

The role of riparian climate corridors in promoting ecological resilience



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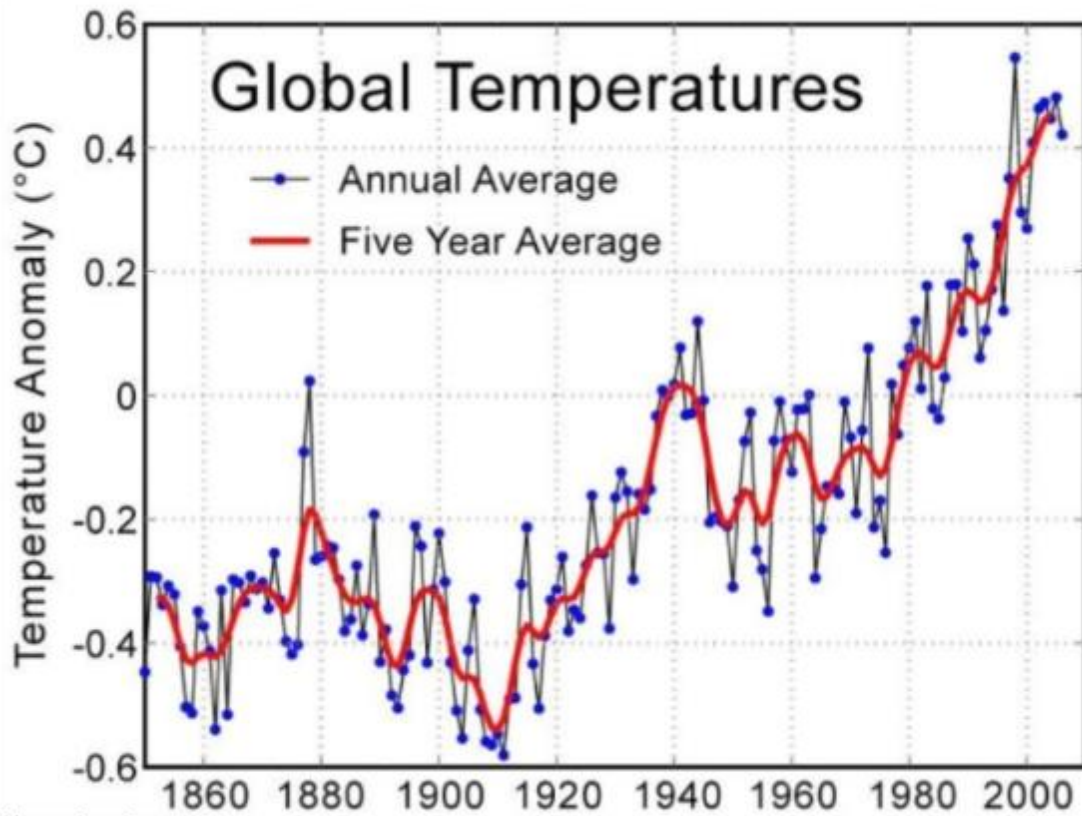


Acknowledgements



- **Mark Anderson and his team**
- **75 scientists, 8 years of work**

The world is changing



Newscientist.com



Plants and animals must adapt or relocate



Key question



- **How do we ensure that the places we conserve today will support a diversity of plants and animals in the future?**

Conserving fundamental processes



Steps in the process



- 1. Climate-Resilient Sites:** Identify natural climate strongholds
- 2. Connected landscapes:** Map the critical connecting features needed for dispersal among climate resilient sites

Resilient Sites



**HOW CAN WE IDENTIFY SITES WHERE
BIODIVERSITY IS LIKELY TO BE ABLE TO
PERSIST IN THE FACE OF CLIMATE CHANGE?**

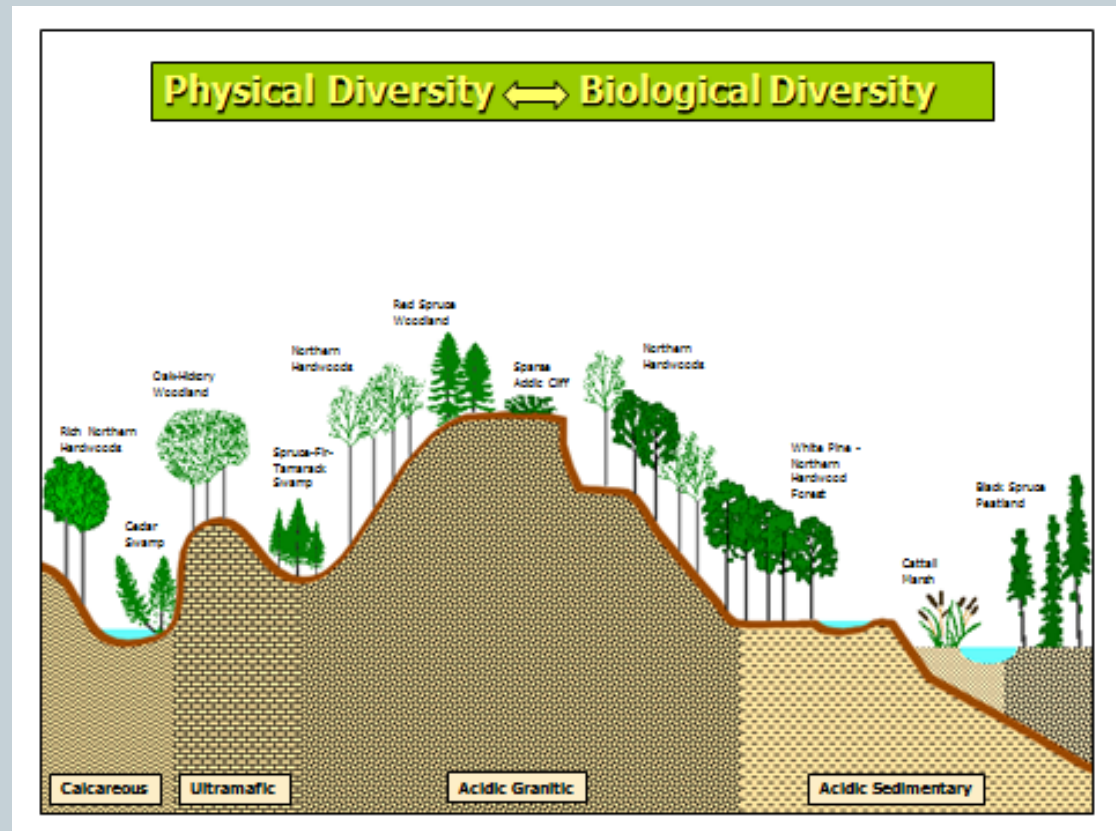
Local redistribution



What creates natural resilience?



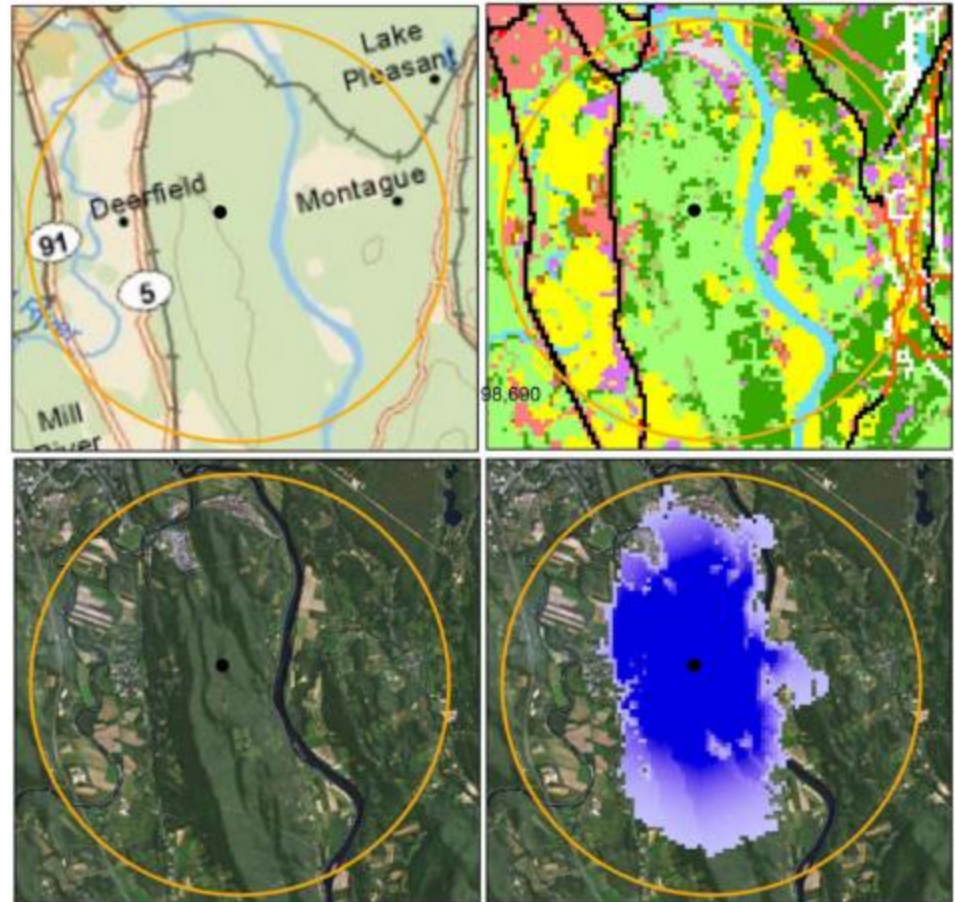
- Many microclimates leading to landscape diversity
 - Topography
 - Elevation range
 - Wetlands
 - Soils



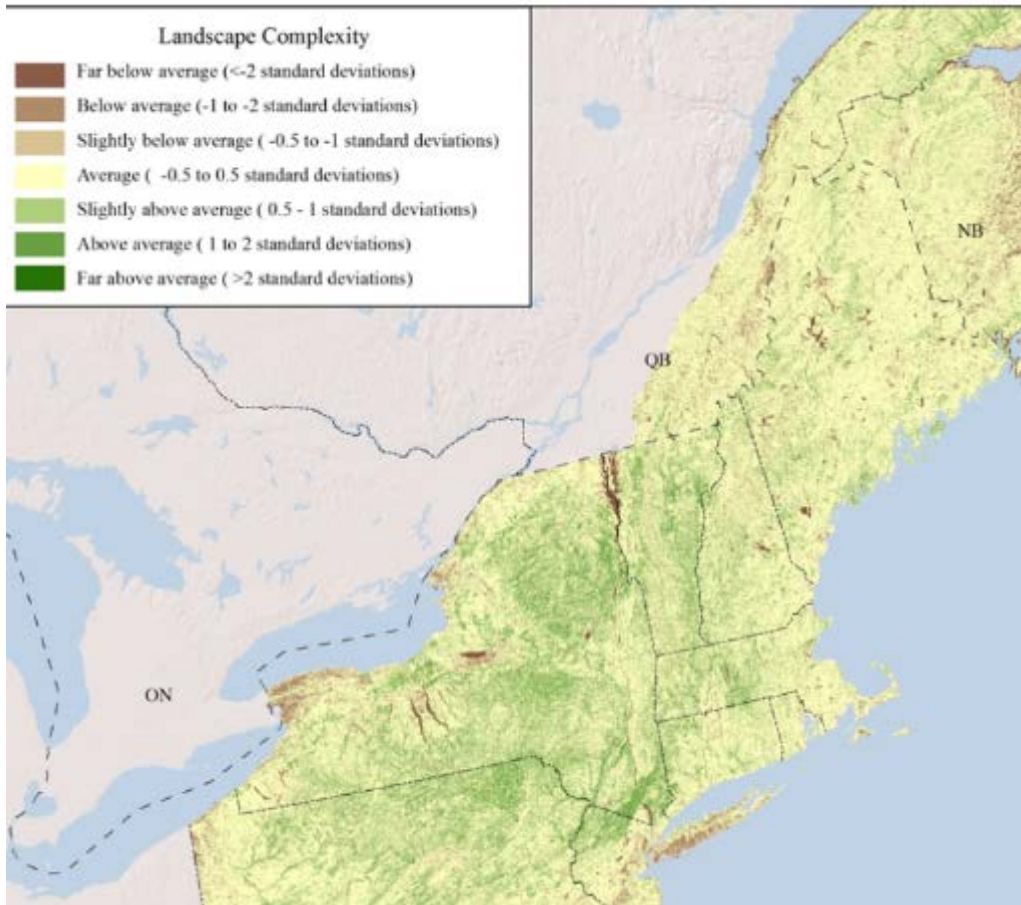
Landscape diversity is only useful if organisms can access better conditions



- Local connectedness
- Less fragmented areas are more connected



Landscape Diversity



Microclimate Estimates

Every 30 m cell gets a score based on

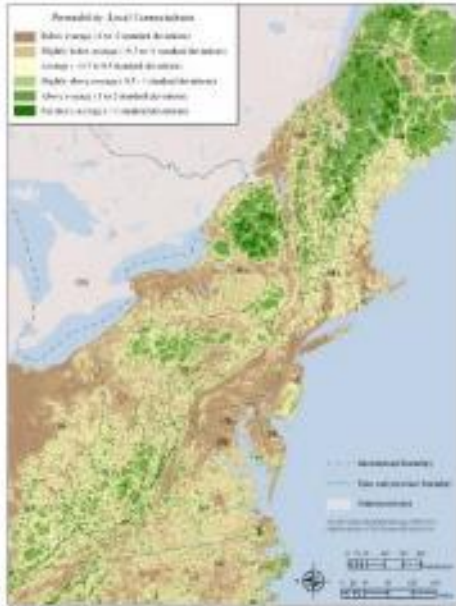
- Landform variety
- Elevation range
- Wetland Density
- Soil Variety

Local Connectedness

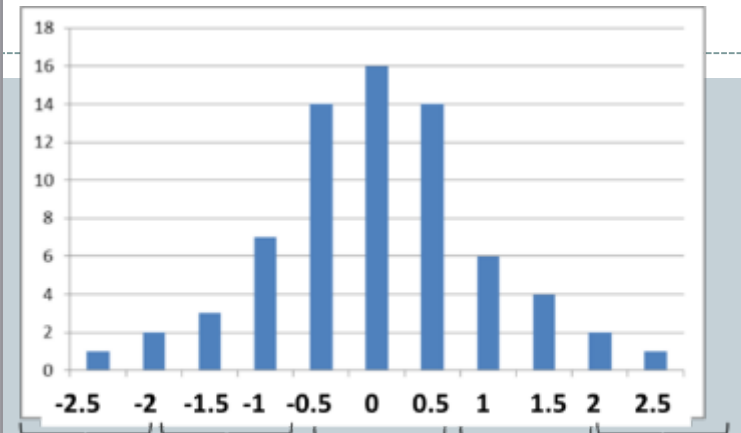
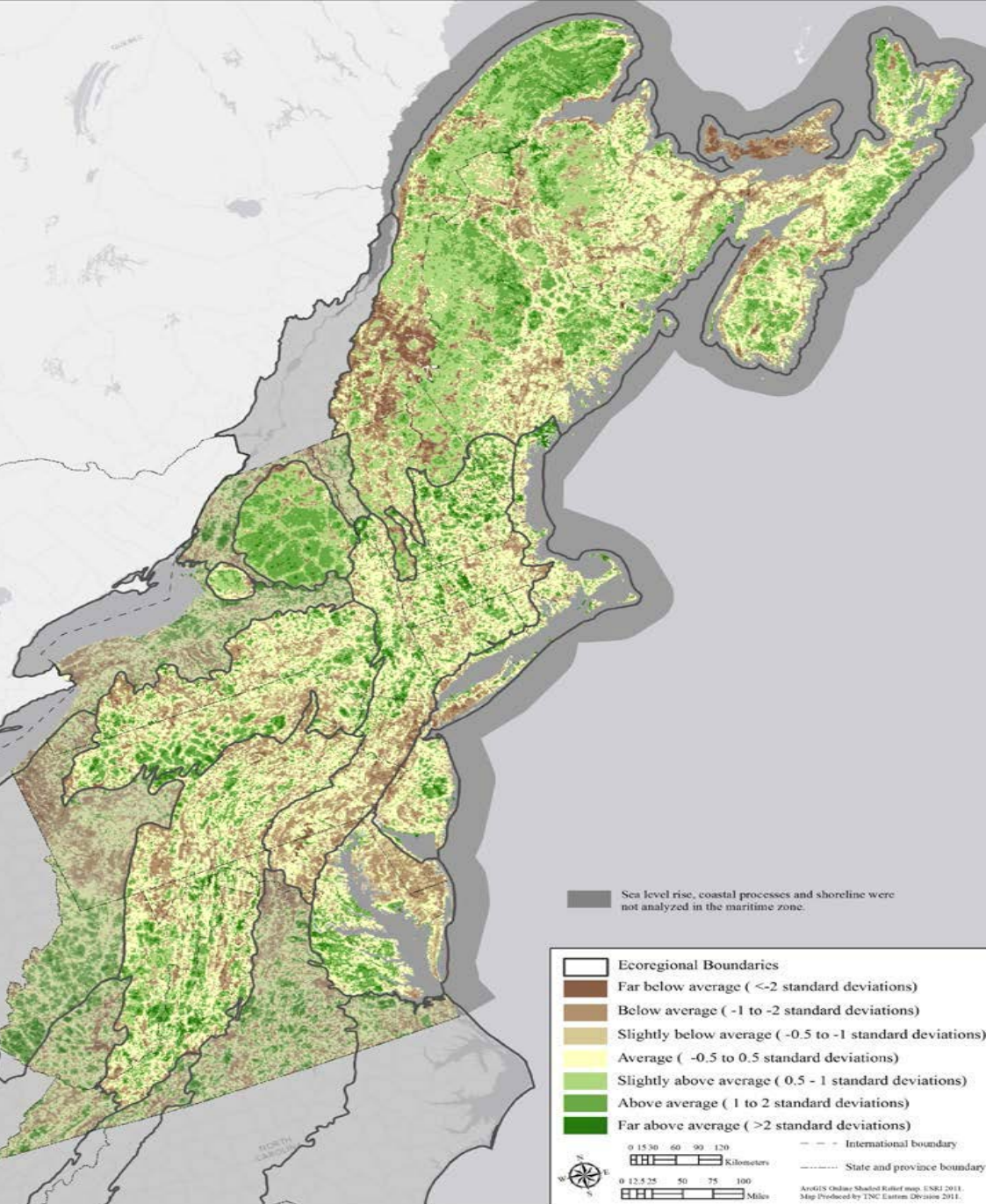


Connectedness Estimates

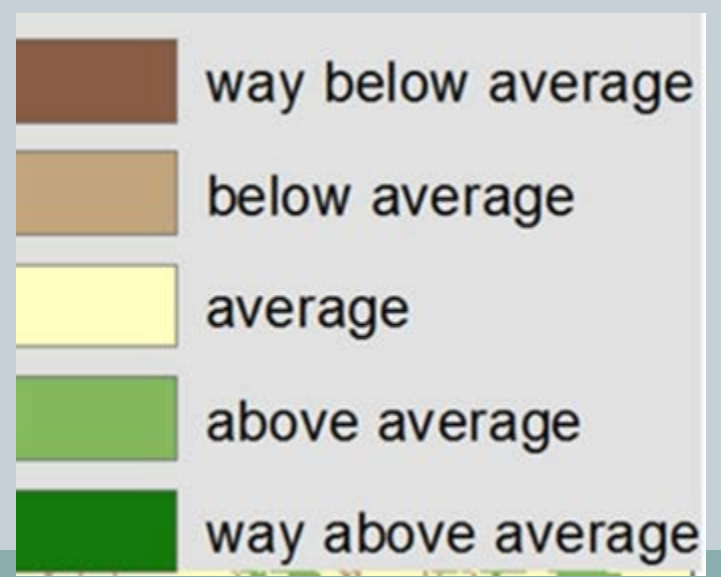
For every 30 m cell based on roads, development, agricultures in a 3 K radius



Resilience Index



Far Below Below Average Above Far Above



Regional Terrestrial Resilience Score

Stratified by Setting and Ecoregion with Regional Override

Resilient and Connected Landscapes

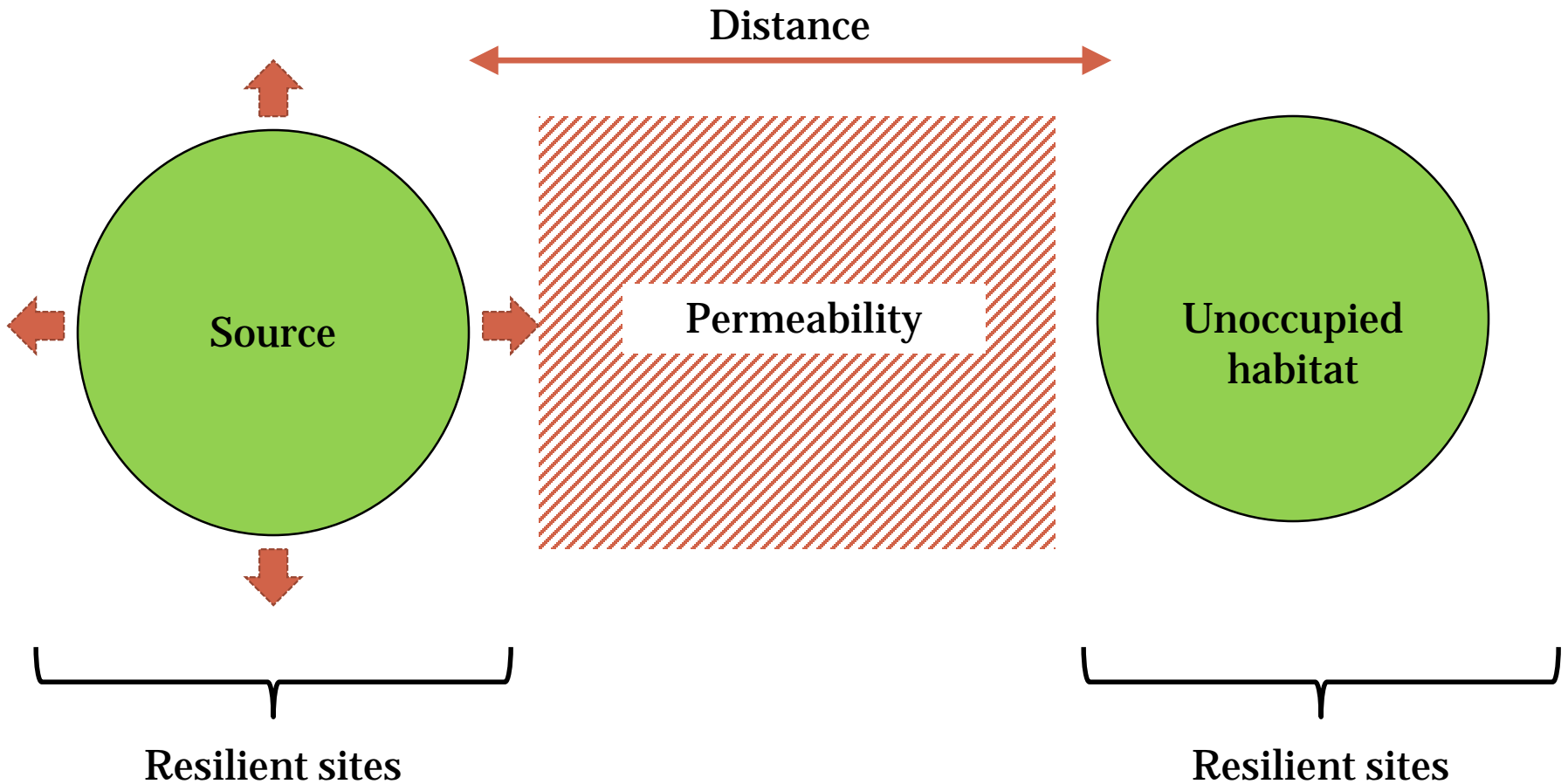


**HOW DO WE ENSURE THAT BIODIVERSITY
CAN REDISTRIBUTE IN A CHANGING WORLD?**



- Conserving resilient sites can help biodiversity persist in the face of “short-term” change
- However, in the long term most organisms will need to redistribute beyond local microclimates to survive climate change
- This involves **dispersing** to newly suitable habitat

What factors influence the likelihood of dispersal?



How we identified connecting landscapes

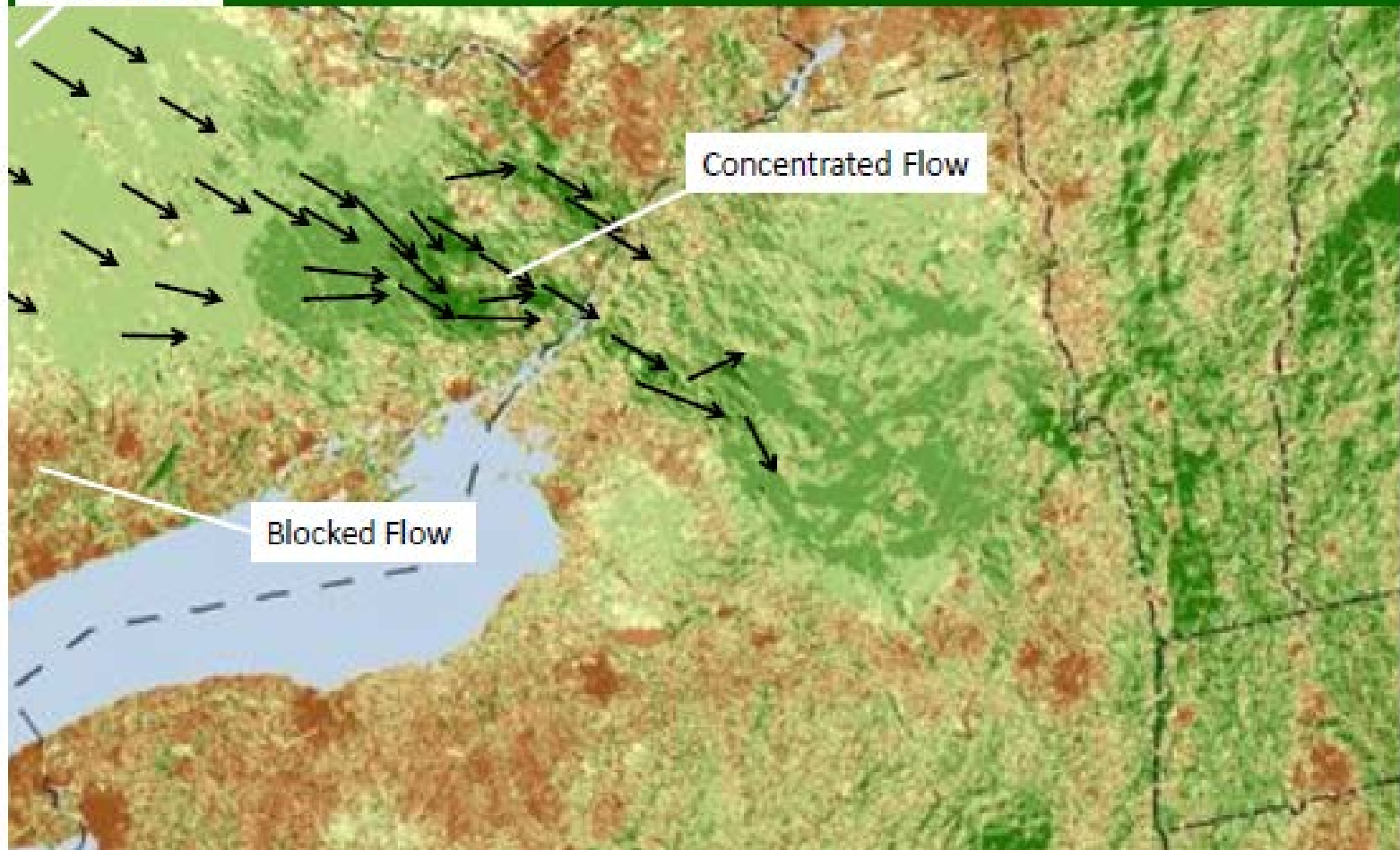


- Used Circuitscape
- Imagines “current” passing through landscape
- Suitable habitat allows current to flow more easily
- Habitat alteration creates “anthropogenic resistance”, reducing flow
- Not focused on specific terrestrial species, but general premise that intact natural habitat facilitates dispersal



Wall to Wall Circuitscape: Anthropogenic Resistance

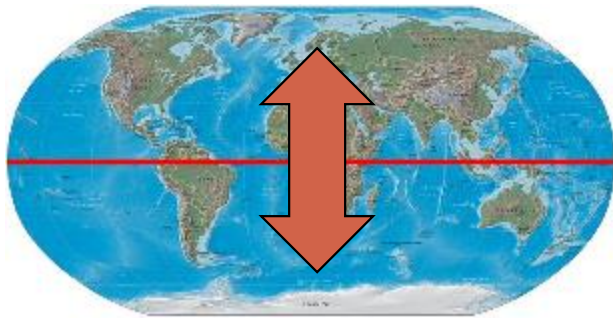
Diffuse Flow



Beyond habitat suitability: dispersal in an era of climate change



- 754 species
- 5 taxa



- Median of 11.0m uphill/decade
- ~65% of species shifted upslope*



- ~25% of species shifted downslope*



- Chen, I. C. et al. 2011. Rapid range shifts of species associated with high levels of climate warming. *Science*, 333(6045), 1024-1026. Meta-analysis of over 51 studies.
- *Illustrative, non-comprehensive survey of published literature. Lenoir et al. 2010. Going against the flow: potential mechanisms for unexpected downslope range shifts in a warming climate. *Ecography*, 33(2), 295-303.

**Regional Flows: Zoom-in
Regional Upslope, Northward, & Anthropogenic Resistance
Showing Upslope Flow only where it is Above Average**

- Far above average (>2 standard deviations)
- Above average (1 to 2 standard deviations)
- Slightly above average (0.5 to 1 standard deviations)
- Average (-0.5 to 0.5 standard deviations)
- Slightly below average (-0.5 to -1 standard deviations)
- Below average (-1 to -2 standard deviations)
- Far below average (<-2 standard deviations)



Weighted connectivity

Upslope, northward and anthropogenic model. Circuitscape analysis applied to a resistance grid derived from landforms and anthropogenic resistance, with northward flows given twice the weight of east-west flows. Areas of high current flow are predicted to be important for upslope range shifts

Riparian habitat and resilience



**IDENTIFYING PRIORITY RIPARIAN AREAS
FOR CLIMATE ADAPTATION**

Riparian habitat as resilient sites



- **Resilient sites analysis coincidentally identified many riparian corridors as key landscape features in providing climate adaptation due to:**
 - Microclimates cooler (5-20°C) and more humid (10-15% higher) than surrounding areas
 - Often high densities of wetlands (contributing to more microclimates)
 - Great regulation/protection of riparian habitat leading to higher local connectivity scores





Why raise the profile of riparian habitat in our climate resilience models?



- High species richness and associated/obligate species
- Regulation/protection of riparian habitat coupled with high conversion rates of surrounding areas leading to *de facto* corridors
- Often higher densities of wetlands, allowing “leapfrog” dispersal for dispersal-limited wetland species



Riparian habitat as climate corridors



Approach to identifying riparian habitat protection priorities



- Model based on Active River Area (meander belt, riparian wetlands, and 100-yr floodplain)
- Omitted small headwater streams as riparian areas not easily differentiated from surrounding forest
- Four classes:
 - Creek
 - Small River
 - Medium River
 - Large River
- 30-m scale analysis

Riparian unit attributes



- **Size** of riparian unit in acres: *Larger patch size, higher value for biodiversity*
- **Regional flow** from Circuitscape modeling (anthropogenic resistance only): *High flow indicates concentrated species movement*
- **Contrast.** Local connectedness in riparian unit compared to surrounding buffer (2.5km for creeks and small rivers, 5km for medium and large rivers): *Higher contrast indicates greater value of riparian habitat as refuge and for connectivity*
- **Resilience.** % of riparian area with above average resilience

Figure 3.19. All riparian units by size class. This map shows all the riparian units assessed in this study colored by their size class.

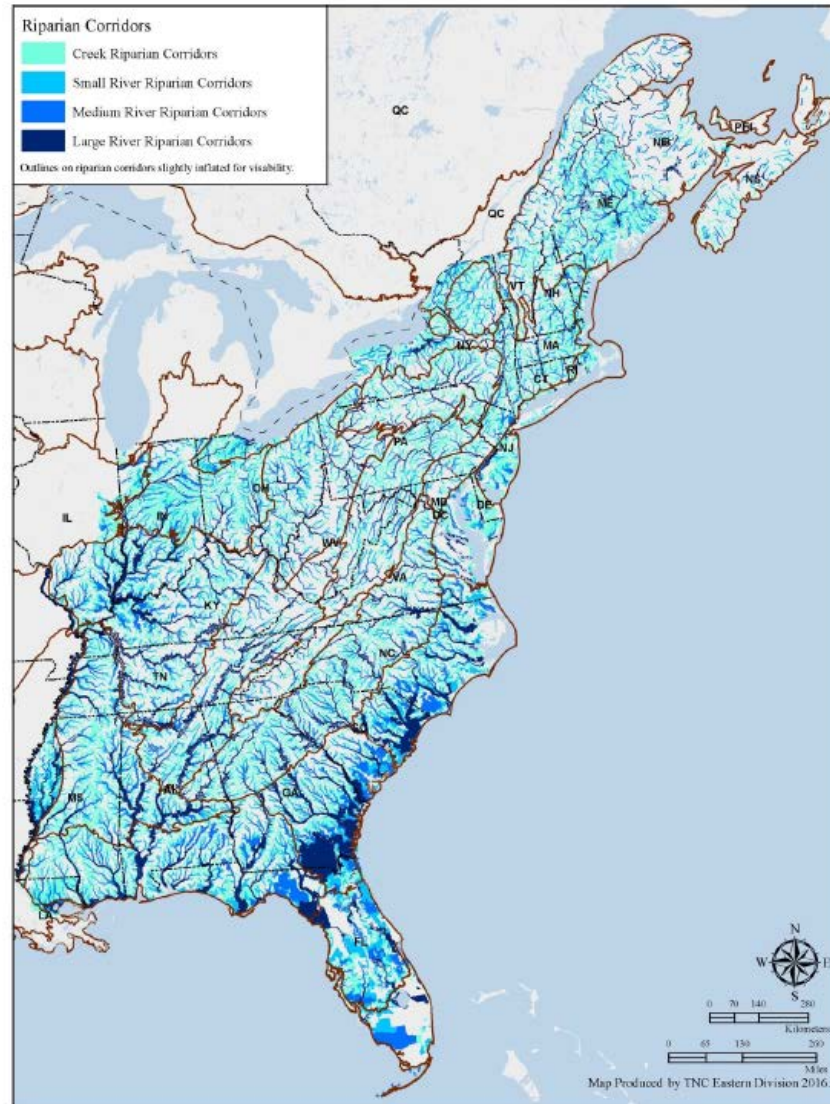


Figure 3.20. Regional flow within riparian climate corridors. This map shows the relative amount of regional flow within each riparian unit compared to the whole study area.

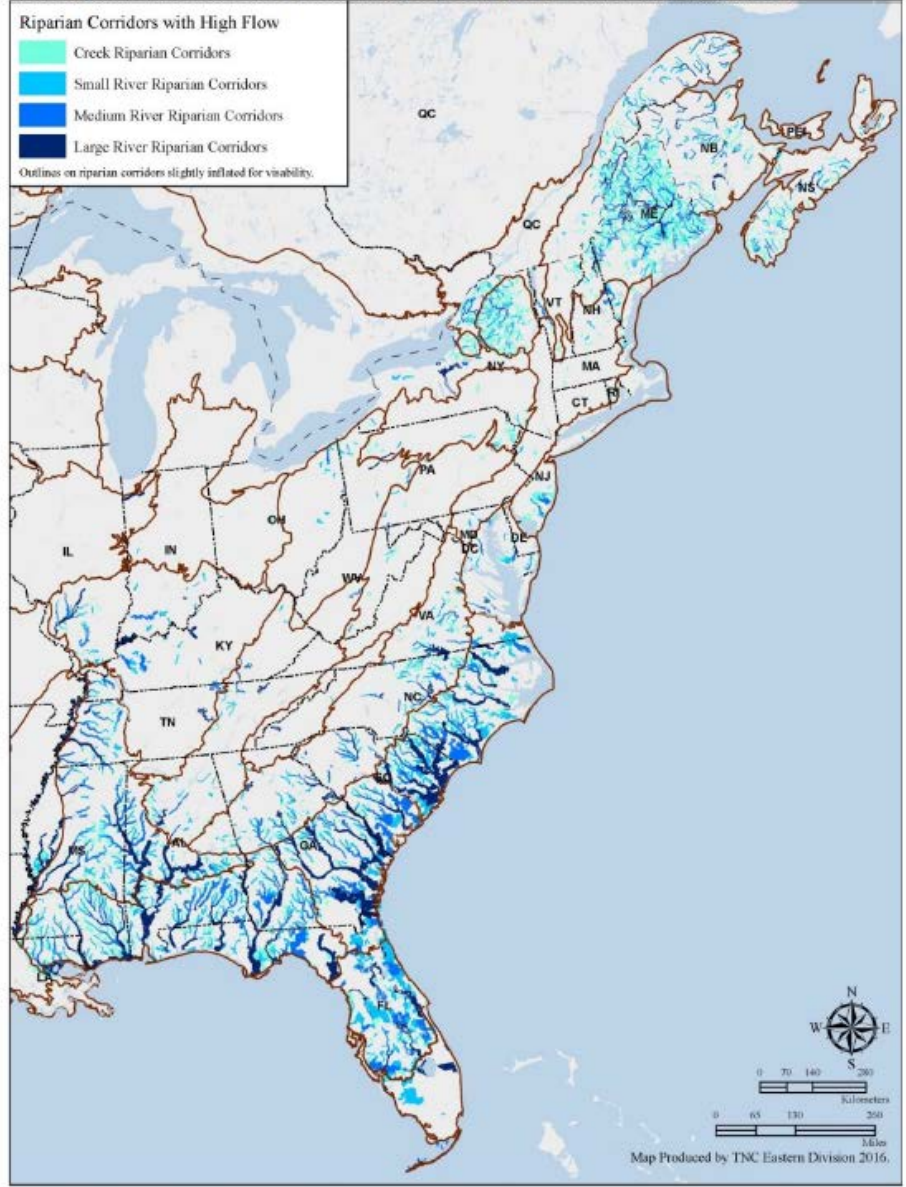


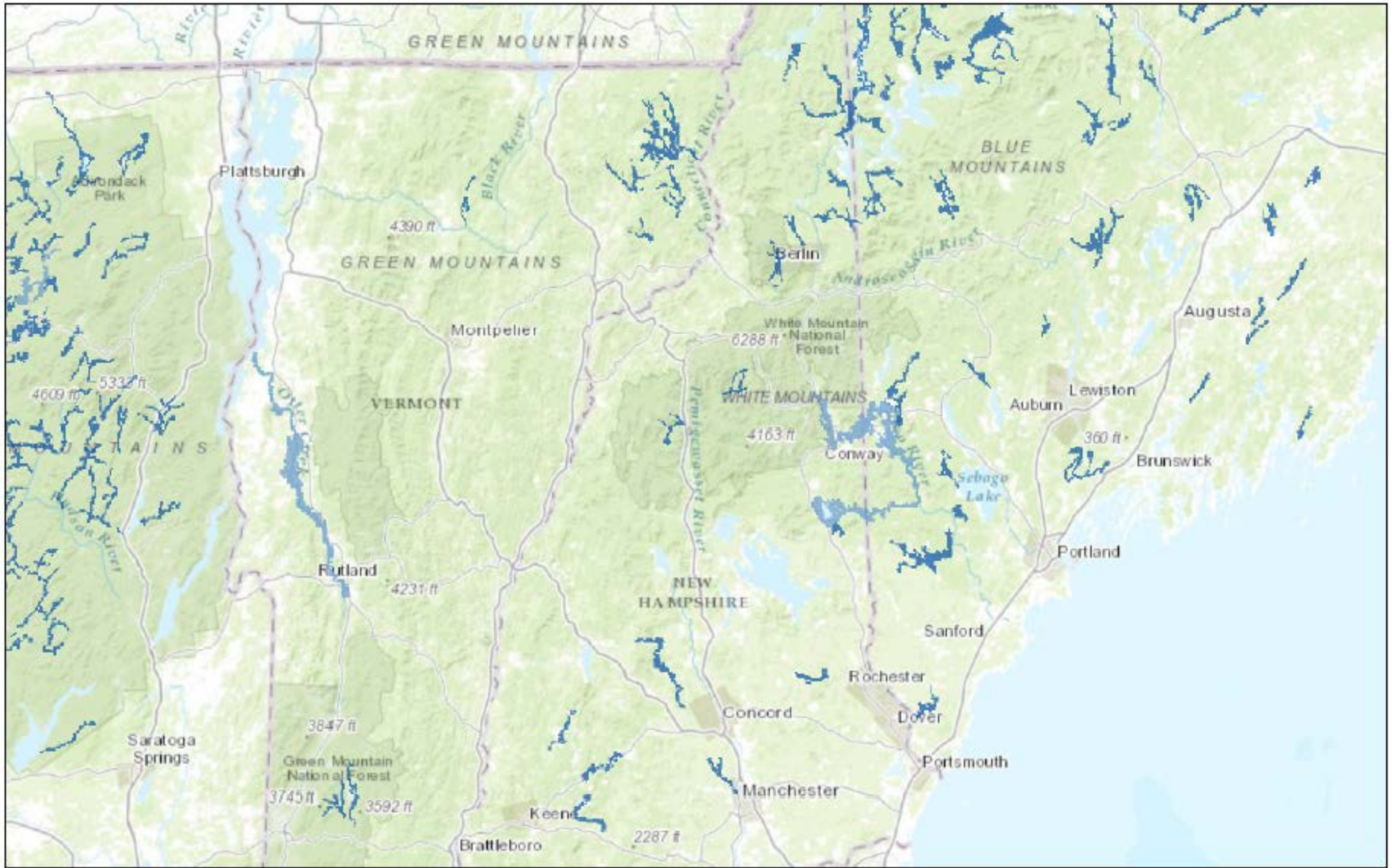
Final query



- **Identify regionally significant riparian corridors that connect other resilient areas. Limited selection to:**
 - Riparian units >1000 acres in size
 - Units that had a high percentage of area in above average regional flow
 - ...or that contained a large contiguous area of high regional flow.

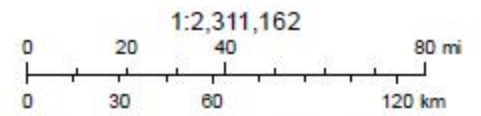
Figure 3.23. Regionally significant riparian climate corridors. This map shows the riparian units with above average regional flow based on either the percent of the unit with high flow, or the size of the largest contiguous stretch of high flow.





March 23, 2017

- High Flow Riparian Corridors, largely outside resilient land
- High Flow Riparian Corridors, largely within resilient land

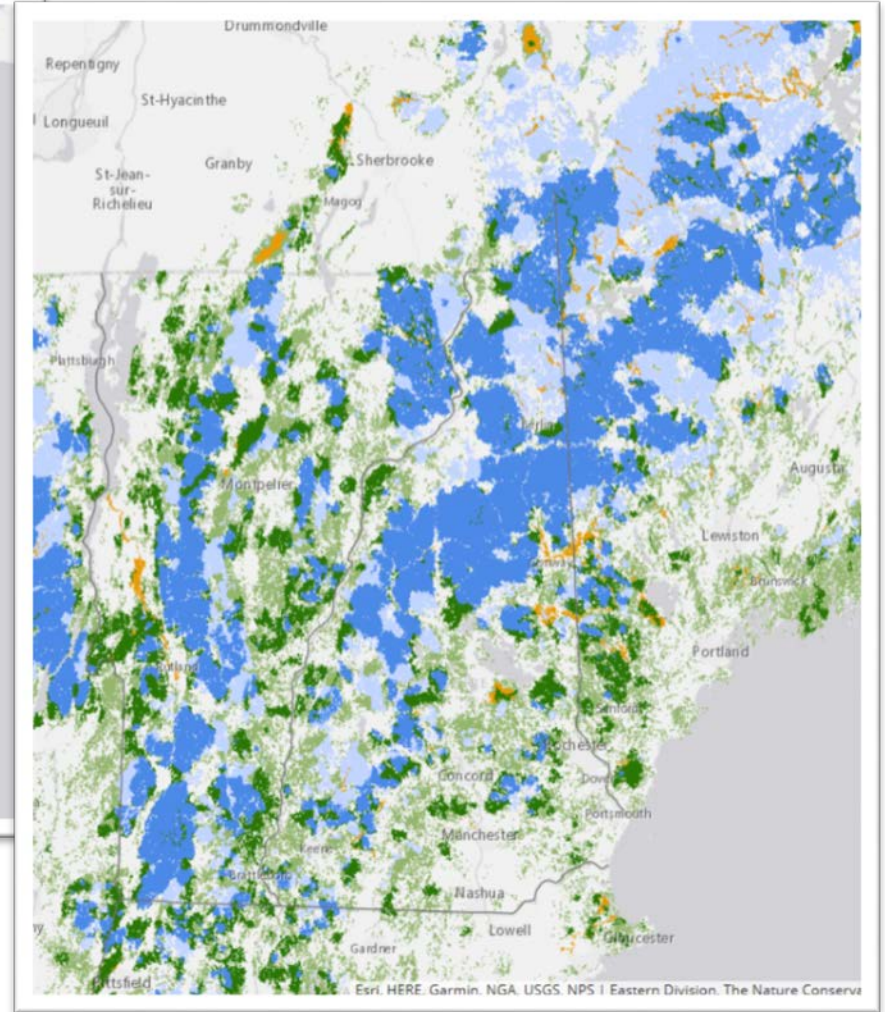
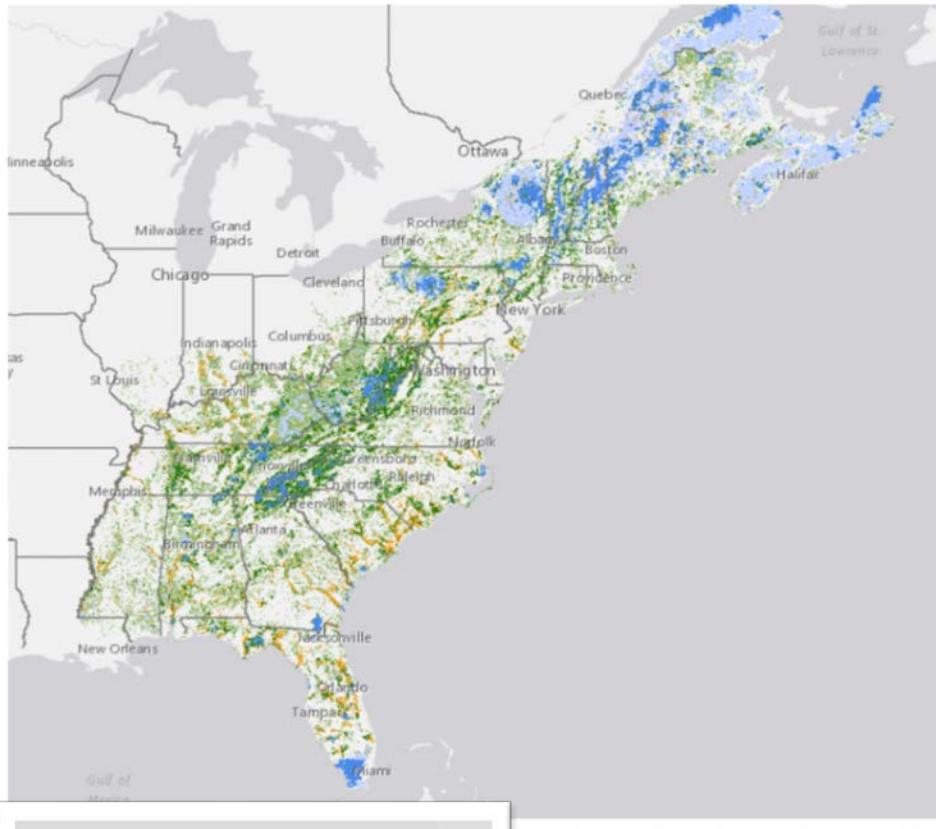


Sources: Esri, HERE, DeLorme, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey,

Bringing it all together



Resilient and Connected Landscapes



MAP LEGEND

Resilient Area



With Confirmed
Diversity

Climate Flow Zone



Climate Corridor



Esri, HERE, Garmin, NGA, USGS, NPS | Eastern Division, The Nature Conservancy

Take Home Messages



- **Tool for identifying land protection priorities for TNC and partners**
- **Riparian habitat can play an important role in climate resilience including**
 - As resilient sites and potential refugia
 - Serving as corridors for dispersal of wetland-associated species
 - Providing corridors for movement of organisms in otherwise altered landscapes

Thanks and Questions

