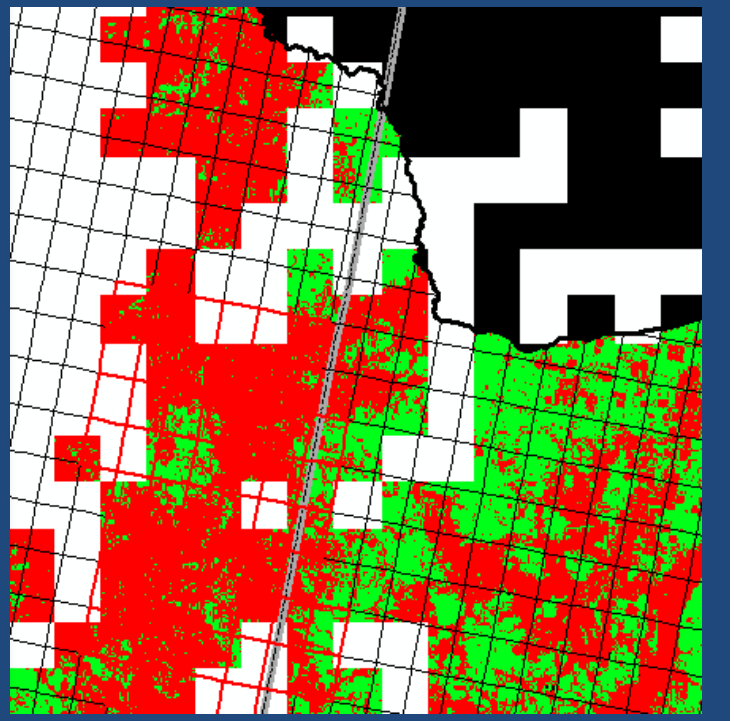
Approaches to Vulnerability Assessment

Scale

Multiple Issues of Scale

- Species habitat and life history aspects
- Data scale/precision differences
- Land planning/management scales
- Time relative to effects, decisions, implementation



Species Issues

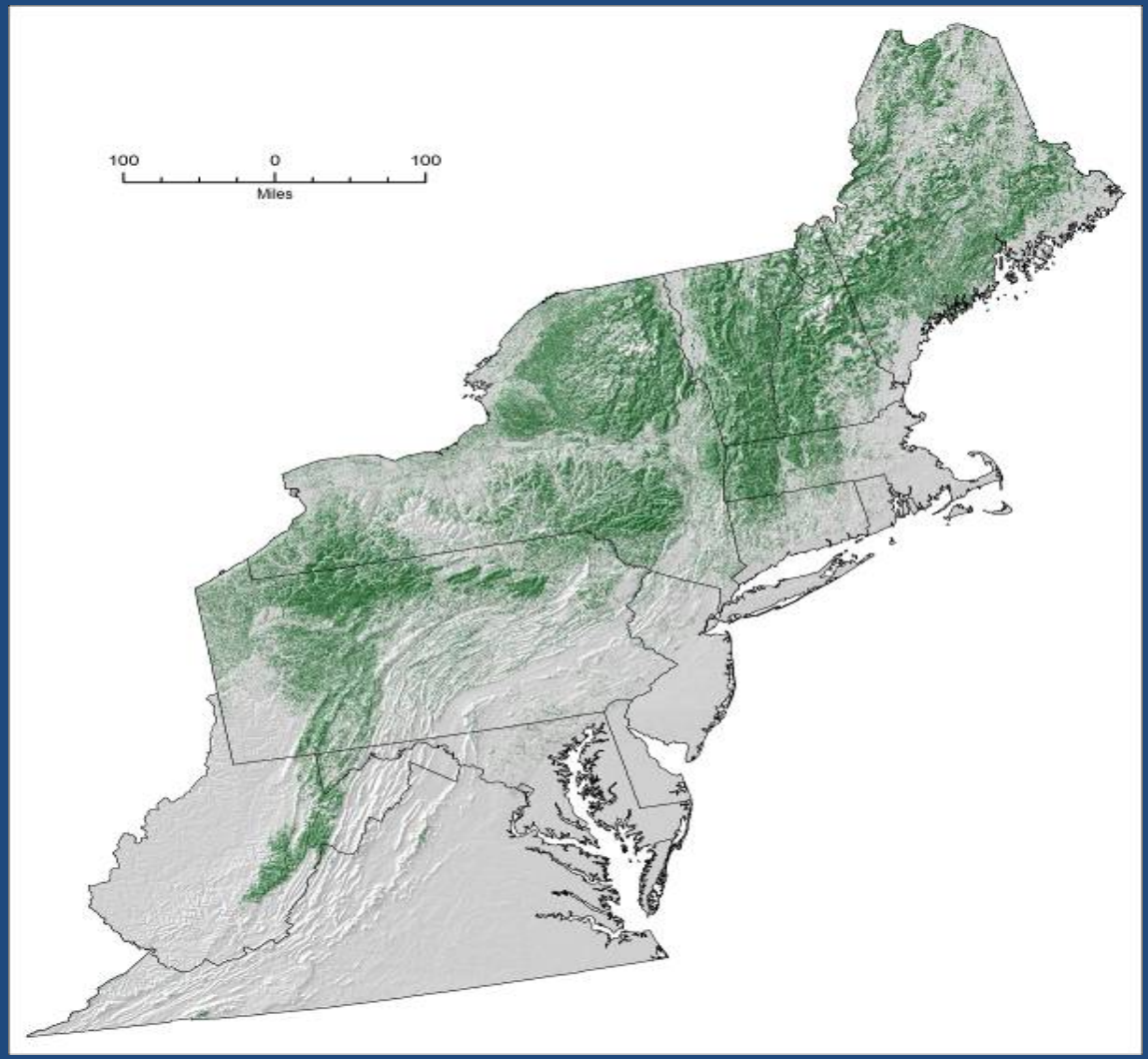
- **Broadly distributed species/habitats may have different exposures across their range**
  - **Naturally wide ranging**
  - **Highly migratory**
- **Species/habitats associated with narrow niches may have microclimates not assessable through normal CCVA**

Massachusetts Wildlife Habitat Climate Change Vulnerability Assessment

- **NORTHERN HARDWOODS FOREST VULNERABILITY EVALUATION**
- *NTWHCS category: Appalachian northern hardwood forest*
- *State ranking* *S5*
- **Vulnerability score** **5 and 6 (lower and higher emissions scenarios, respectively)**
- **Confidence evaluation** **Medium**
- **Rationale**
- With the distributional range of this habitat extending from Quebec in the north to high-elevation areas of Virginia and West Virginia, Massachusetts is close to the center of this community type's geographical distribution. In Massachusetts, where it is the predominant hardwood forest (see map below from the Massachusetts Natural Heritage and Endangered Species Program [NHESP]) in many areas, it is generally restricted to an altitudinal range of about 1,000-3,000 feet, being more adapted to colder temperatures and shorter growing seasons than southern/central hardwood forest (but less so than spruce-fir forest). It is dominated by Sugar Maple, Yellow Birch, and American Beech mixed with White Pine; with Eastern Hemlock at lower elevations; and with Red Spruce and Balsam Fir becoming important at the highest elevations where it grades into spruce-fir forest (Swain and Kearsley, 2001). Within the broad matrix of northern hardwood forest a number of variants occur, depending on local conditions. These include rich mesic forests dominated by Sugar Maples, Eastern Hemlock groves on cool, north-facing slopes or in ravines, and transition forests that include some species more typical of southern/central hardwood forest. It is not a fire-adapted community and fire suppression may have extended the range of this habitat in New England (J. Scanlon, Massachusetts DFW, *pers comm*.). This forest type is vulnerable to attack by insects, including gypsy moth and hemlock wooly adelgid, and to beech scale disease. Disturbance from blowdown, logging, or fire can lead to the (at least temporary) dominance of White Pine over other species. In areas closer to human habitation or powerline cuts, non-native plant species, including Japanese Barberry, Japanese Knotweed, etc., can form dense growths.

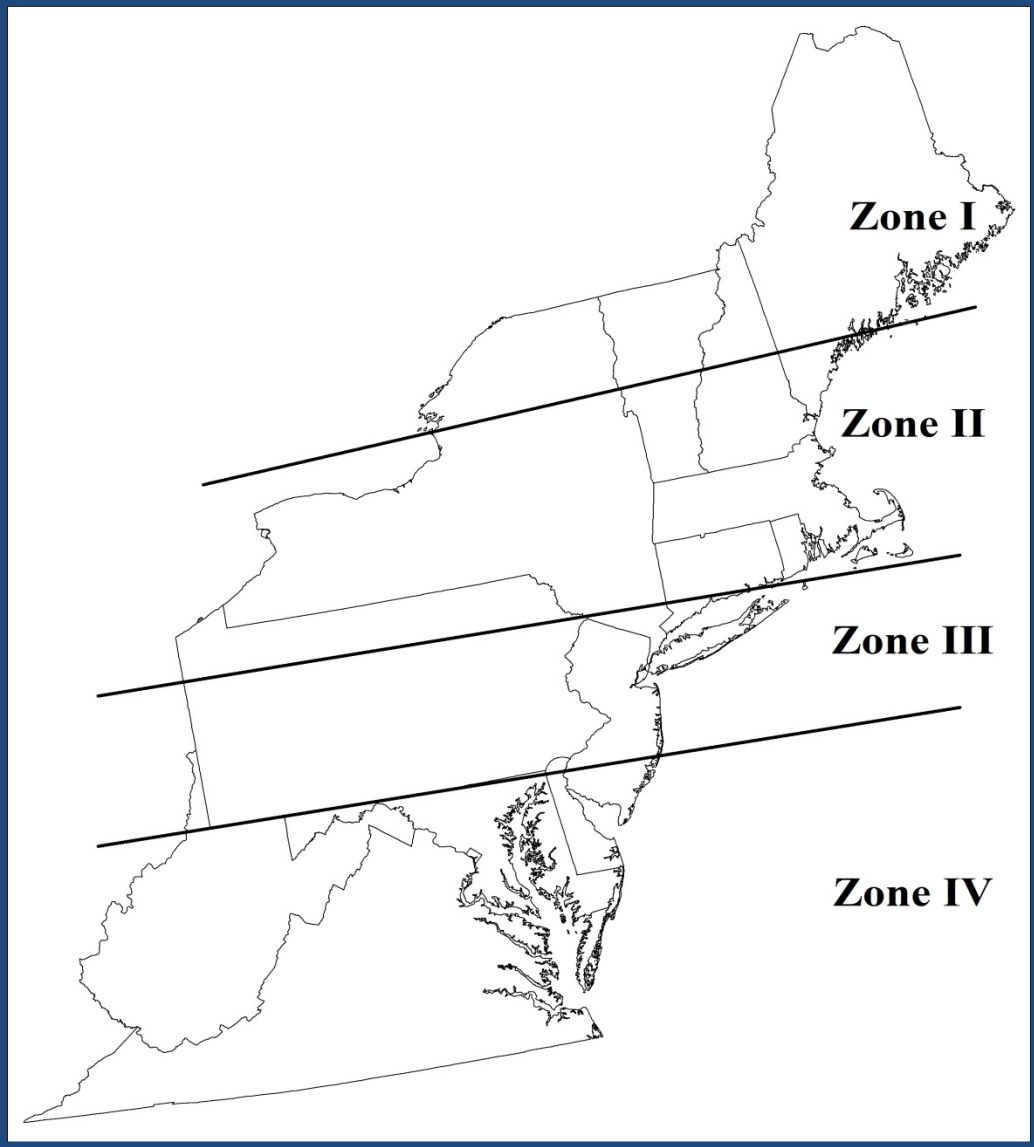
NORTHERN HARDWOODS – A WIDELY DISTRIBUTED HABITAT

Vulnerability may vary across range



REGIONAL ZONES

A “zoning” approach based on latitude may help understand vulnerability



Habitat Vulnerability Varies Across Scales				
	Zone I	**Zone II**	**Zone III**	**Zone IV**
Acadian-Appalachian Alpine Tundra	Highly Vulnerable			
Acadian-Appalachian Montane Spruce-Fir Forest	Vulnerable	Critically Vulnerable		
Laurentian-Acadian Northern Hardwood Forest	Less Vulnerable	Vulnerable	Vulnerable	Critically Vulnerable
Central Mixed Oak-Pine Forests	Least Vulnerable	Least Vulnerable	Less Vulnerable	Vulnerable
Pitch Pine Barrens		Less Vulnerable	Less Vulnerable	Less Vulnerable
Northern Atlantic Coastal Plain Basin Peat Swamp		Less Vulnerable	Less Vulnerable	Less Vulnerable
Central and Southern Appalachian Spruce-Fir Forest				Critically Vulnerable
Boreal-Laurentian Bog	Highly Vulnerable	Highly Vulnerable		
Shrub Swamp	Vulnerable	Vulnerable	Vulnerable	Vulnerable
Emergent Marsh	Vulnerable	Vulnerable	Vulnerable	Vulnerable

Massachusetts Habitat Vulnerability Assessments

A joint effort by the

Manomet Center for Conservation Sciences

and the

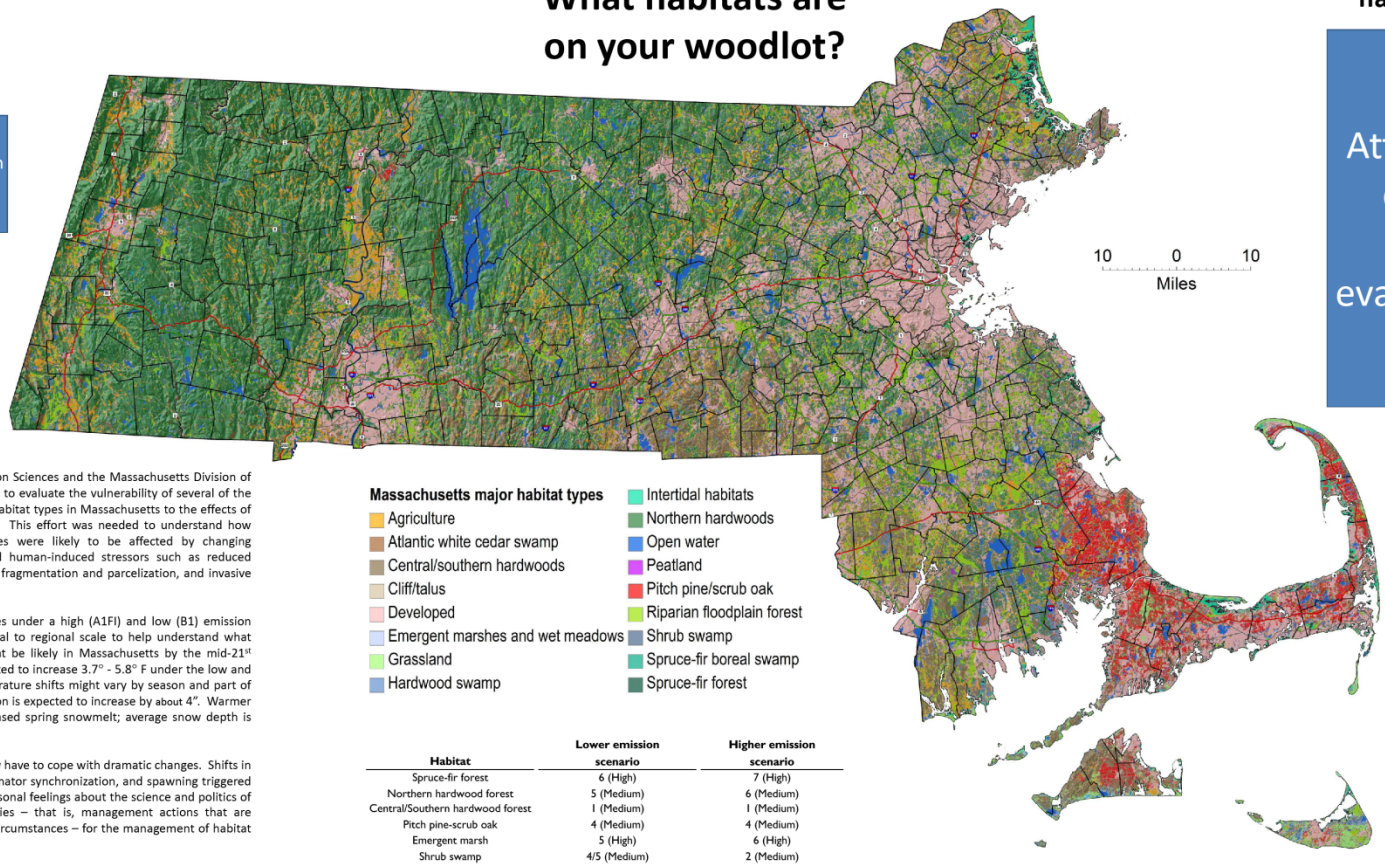
Massachusetts Division of Fisheries and Wildlife

Special thanks to:
Hector Galbraith, Manomet Center for Conservation Sciences
John O'Leary, Massachusetts Division of Fisheries and Wildlife
John Scanlon, Massachusetts Division of Fisheries and Wildlife
The Nature Conservancy
Northeast Association of Fish and Wildlife Agencies

Download the full report

Attach pouch of cards with URL of report on it

What habitats are on your woodlot?



Sample forested habitat evaluations

Attach printout of forested habitat evaluations here

In 2010, the Manomet Center for Conservation Sciences and the Massachusetts Division of Fisheries and Wildlife undertook a joint effort to evaluate the vulnerability of several of the most common broad terrestrial and aquatic habitat types in Massachusetts to the effects of climate change and anthropogenic stressors. This effort was needed to understand how Massachusetts' wildlife habitats and species were likely to be affected by changing temperature and precipitation regimes, and human-induced stressors such as reduced riparian buffers, impervious surfaces, habitat fragmentation and parcelization, and invasive species.

Several efforts to predict future temperatures under a high (A1FI) and low (B1) emission scenario have been downscaled from a global to regional scale to help understand what temperature and precipitation patterns might be likely in Massachusetts by the mid-21st century. Mean average temperature is expected to increase 3.7° - 5.8° F under the low and high emission scenarios, respectively. Temperature shifts might vary by season and part of the state, though. Annual average precipitation is expected to increase by about 4". Warmer winters could mean less snowfall and decreased spring snowmelt; average snow depth is likely to be 5-8" less than current conditions.

This means that wildlife and habitat types may have to cope with dramatic changes. Shifts in breeding seasons, flowering periods and pollinator synchronization, and spawning triggered by snowmelt may all occur. Regardless of personal feelings about the science and politics of climate change, adopting no-regrets strategies – that is, management actions that are unlikely to have a negative effect under any circumstances – for the management of habitat will be valuable.

Adaptation Strategies:

1. Promote resilience through things like controlling outbreaks of invasive species.
2. Implement landscape-level planning for things such as movement corridors and large habitat blocks.
3. Promote effective management of site-level resilience and change

Example management strategies for forested habitats:

Resilience

Forest age structure: promoting age class diversity at the stand and landscape level can help habitats cope with disturbances and more gradual shifts in climate

Control of white-tailed deer densities and grazing: overbrowsing by deer has affected the structure and composition of forests, and as opened the way for increased rates of infestation by non-native plants.

Pests and invasive species: it is likely that invasive plants and destructive pests will become more problematic as time goes by. Early identification and aggressive elimination of pests will become more important.

Change

Our current management paradigm is to preserve the status quo. It will be necessary to realize that preservation is not likely to be successful in the long term: change will occur eventually. It will be necessary to (1) define an amount of change beyond which maintain the status quo is too expensive, and (2) guide the change to a new, desirable equilibrium so that all ecological value is not lost.

Massachusetts major habitat types

- Agriculture
- Atlantic white cedar swamp
- Central/southern hardwoods
- Cliff/talus
- Developed
- Emergent marshes and wet meadows
- Grassland
- Hardwood swamp
- Intertidal habitats
- Northern hardwoods
- Open water
- Peatland
- Pitch pine/scrub oak
- Riparian floodplain forest
- Shrub swamp
- Spruce-fir boreal swamp
- Spruce-fir forest

Habitat	Lower emission scenario	Higher emission scenario
Spruce-fir forest	6 (High)	7 (High)
Northern hardwood forest	5 (Medium)	6 (Medium)
Central/Southern hardwood forest	1 (Medium)	1 (Medium)
Pitch pine-scrub oak	4 (Medium)	4 (Medium)
Emergent marsh	5 (High)	6 (High)
Shrub swamp	4/5 (Medium)	2 (Medium)
Spruce-fir boreal swamp	6 (High)	7 (High)
Atlantic white cedar swamp	4 (Medium)	5 (Medium)
Riparian forest	5 (Low)	5 (Low)
Hardwood swamp	4 (Medium)	5 (Medium)
Intertidal habitats	6 (High)	6 (High)

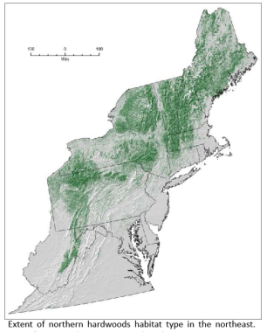
Score:	(certainty in parenthesis)
7	Habitat at risk of being eliminated from the state
6	Majority of habitat at risk of being eliminated
5	Extent of habitat at risk of being moderately reduced
4	Extent of habitat at risk of being moderately reduced
3	outside
2	Extent of habitat may expand moderately
1	Habitat may expand greatly
0	Vulnerability of habitat under climate change is uncertain

Habitat variables likely to affect vulnerability to climate change

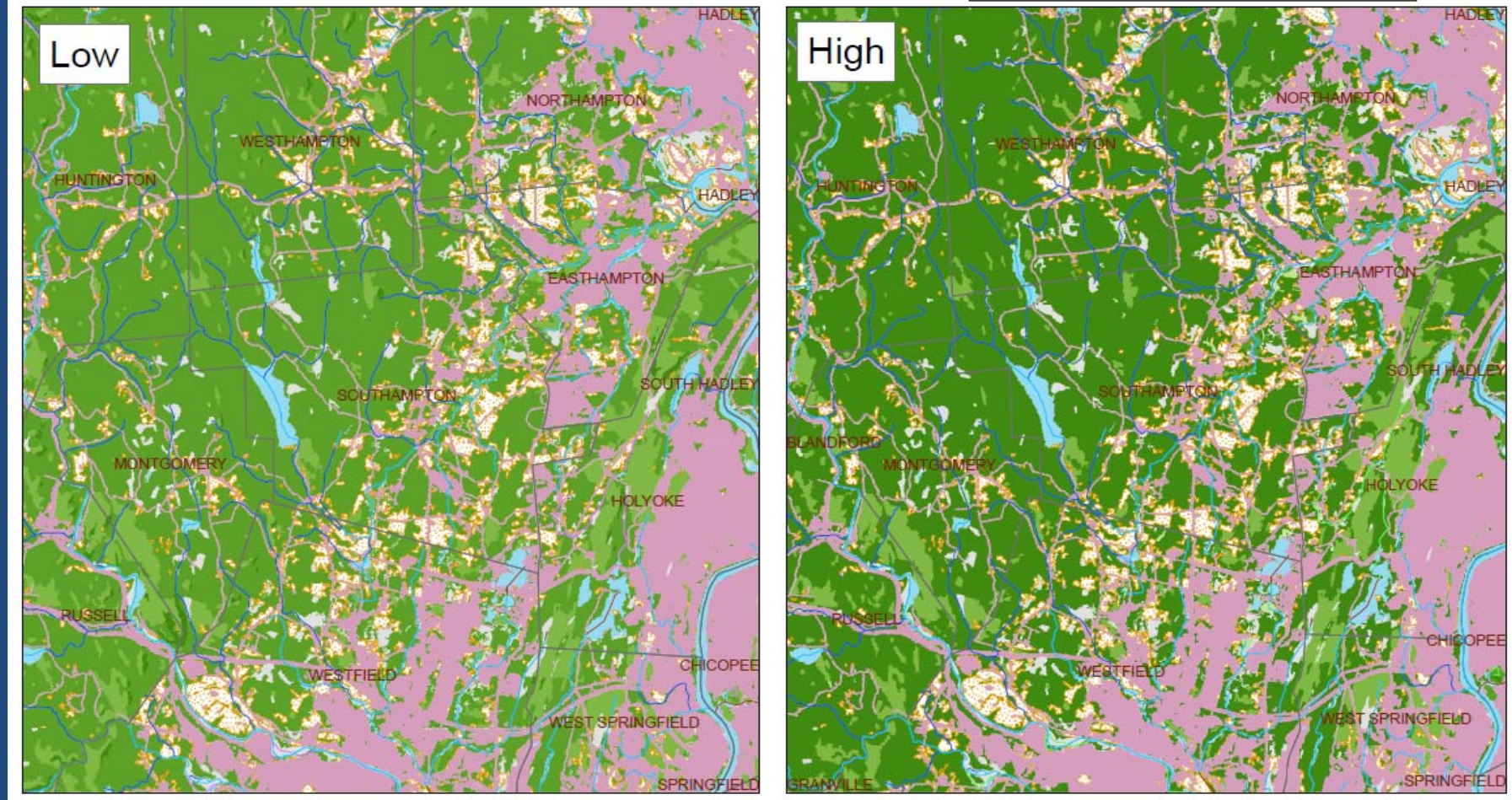
- **Current rate of loss**: habitats with low current rates of loss may be less vulnerable.
- **Elevation**: montane habitats at high elevations cannot extend their ranges upward in elevation, since the highest point in Massachusetts is less than 3,500 feet.
- **Latitude**: habitats closer to the northern edge of their limit may extend northward and/or upward in elevation.
- **Vulnerability to increasing temperature**: cold-adapted communities may be more vulnerable to higher temperatures.
- **Vulnerability to increased attack by biological stressors (grazers, browsers, pests, pathogens)**: improved overwinter survival of animals could jeopardize some habitats.
- **Intrinsic dispersive rate**: some habitats may more readily shift their ranges in response to disturbance.
- **Vulnerability to increased frequency/intensity of extreme disturbance**: habitats with certain dispersal/regeneration types may be more vulnerable to certain types of disturbance.
- **Vulnerability to phenologic change**: habitats dependent upon the timing of seasonal events may be impacted.
- **Vulnerability to human maladaptive responses**: construction of sea walls or riprap may affect the ability of habitats to migrate.
- **Likely future impacts of non-climate stressors**

Future work

The Manomet Center for Conservation Sciences is still working with state wildlife agencies to evaluate the vulnerability of major habitat types throughout the 13-state northeast region (ME, NH, VT, NY, MA, RI,CT, NJ, PA, DE, MD, DC, VA, WV). A series of in-depth reports detailing specific vulnerabilities, stressors, and results of modeling exercises will be produced over the coming months.



Extent of northern hardwoods habitat type in the northeast. Data from Northeast Terrestrial Habitat Mapping Project (TNC/NEAFWA, 2011).


NHD Streams
Cold
Missing
Transitional Cool
Transitional Warm
Developed
Agriculture
Open Water
NETHM Mass.
Vulnerability
<Null>
1
2
3
4
5
6
7
Low
HADLEY
NORTHAMPTON
WESTHAMPTON
HUNTINGTON
HADLEY
EASTHAMPTON
SOUTHAMPTON
SOUTH HADLEY
MONTGOMERY
HOLYOKE
RUSSELL
CHICOPEE
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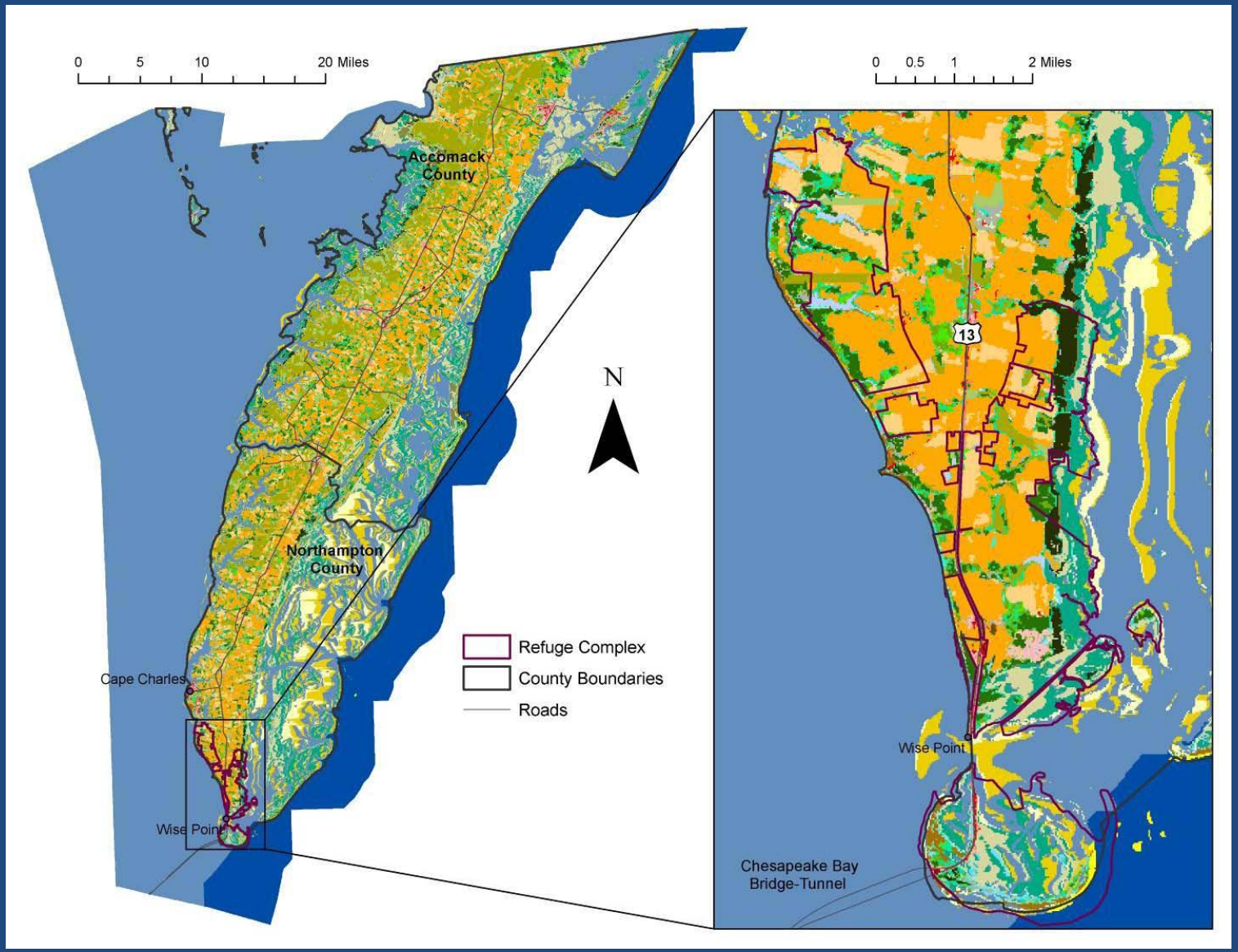
SOUTH HADLEY
SOUTHAMPTON
BLANDFORD
MONTGOMERY
HOLYOKE
RUSSELL
CHICOPEE
WESTFIELD
WEST SPRINGFIELD
GRANVILLE
SPRINGFIELD

Data Issues

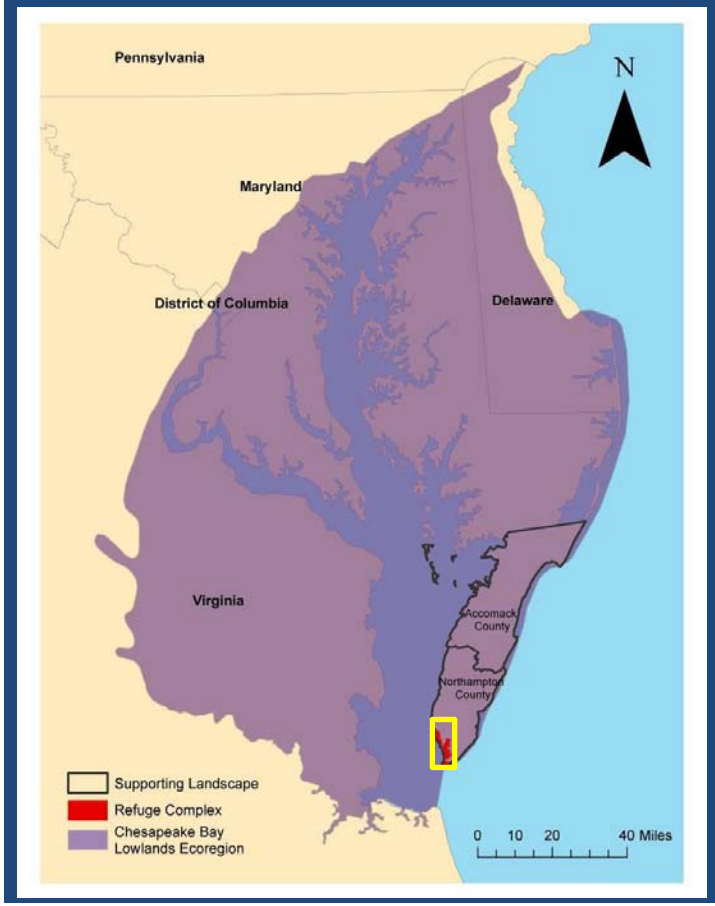
- Consider how well CC effects data match your resource data in resolution
  - If species is associated with fine grain features (e.g., rare soil type, north facing slopes, etc.) can you determine vulnerability from downscaled climate data? (one option: use geophysical features to further "filter" results)
  - What about migrants with key part of range outside the U.S.? (outside existing downscaled data, one option—live with uncertainty of GCM scale)

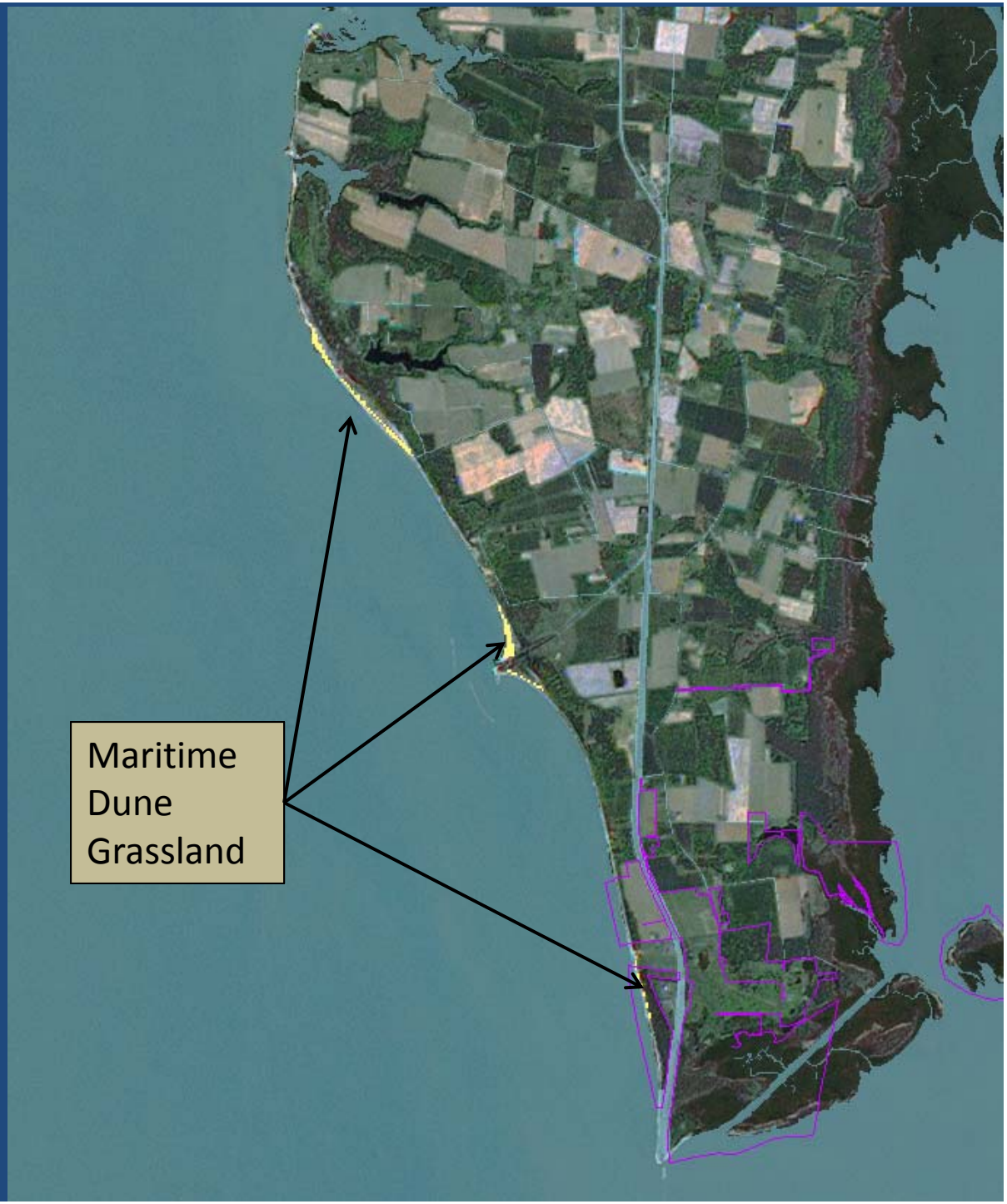
Grain of Resource Distribution

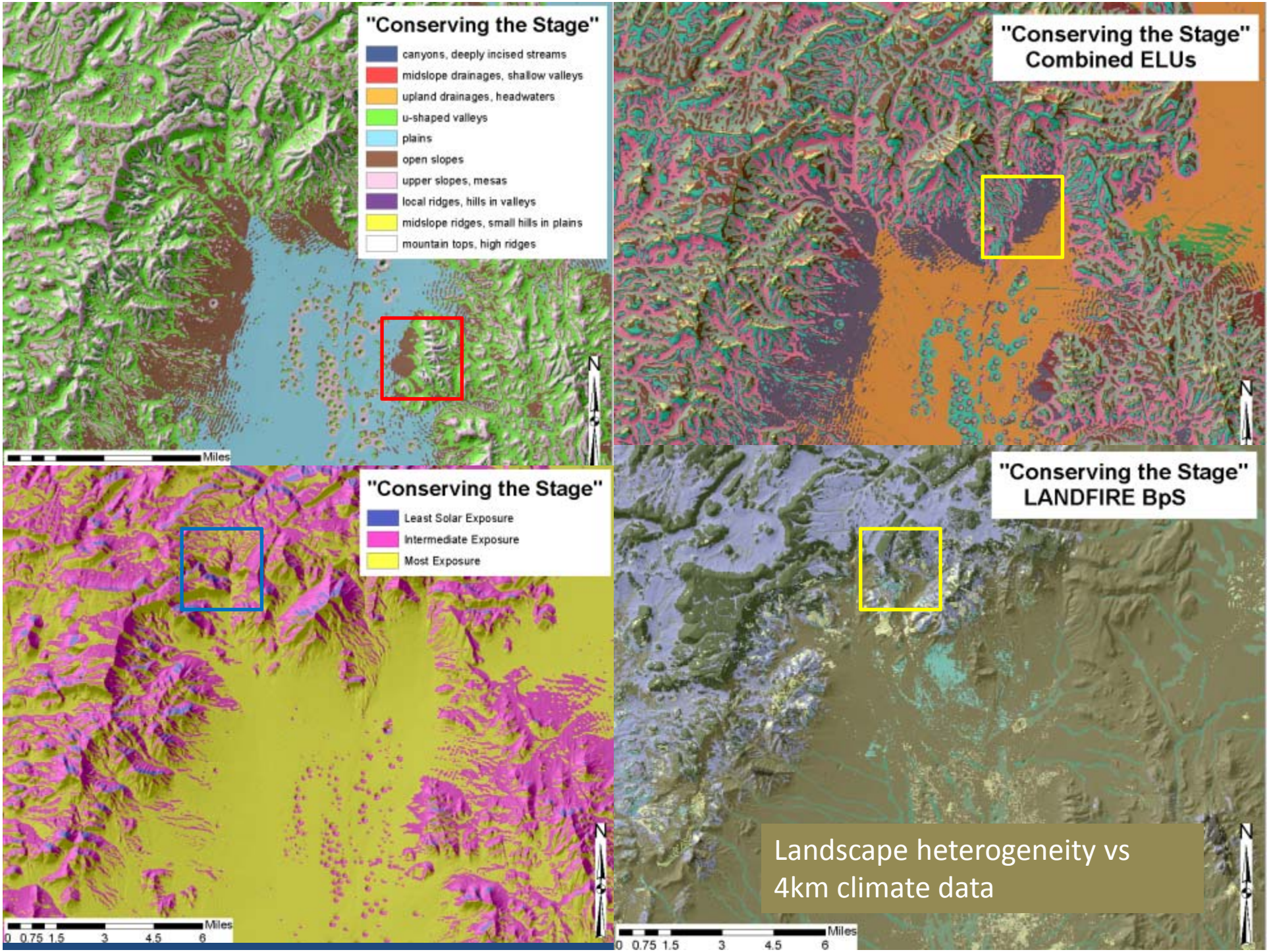


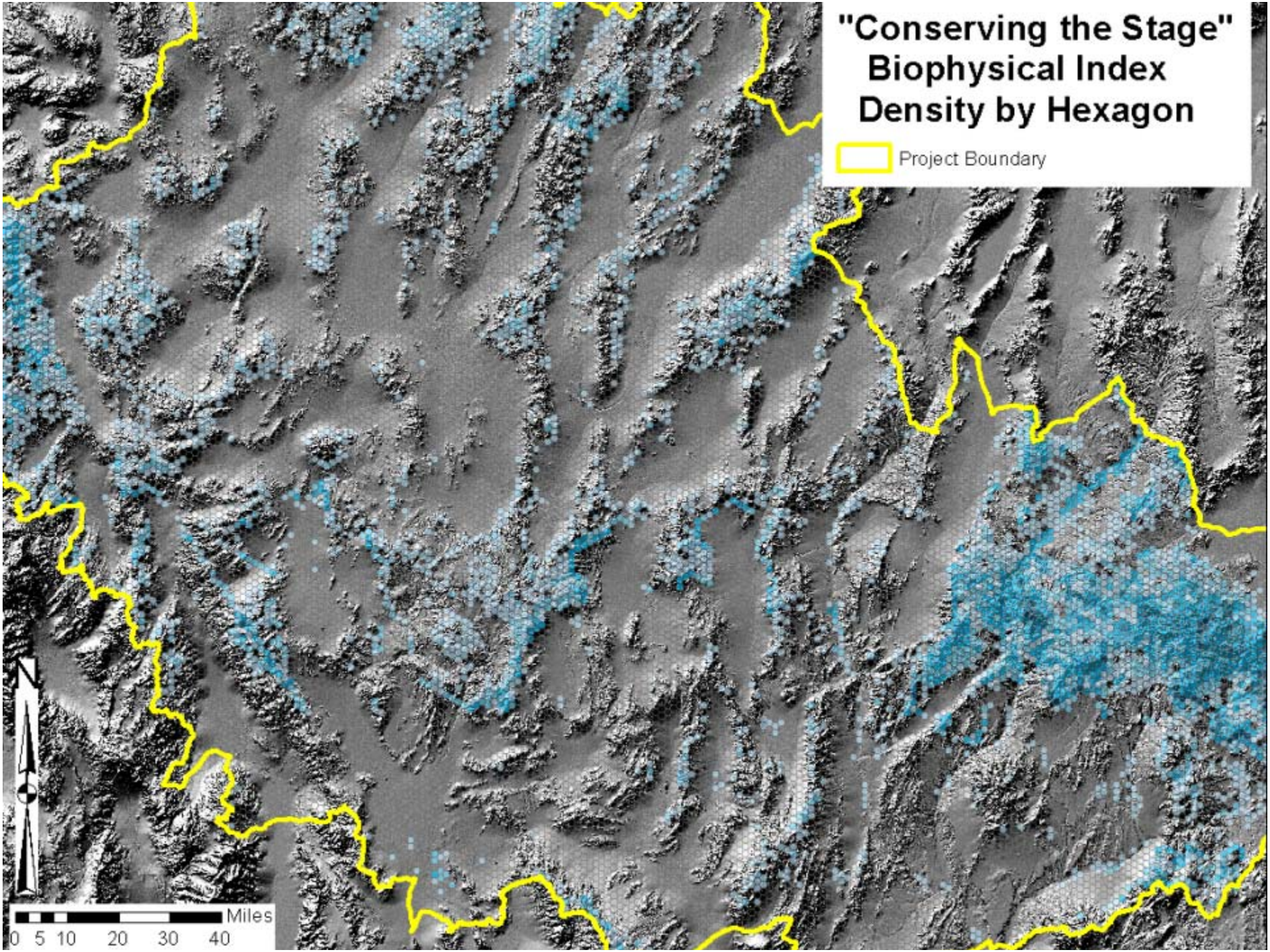
Grain of resources matters for how they can be assessed:

- Spatial/quantitative: stressors must roughly match scale of resource distribution
- Qualitative: examine stressor scenarios and "hypothesize" vulnerability outcome






"Conserving the Stage"
canyons, deeply incised streams
midslope drainages, shallow valleys
upland drainages, headwaters
u-shaped valleys
plains
open slopes
upper slopes, mesas
local ridges, hills in valleys
midslope ridges, small hills in plains
mountain tops, high ridges
N
Miles
"Conserving the Stage"
Combined ELUs
N
"Conserving the Stage"
Least Solar Exposure
Intermediate Exposure
Most Exposure
N
Miles
0 0.75 1.5 3 4.5 6
"Conserving the Stage"
LANDFIRE BpS
N
Miles
0 0.75 1.5 3 4.5 6
Landscape heterogeneity vs
4km climate data


"Conserving the Stage"
Biophysical Index
Density by Hexagon
Project Boundary
N
Miles
0 5 10 20 30 40

Considerations for Implementation Scale

Informs what are the useful types and scale of products to inform decision making

- Geographic position can matter:
  - On the coast vs upland
  - Implementers with small or narrowly defined jurisdictions (e.g., only river management)
- Type of implementation
  - Broad brush policy
  - Comprehensive use/management planning
  - Narrow site scale project design or regulation

Scale of Implementation

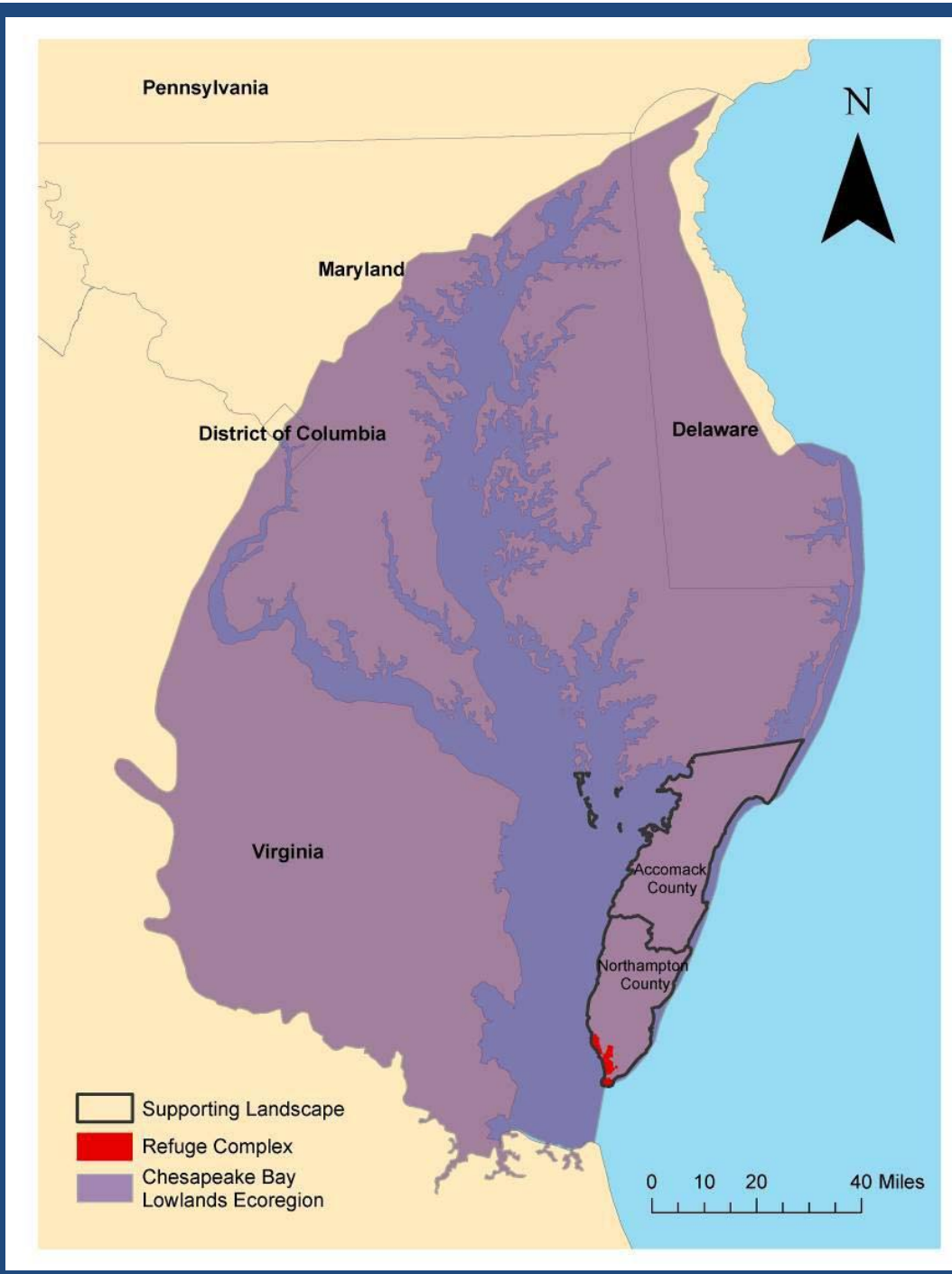
- Scales often mixed within the same landscape:
  - Federal region
  - State government
  - Local governments
  - Agency jurisdiction
  - Watershed management
  - Individual land owner
  - Project site

All in same planning area

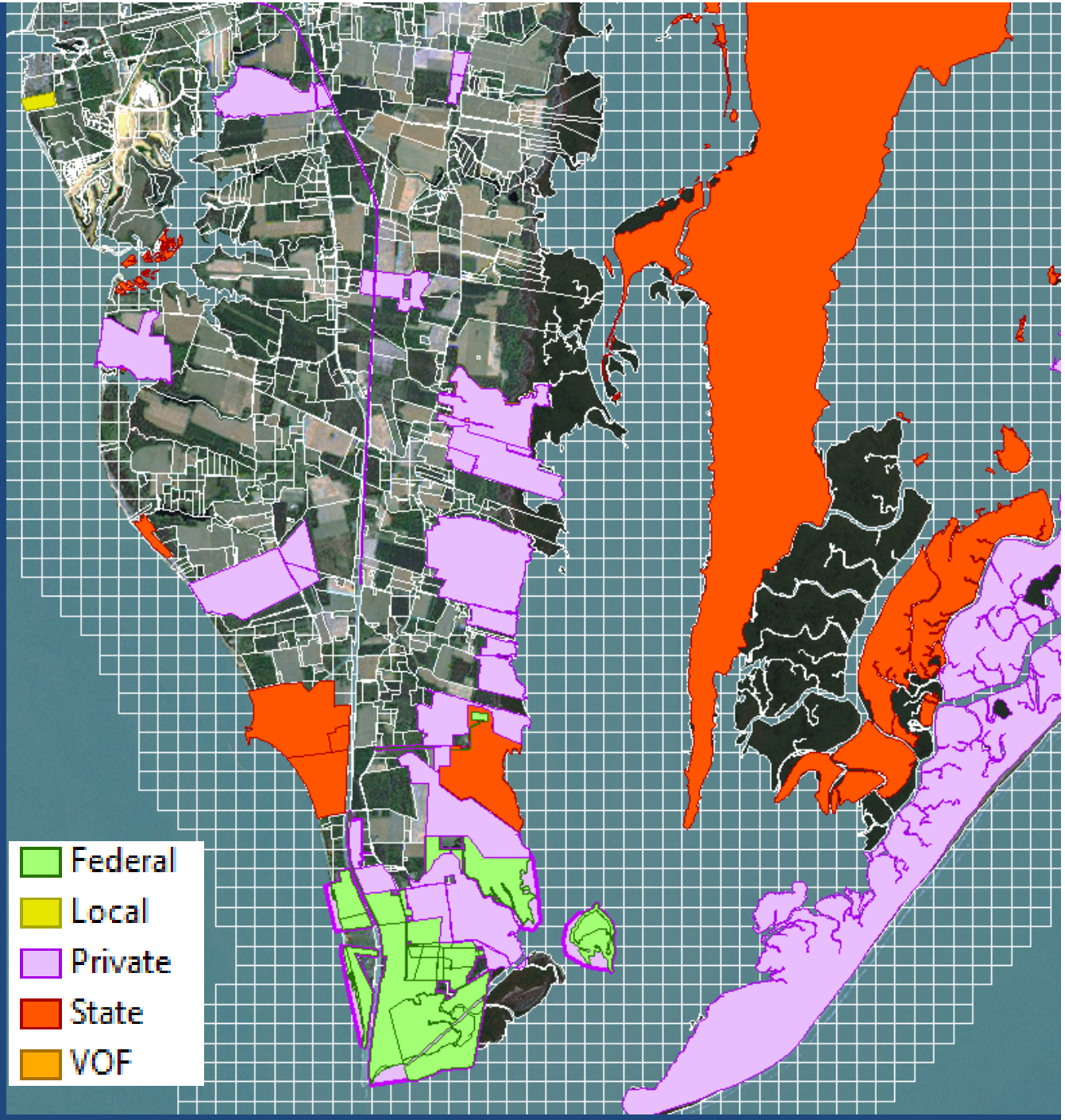
Context vs Scale of Implementation

Eastern Shore of Virginia National Wildlife Refuge

- Context: Chesapeake region influences policies and broader ecosystem function
- Implementation: 1850 acres refuge but highly influenced by surrounding land planners, owners, other NGOs activities



Grain of Implementation



Conclusion

- Scale has large implications
  - Types of possible assessments
  - Data needed
  - Uncertainty
  - Applicability to different scales and purposes
- Scale can only be somewhat controlled
  - Downscaling and modeling
  - New data collection and mapping
  - But projects will inherently contain resources and processes functioning at a variety of scales
    - One size fits all will not serve the assessment well
    - But can’t have the ideal scale for all features
    - Compromise is necessary