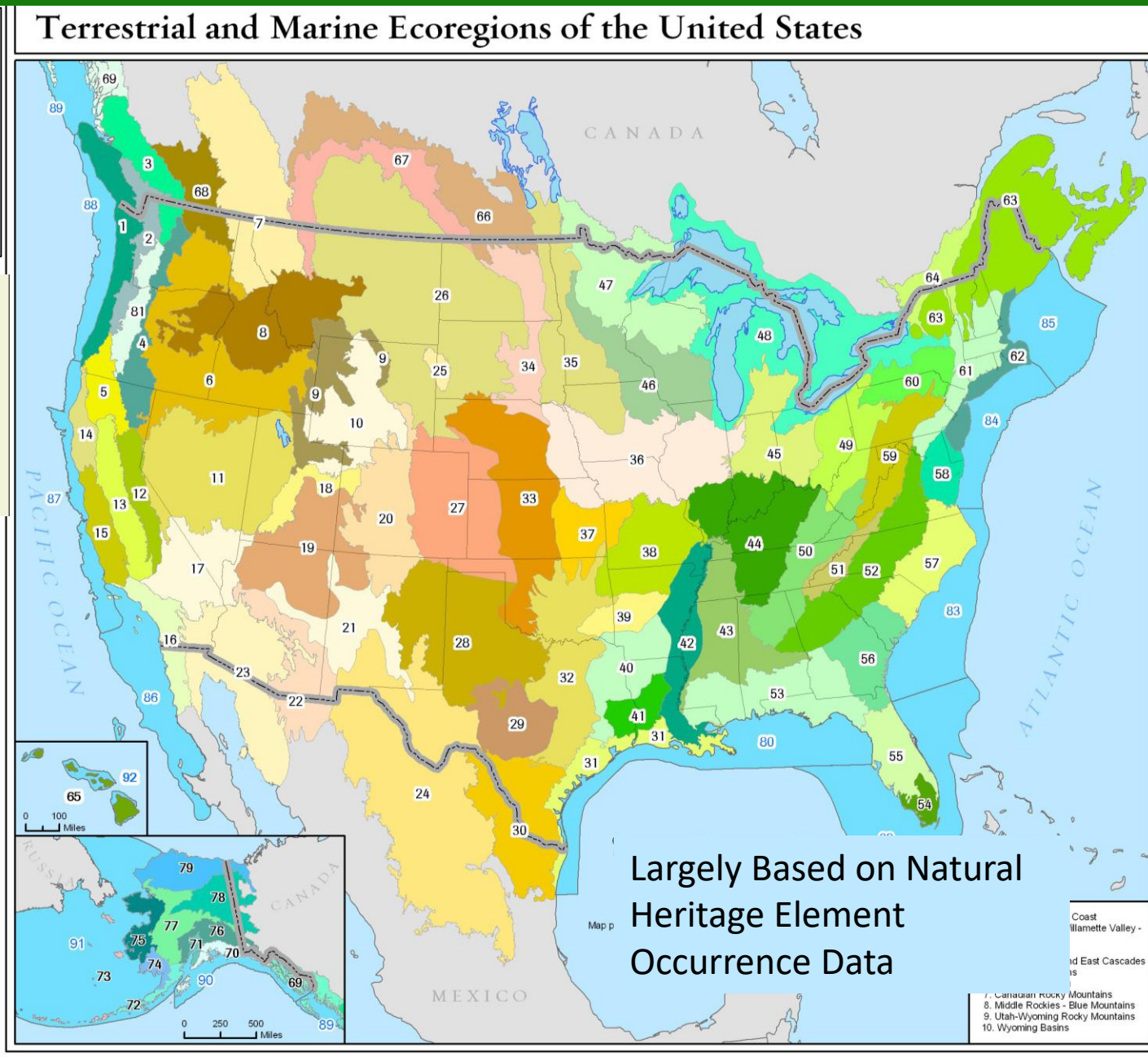
Resilient Ecosystems

Intact Habitats
Rare Species Populations
Unique Communities

Biodiversity Assessments







Biodiversity Assessments

VERMONT CONSERVATION DESIGN

MAINTAINING AND ENHANCING AN ECOLOGICALLY FUNCTIONAL LANDSCAPE

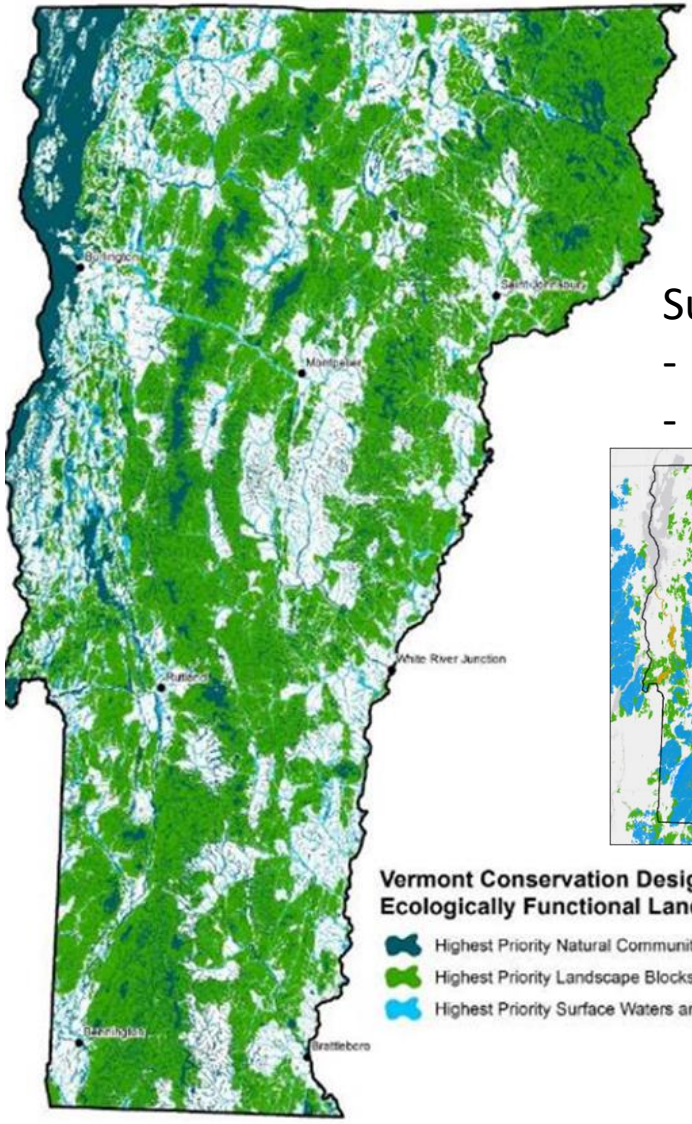
Summary Report for
Landscapes, Natural Communities, Habitats, and Species

February 2018

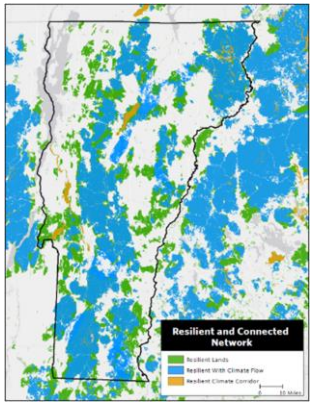
Eric Sorenson and Robert Zaino

Core Participants:
Jens Hilke, Doug Morin – Vermont Fish and Wildlife Department
Keith Thompson – Vermont Department of Forests, Parks and Recreation
Elizabeth Thompson – Vermont Land Trust

VERMONT
AGENCY OF NATURAL RESOURCES
Respect. Protect. Enjoy.



Subset
- resilient
- high flow

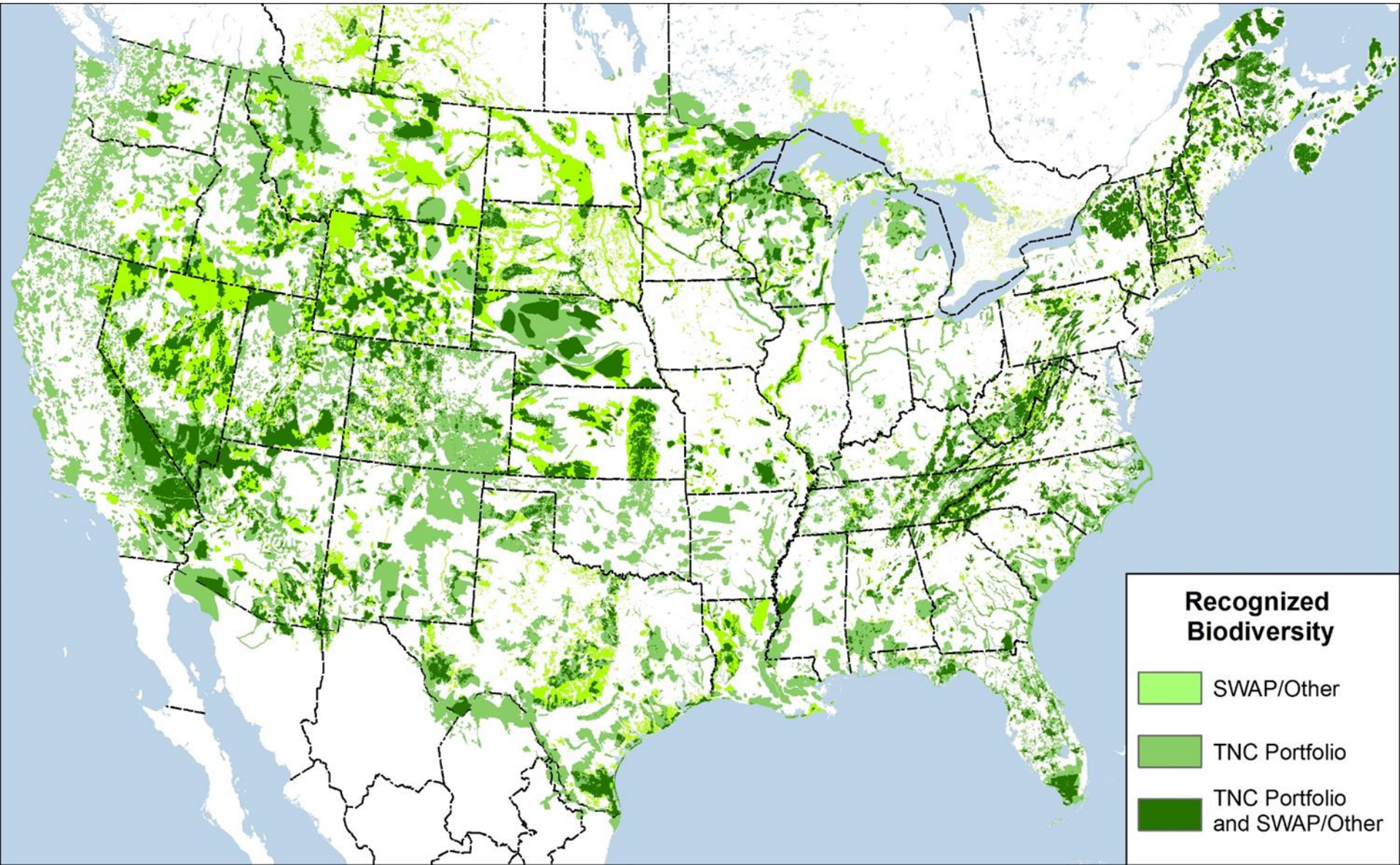


Vermont Conservation Design
Ecologically Functional Landscape

- Highest Priority Natural Community & Habitat Features
- Highest Priority Landscape Blocks
- Highest Priority Surface Waters and Riparian Areas

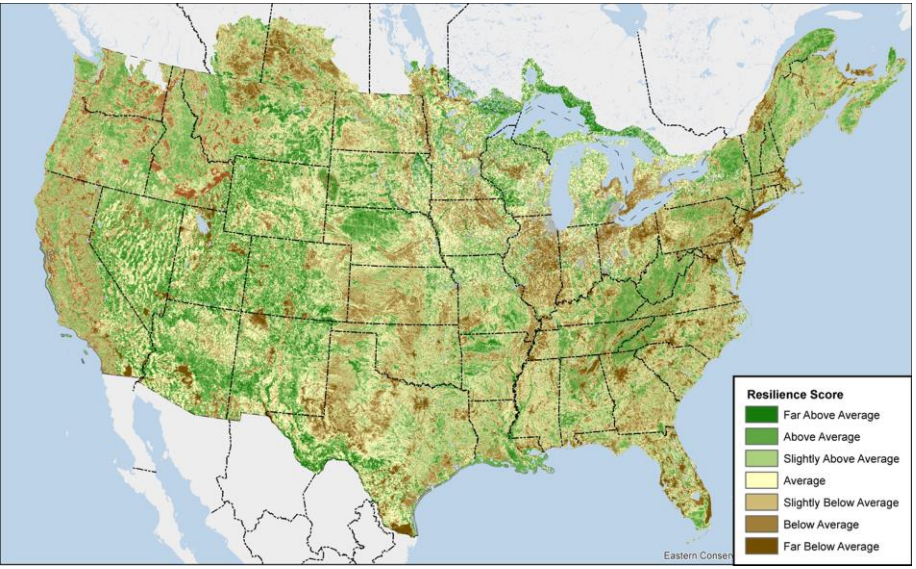
Recognized Conservation Value

(Places with confirmed diversity or critical habitat TNC Ecoregional Plans, SWAPs, NHP)

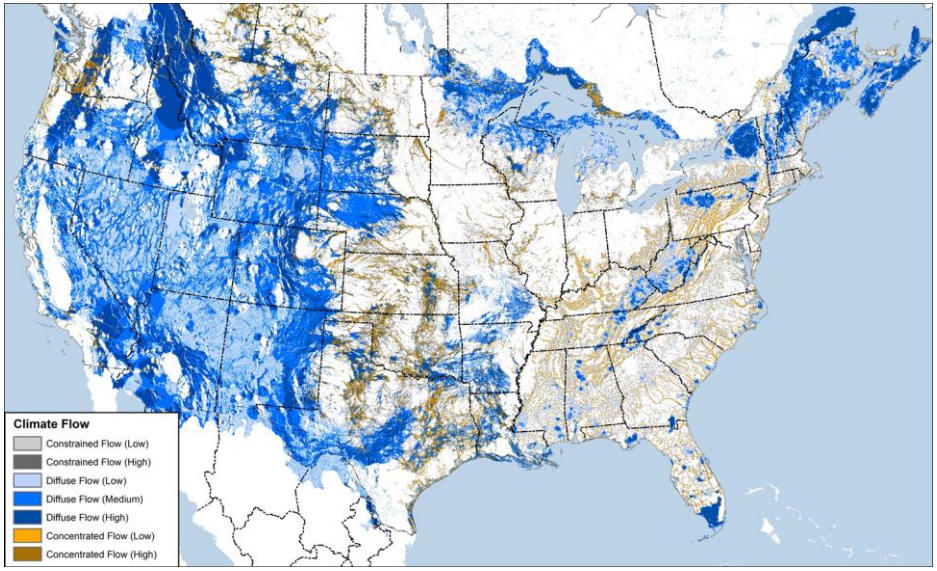


Resilient and Connected Network

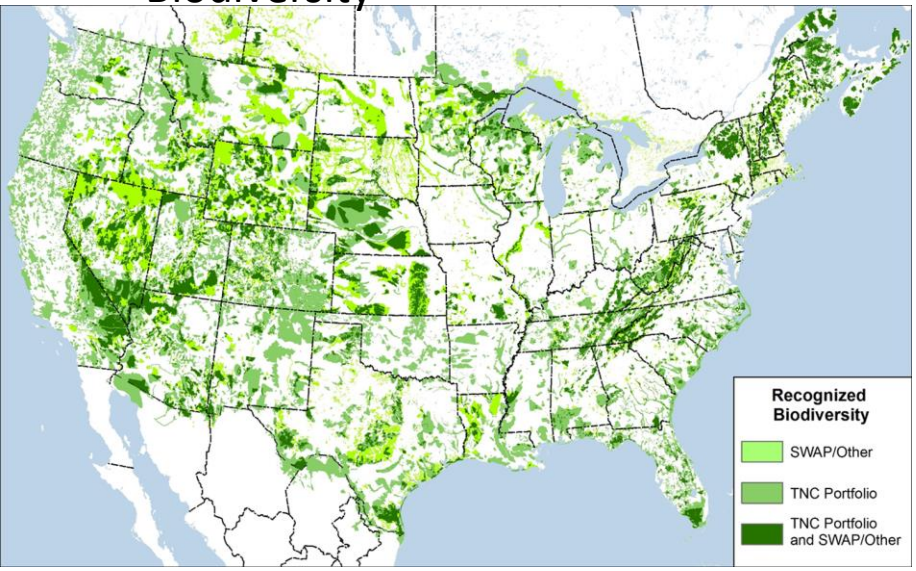
Site Resilience



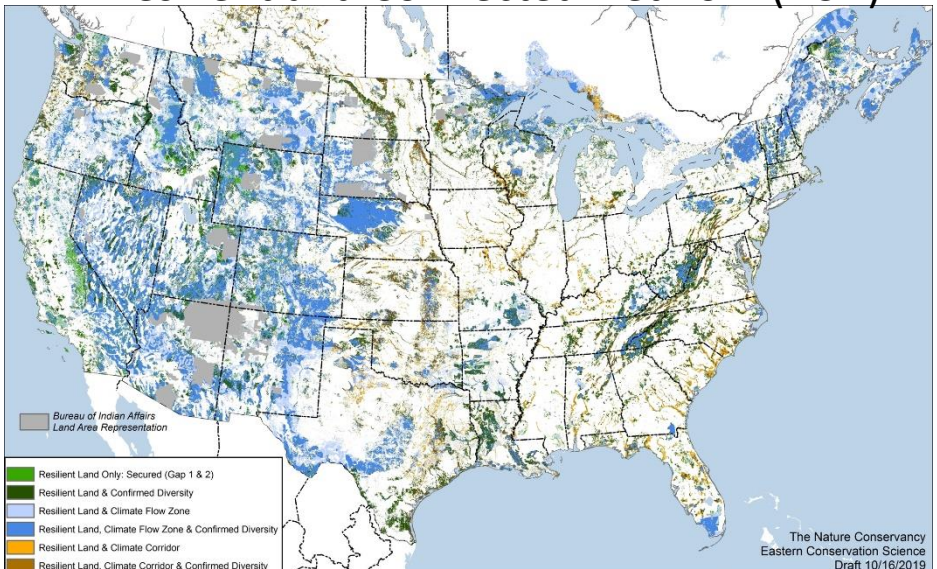
Climate Flow



Biodiversity



Resilient and Connected Network (RCN)

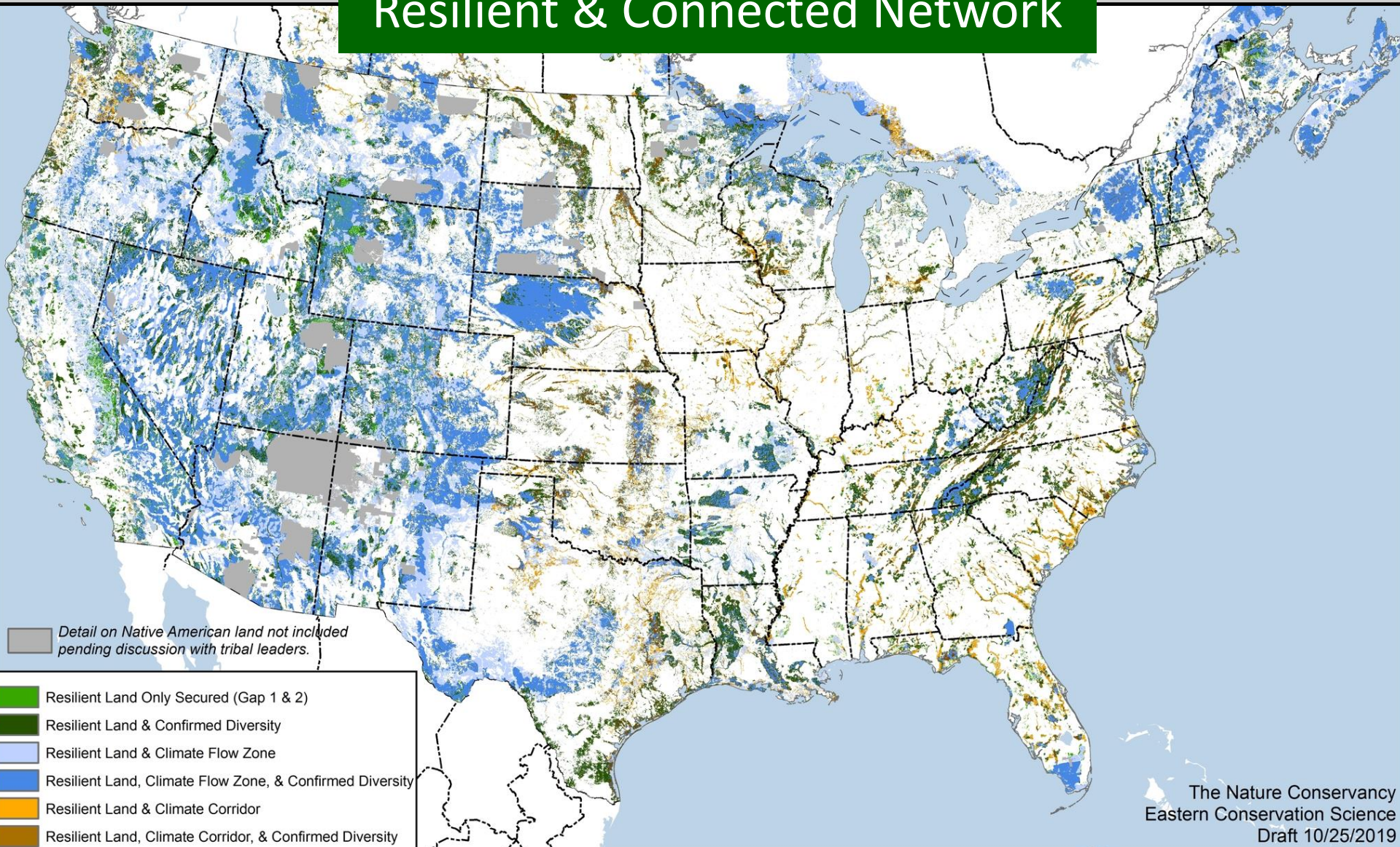


33 % of Land Area *-Resilient examples of all environments,* ***46%*** *Secured against conversion*

Over 250,000 *occurrences of intact habitats, rare species, unique communities*

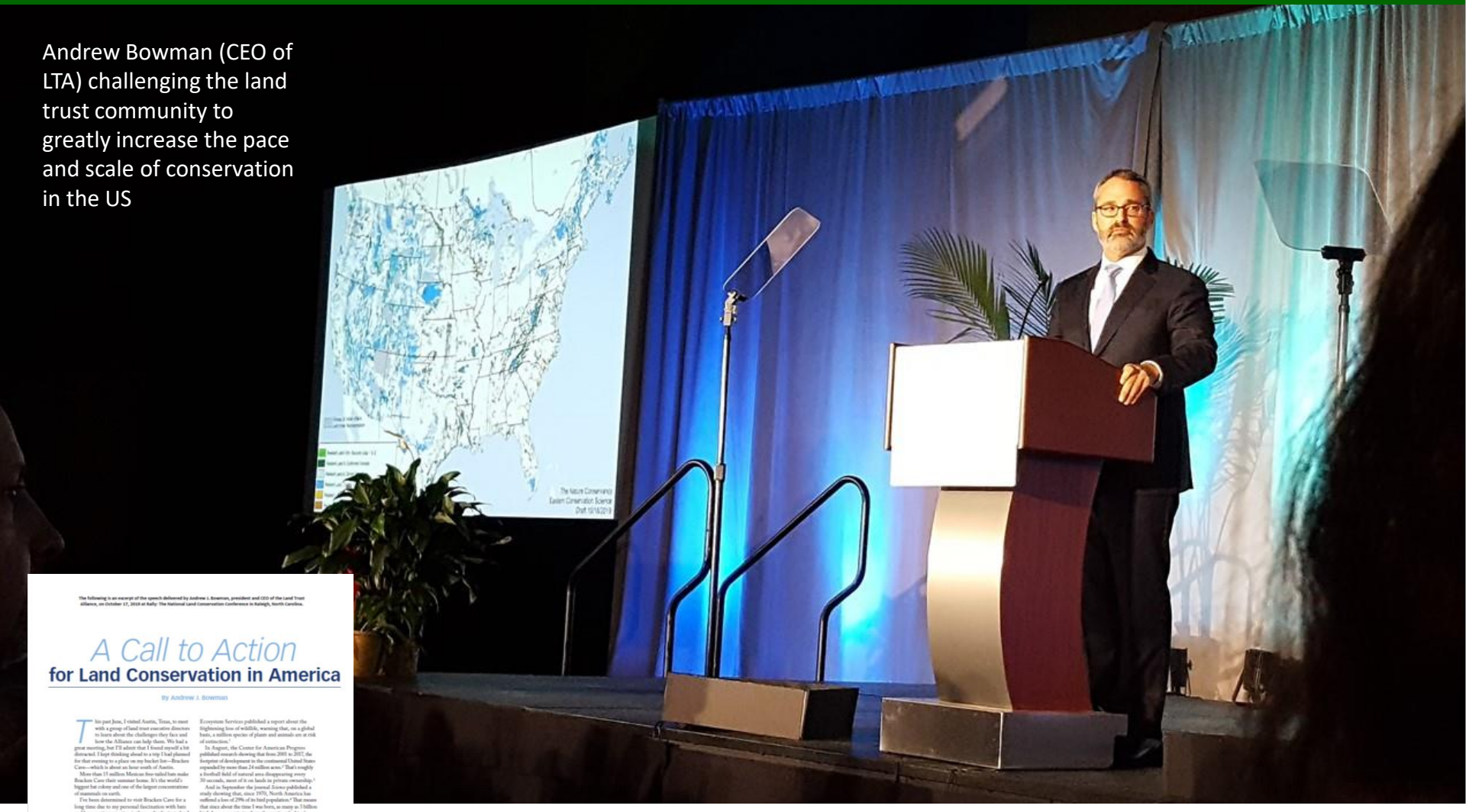
Arranged *for maximum climate flow*

Resilient & Connected Network



COLLABORATION

Andrew Bowman (CEO of LTA) challenging the land trust community to greatly increase the pace and scale of conservation in the US



The following is an excerpt of the speech delivered by Andrew J. Bowman, president and CEO of the Land Trust Alliance, on October 17, 2018 at Rally: The National Land Conservation Conference in Raleigh, North Carolina.

A Call to Action
for Land Conservation in America

By Andrew J. Bowman

This past June, I visited Austin, Texas, to meet with a group of land trust executive directors to learn about the challenges they face and how the Alliance can help them. We had a great meeting, but I'll admit that I found myself a bit distracted. I kept thinking ahead to a trip I had planned for that evening to a place on my bucket list—Bracken Cave—which is about an hour south of Austin.

More than 15 million Mexican free-tailed bats make Bracken Cave their summer home. It's the world's biggest bat colony and one of the largest concentrations of mammals on earth.

I've been determined to visit Bracken Cave for a long time due to my personal fascination with bats and because its protection is the result of private land conservation at its best. The Nature Conservancy, Bat Conservation International and other conservation partners have worked tirelessly for decades to protect not just the cave but 1,500 acres of critical surrounding habitat.

Visiting Bracken Cave at dusk allowed me to witness millions of bats emerging to hunt for insects. The show did not disappoint. The sheer abundance of life moved me deeply. The sound and sight of millions of bats soaring overhead was awe-inspiring. It was beautiful. Stunning. Life and career-affirming. And to think that this process unfolds for hours and hours, every summer night, as it has for thousands of years.

The Real Story of Our Time

I share this experience with you not only to highlight what motivates so many of us to do our work and to celebrate what our community has achieved. I am also using this example of species and ecosystem health as a foil for what I see as the real story of our time.

Since last year's Rally, we have been inundated with scientific evidence that the natural world is emptying and unraveling.

In May, the United Nations Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services published a report about the frightening loss of wildlife, warning that, on a global basis, a million species of plants and animals are at risk of extinction.[1]

In August, the Center for American Progress published research showing that from 2001 to 2017, the footprint of development in the continental United States expanded by more than 24 million acres.[2] That's roughly a football field of natural area disappearing every 30 seconds, most of it on lands in private ownership.[3]

And in September the journal *Science* published a study showing that, since 1970, North America has suffered a loss of 29% of its bird population.[4] That means that since about the time I was born, as many as 3 billion birds have gone missing from the continent's skies.[5]

Shocking as they are, these sobering statistics don't surprise those of us in this room tonight. We see with our own eyes the disappearance of wildlife, whether they are insects, birds or charismatic megafauna.

Paraphrasing Aldo Leopold, one of the penalties of working in our field and having deep knowledge of ecology is that one lives in a world of wounds. And he made that observation decades before climate change was even on our radar.

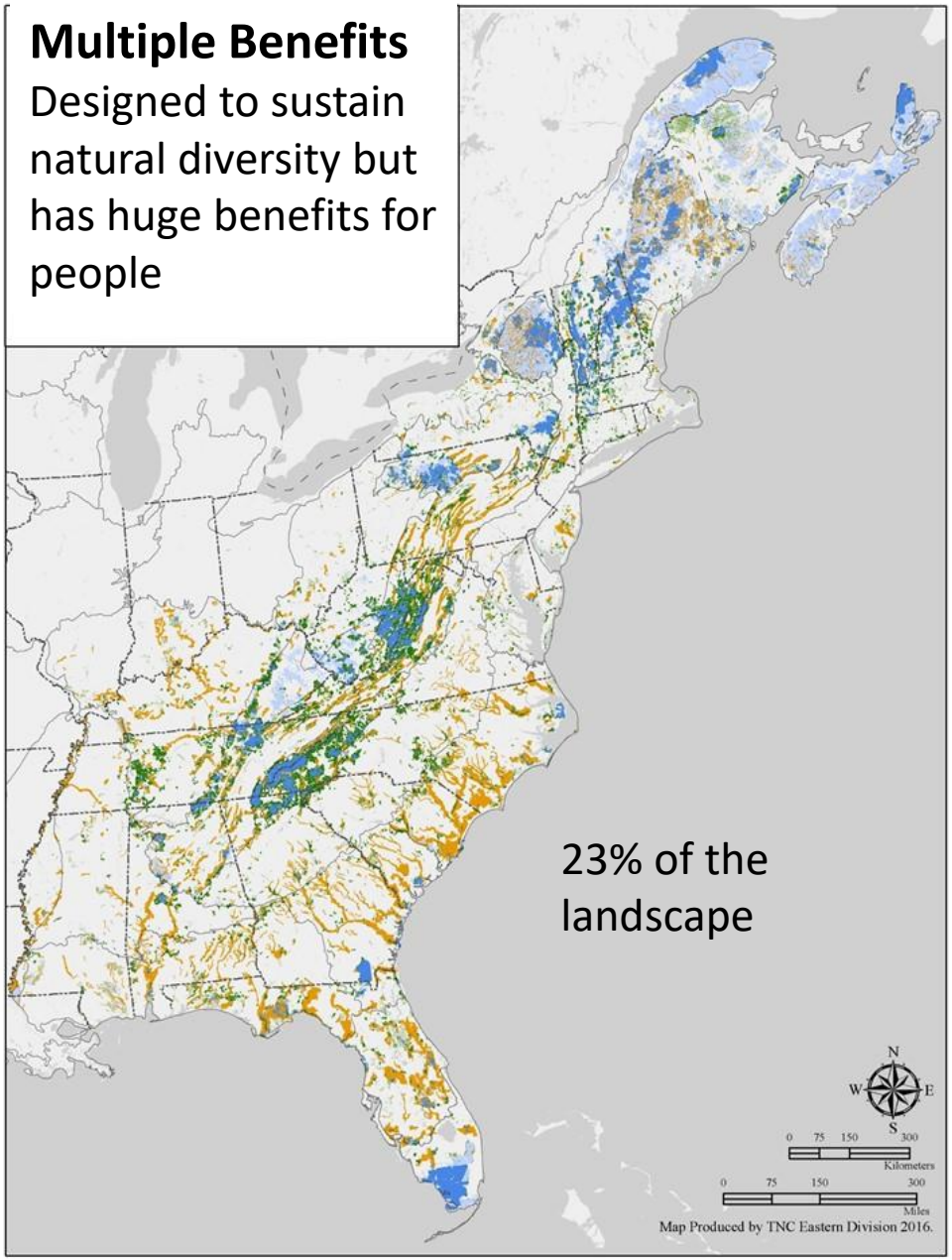
Last October the U.N. Intergovernmental Panel on Climate Change issued a particularly hard-hitting report. It laid out compelling reasons why the world should aim to keep the increase in global mean temperature from exceeding 1.5°C rather than 2°, and it explained just how difficult that will be to accomplish.[6] The report asserts that to avoid truly catastrophic climate change, we must cut global greenhouse gas emissions roughly in half by 2030.[7]

And a scientific report released in conjunction with this September's U.N. Climate Action Summit revealed that emission reduction commitments of nations under the Paris Climate Agreement are woefully inadequate.[8] The level of commitment needs to triple to achieve a 2°C limit and must be increased fivefold to reach a 1.5°C limit.[9]

Land Trusts: Over 100 are using the data for decision making
Agencies: Majority of Eastern SWAPS, Many Federal Adopters
Funders: 37 million from Doris Duke Charitable Foundation
TNC: Division Protection Plans, USGR

Co-Benefits

Multiple Benefits
Designed to sustain natural diversity but has huge benefits for people



56% of all **Above-Ground Carbon** (3.9 B tons)

75% of **High Value Source Water** (66+ M acres)

O2 for **1.8 Billion People**

Mitigates 1.3 M Tons of Pollution ($913 M)

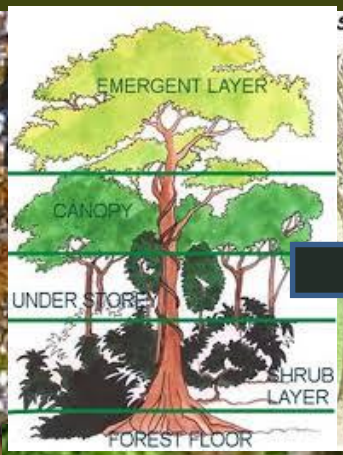
Generates ~$25 Billion - Recreation

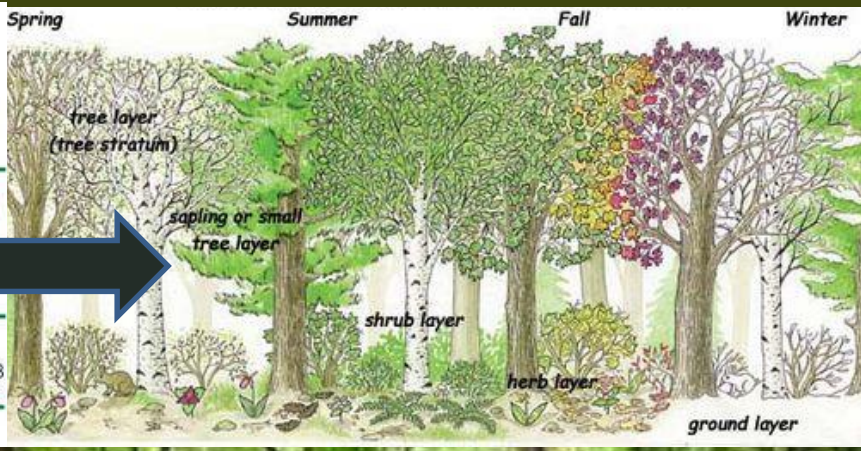
Carbon

Leaf Area Index + Complex Structure

Higher vegetation area indices, absorb more light and used light more efficiently

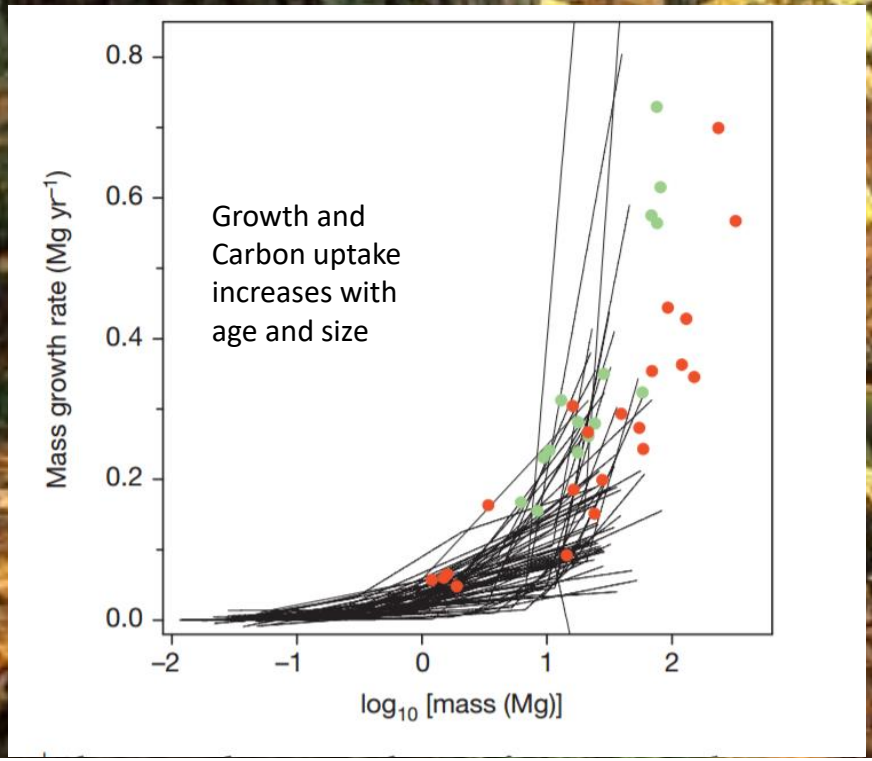
Gough et al 2019





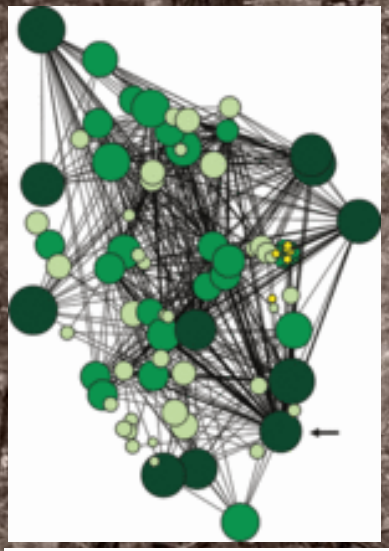
Carbon Storage

”A single big tree can add the same amount of carbon to the forest within a year as is contained in an entire mid-sized tree.”



Stephenson et al. 2014. *Rate of tree carbon accumulation increases continuously with tree size Nature 507 (600K trees, 6 countries, 403 sp)*
Luyssaert et al. 2008. *Old-growth forests as global carbon sinks. Nature 455. Sept 11 (519 published carbon flux estimates 15-800 yr stands)*

Carbon Sharing



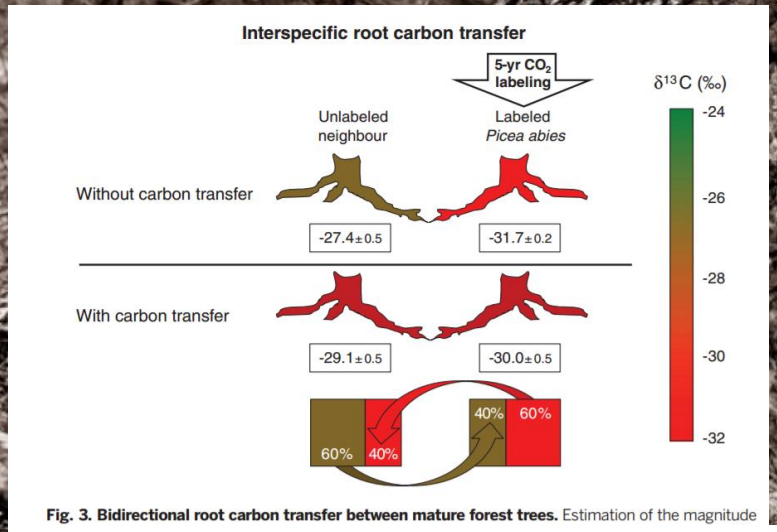


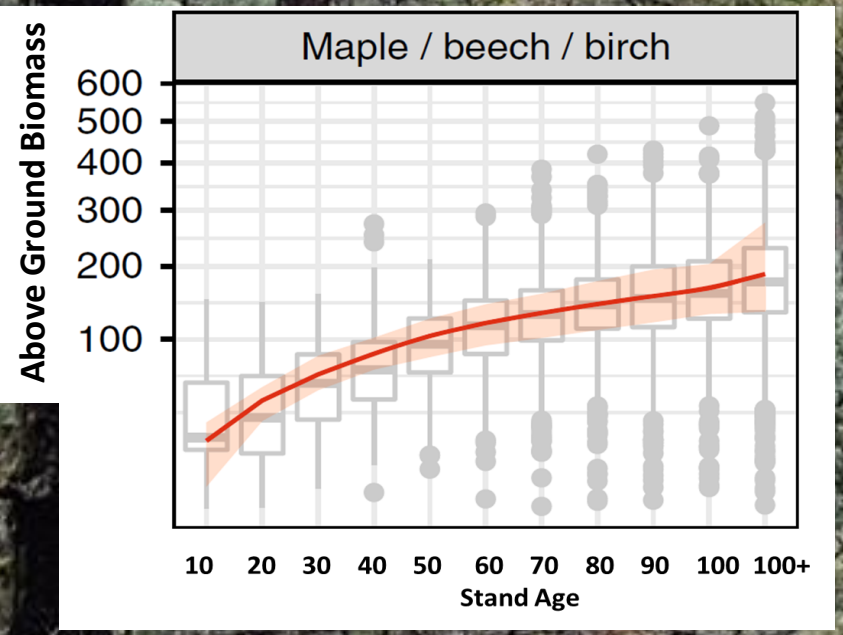
Fig. 3. Bidirectional root carbon transfer between mature forest trees. Estimation of the magnitude

Up to 40% of the carbon in the fine roots are shared, Also share water and nutrients across species. Old trees are central, favor offspring

Klein et al. 2016. *Belowground carbon trade among tall trees in a temperate forest*

Simard et al. 2015*. Resources transfer between plants via ECM networks*

Sequestration vs Storage



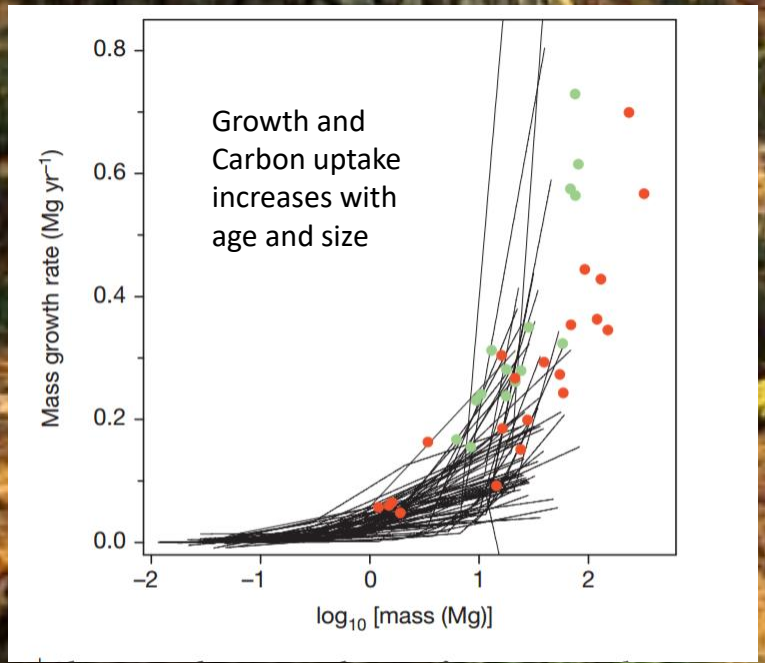
Sequestration
(Annual Drawdown)

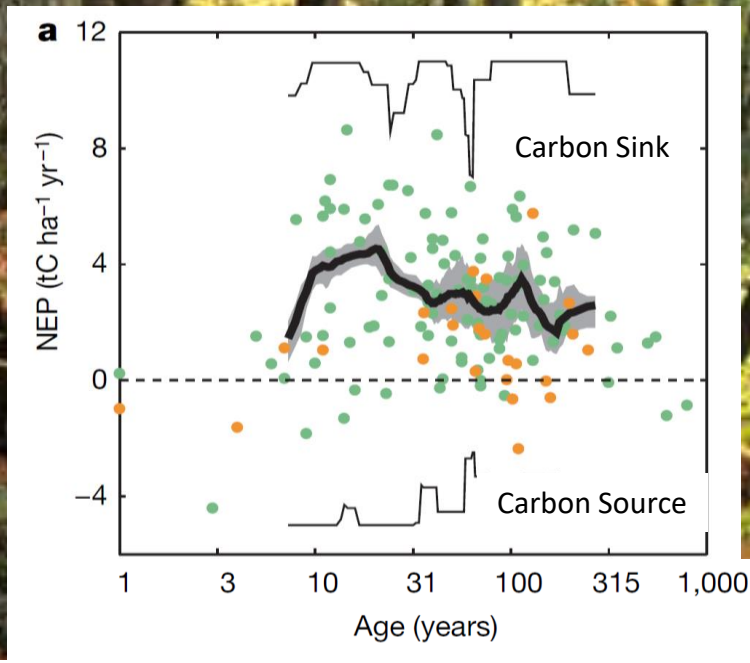
Storage
(Accumulation over Time)

Carbon Storage

”A single big tree can add the same amount of carbon to the forest within a year as is contained in an entire mid-sized tree.”

“Old forests accumulate carbon for centuries and contain large quantities of it.”





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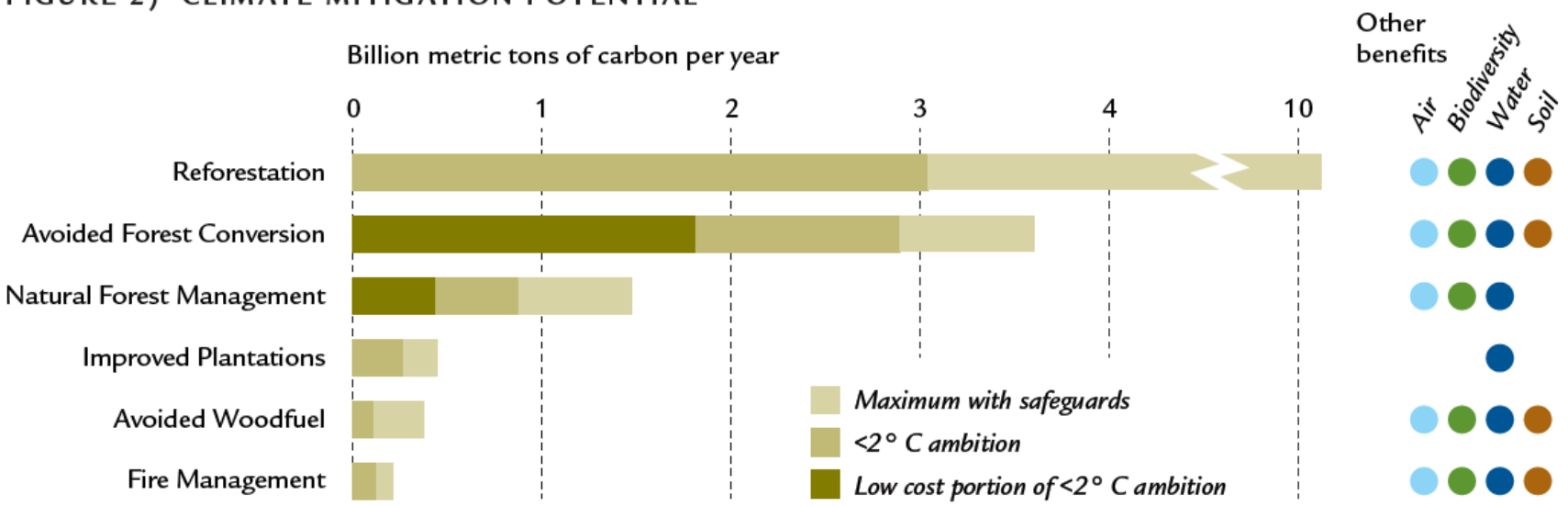
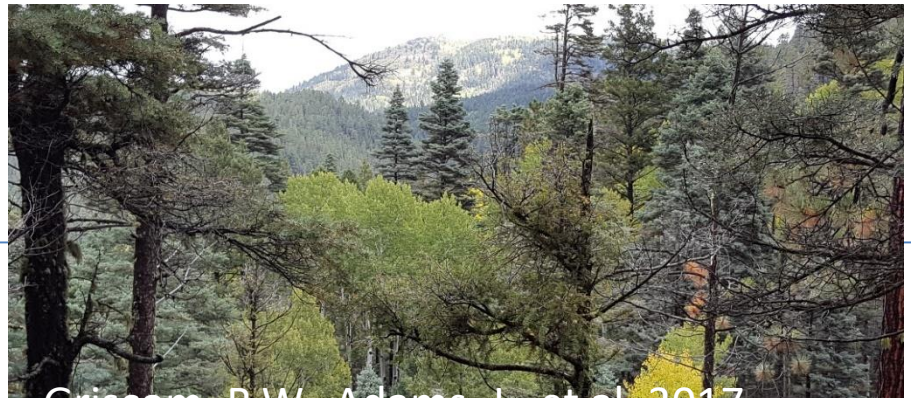
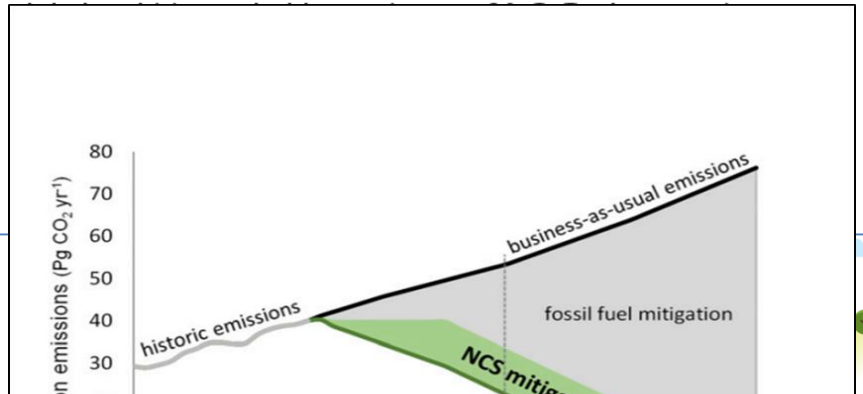
Natural Climate Solutions

FIGURE 2) CLIMATE MITIGATION POTENTIAL

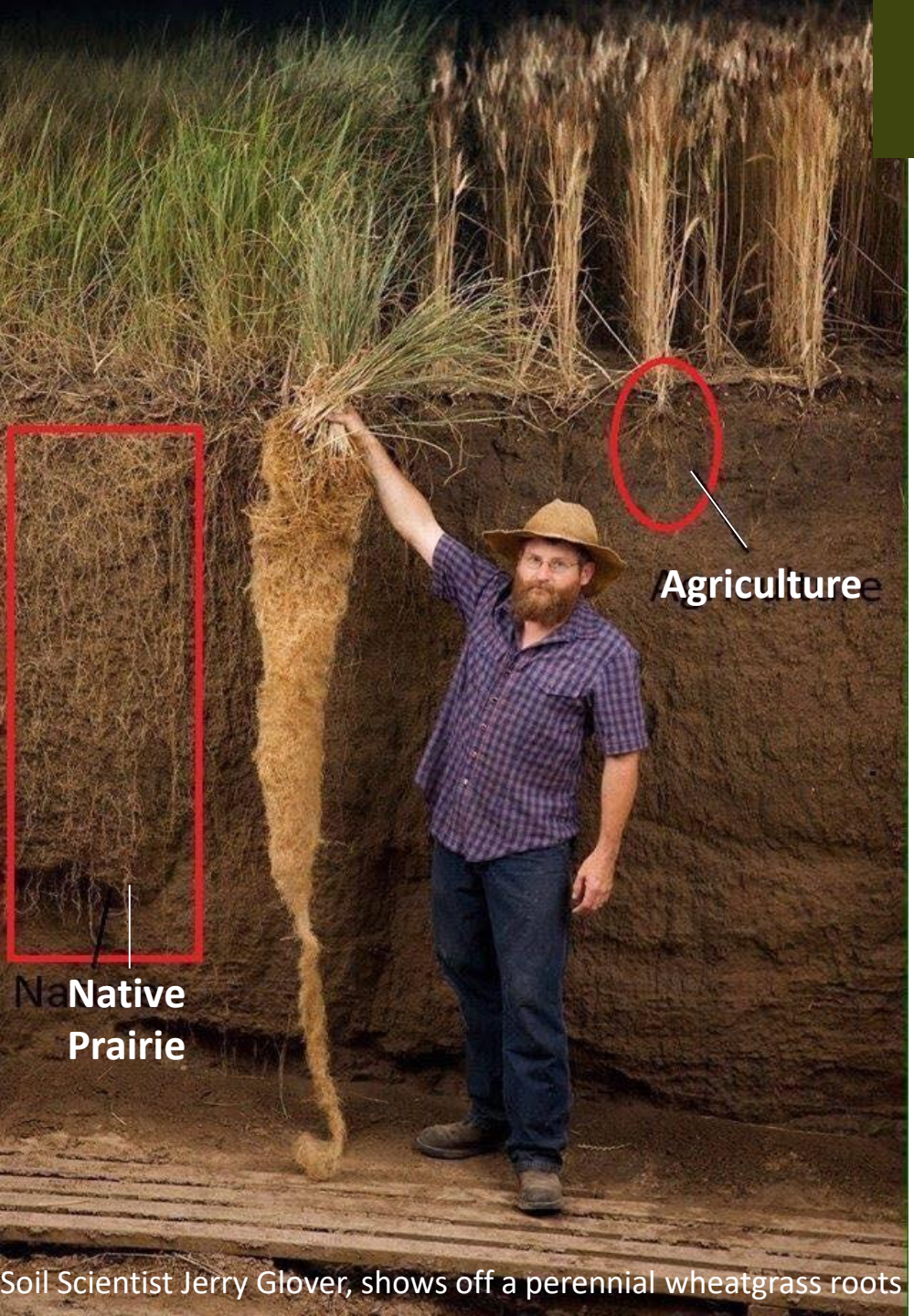




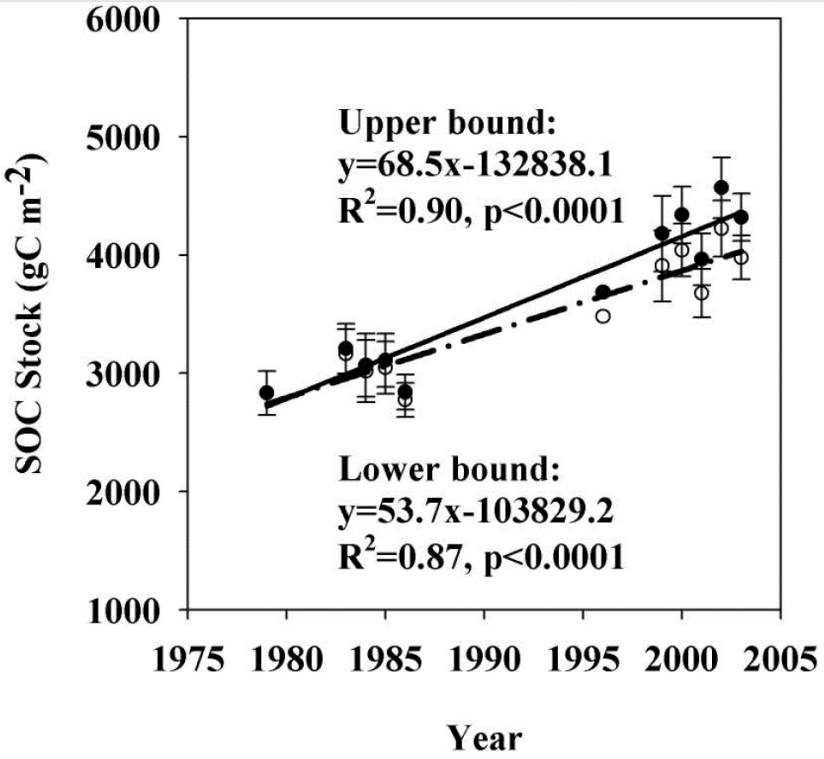
Griscom, B.W., Adams, J., et al. 2017. Natural Climate Solutions. PNAS 114 (44) 11645–11650.



Soil Carbon



Soil Scientist Jerry Glover, shows off a perennial wheatgrass roots

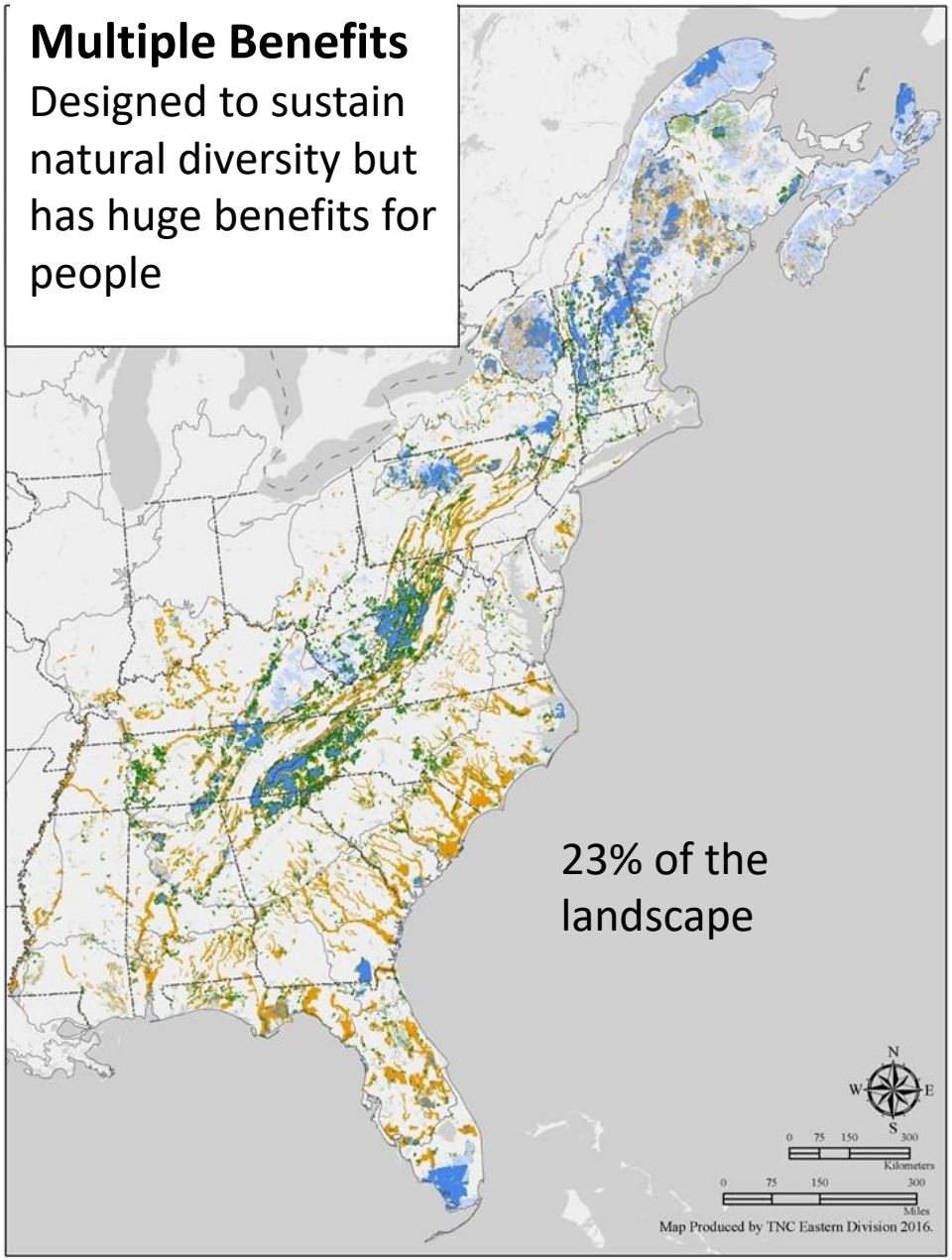


Soil Organic Carbon

Steady State? Zhou et al 2017 24-year dynamics of the soil carbon in an old growth forest at China's Dinghushan Biosphere Reserve. They found that soils in the top 20-cm soil layer accumulated atmospheric carbon at an unexpectedly high rate, - 0.61 Mg C ha year.

Diversity and Carbon

Multiple Benefits
Designed to sustain natural diversity but has huge benefits for people



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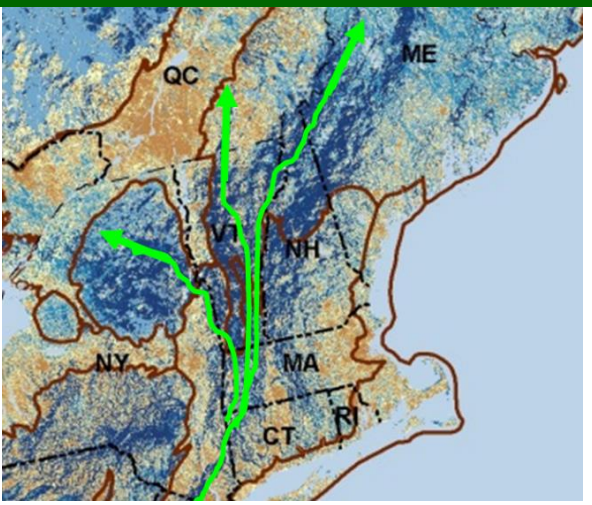
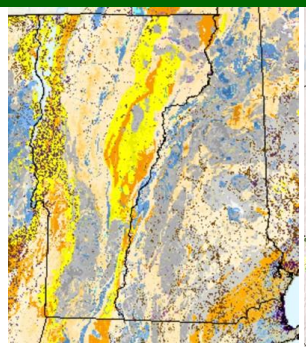
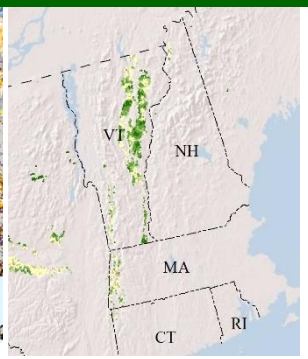
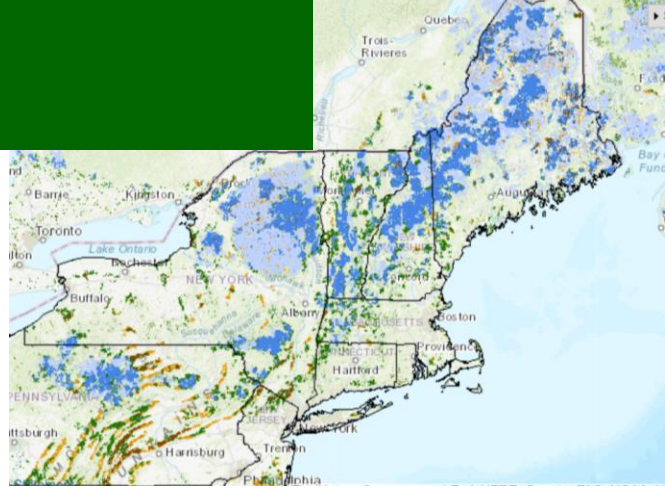
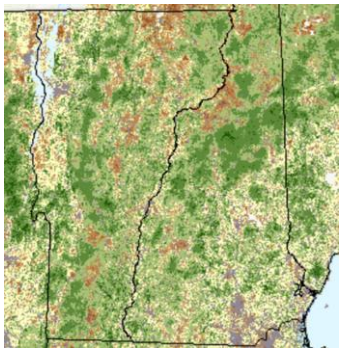
Vermont has it all

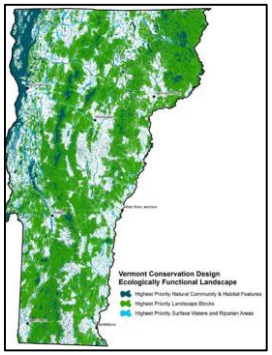


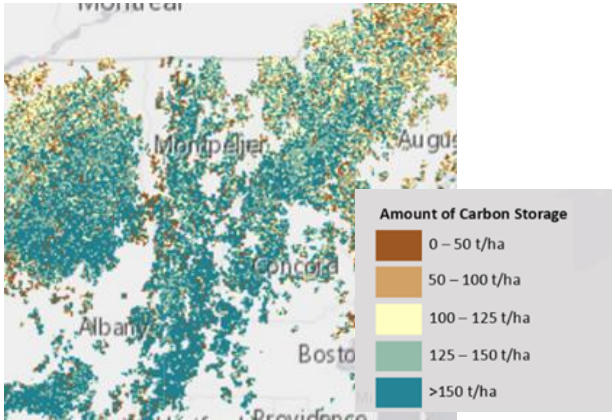












- A crossroads of Connectivity
- A diverse physical landscape
- Largest concentration resilient limestone in East
- A center of terrestrial resilience
- A terrific state plan that reinforces and complements TNC network
- Relatively intact forests that store huge amounts of carbon
- A community that values nature