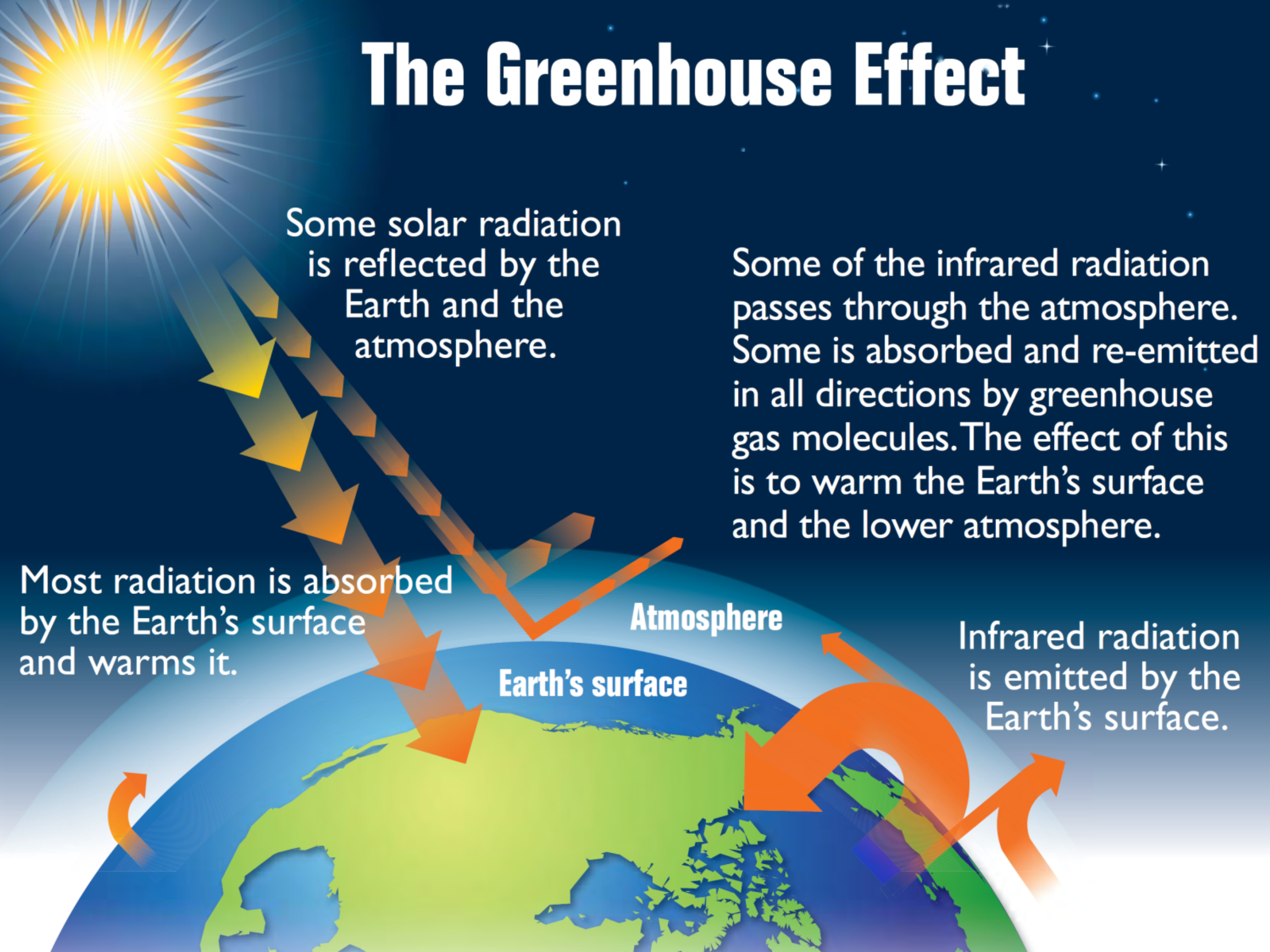
Climate Change & Land Conservation

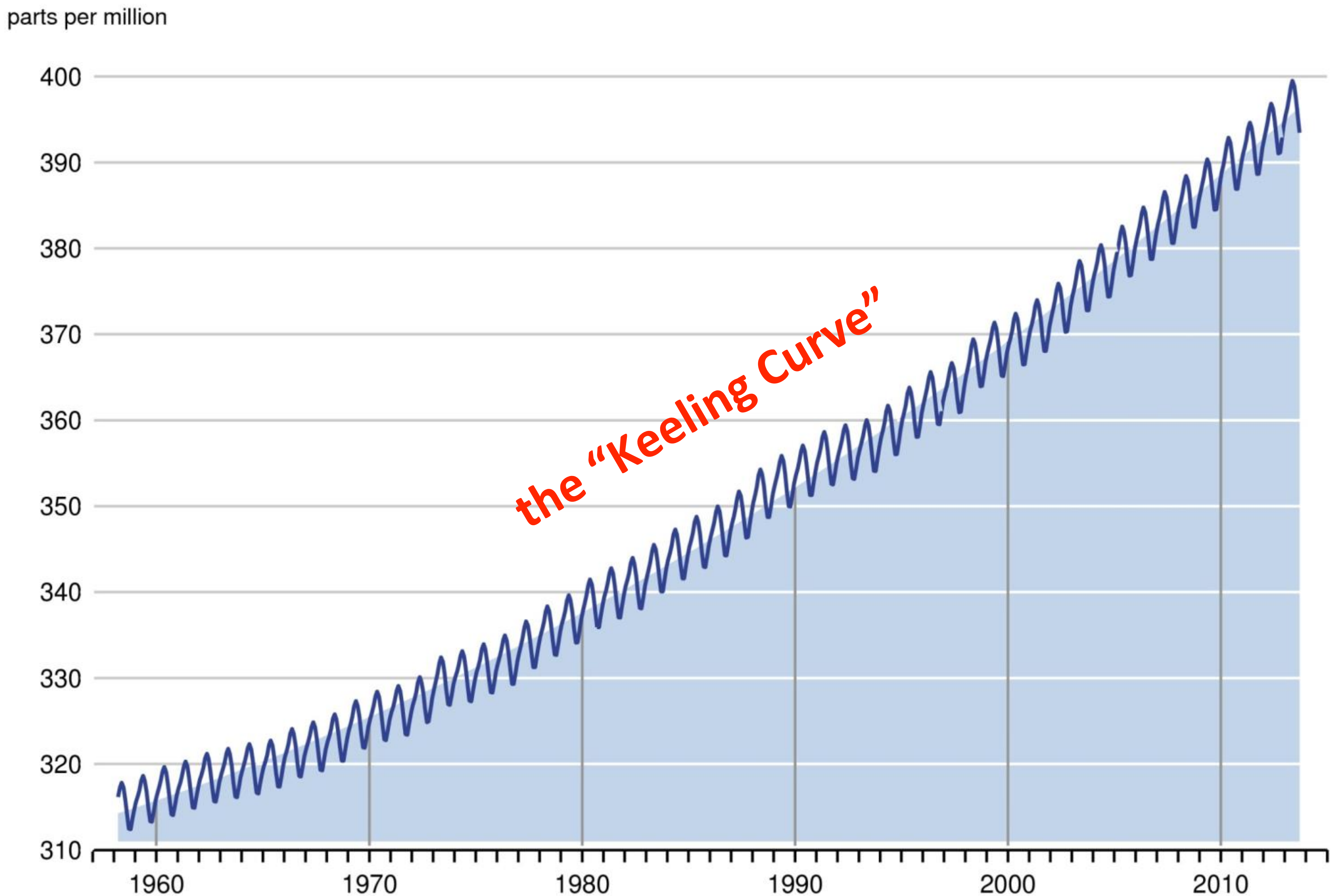
Jeff Walk

The Nature Conservancy

Protecting nature. Preserving life.™


The Greenhouse Effect
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Most radiation is absorbed by the Earth's surface and warms it.
Atmosphere
Earth's surface
Infrared radiation is emitted by the Earth's surface.

Monthly CO_2 Concentration, Mona Loa, Hawaii

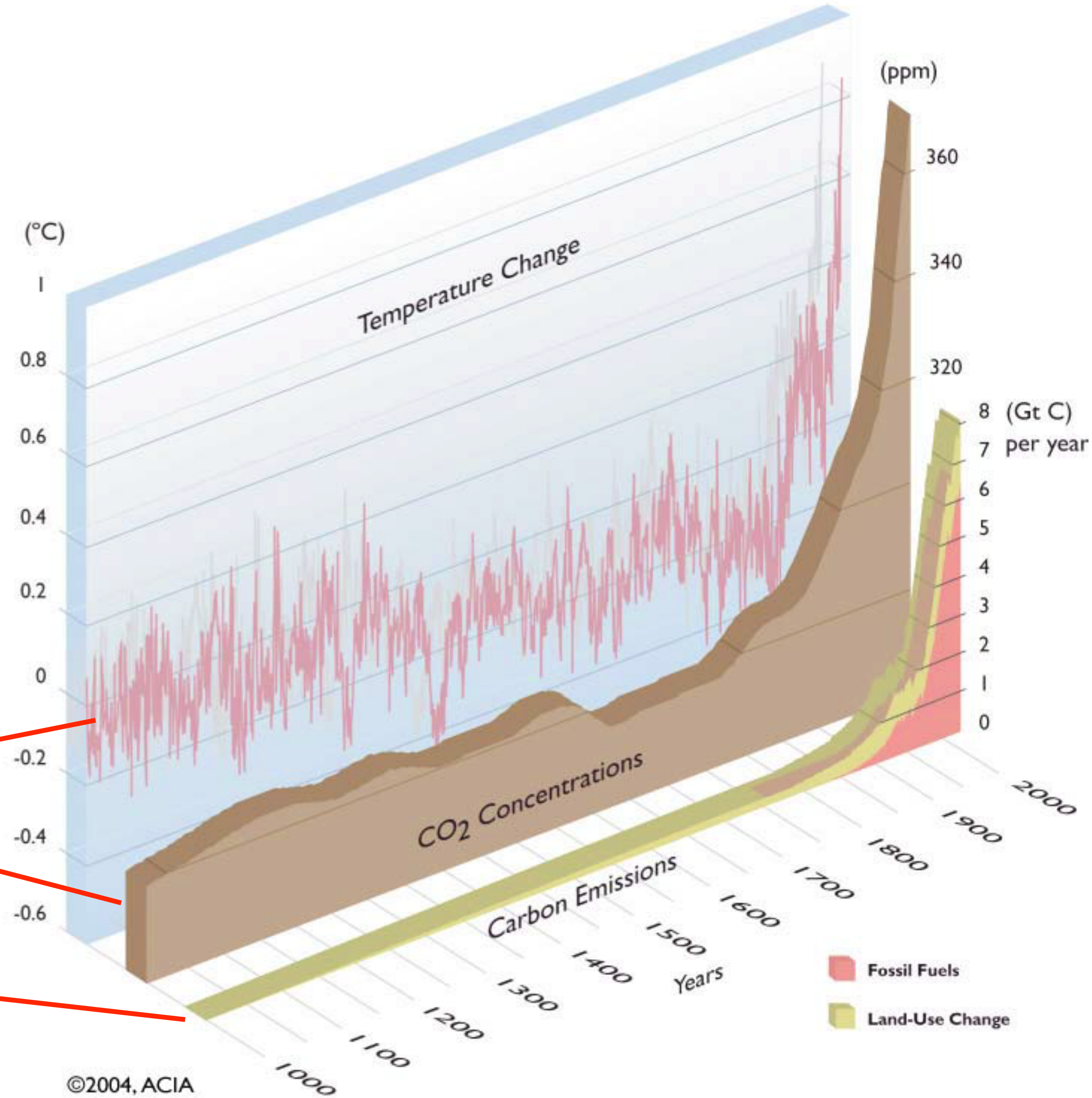


Strong Correlation!

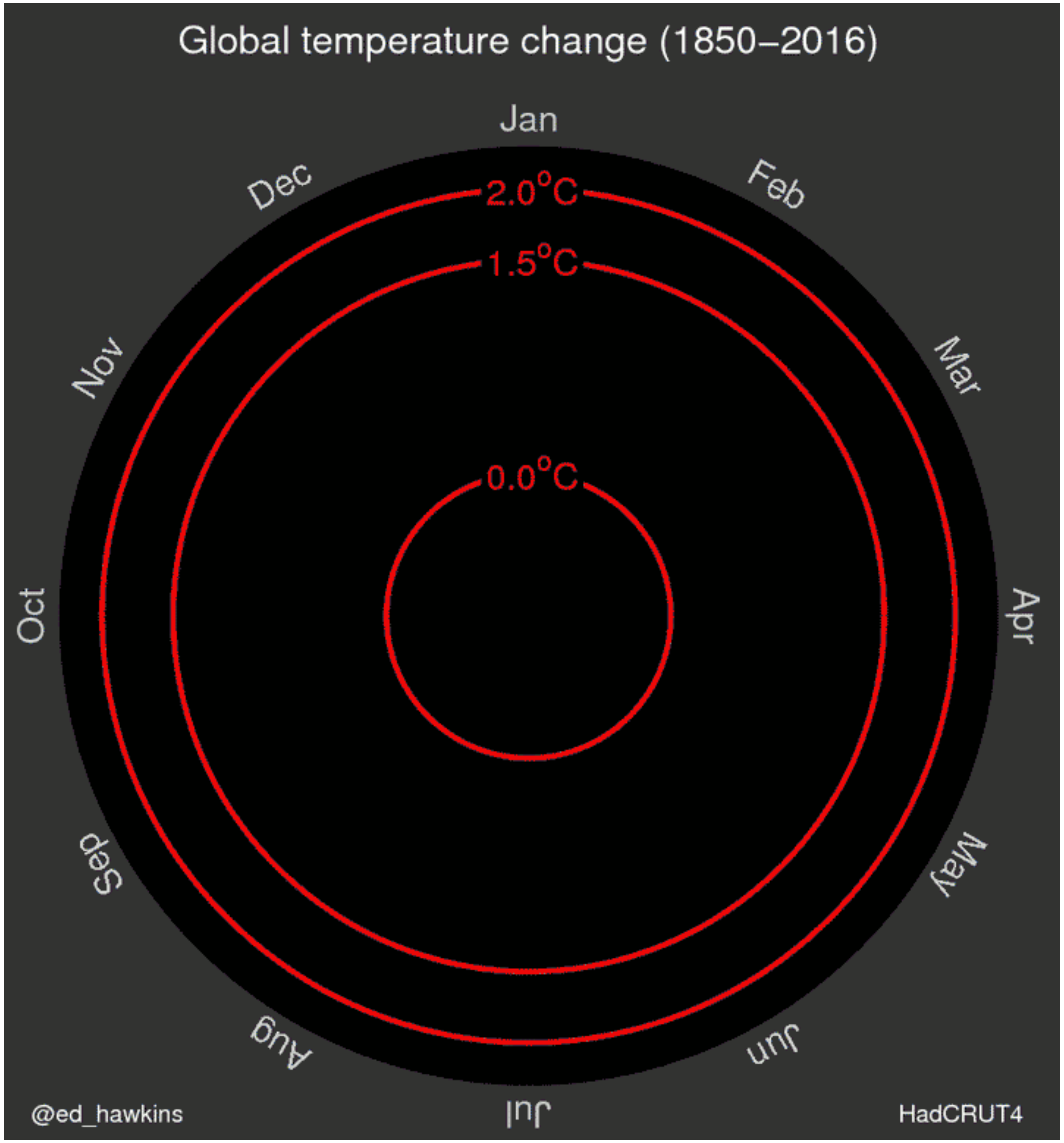
global temperature

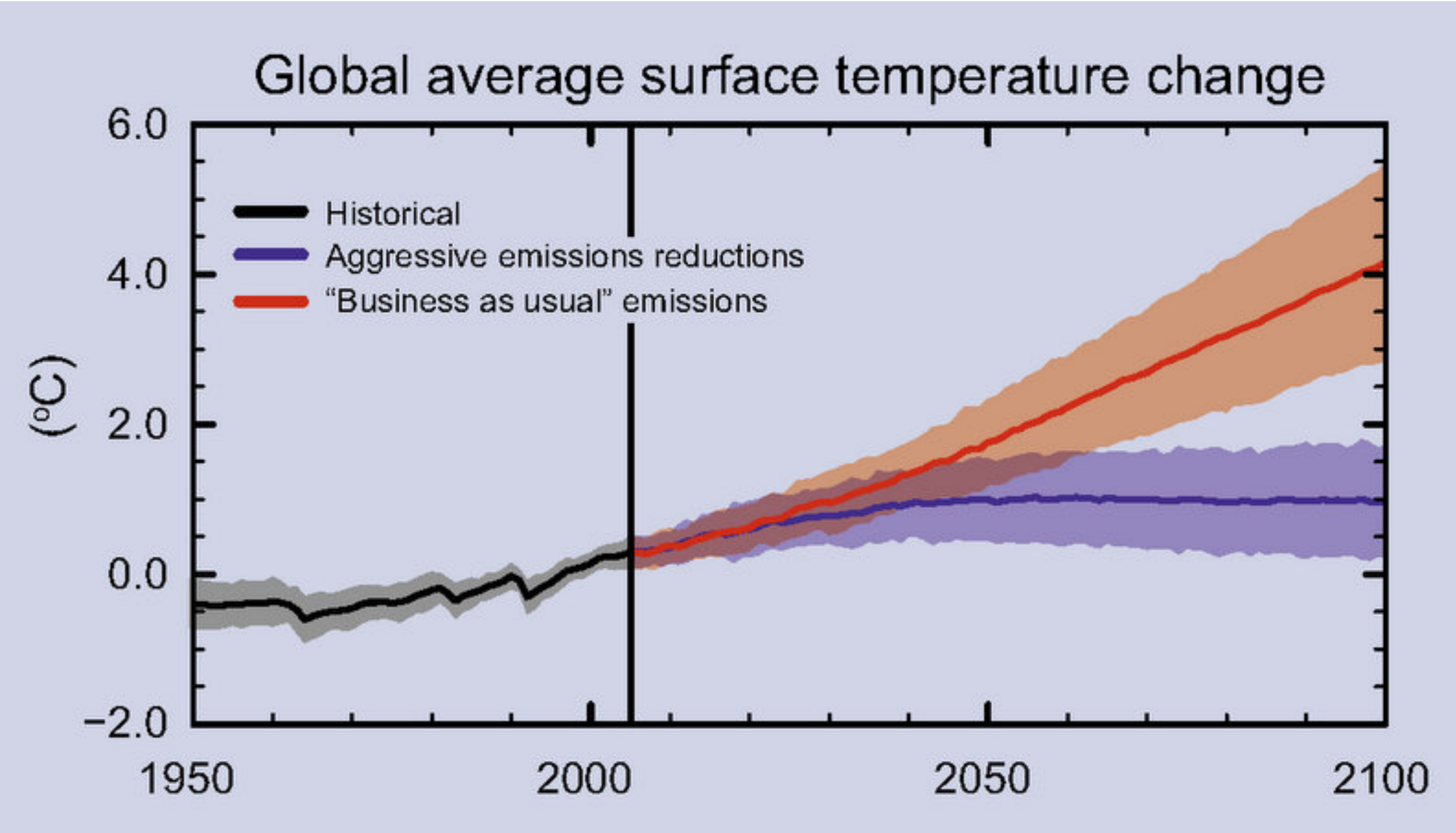
atmospheric CO2

GHG emissions

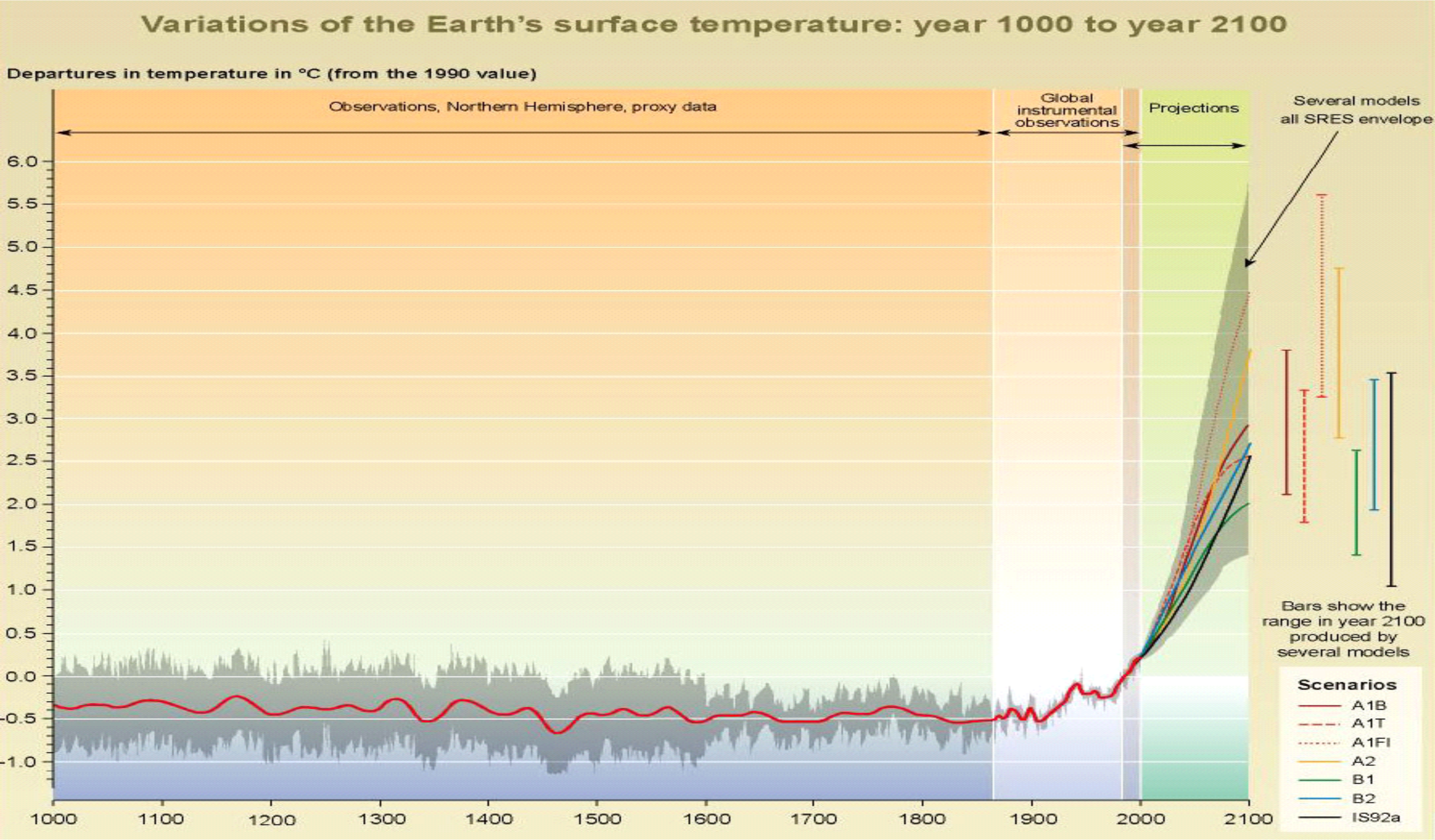


See Earth’s Temperature Spiral Toward 2°C





Global average surface temperature change
6.0
4.0
2.0
0.0
−2.0
(ºC)
Historical
Aggressive emissions reductions
"Business as usual" emissions
1950
2000
2050
2100



Variations of the Earth's surface temperature: year 1000 to year 2100
Departures in temperature in °C (from the 1990 value)
Observations, Northern Hemisphere, proxy data
Global instrumental observations
Projections
Several models all SRES envelope
Bars show the range in year 2100 produced by several models
Scenarios
A1B
A1T
A1FI
A2
B1
B2
IS92a
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100

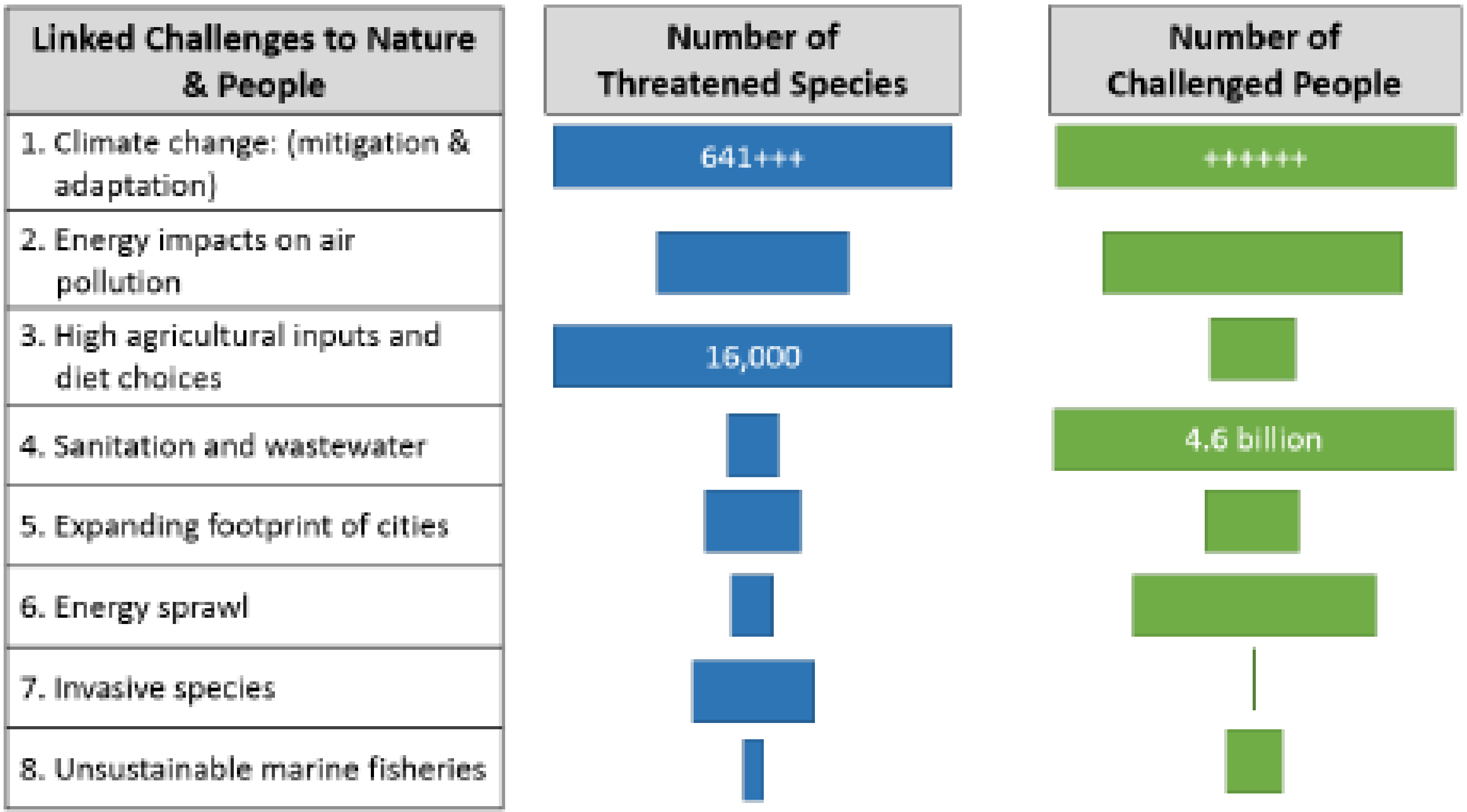
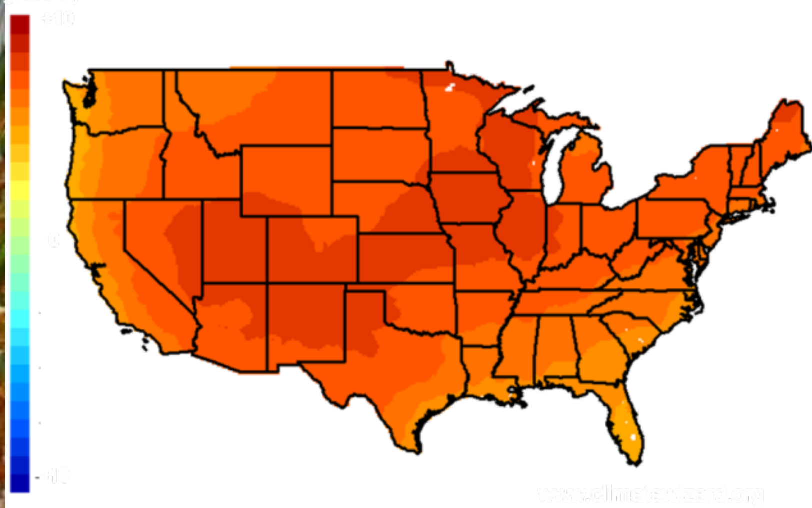


Figure 5. Global Challenges and associated species in decline and people at risk. All species bars are

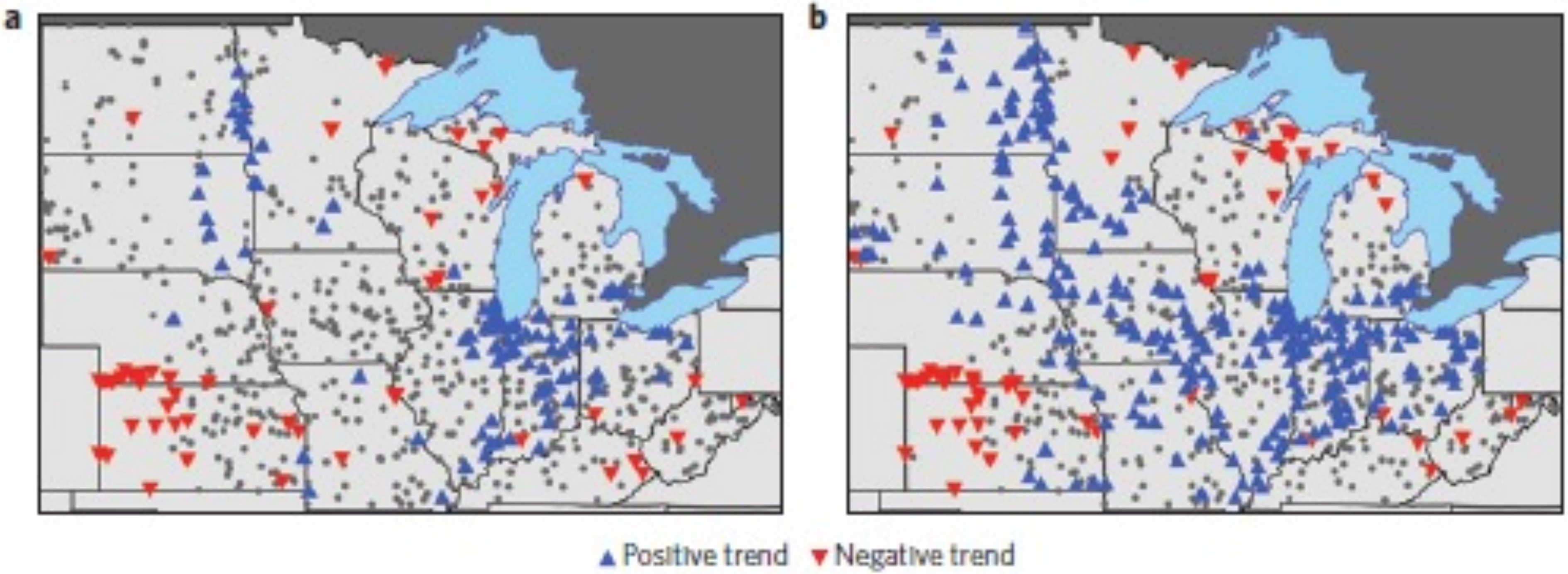
Direct Climate Change Effects


Louisville, IL, July 2012
Robert Ray/Assoc Press




near Havana, IL, April 2013
K. Doug Blodgett, TNC

50-Year Changes in Flooding in the Central US

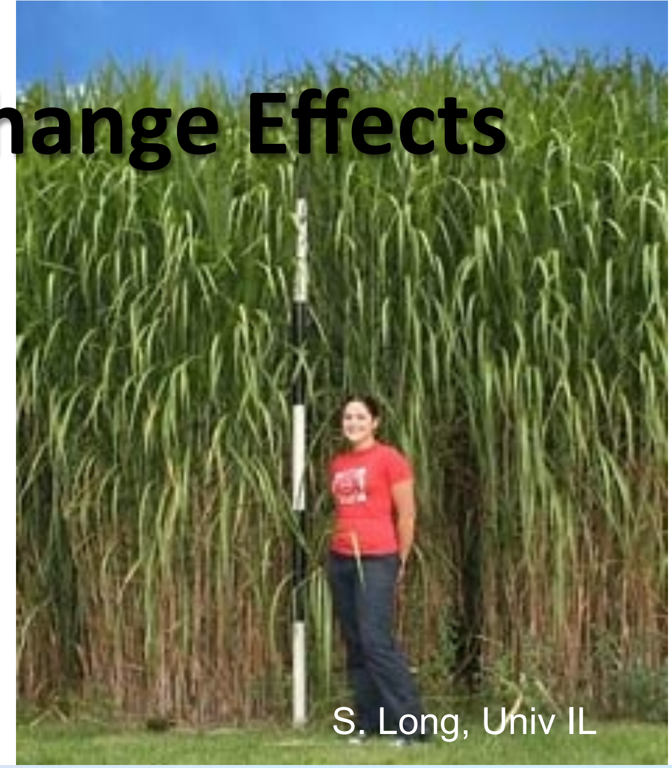


Higher Flood Magnitude **And Especially Flood Frequency**

Mallakpour and Villarini 2015

Indirect Climate Change Effects

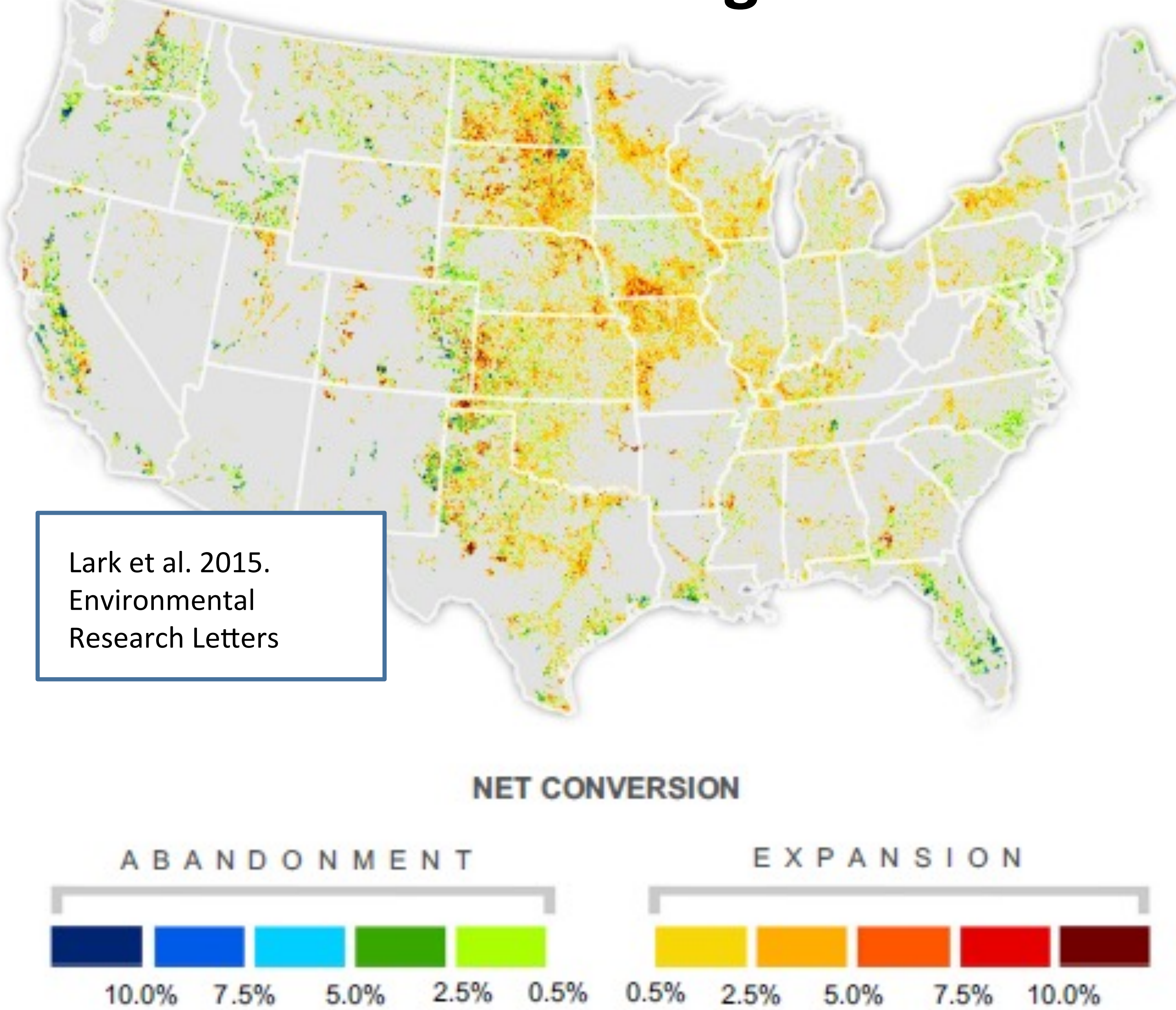

Energy Law Wisconsin


S. Long, Univ IL


tlirr.com

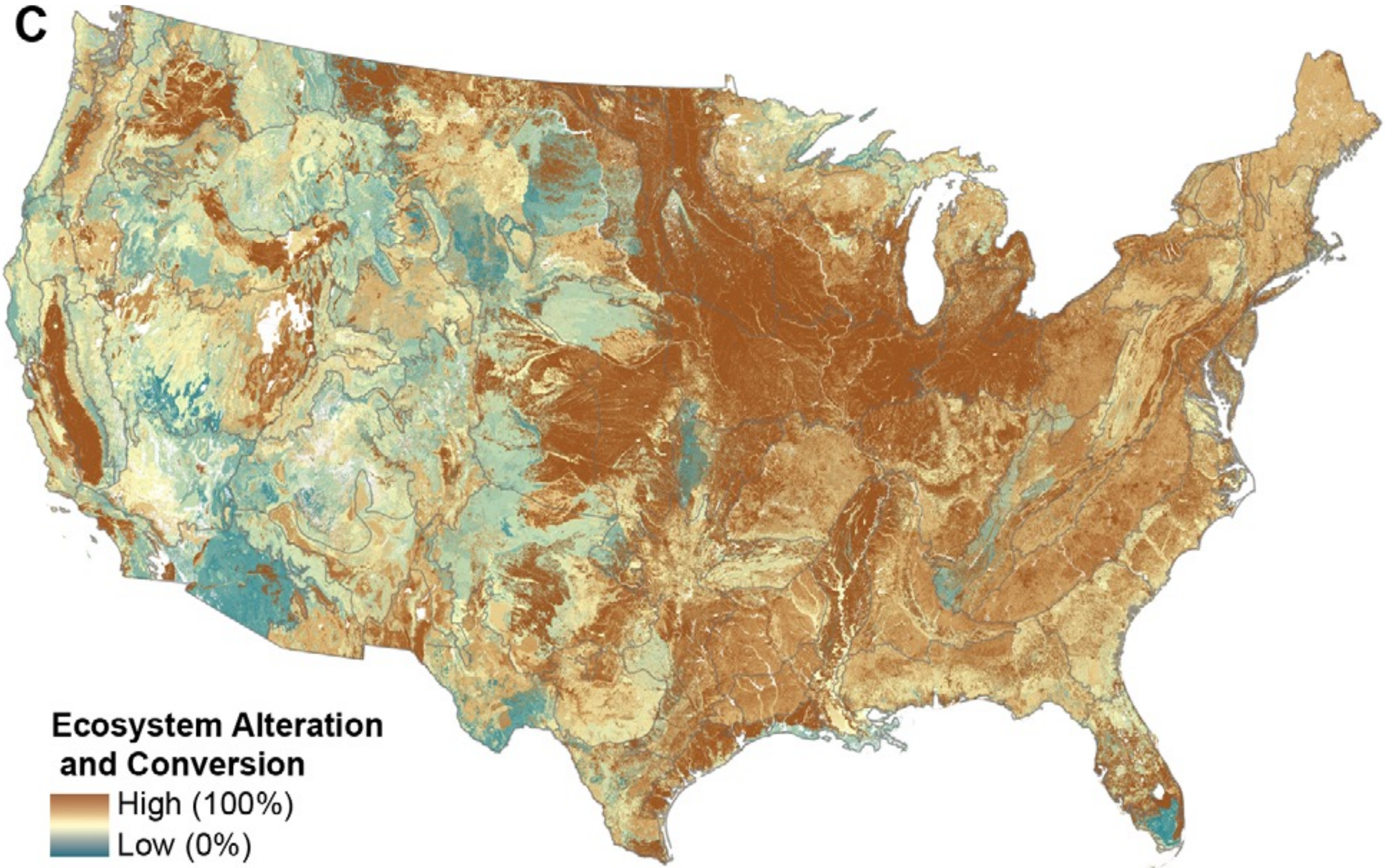

P. Aronsson

Grassland Conversion During the Ethanol Boom

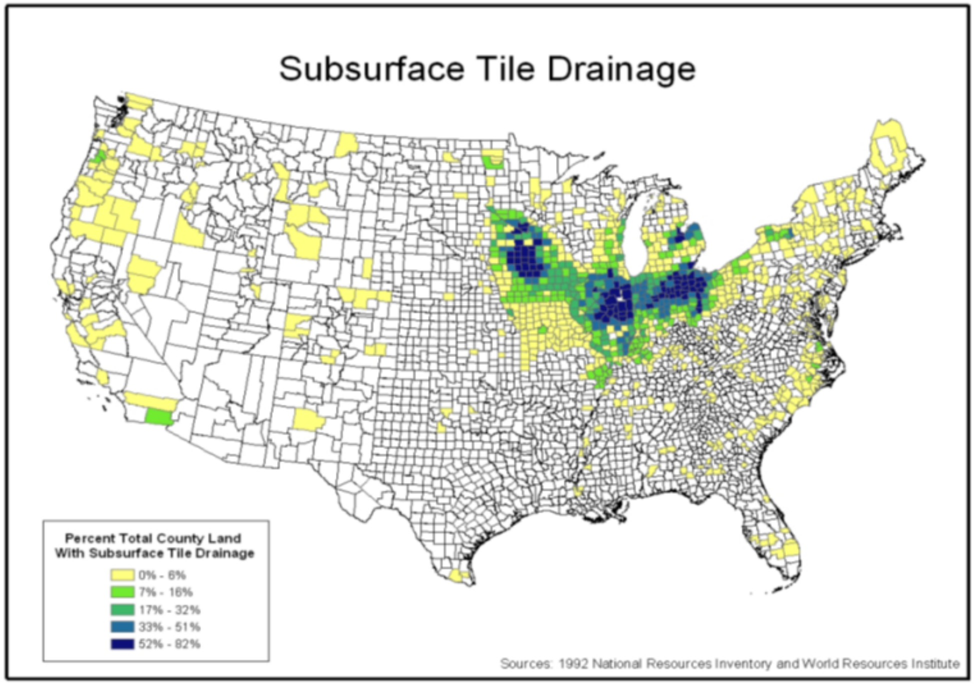


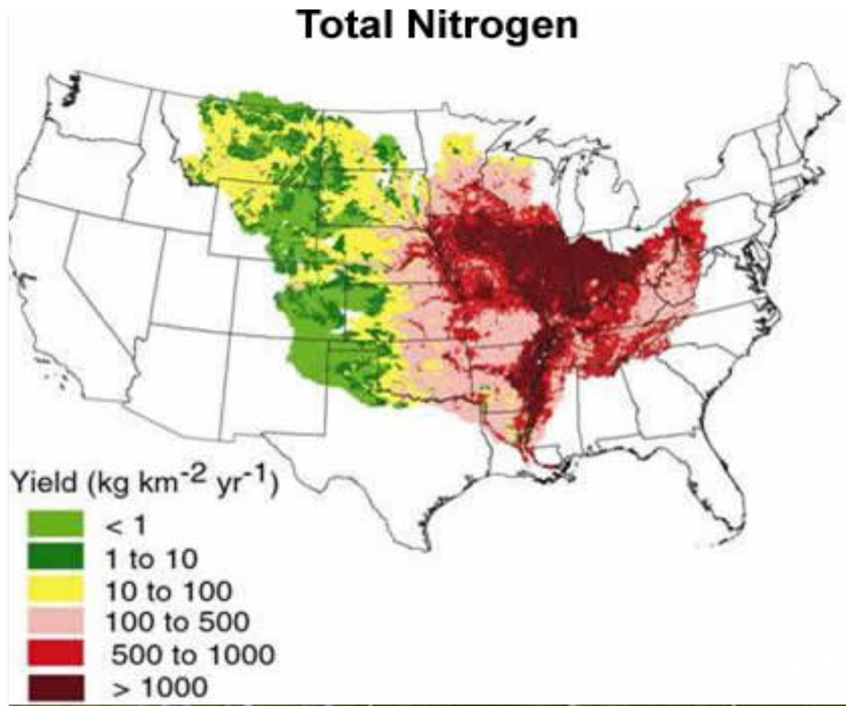
Lark et al. 2015.
Environmental
Research Letters

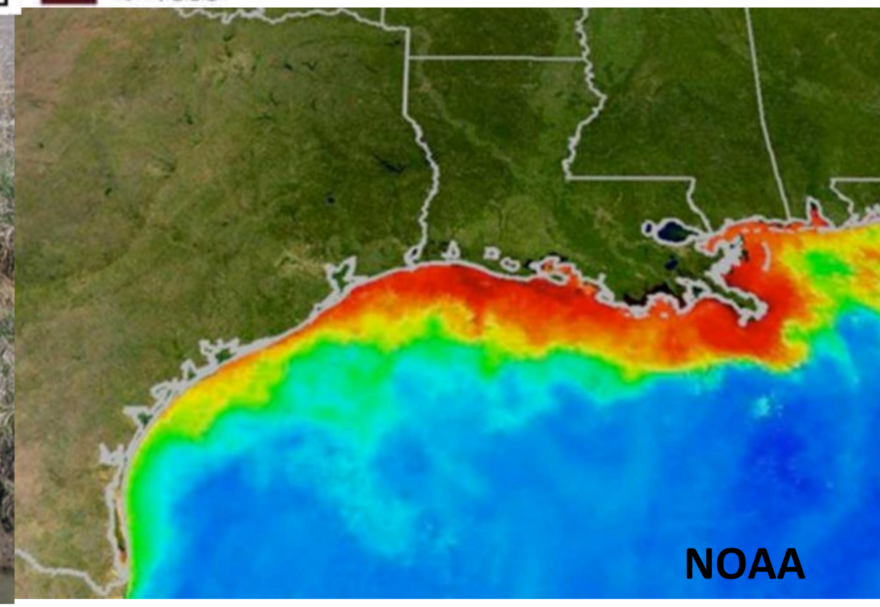
A Challenging Region, on the Land…



…Under the Land…



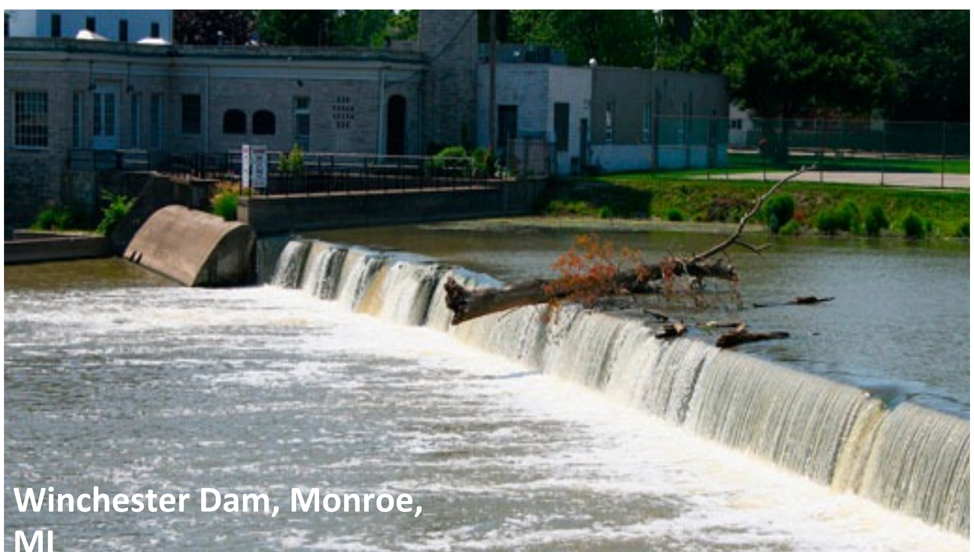




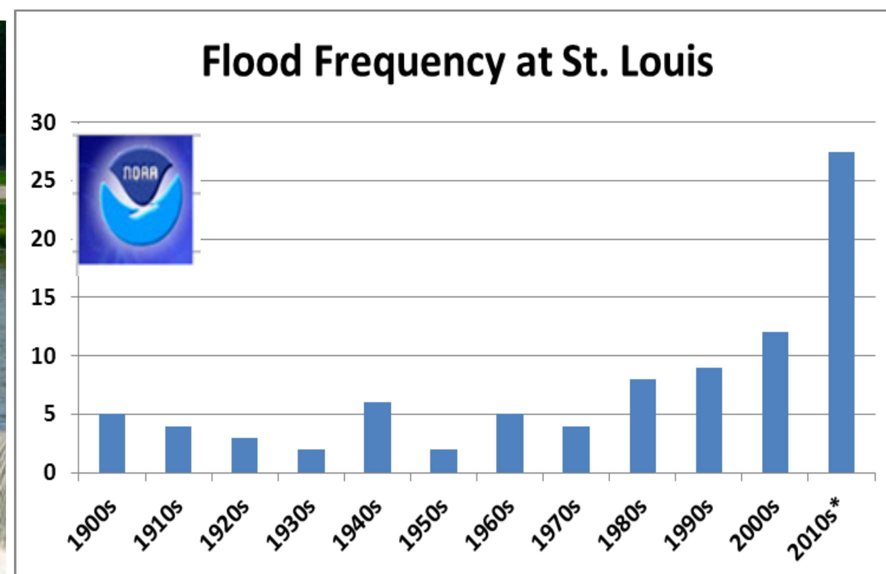
…And in the Water

Lock & Dam #7 La Crescent MN; mvp.usace.army.mil

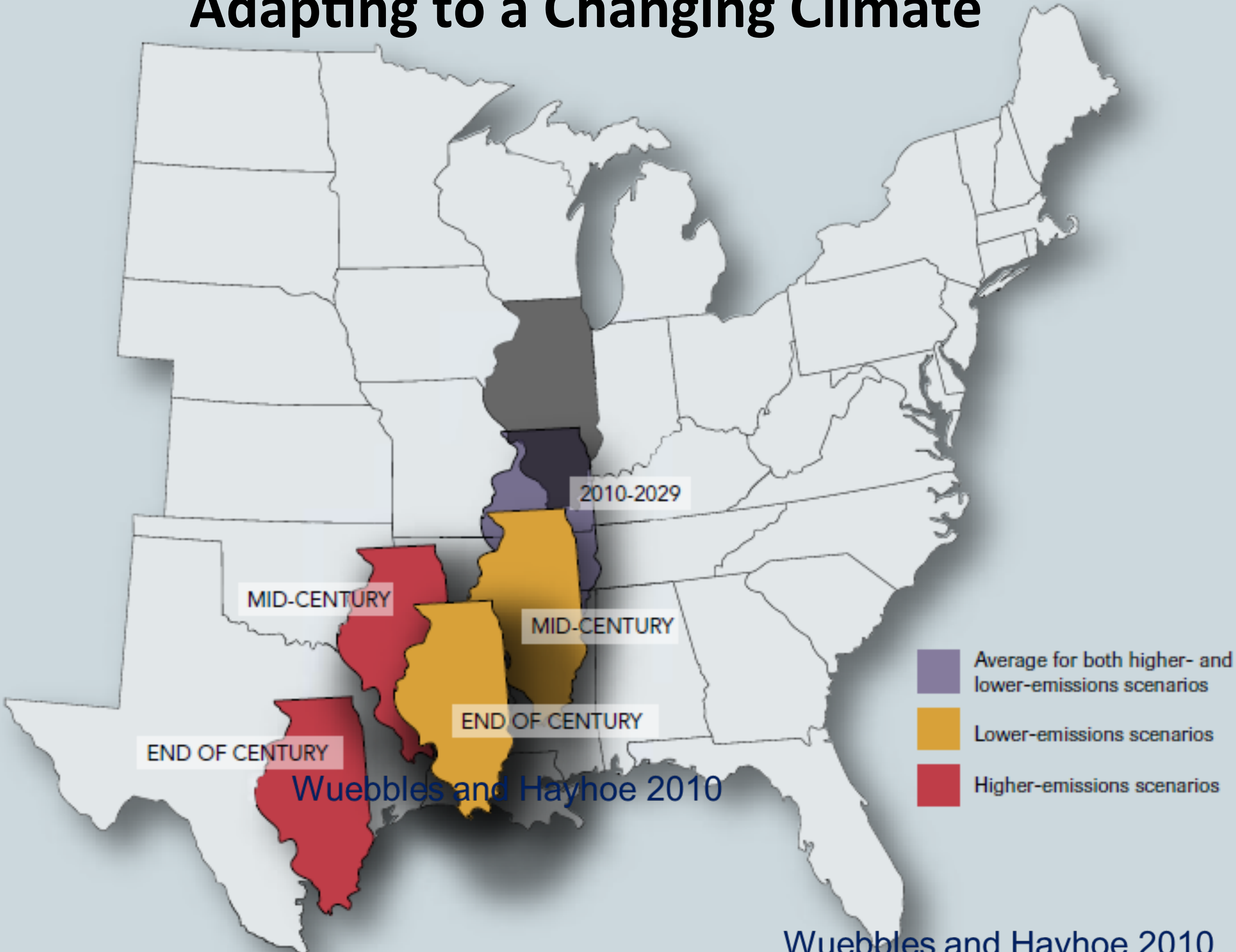
Illinois River sediment; dnr.illinois.gov



Winchester Dam, Monroe, MI

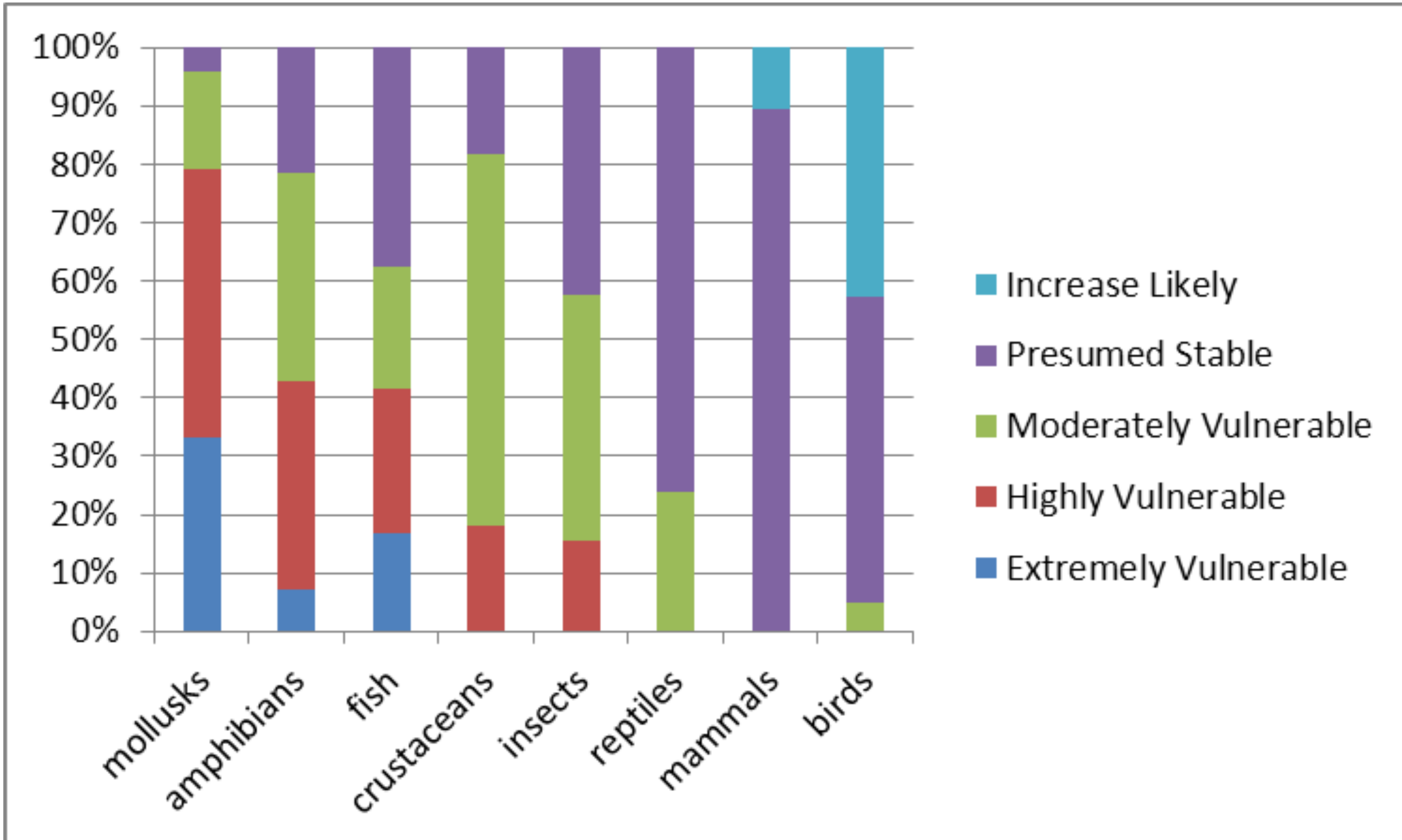


Adapting to a Changing Climate

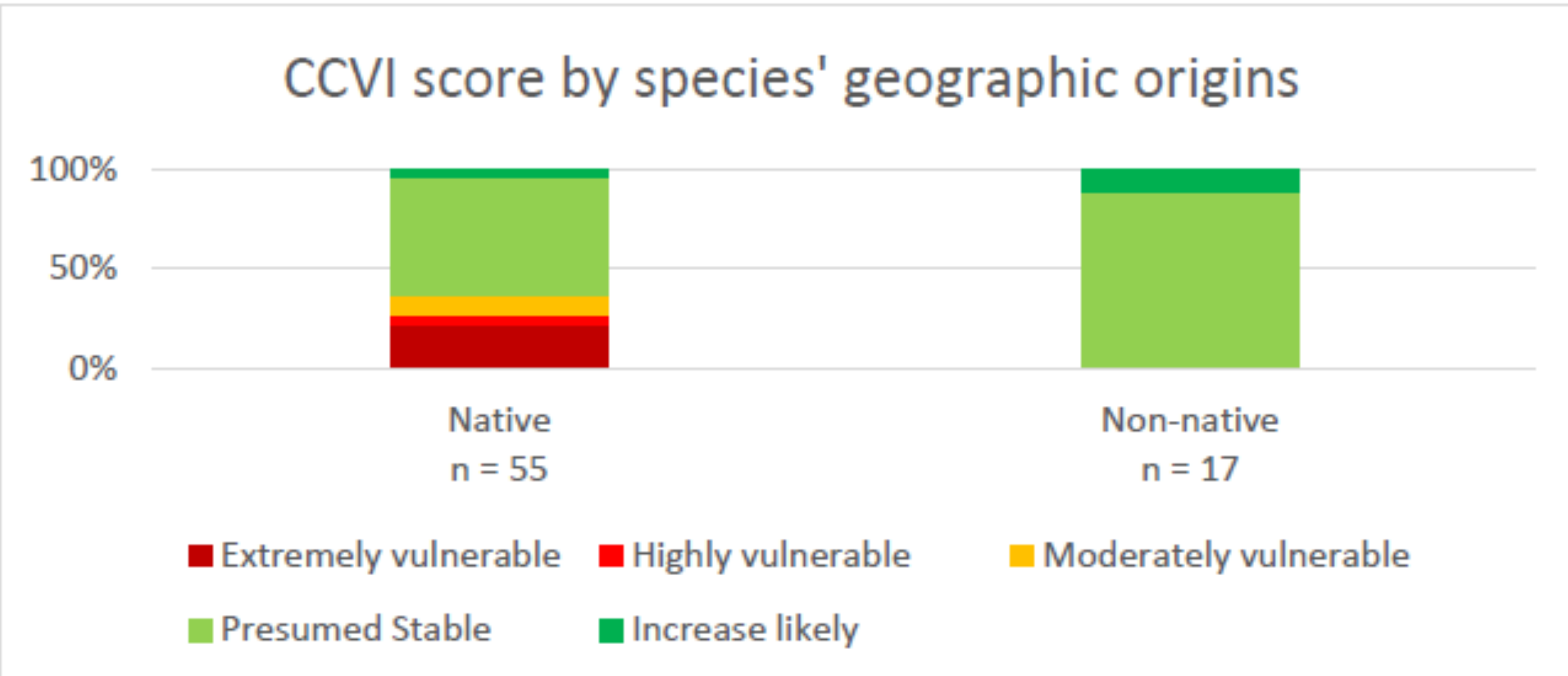


Wuebbles and Hayhoe 2010

Aquatic Wildlife Are More Vulnerable to Climate Change

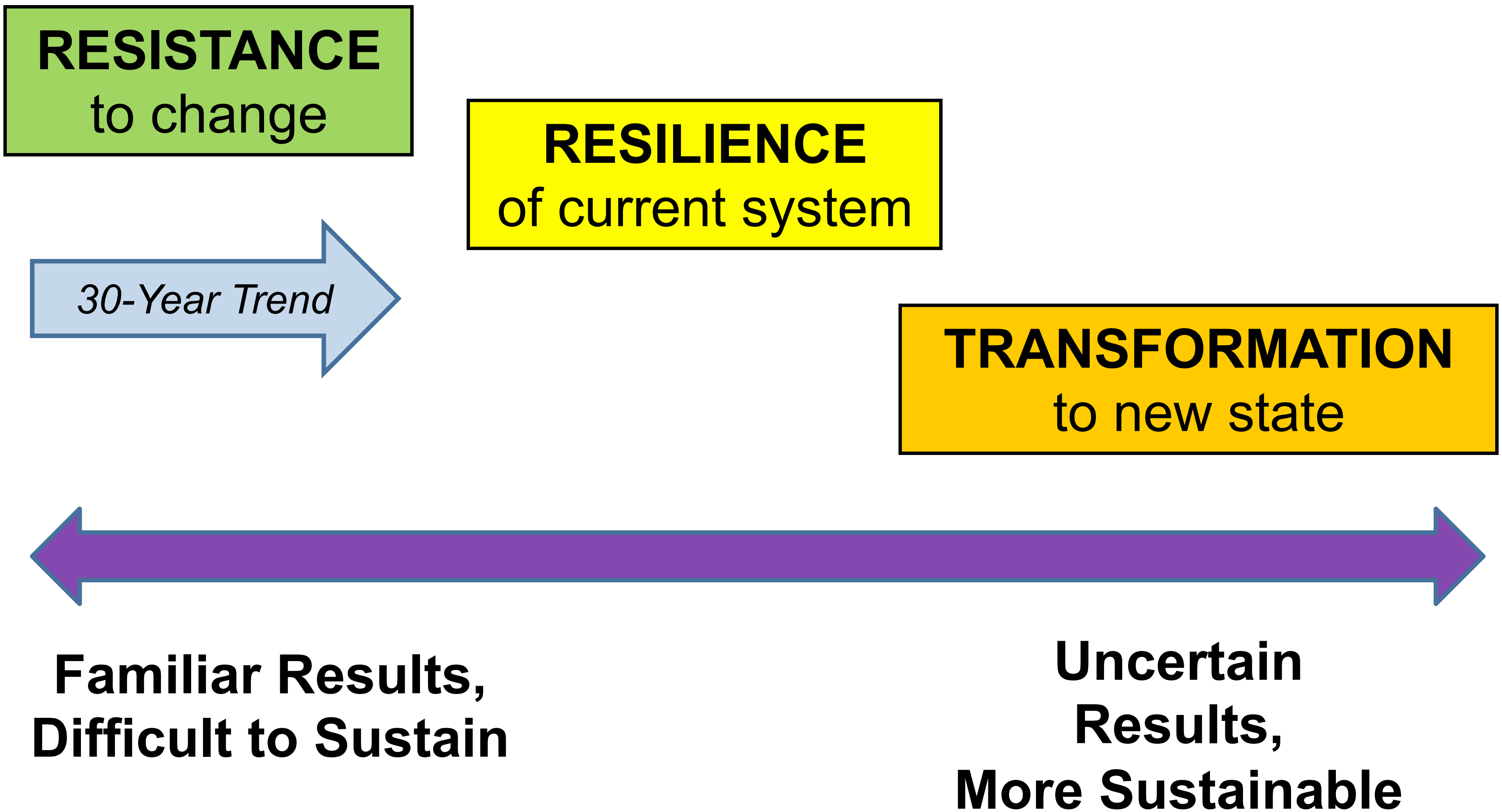


Native Plants are More Vulnerable than Non-Native Plants



Baty et al. 2015. INHS Tech Report 2015(32).

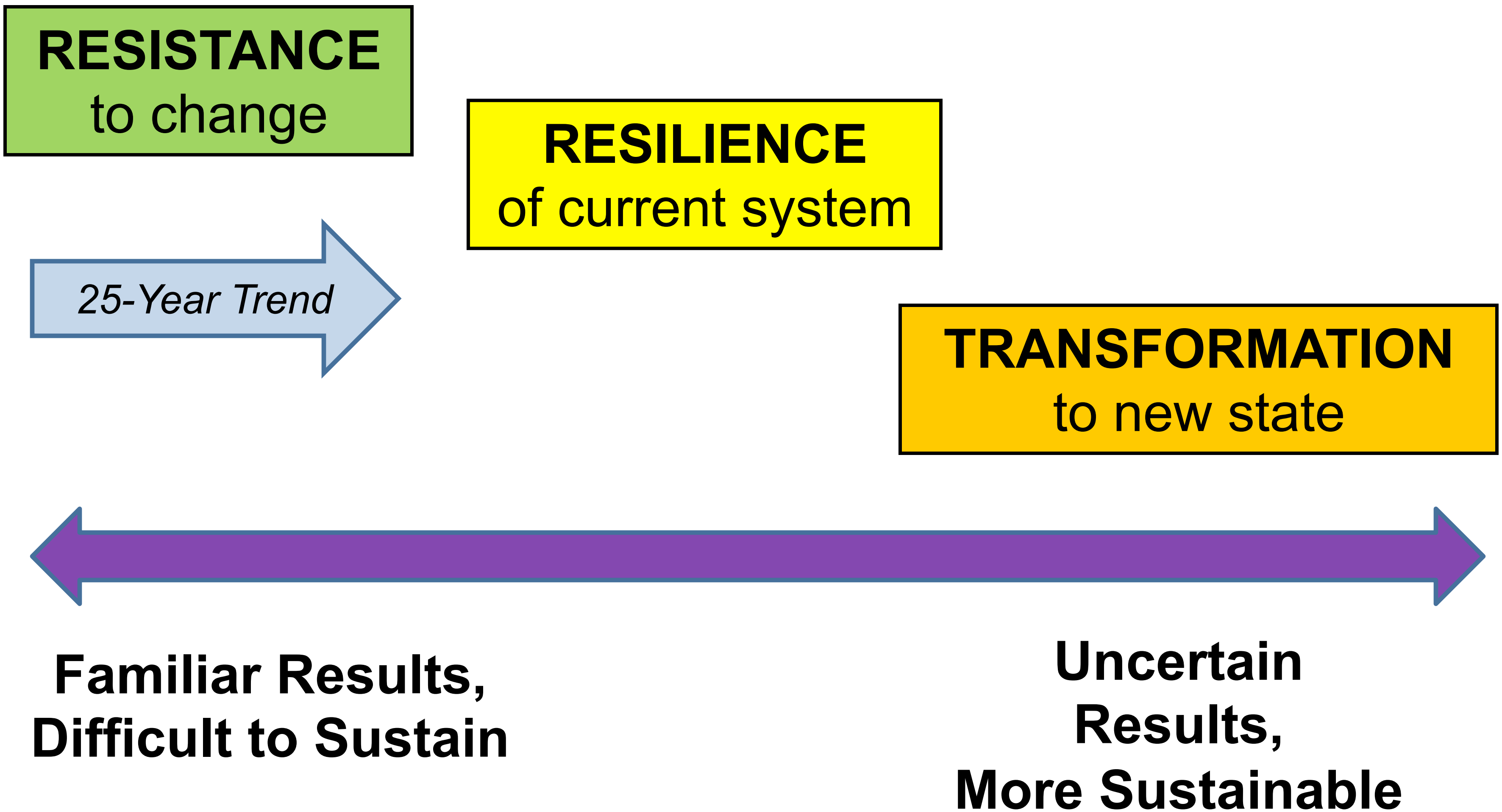
Adaptation Strategies



Modified from Heller and Zavaleta 2009


ARKive
www.arkive.org
© Allen Blake Sheldon / Animals Animals

Adaptation Strategies



Modified from Heller and Zavaleta 2009

Improving Resilience

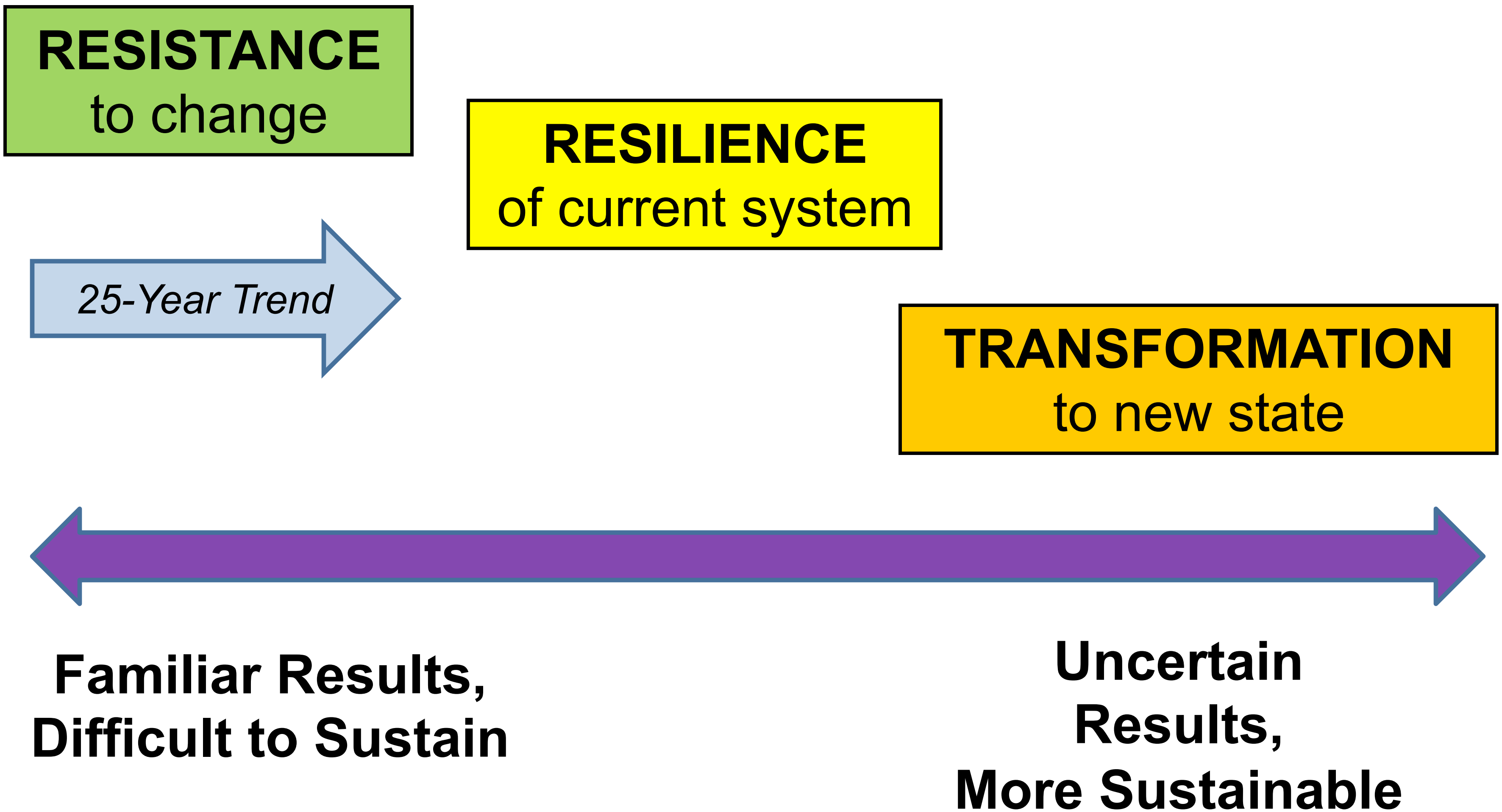
- Enhance connectivity, reduce fragmentation
- Restore natural processes
- Reduce pollution, invasive species, other stressors
- Increase population size

Illinois Fire Needs Assessment

Survey Respondents	Water, parks, crops	Degraded/ Unburnable	Burn-Worthy	Burned June 2014- May 2015
1,049,573 acres managed; 25 organizations	256,379 acres	210,533 acres	582,661 acres	50,789 acres
100%	24%	20%	56%	5% (9% of burn-worthy)

- We need to burn more area
- With higher frequency
- Far too many ecologically degraded acres cannot recover with fire alone

Adaptation Strategies



Modified from Heller and Zavaleta 2009

Conserving Nature's Stage

Create arenas for evolution not museums of the past

Sedimentary

Granite

Coarse Sand

Limestone

Fine Silt/Organic

Mafic

Moderately Calcareous

Granite

Conserving Nature’s Stage

http://magazine.nature.org/features/grounded.xml
June/July 2014

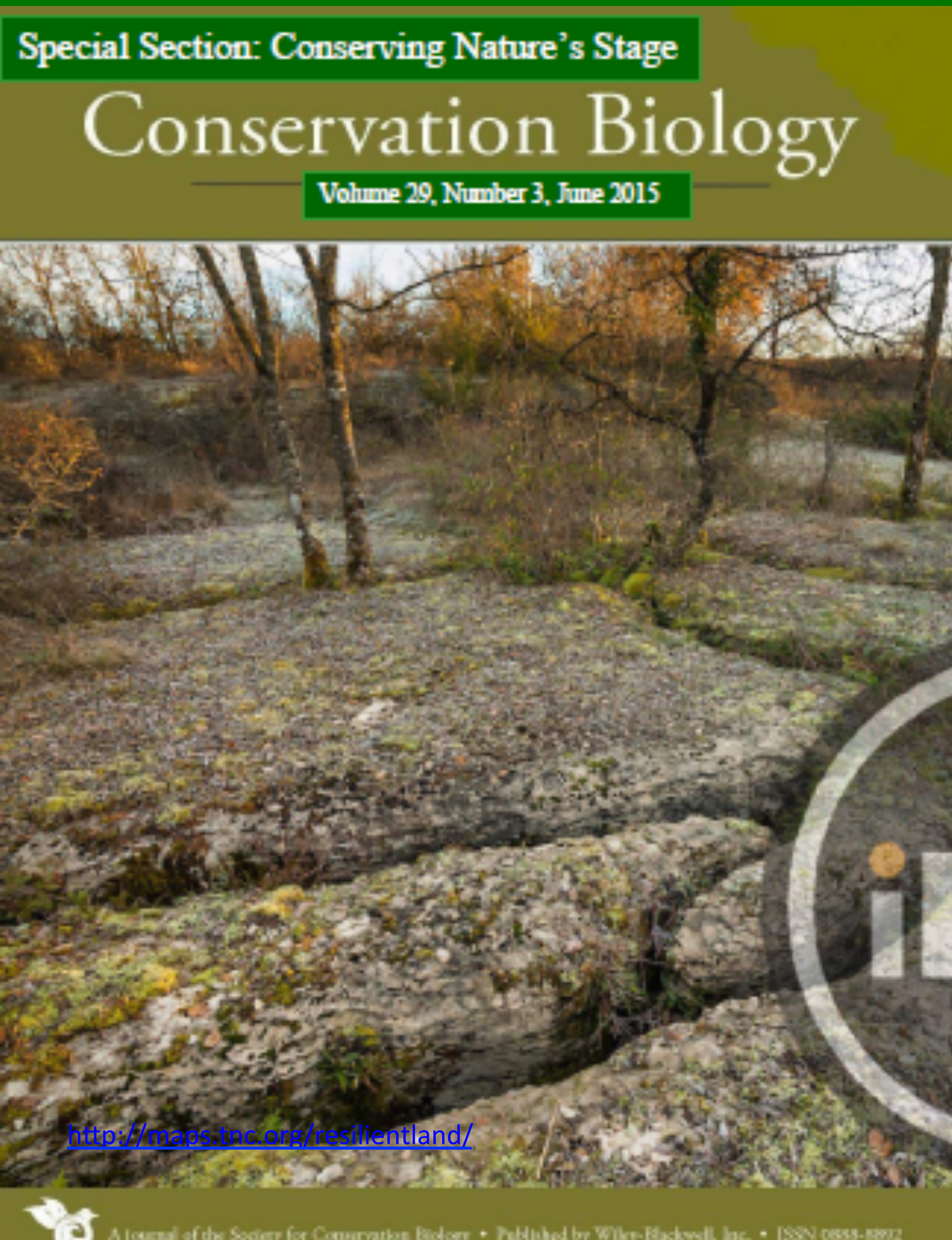
“Geodiversity…. drives patterns of biodiversity.”

—Mark Anderson, Director of Conservation Science, Eastern Division

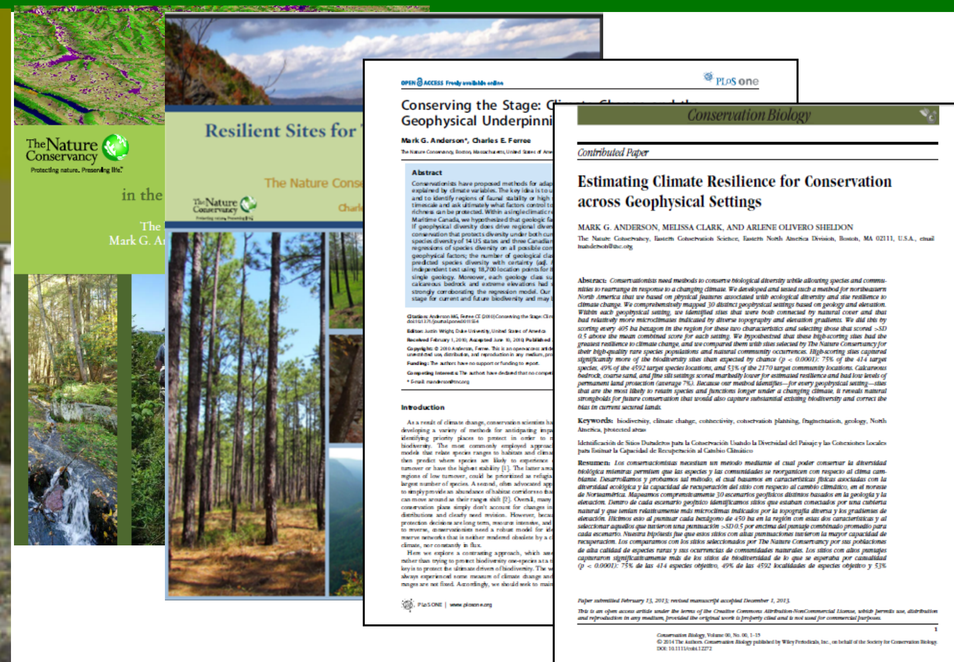
DORIS DUKE
CHARITABLE FOUNDATION

Primary Funder:
Doris Duke Charitable Foundation

A Well-Established Approach

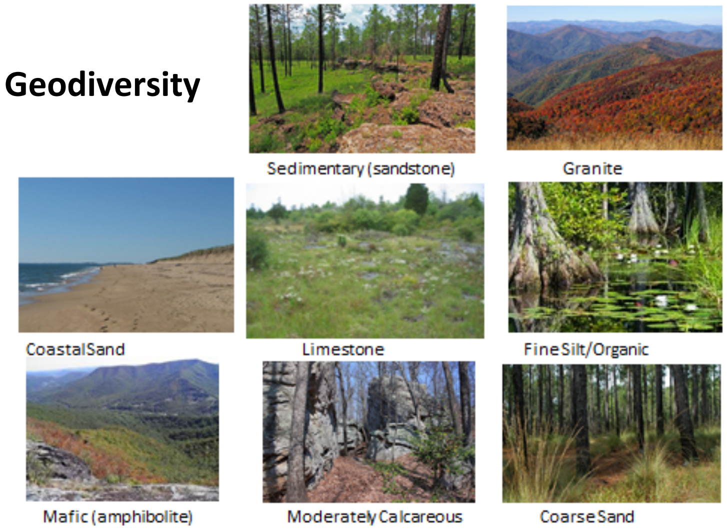


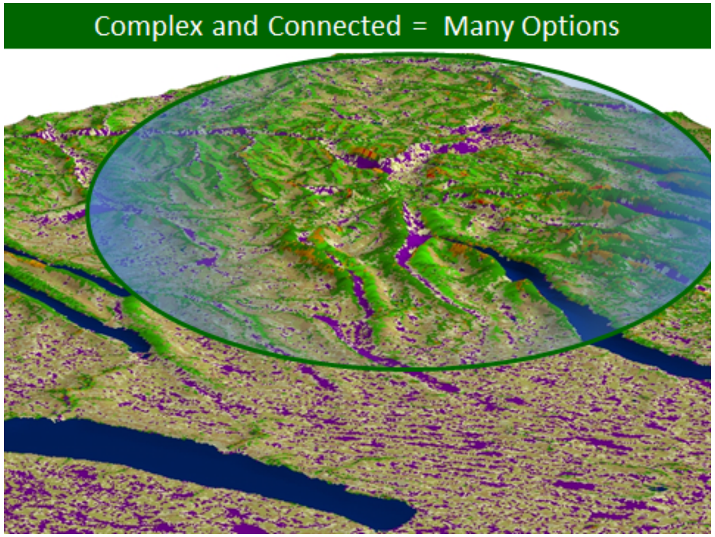
http://maps.tnc.org/resilientland/



- Theory
- Ecosystem services
- Evidence in past
- Current protection
- Surrogate for diversity
- Approaches
- Management implications

Two Main Concepts





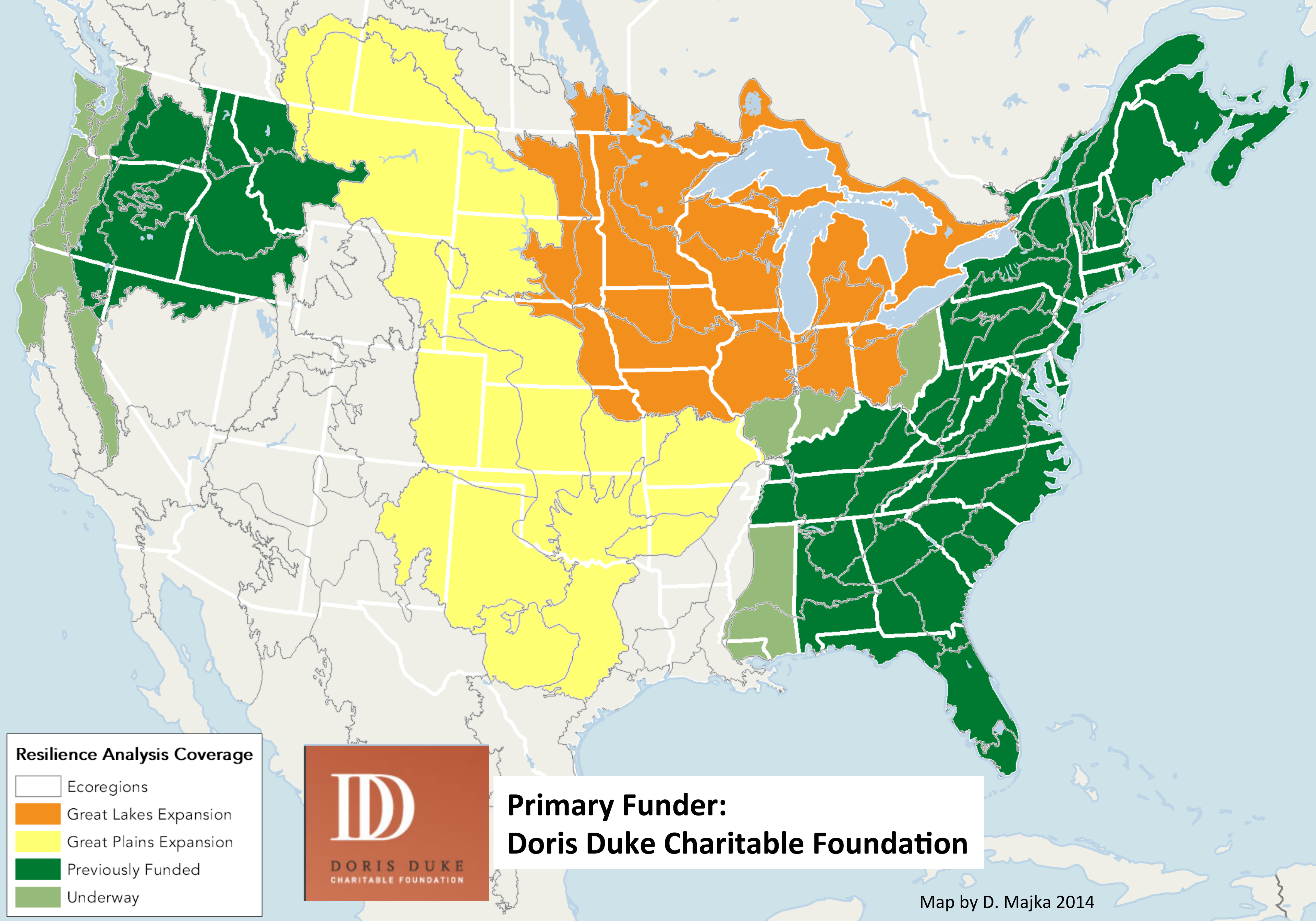
1. Geodiversity

Conserve examples of different physical environments

2. Climate-Resilient Sites

Focus conservation on natural climate strongholds

Conserving Nature's Stage

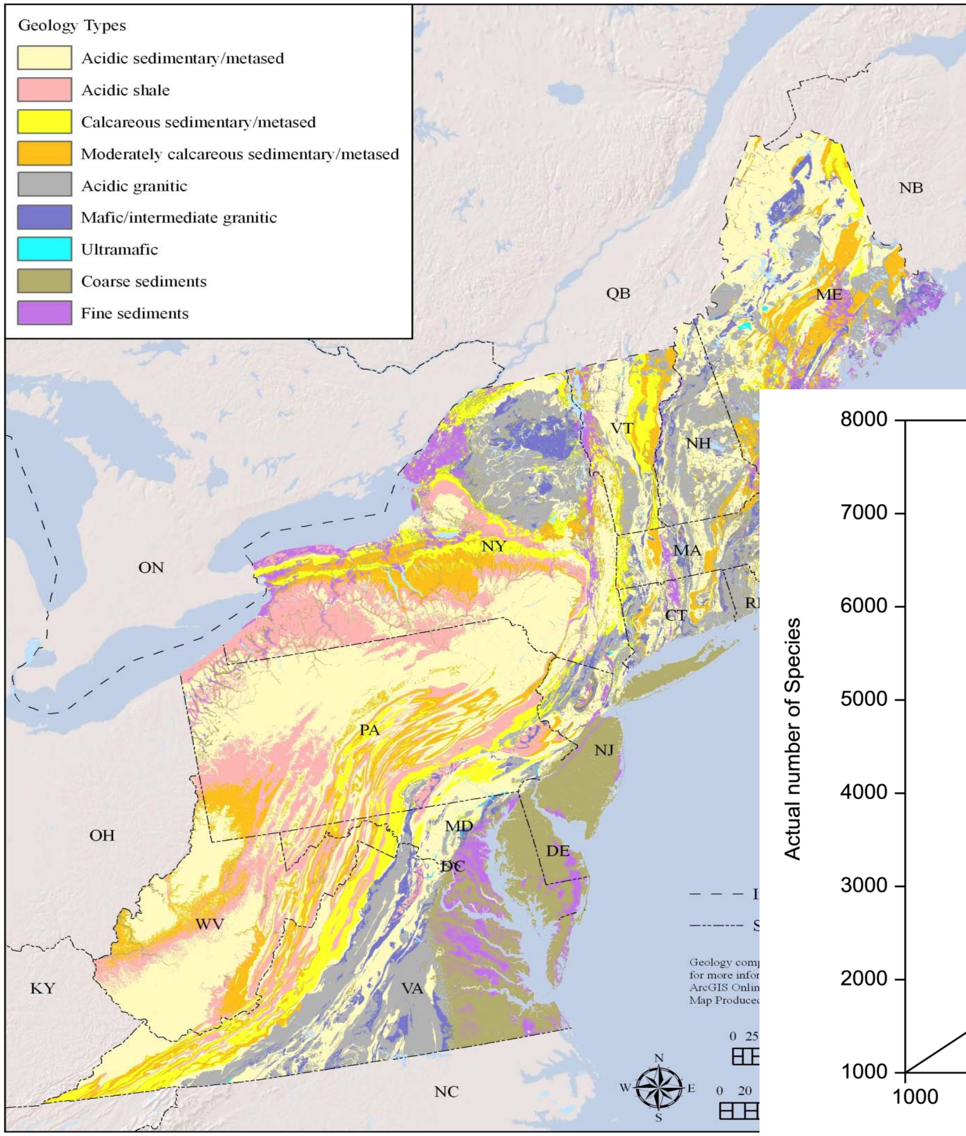


DORIS DUKE
CHARITABLE FOUNDATION

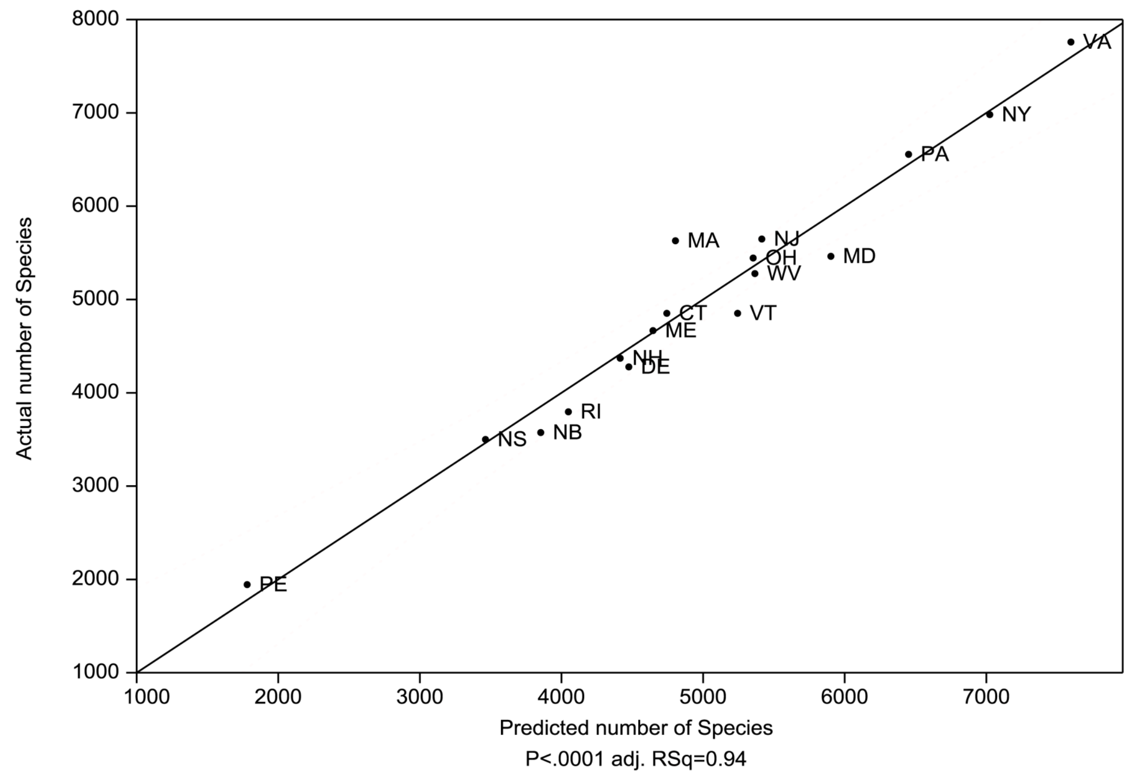
Primary Funder:
Doris Duke Charitable Foundation

Map by D. Majka 2014

1. Species as Actors on the Geophysical Stage



- **Latitude**
- **Elevation**
- **Bedrock**



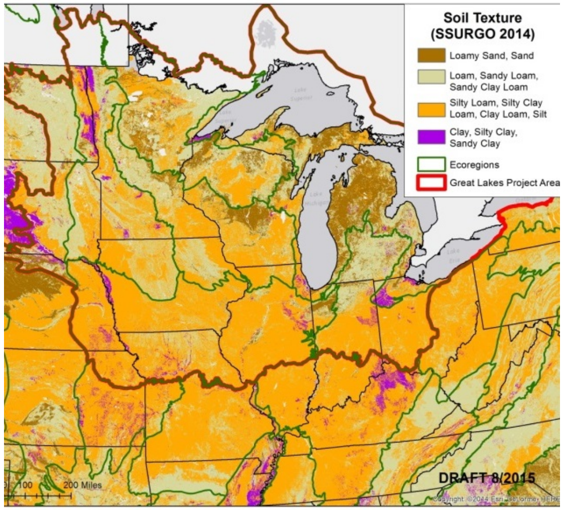
Anderson and Ferree. 2010. Plos One

Large Scale Factors for Stratification

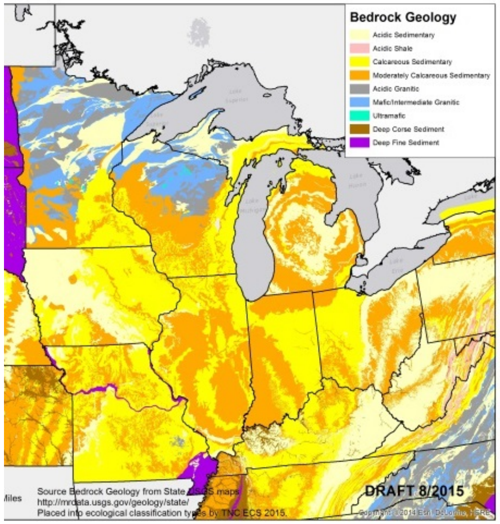
Survey

Factor	ON	MB	All/ NRCS	GL	MN	MO	IA	IL	OH	MI	WI
Soil Type			✓			✓	✓	✓		✓	✓
Great Lakes "Effect"	✓		✓	✓				✓		✓	
Geology/Parent Material	✓	✓	✓						✓	✓	
Glaciated vs. unglaciated							✓	✓	✓		
Hydrology		✓	✓							✓	
North-South Gradient							✓			✓	✓
East-West Gradient					✓						✓
Glacial Landforms					✓			✓			
Mississippi R. Drainage (historical connections)	✓										

Soil Texture

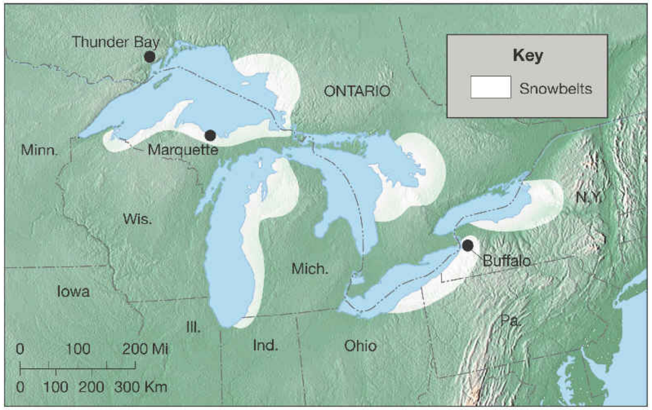


Bedrock/Parent Material

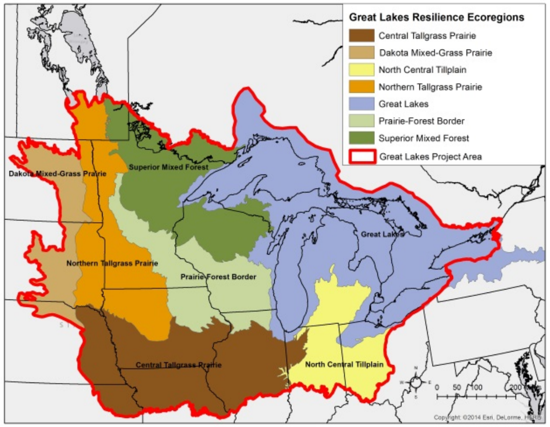


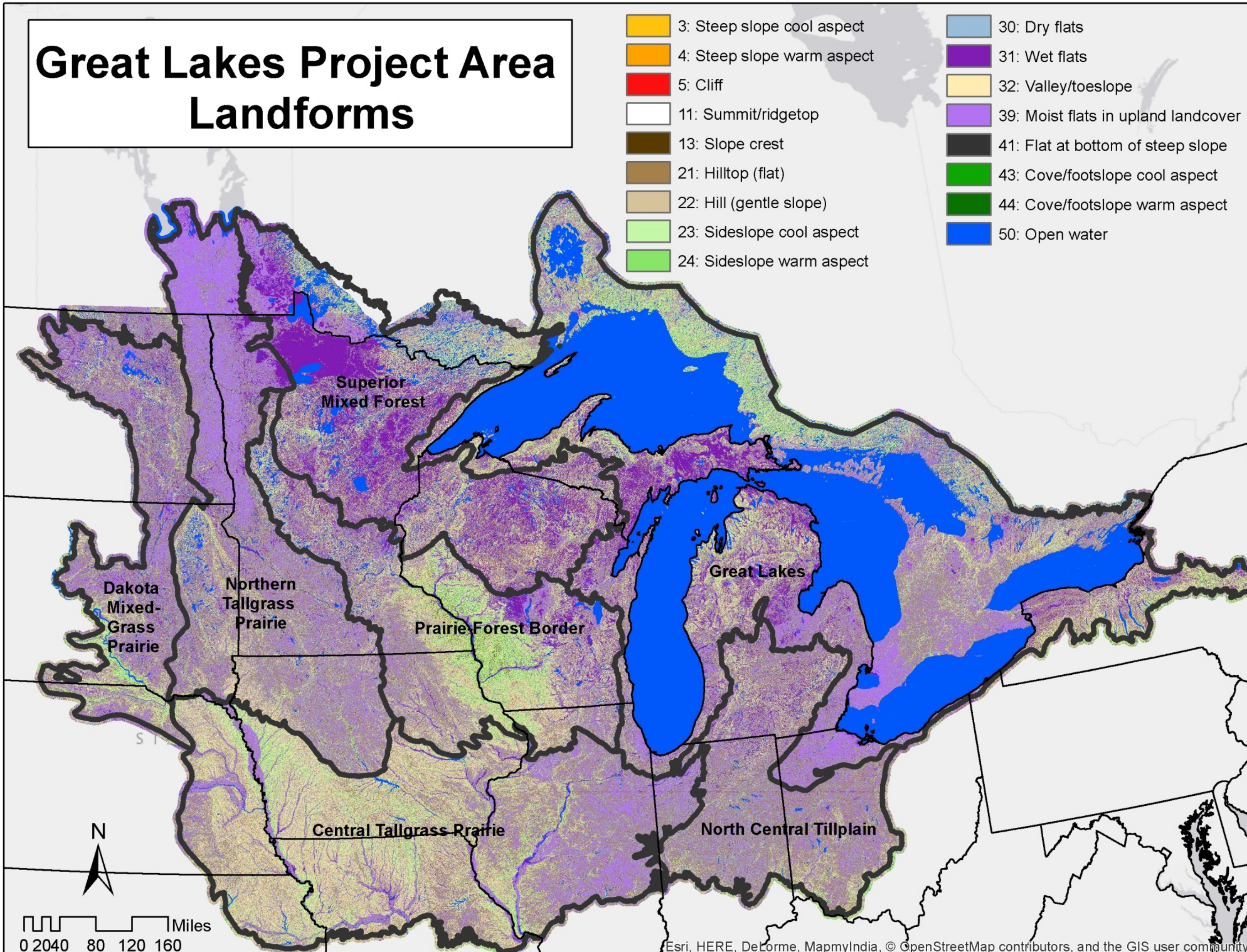
Glacial Boundary

Lake Effect



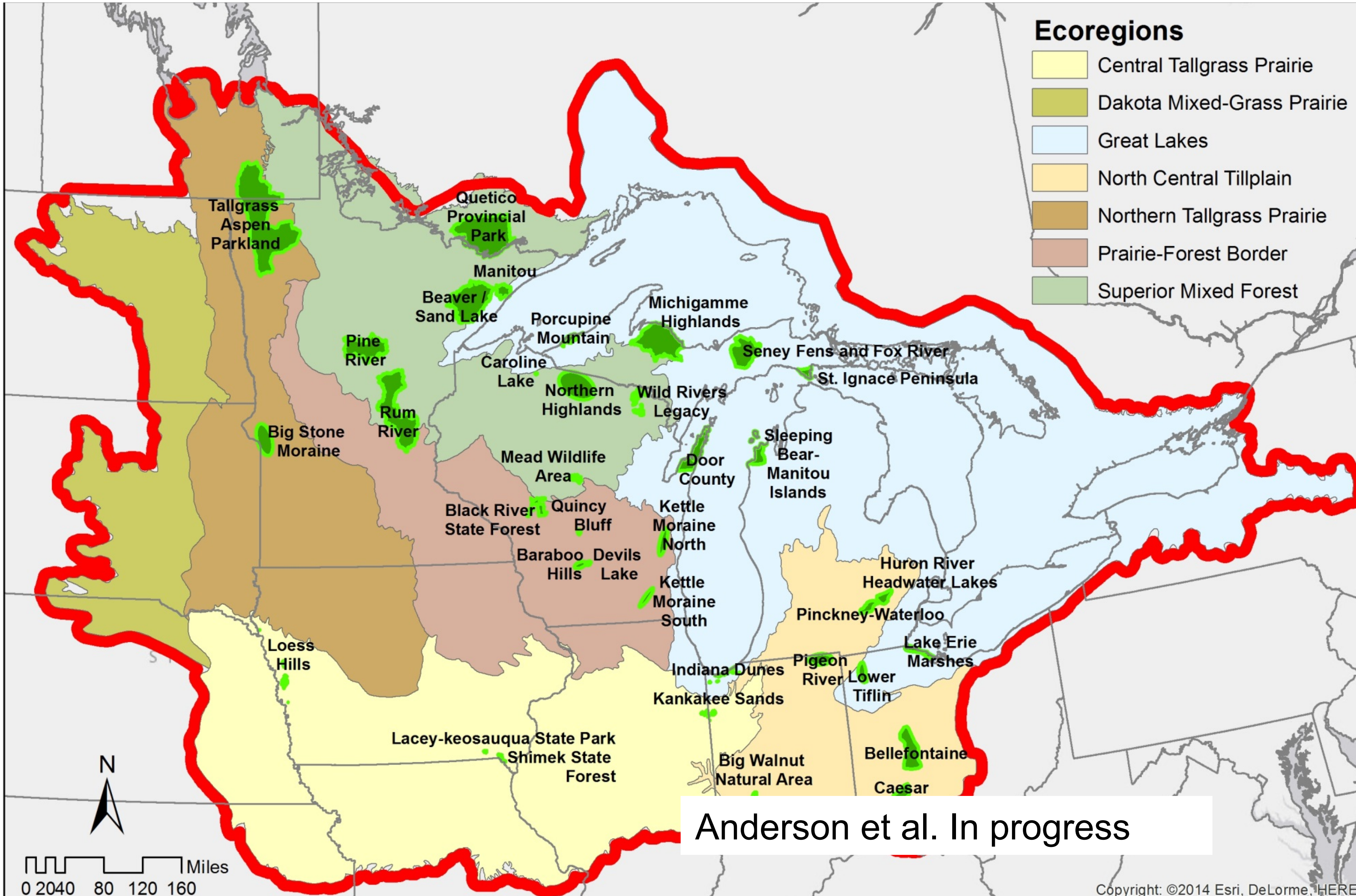
Ecoregion (EW, NS)





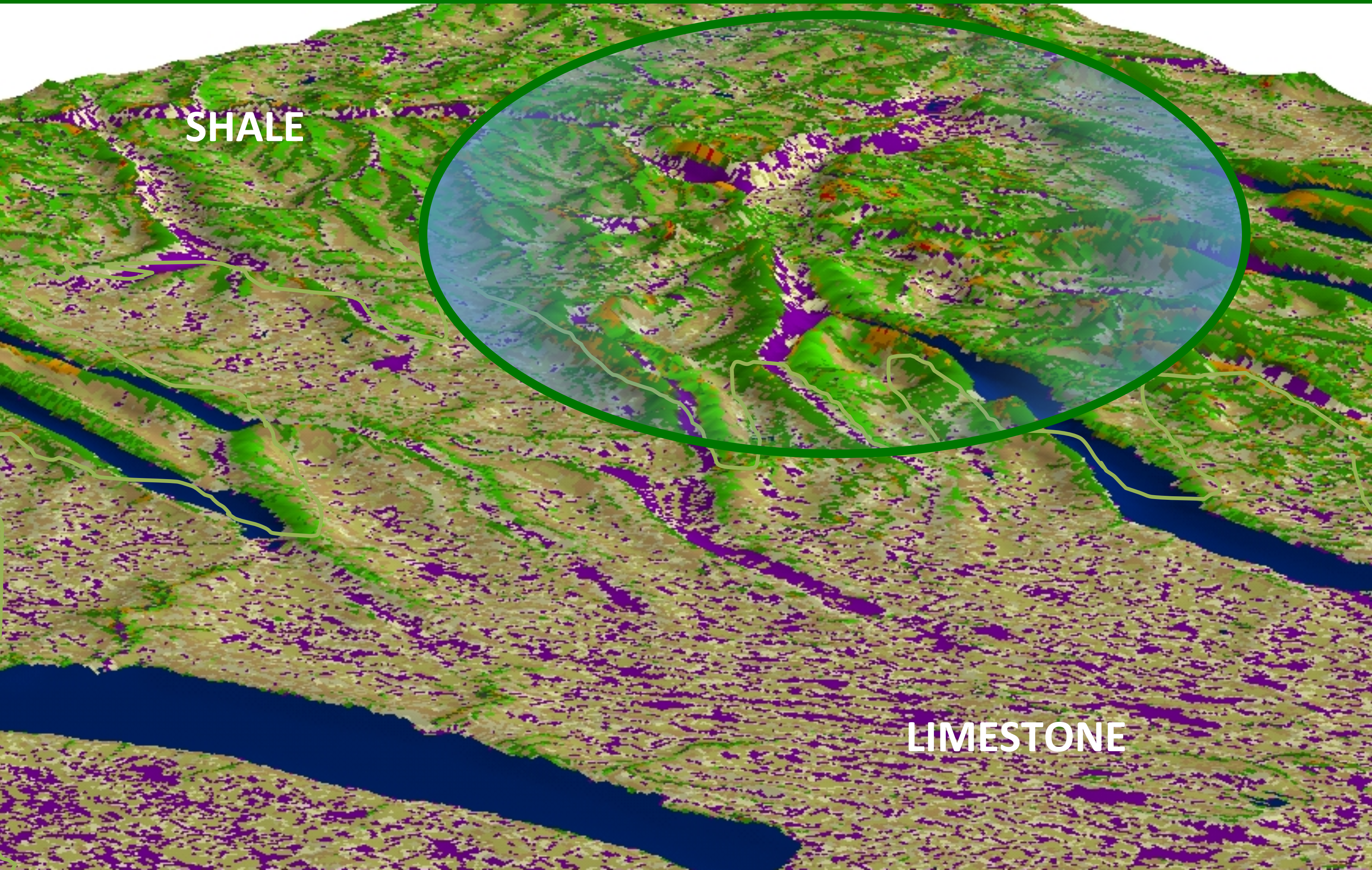
Great Lakes Project Area Landforms
3: Steep slope cool aspect
4: Steep slope warm aspect
5: Cliff
11: Summit/ridgetop
13: Slope crest
21: Hilltop (flat)
22: Hill (gentle slope)
23: Sideslope cool aspect
24: Sideslope warm aspect
30: Dry flats
31: Wet flats
32: Valley/toeslope
39: Moist flats in upland landcover
41: Flat at bottom of steep slope
43: Cove/footslope cool aspect
44: Cove/footslope warm aspect
50: Open water
Superior Mixed Forest
Dakota Mixed-Grass Prairie
Northern Tallgrass Prairie
Prairie-Forest Border
Great Lakes
Central Tallgrass Prairie
North Central Tillplain
N
Miles
0 20 40 80 120 160
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Conserving Nature's Stage: Test Sites for Great Lakes

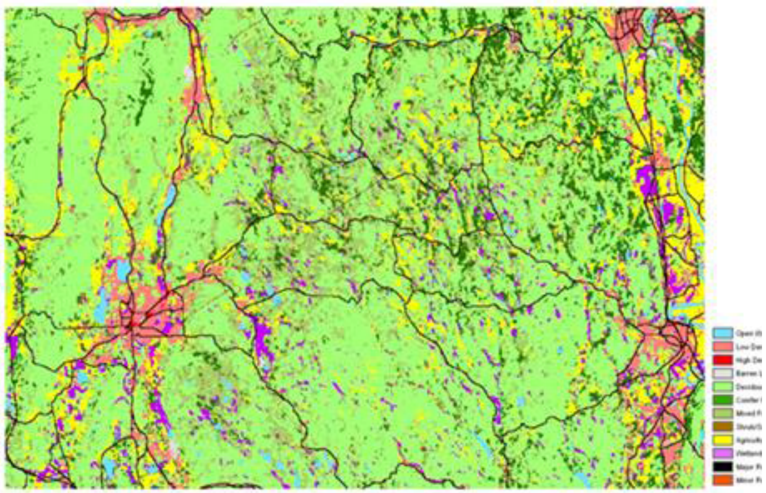


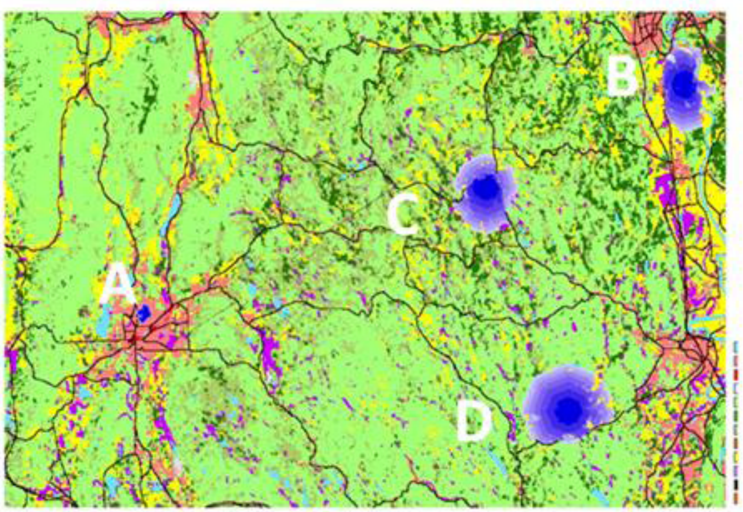
Anderson et al. In progress

2. Resilient Sites are Complex and Connected = Many Options

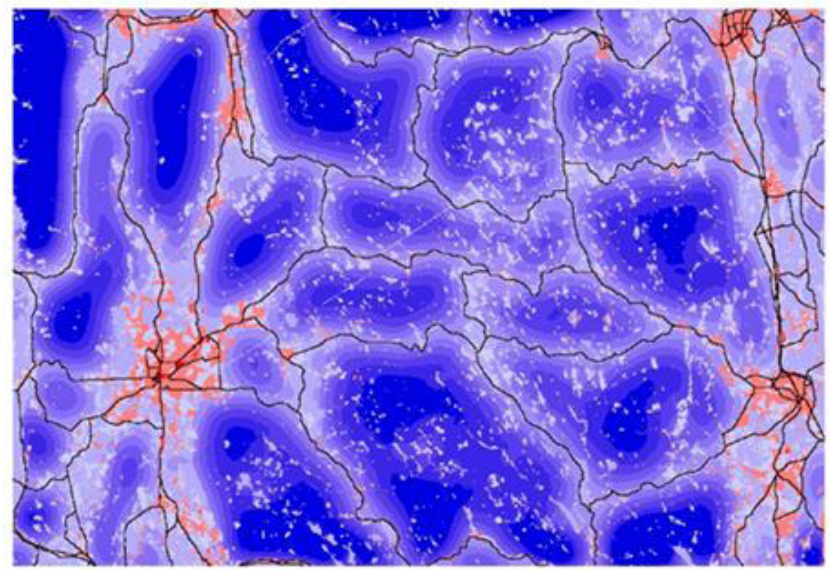


Local Connectedness





Going from points to a continuous surface



Calibrating the Resistance Grid

Settings used in Eastern Region (log scale)

Low Resistance

1 Completely Natural (wetlands, forests, shrub/scrub)

Everything else somewhere in between. Hay/Pasture, Cultivated Crops, Water, Industrial Forests

8 Low Density Developed

9 Medium Density Developed

20 High Density Developed

High Resistance

Examples of Local Connectedness Score

Scores range 0 to 1

Based on Eastern Values: Mean 0.42 and SD 0.25 for the region


RK = 0.017


RK = 0.02

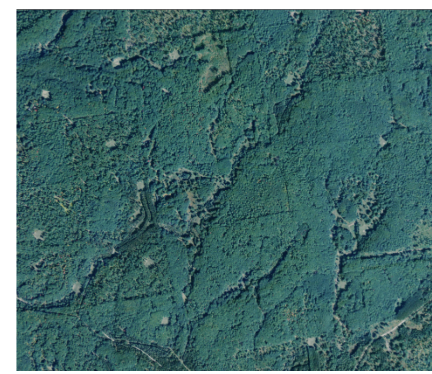

RK = 0.06


RK = 0.21

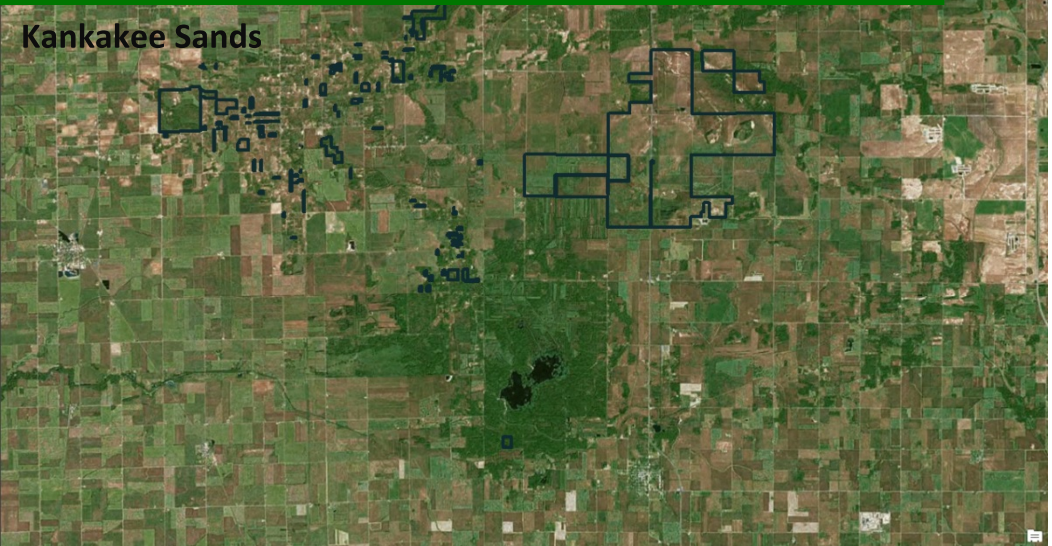

RK = 0.32

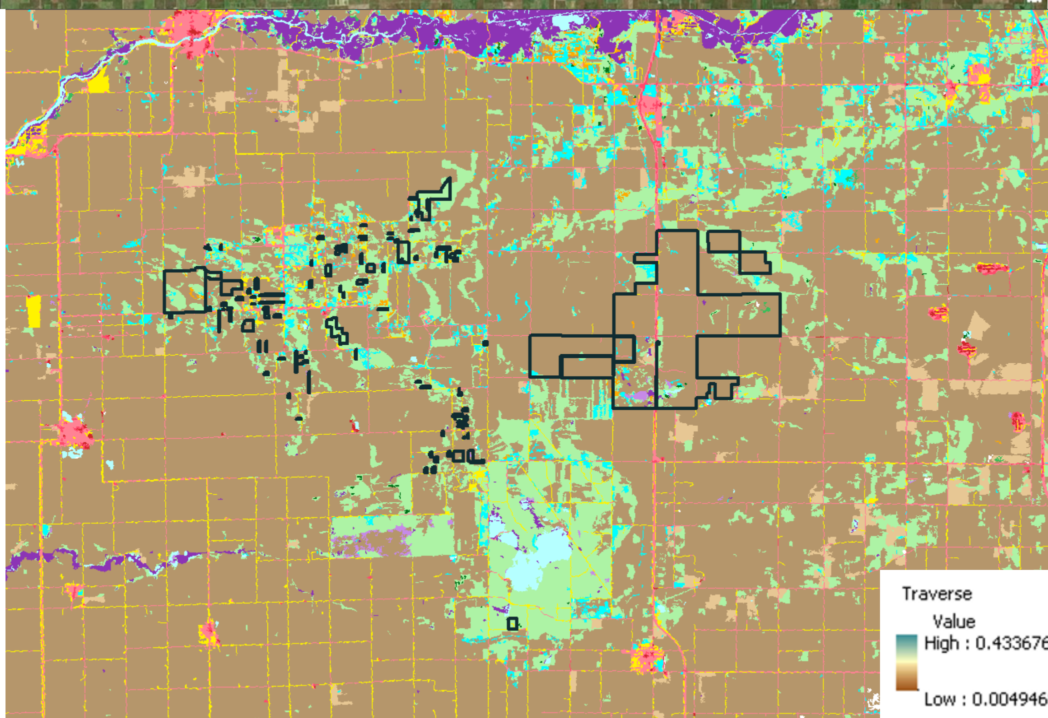

RK = 0.48


RK = 0.67


RK = 0.80

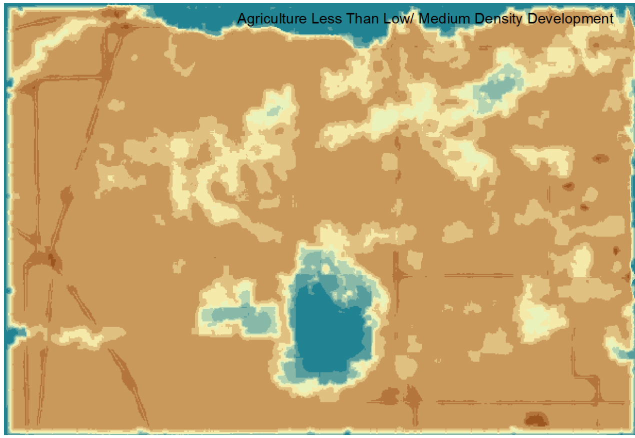
Kankakee Sands



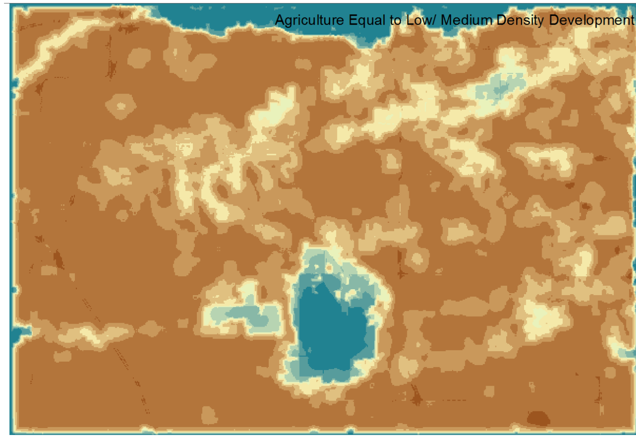


Agriculture Resistance

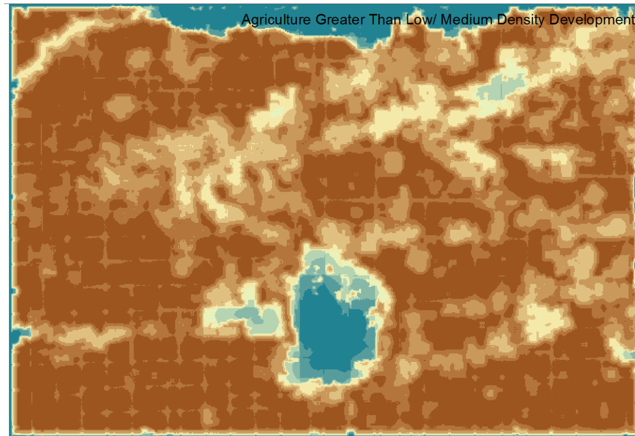
Less than > Development



Equal to = Development



Greater than > Development



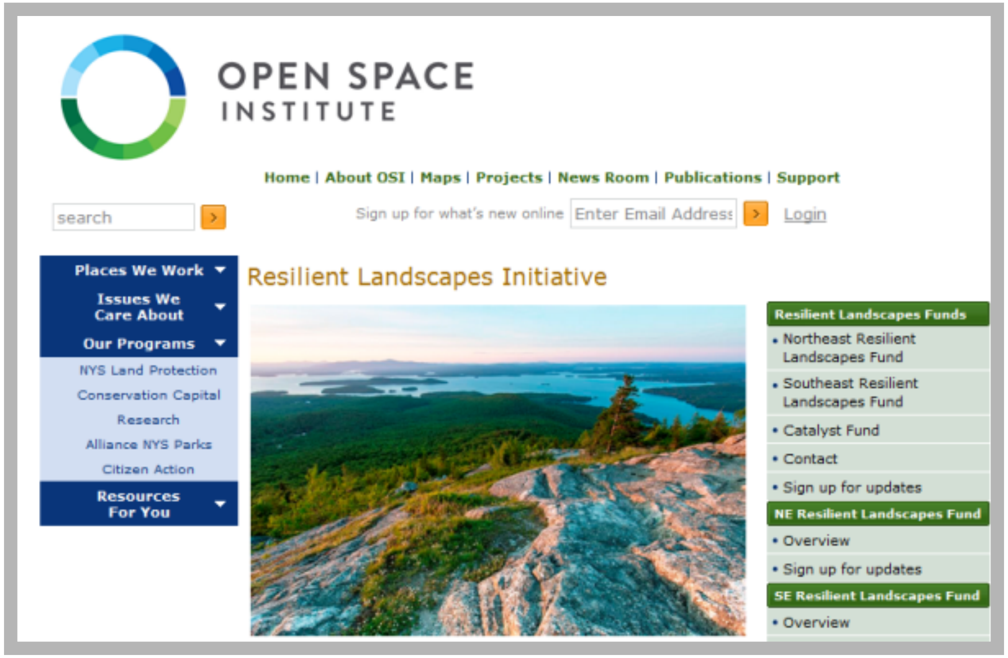
3. Who is Using the Results?

Doris Duke Charitable Foundation: $37M

$11M in land capital in the East

$ 6M in land capital in the Pacific Northwest

$20M revolving loan fund for central Appalachians



LCCs

Conservation Design &

“Resilient Network” multi-LCC collaboration

State Agencies

VT DNR BioFinder

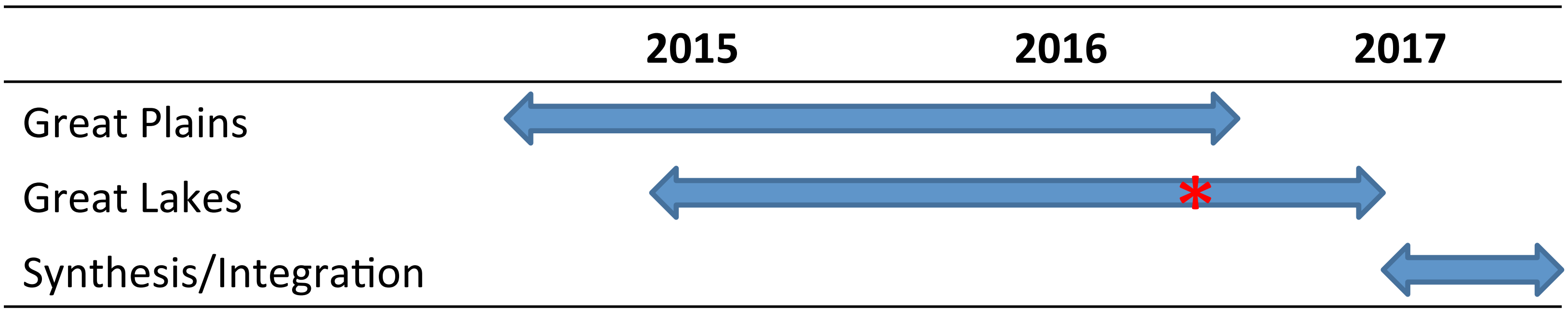
MA DEP Landscape Partnership Grant

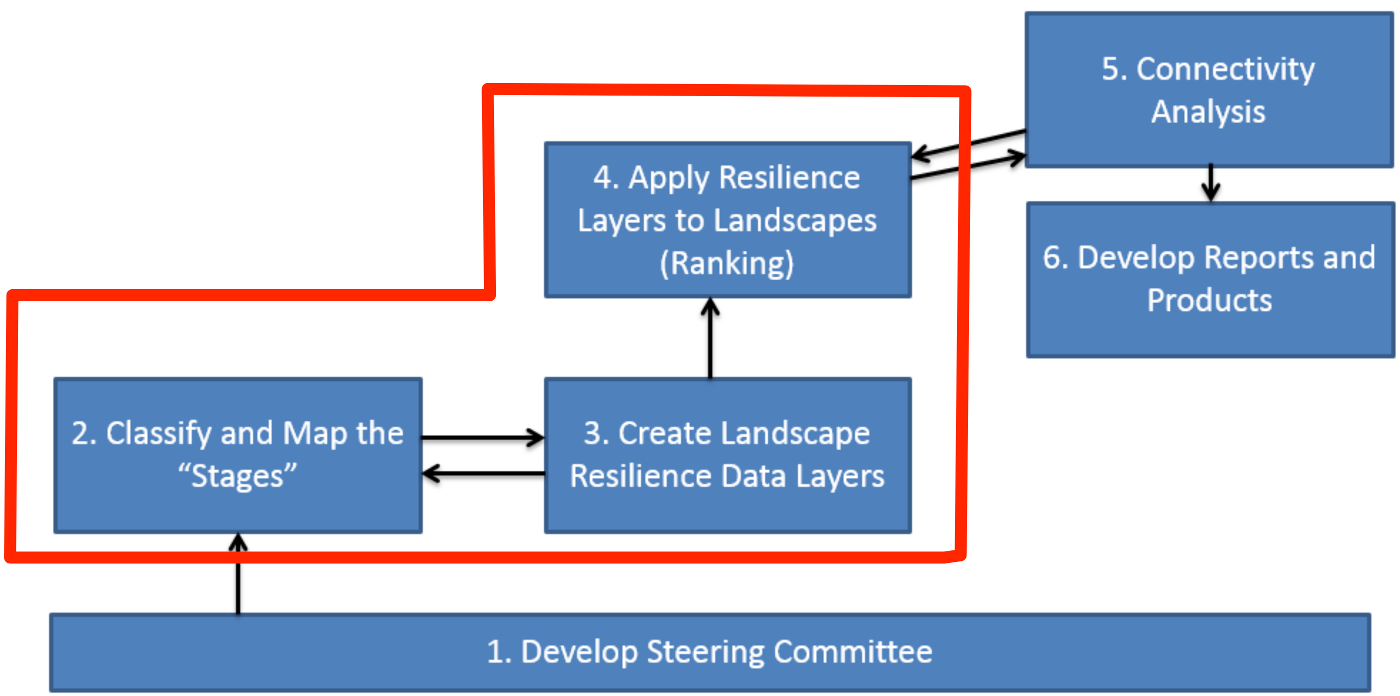
ME NHP Beginning with Habitat

SC DNR Re-evaluate state landholdings

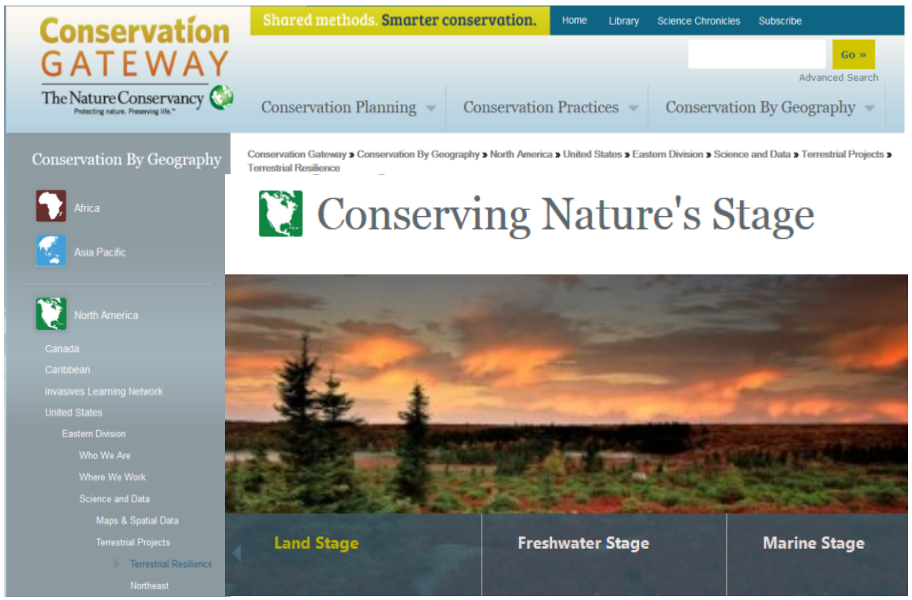
Many State Wildlife Action Plans

Central US: Timeline & Steps





How to Learn More



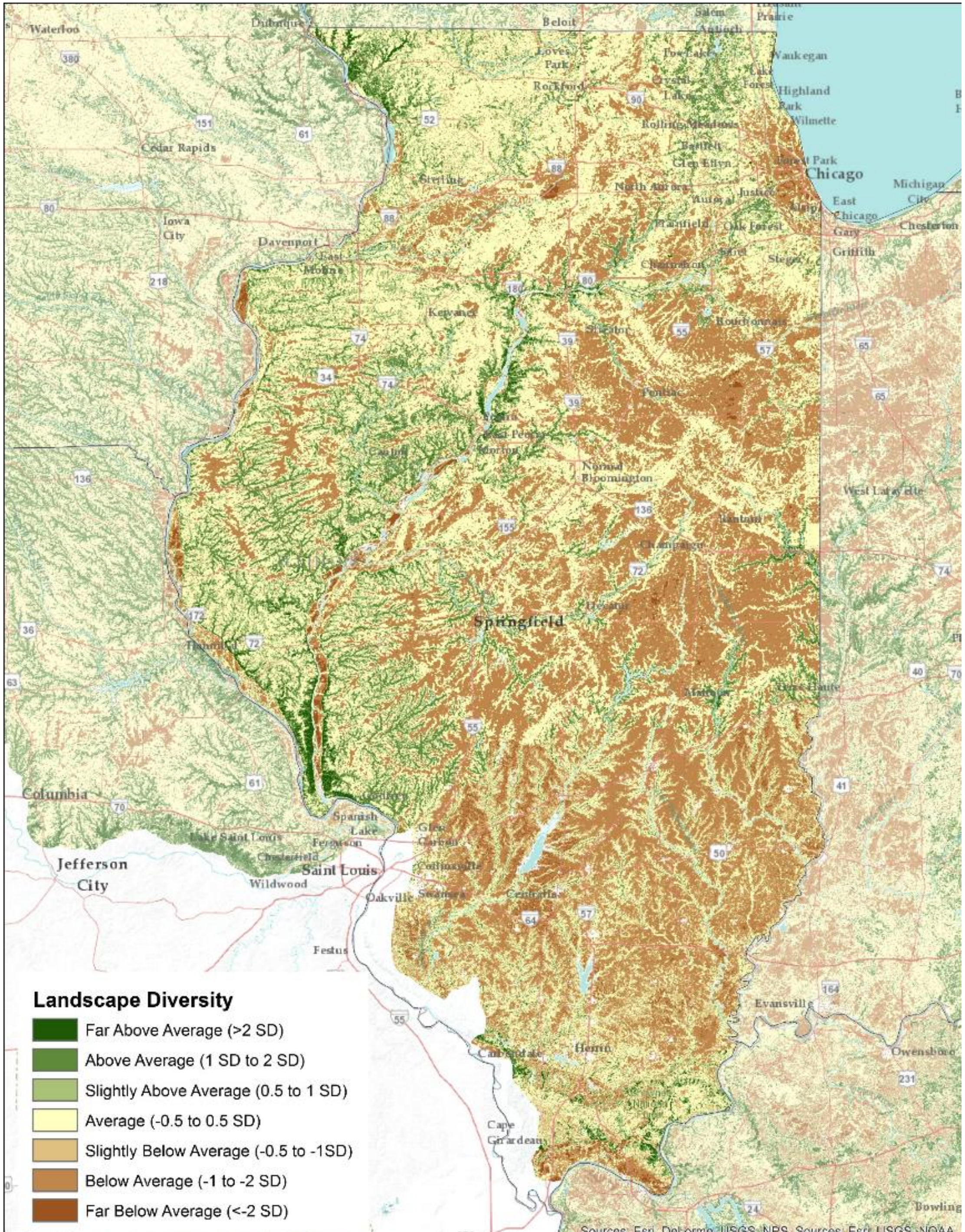
http://www.nature.ly/TNCresilience

Special Section: *Conserving Nature's Stage*

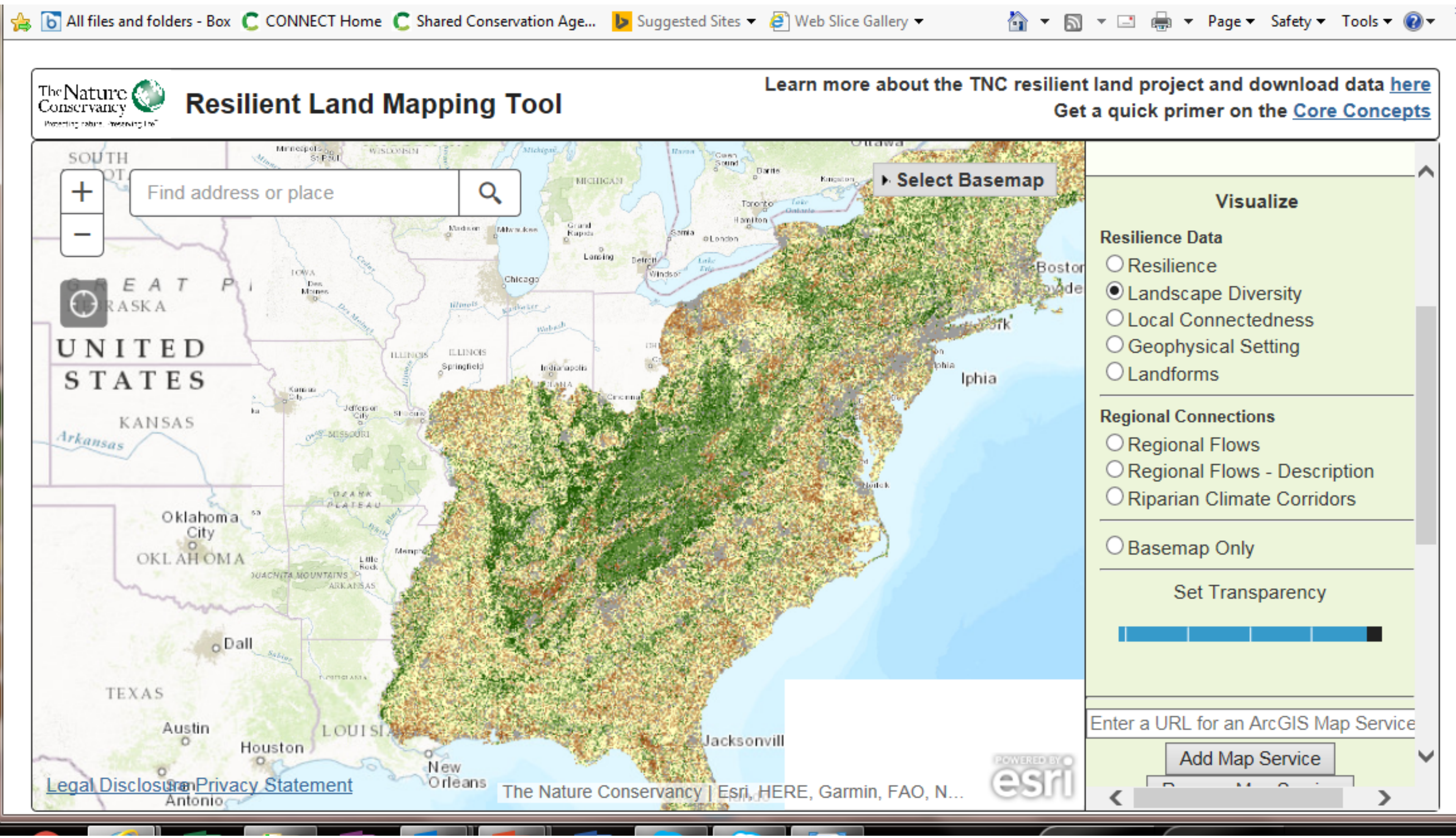
Life is a gloss on geography. And if you dig your fists into the earth and crumble geography, you strike geology. Climate is the wind of mineral earth's rondure, tilt, and orbit modified by local geological conditions. The Pacific Ocean, the Negev Desert, and the rain forest in Brazil are local geological conditions. So are the slow carp pools and splashing trout riffles of any backyard creek. It is all, God help us, a matter of rocks.

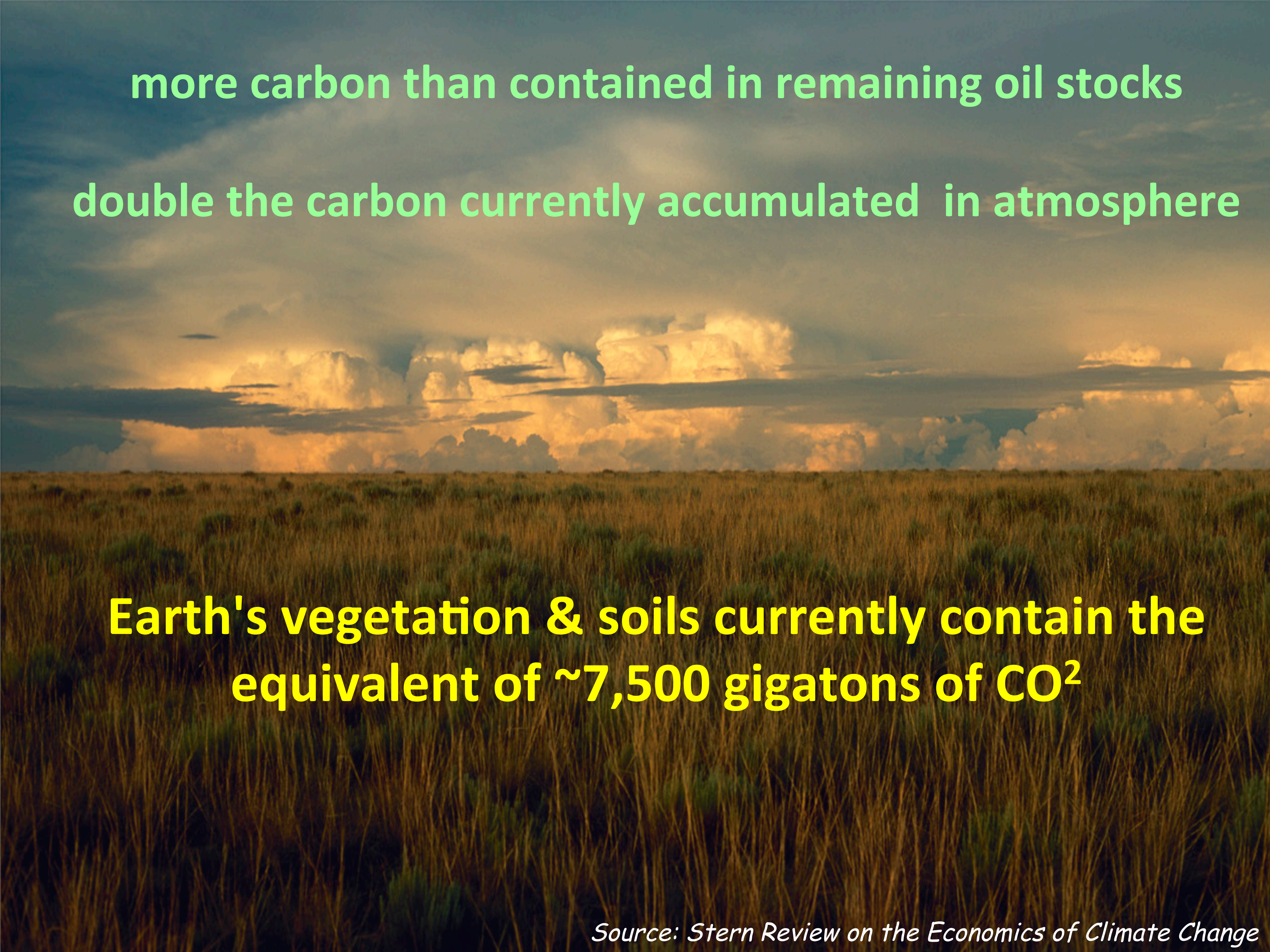
The rocks shape life like hands around swelling dough. In Virginia, the salamanders vary from mountain ridge to mountain ridge, so do the fiddle tunes the old men play. All this because it is hard to move from mountain to mountain. These are not merely anomalous details. This is what life is all about: salamanders, fiddle tunes, you and me and things, the split and burr of it all, the fizz into particulars. No mountains and one salamander, one fiddle tune, would be a lesser world. No continents, no fiddlers. No possum, no soup, no taters. The earth without form is void . . .

Annie Dillard (1982)


Landscape Diversity
Far Above Average (>2 SD)
Above Average (1 SD to 2 SD)
Slightly Above Average (0.5 to 1 SD)
Average (-0.5 to 0.5 SD)
Slightly Below Average (-0.5 to -1SD)
Below Average (-1 to -2 SD)
Far Below Average (<-2 SD)
Sources: Esri, DeLorme, USGS, NPS. Sources: Esri, USGS, NOAA
Chicago
Springfield
Saint Louis
Jefferson City
Cedar Rapids
Davenport
Waterloo
Dubuque
Beloit
Rockford
Waukegan
Highland Park
Wilmette
Michigan City
Chesterton
Gary
Griffith
Sterling
Kewanee
Pontiac
Normal
Bloomington
Champaign
Rantoul
Decatur
Terre Haute
West Lafayette
Columbia
Wildwood
Chesterfield
Ferguson
Oakville
Festus
Evansville
Owensboro
Cape Girardeau
Carbondale
Herrin

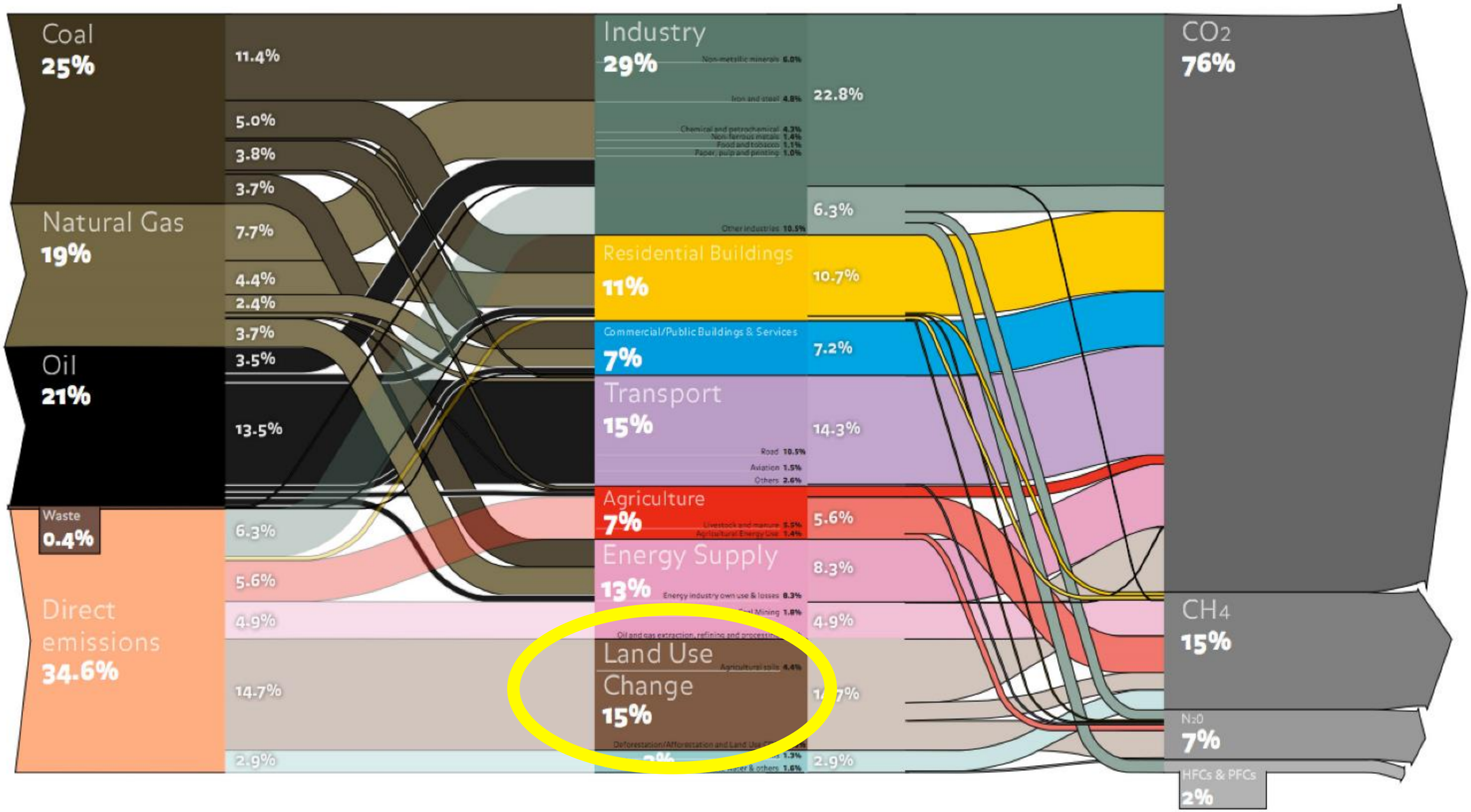
http://maps.tnc.org/resilientland/




more carbon than contained in remaining oil stocks
double the carbon currently accumulated in atmosphere
Earth's vegetation & soils currently contain the equivalent of ~7,500 gigatons of CO^2
Source: Stern Review on the Economics of Climate Change

WORLD GHG EMISSIONS FLOW CHART 2010

Total emission worldwide (2010)
48 629
MTCO2 EQ



ASN BANK ECOFYS

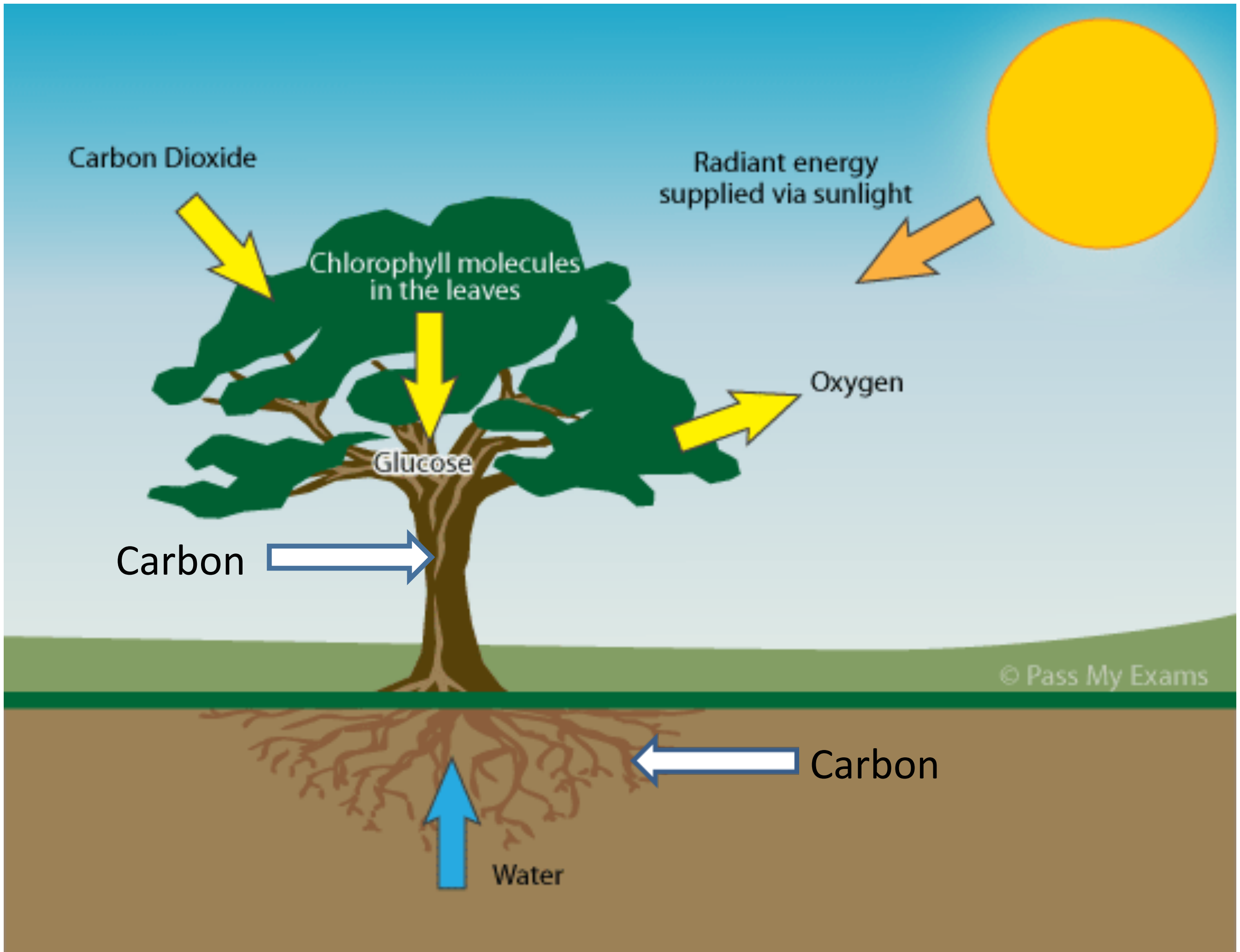
ANALYSIS BY ECOFYS. ALL THE DATA ARE FOR 2010.

Avoided Conversion

Chicago Wilderness: Avoided emission of 53 million tons of carbon dioxide into the atmosphere!

Mitigation By Biosequestration

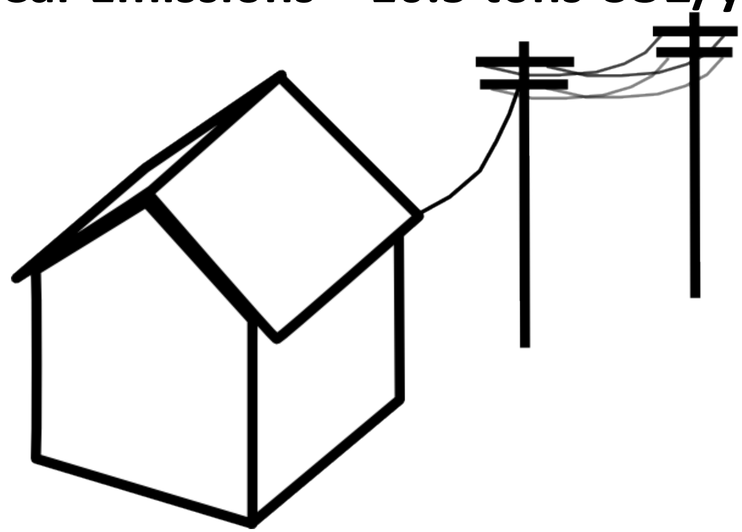
(Or Photosynthesis is Our Friend)



Restoration

Restored Prairie =
~1 ton CO_2 equivalent/acre/yr

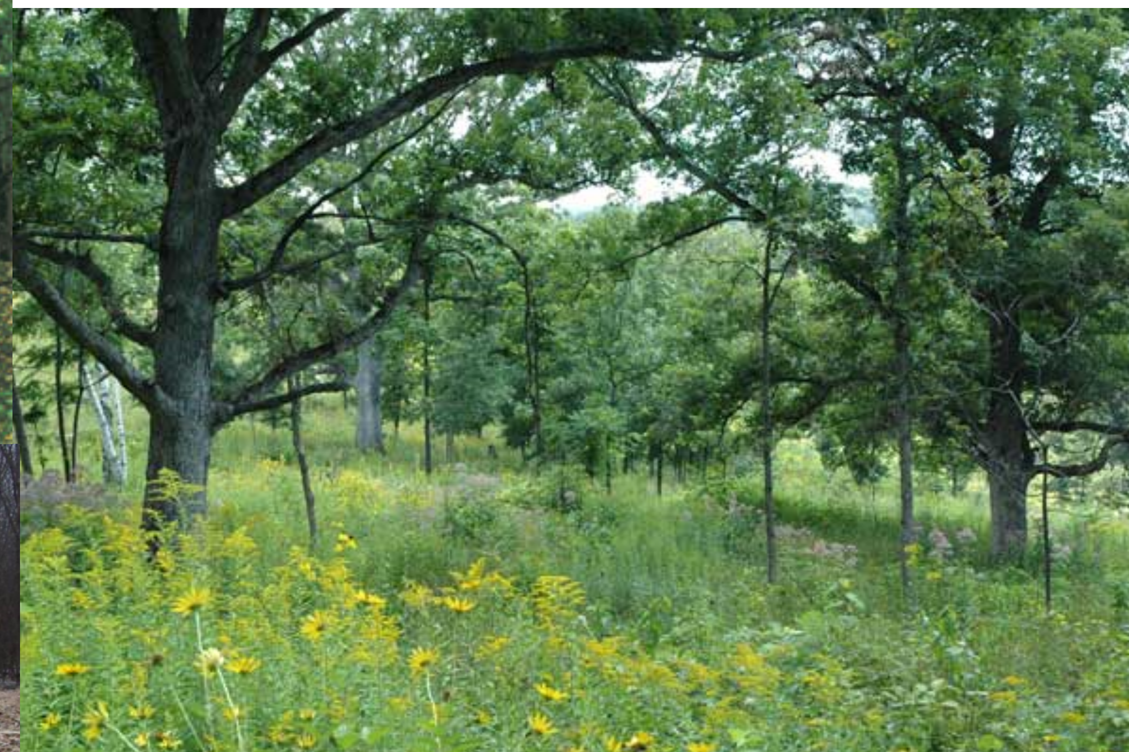
Car Emissions = 10.5 tons CO_2/yr



Emissions for Household Electricity = 7.4 tons CO_2/yr

Enhancement and Rehabilitation

healthier soils and larger plants store more carbon



Surprising Strategies…

More and more studies are documenting how "good fire" increases long-term biosequestration

No-till farming and managed grazing can minimize loss of - and even rebuild – soil organic matter