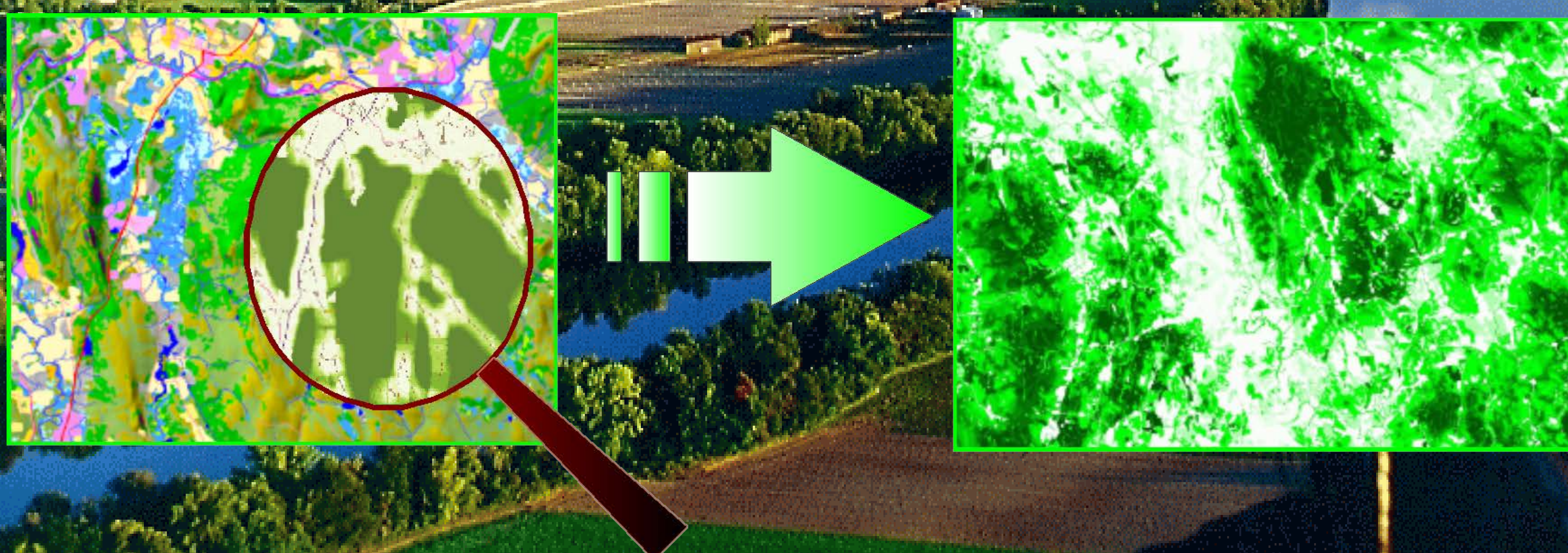
Designing Sustainable Landscapes in the Northeast

A project of the North Atlantic Landscape Conservation Cooperative & Northeast Climate Science Center

NALCC Technical Advisory Committee

June 2, 2014



The UMass Team

Contributors:

Liz Willey
Scott Schwenk
Curt Griffin
Scott Jackson
Carly Chandler
Janice Zepko
And others

Designing Sustainable Landscapes Project

The **purpose** of the Designing Sustainable Landscapes (DSL) project is to:

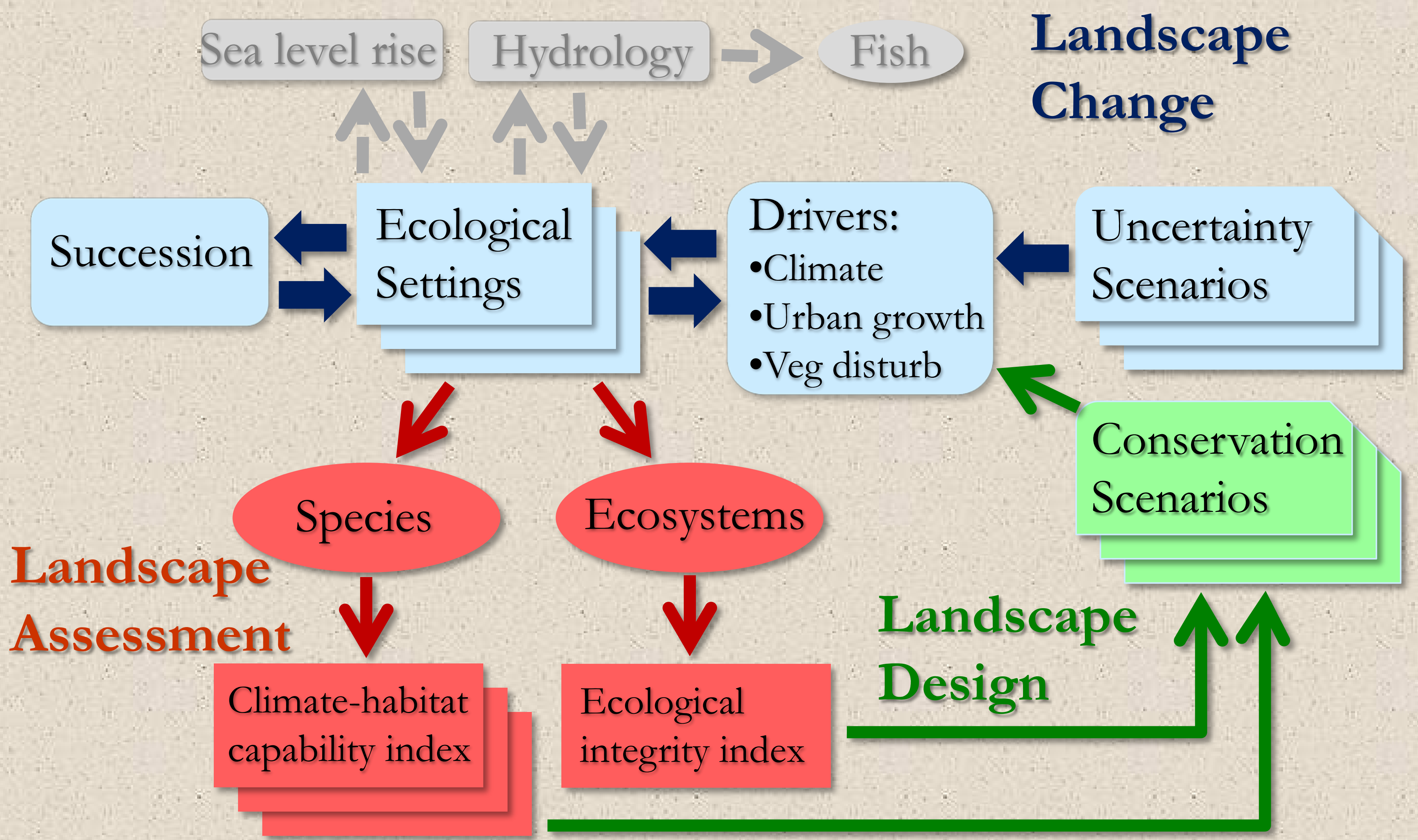
- Assess the capability of current and potential future landscapes to provide integral ecosystems and suitable habitat for a suite of representative species, and provide guidance for strategic habitat conservation

Landscape

- **C**hange
- **A**ssessment
- **D**esign

LCAD Model

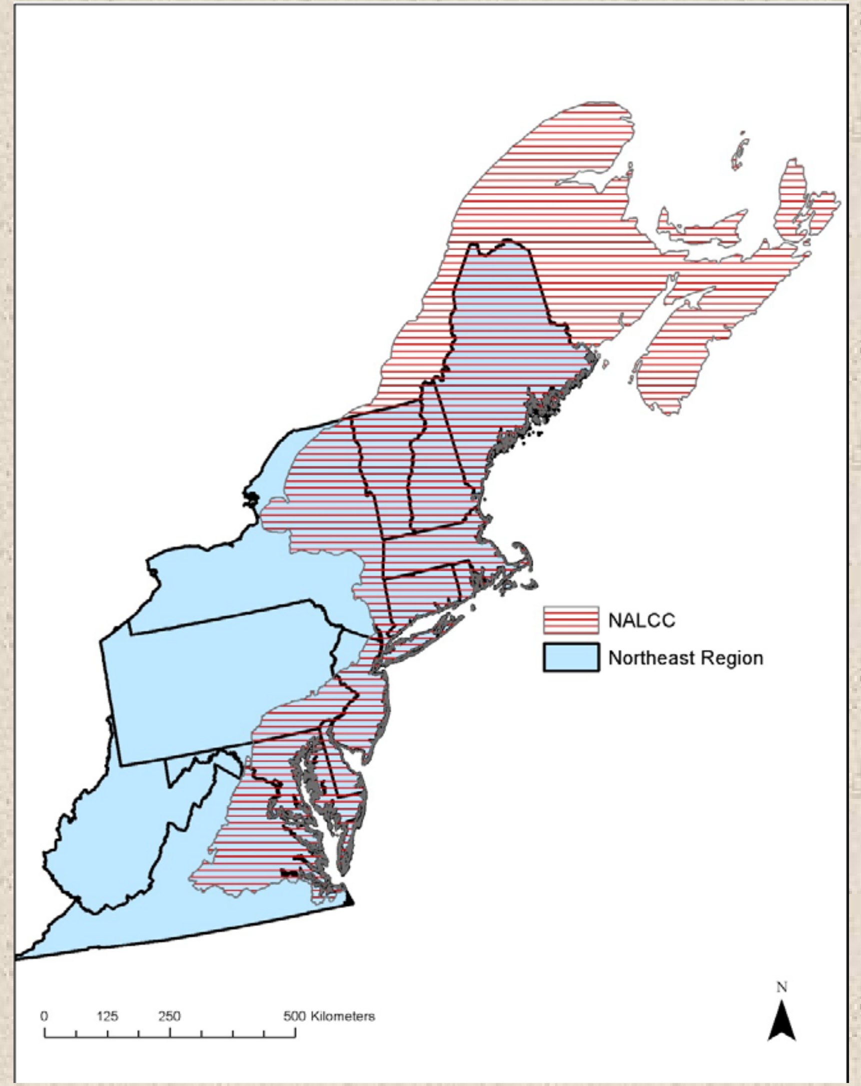
LCAD Model



Sea level rise
Hydrology
Fish
Landscape Change
Succession
Ecological Settings
Drivers:
•Climate
•Urban growth
•Veg disturb
Uncertainty Scenarios
Conservation Scenarios
Species
Ecosystems
Landscape Assessment
Climate-habitat capability index
Ecological integrity index
Landscape Design

Designing Sustainable Landscapes Project

- **Geographic scope** of DSL
  - Northeast Region
  - Includes U.S. portion of the *North Atlantic* LCC (for the interim) and portions of the *Upper Midwest/Great Lakes* LCC and *Central Appalachian* LCC

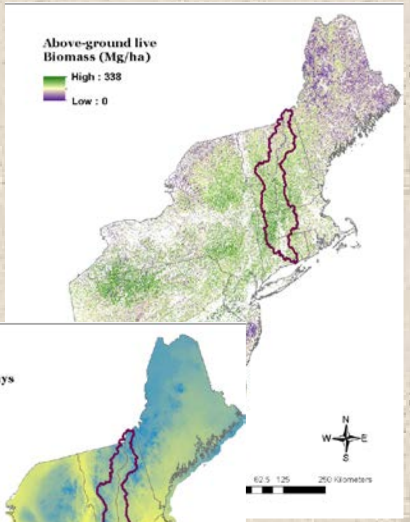


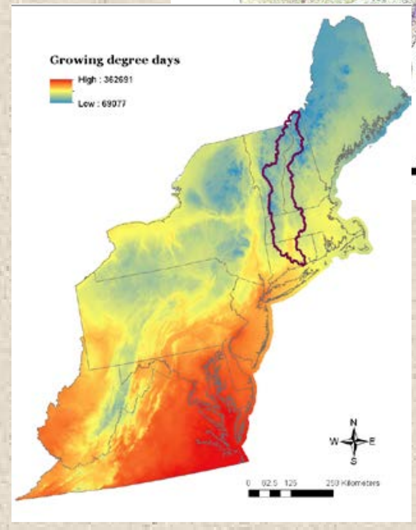
Landscape Change

Ecological Settings

"GIS layers including a broad but parsimonious suite of biophysical variables representing the natural and anthropogenic environment at each cell at each timestep"

- Measure magnitude of abiotic, vegetation or anthropogenic attributes
- Raw-scaled metrics (most are non-negative and unbounded)
- High value = more of it
- Used to measure ecological dissimilarity and resistance in ecological integrity metrics and in modeling species distributions





Landscape Change

Ecological Settings

Abiotic (15):

- Temperature:
  - Min winter temperature
  - Growing season degree days
  - Heat index (>35^0 C)
  - Stream temperature
- Solar energy:
  - Incident solar radiation
- Moisture & hydrology:
  - Topographic wetness
  - Flow volume
  - Flow gradient
- Chemical & physical substrate:
  - $CaCO_3$ content
  - Soil available water supply
  - Soil depth
  - Soil pH
  - Substrate mobility
- Physical disturbance:
  - Slope
  - Wind exposure

Landscape Change

Ecological Settings

Vegetation (2):

- Potential dominant life form
- Above-ground live biomass

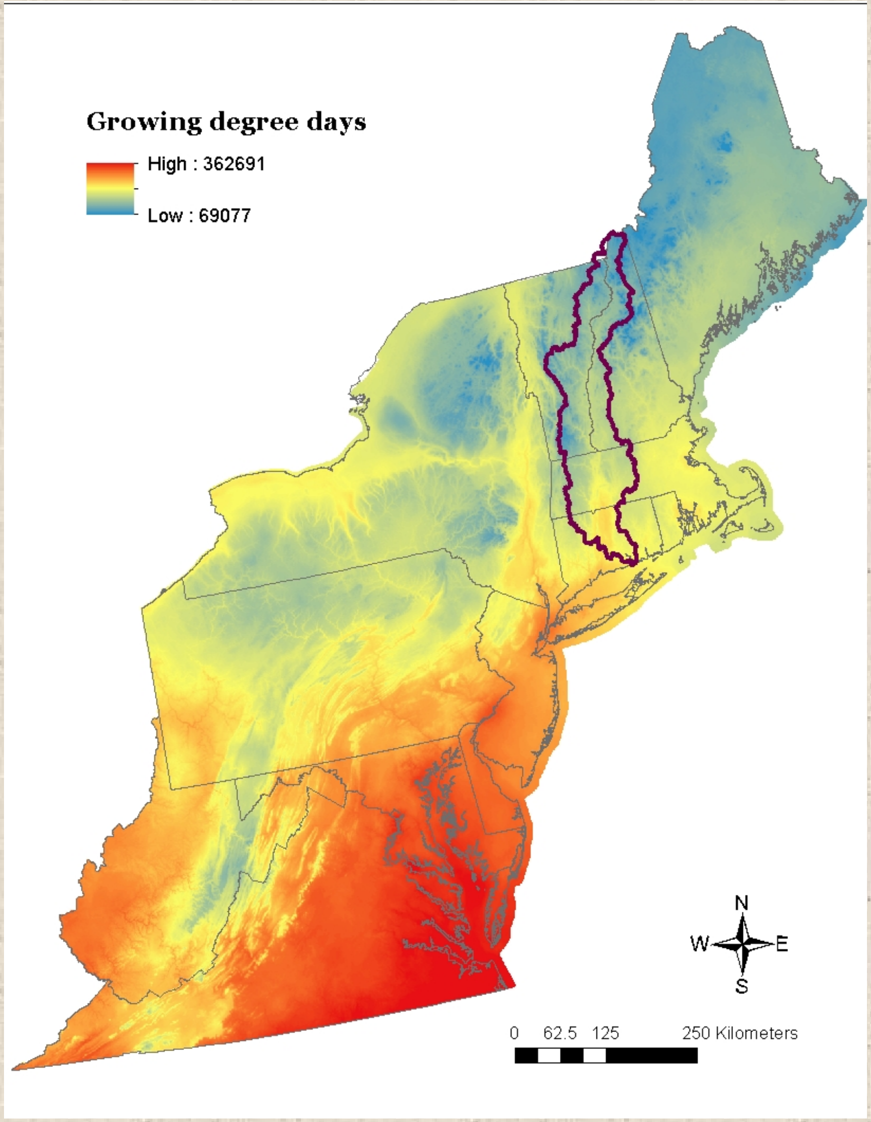
Anthropogenic (6):

- Gibbs traffic rate
- Developed
- Hard development
- Imperviousness
- Terrestrial barriers
- Aquatic barriers

Landscape Change

Ecological Settings

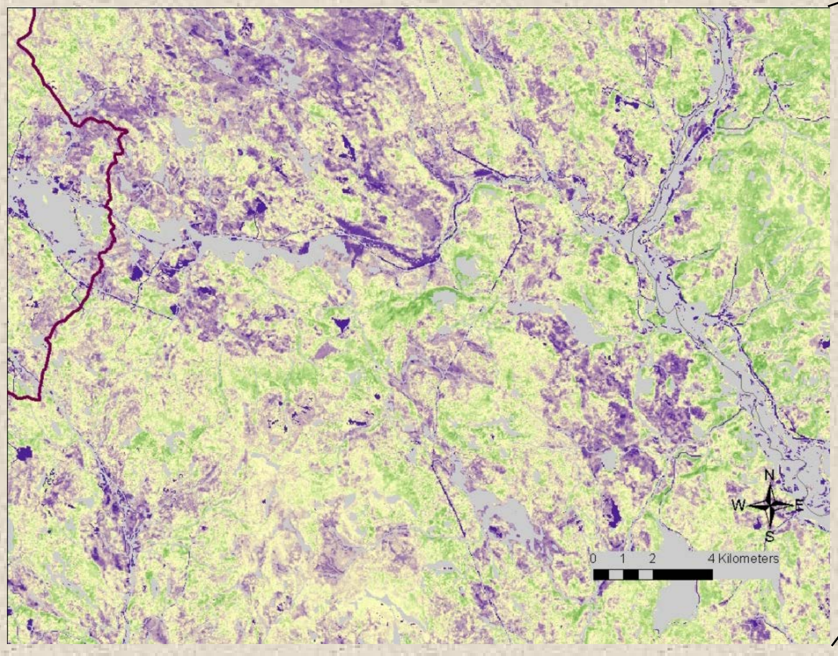
- **Growing degree days…** the sum across days of the number of degrees by which the mean daily temperature exceeds a threshold of 10^0 C

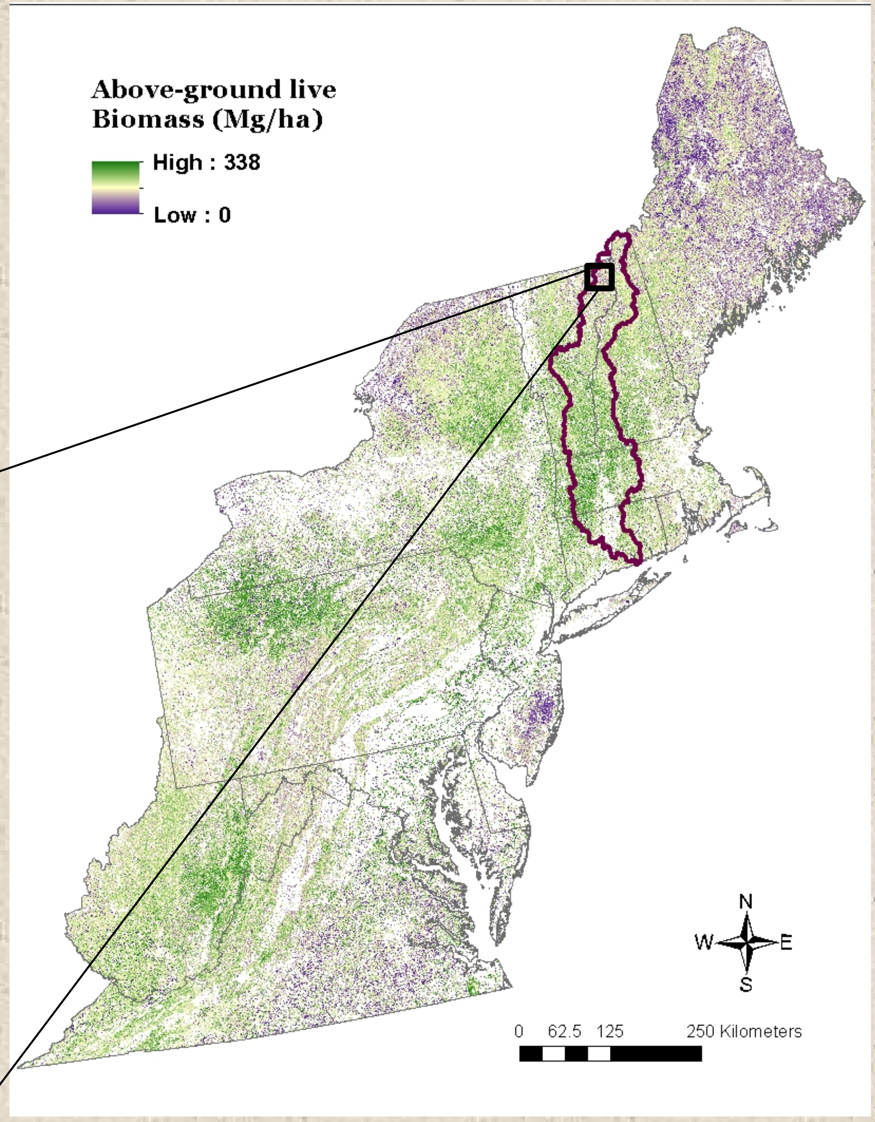


Landscape Change

Ecological Settings

- **Above-ground live biomass…** modified from Woods Hole NACP Above-ground National Biomass and Carbon Baseline Data V.2

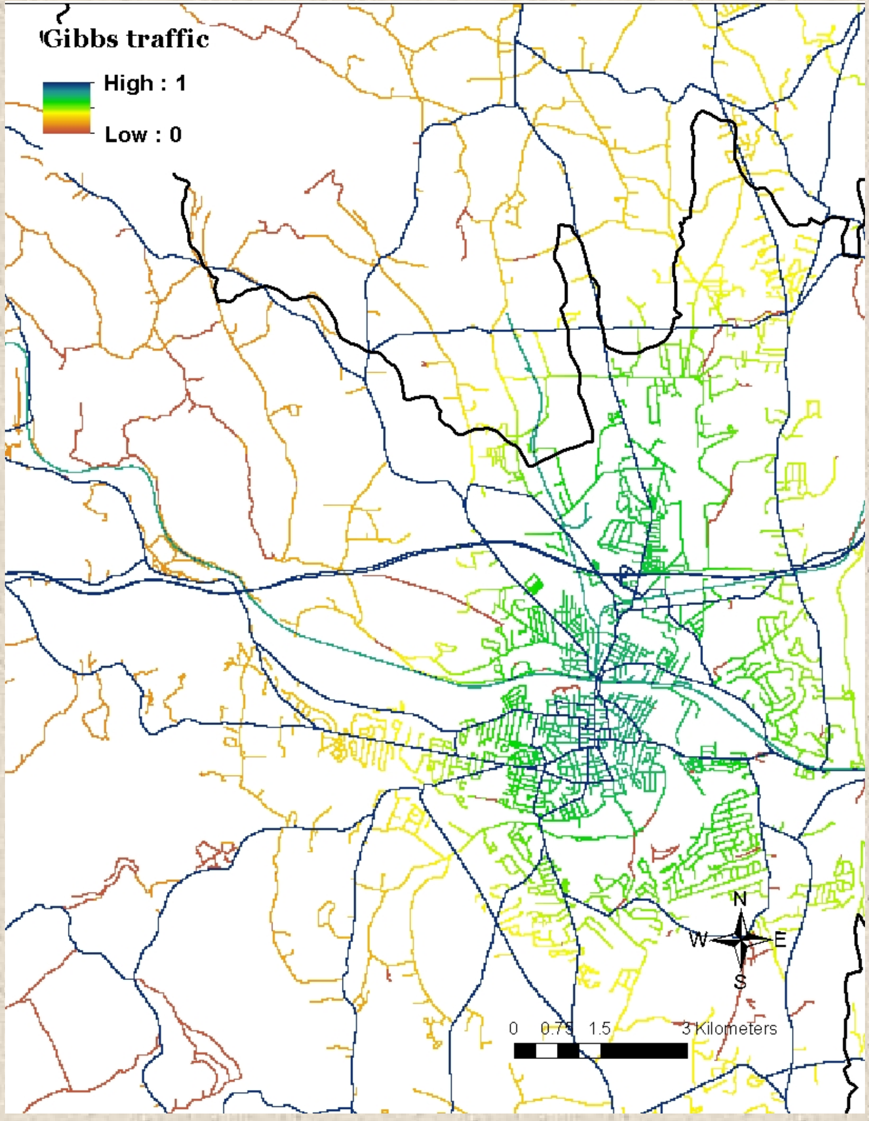




Landscape Change

Ecological Settings

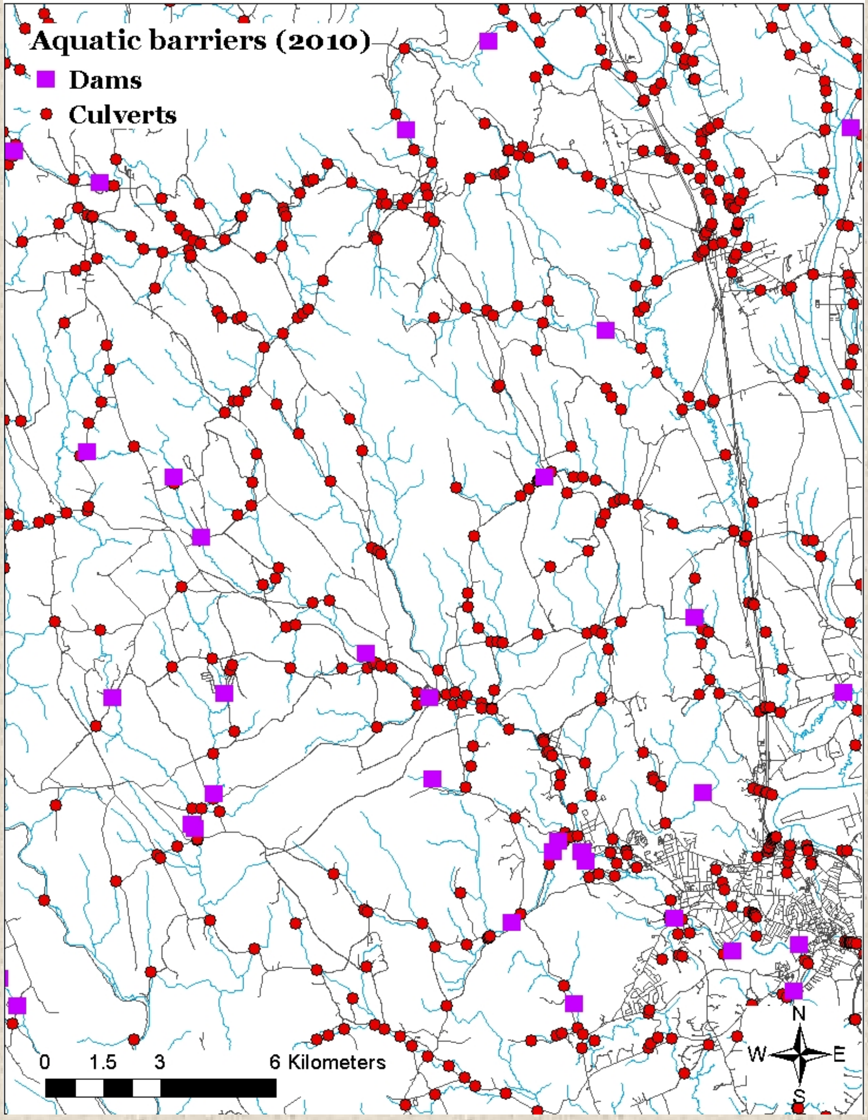
- **Gibbs traffic rate…** imputed average number of vehicles per day on roads and railways transformed into probability of road-crossing mortality based on the Gibbs model (Gibbs and Shriver 2002).



Landscape Change

Ecological Settings

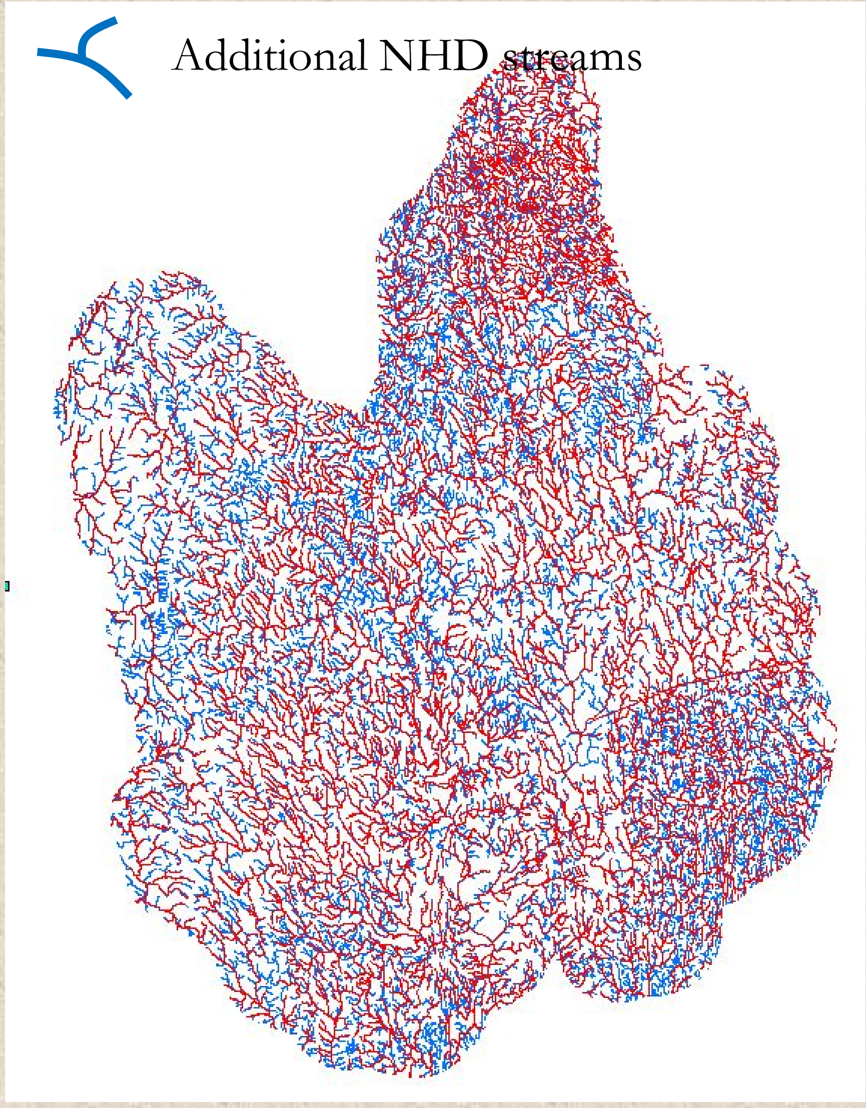
- **Aquatic barriers…** the degree to which culverts and dams may physically impede upstream and downstream movement of aquatic organisms; passability scores derived from custom algorithm based on field observations (where we have them) or modeled and applied to dams and road-stream crossings.



Landscape Change

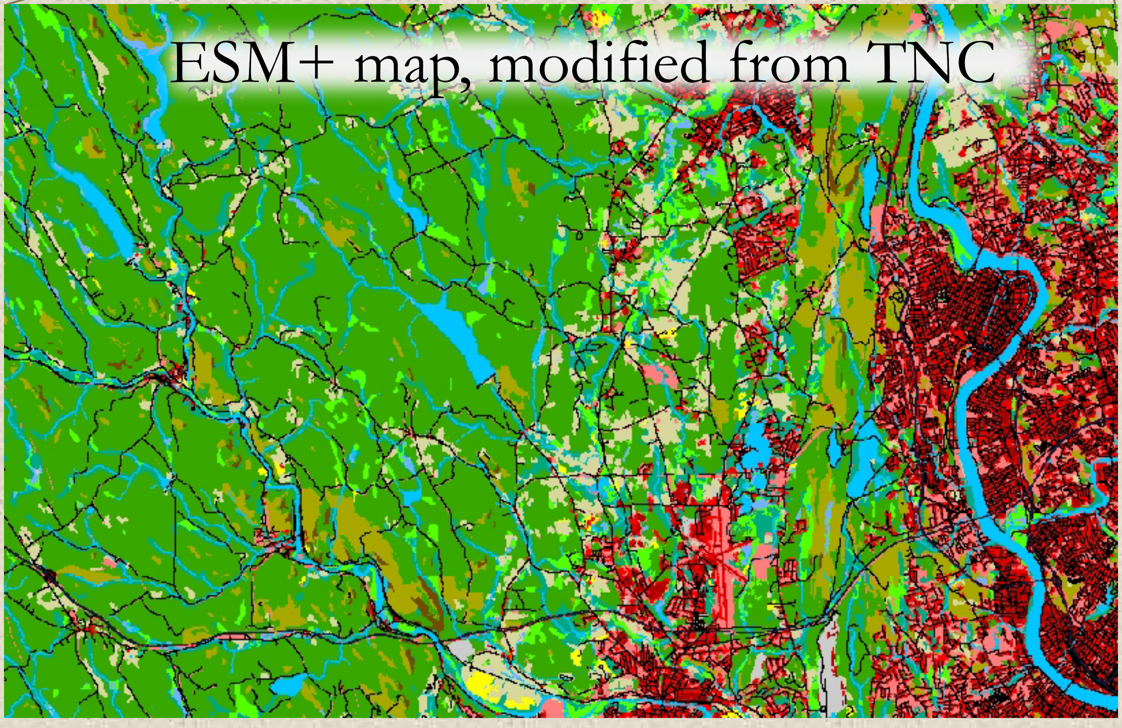
Ecological Settings

- **NHD based streams…** hydrologically corrected the high resolution (1:24k) NHD streams for use in representing the stream network and deriving the flow related ecological settings variables for streams.



Ecological Settings

"Ecological systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding" (Natureserve)



17 formations
27 macrogroups
196 systems

Appalachian hemlock-northern hardwood forest: typic

Landscape Change

Ecological Settings

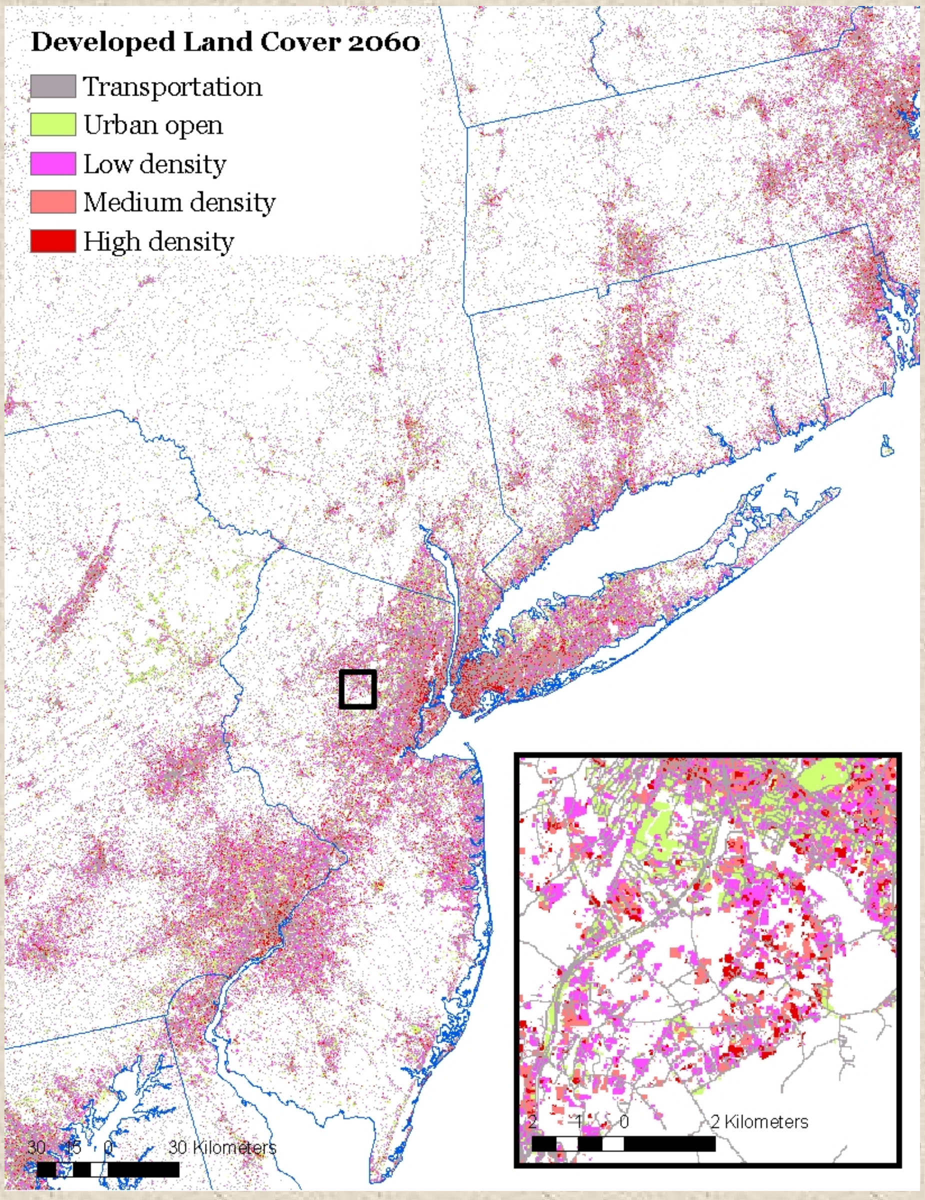
Major modifications to TNC's ESM:

- Replaced misaligned NLCD roads (confounded with development) with more accurate roads/trains;
- Removed spurious development (mostly developed open space) from the edges of NLCD roads;
- Added NHD high resolution streams, road-stream crossings and dams;
- Replaced the single open water class in ESM with various lentic and lotic classes;
- Replaced the ESM estuarine classes with updated NWI estuarine and marine classes;
- Replaced the single developed and agriculture classes in ESM with five developed and two agriculture classes from NLCD 2006.

Landscape Change

Urban Growth

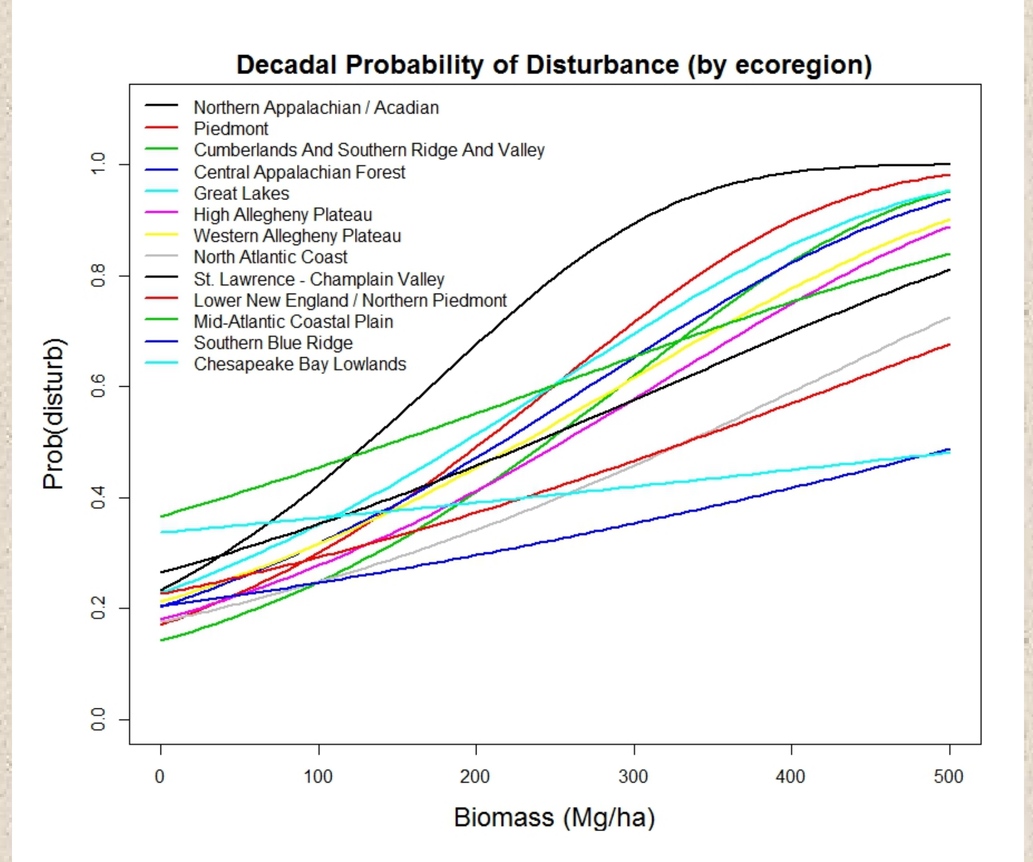
- Multi-stage statistical model to stochastically allocate amount and pattern of development at each timestep
- Updated to model growth across the region with scenarios to vary total amount and sprawliness of growth relative to historical patterns



Landscape Change

Vegetation Disturbance

- Generic statistical disturbance model
- Updated to reflect variation in disturbance rate and intensity as a function of ecoregion and existing biomass based on FIA data

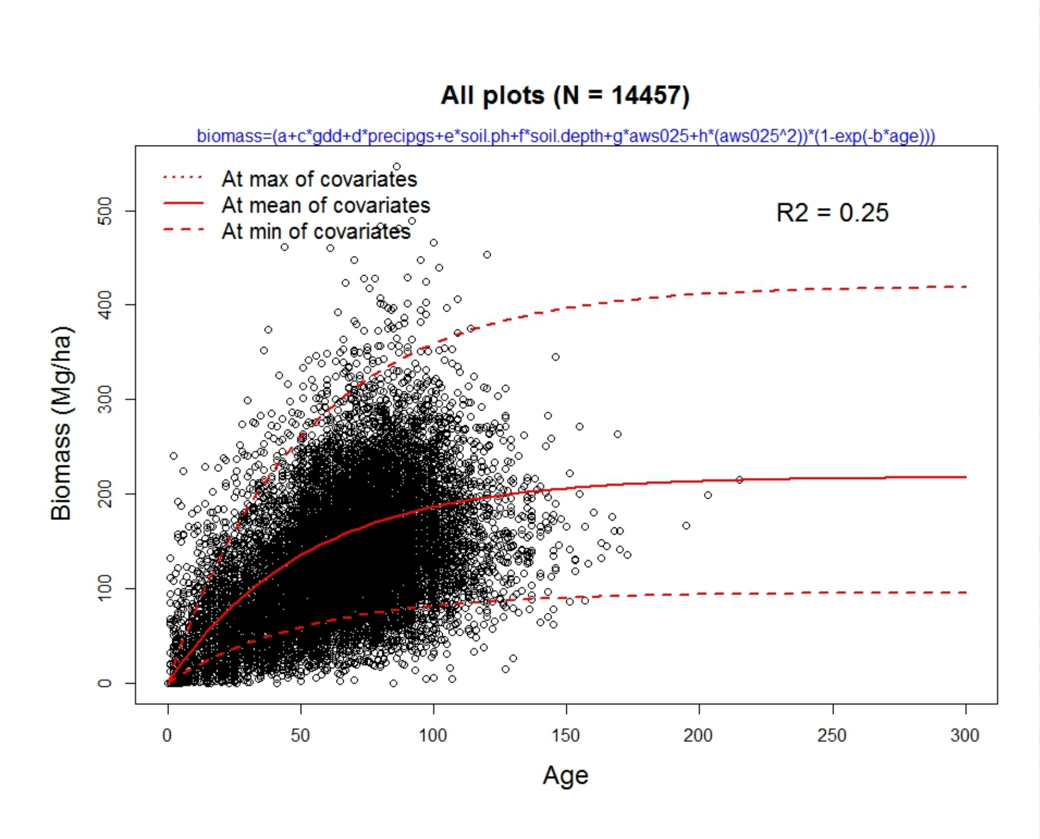


Note, disturbance types are confounded

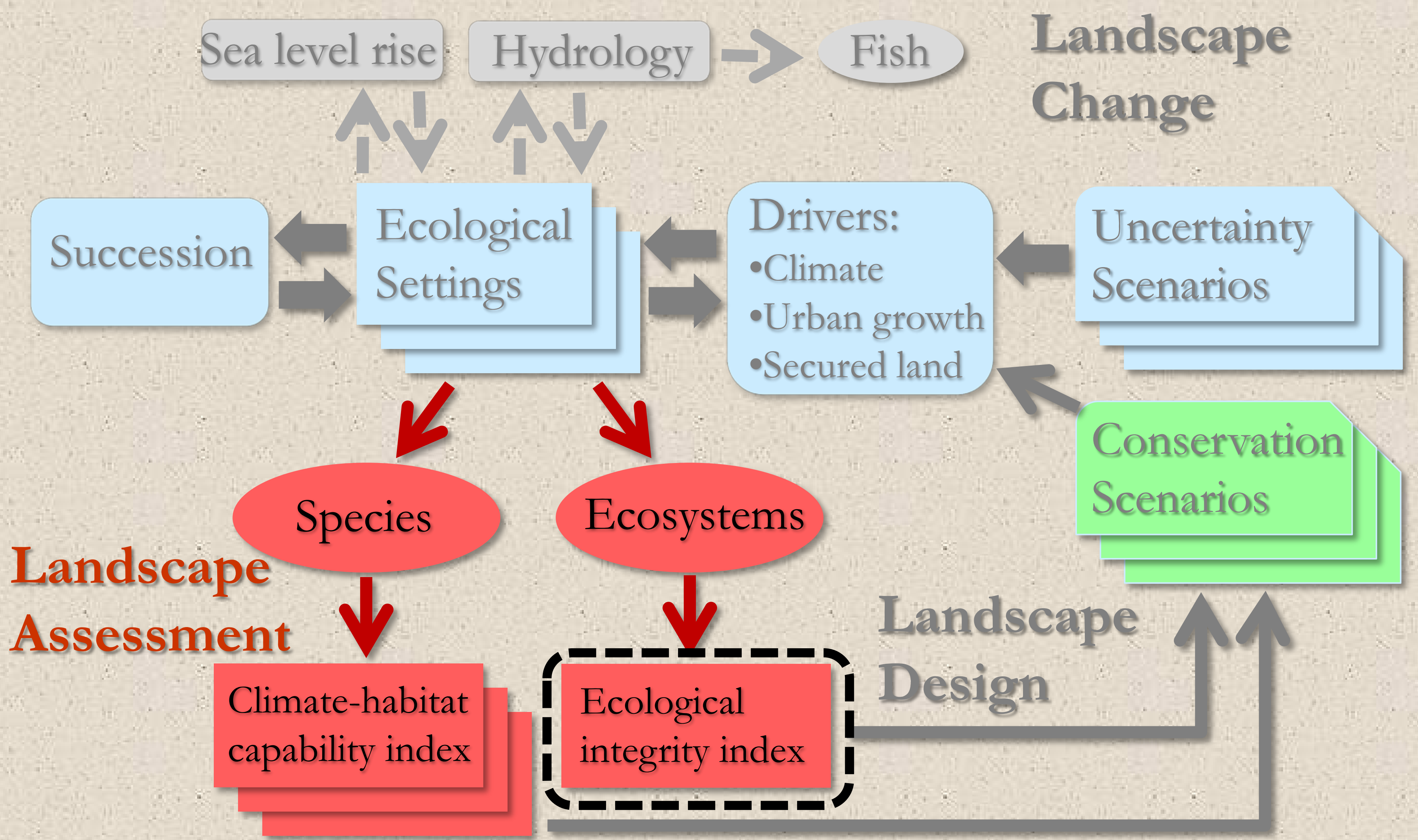
Landscape Change

Succession

- Generic statistical succession model
- Updated to reflect variation in succession trajectory as a function of spatial covariates (gdd, precipgs, soil.ph, soil.depth, aws025) and stand age based on FIA data



LCAD Model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Landscape Assessment

Local integrity metrics

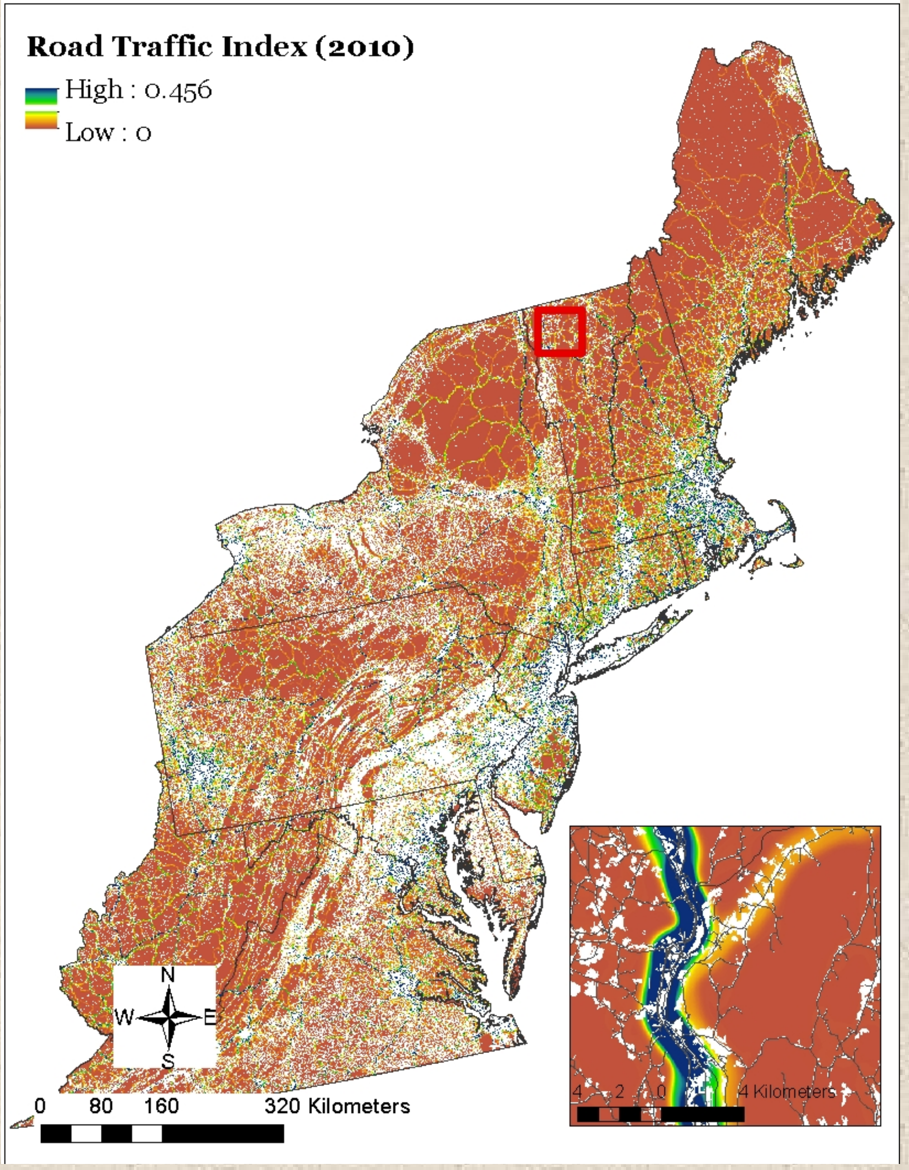
*future only

- Development and roads:
  - Habitat loss
  - Watershed habitat loss
  - Road traffic
  - Mowing and plowing
  - Microclimate alterations
- Pollution:
  - Watershed road salt
  - Watershed sediment
  - Watershed nutrient enrichment
- Climate change:
  - Climate alteration*
- Biotic alterations:
  - Domestic predators
  - Edge predators
  - Non-native invasive plants
  - Non-native earthworms
- Hydrologic alterations:
  - Watershed imperviousness
  - Dam intensity
  - Sea level rise inundation*
- Resiliency:
  - Similarity
  - Connectedness
  - Aquatic connectedness

Landscape Assessment

Local integrity metrics

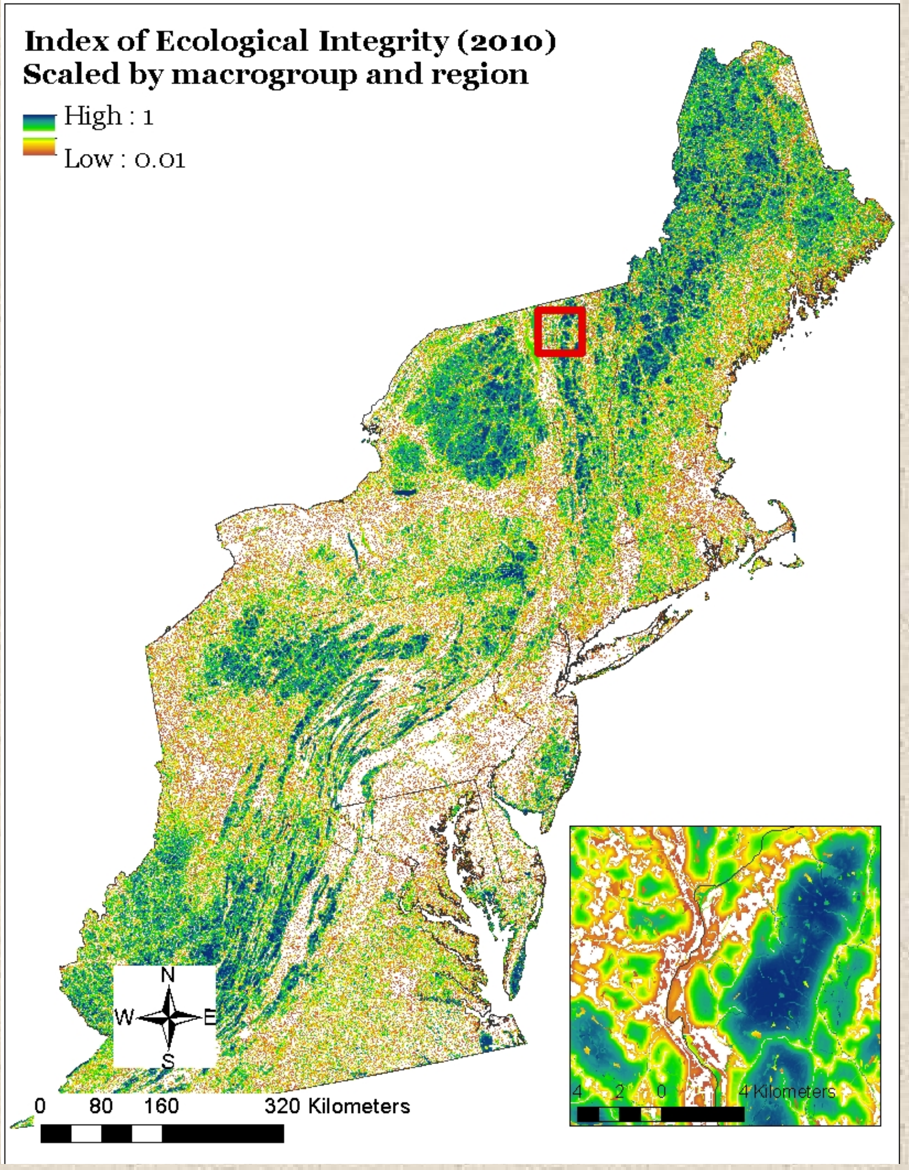
- **Road traffic index**
  - Traffic intensity (Gibbs model transformed) within the ecological neighborhood of a cell
  - Raw-scaled (0-1)
  - High value = <u>high</u> traffic intensity (stressor level)



Landscape Assessment

Local integrity metrics

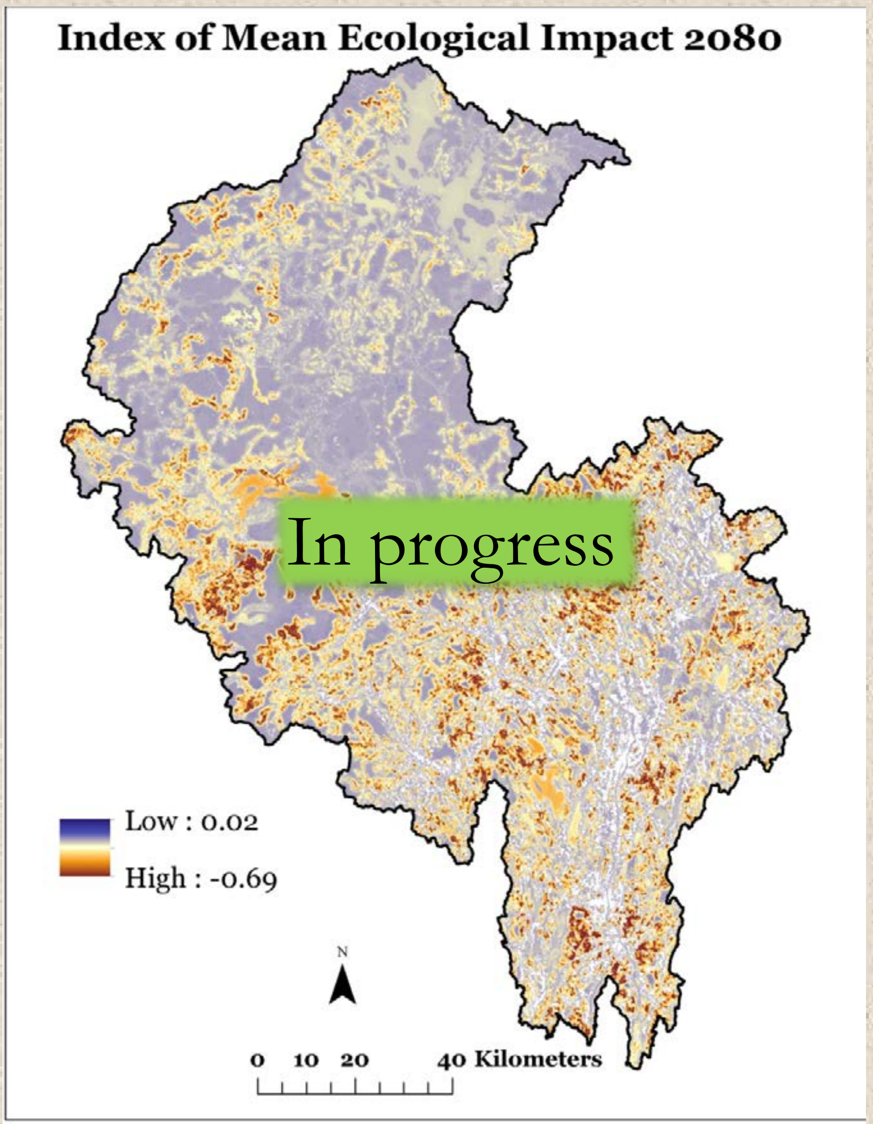
- **Index of ecological integrity (IEI)**
  - Weighted (by ecosystem) linear combination of individual metrics
  - Quantile-scaled (0-1) by ecosystem & extent (benchmarked to 2010)
  - High value = high integrity
  - Top x% interpretation



Landscape Assessment

Local integrity metrics

- **Index of ecological impact**
  - Weighted (by ecological system) linear combination of delta-scaled intactness and resiliency metrics multiplied by IEI in 2010
  - Mean Impact across uncertainty simulations
  - Computed for 2030 & 2080
  - Suitable for scenario comparison



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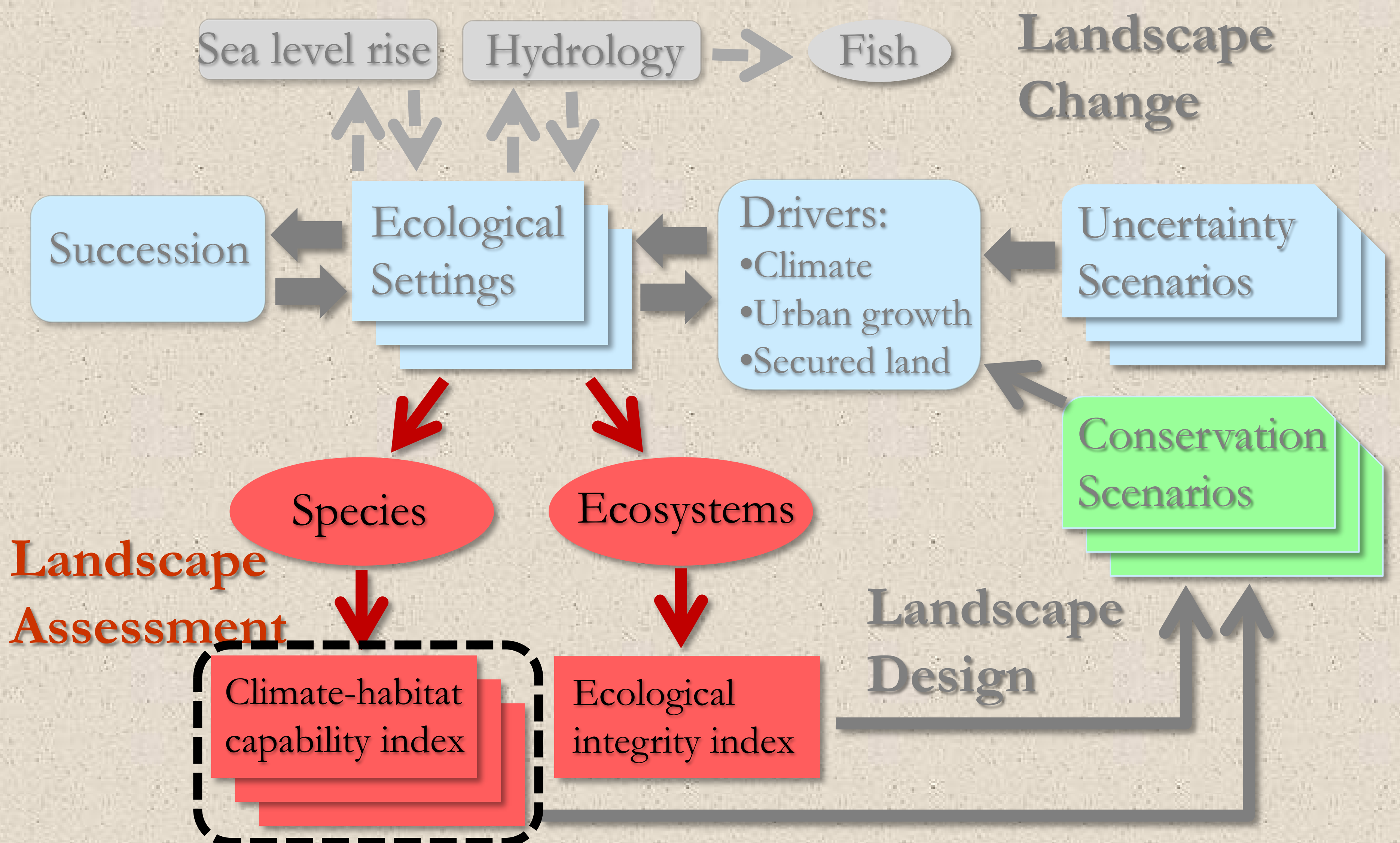

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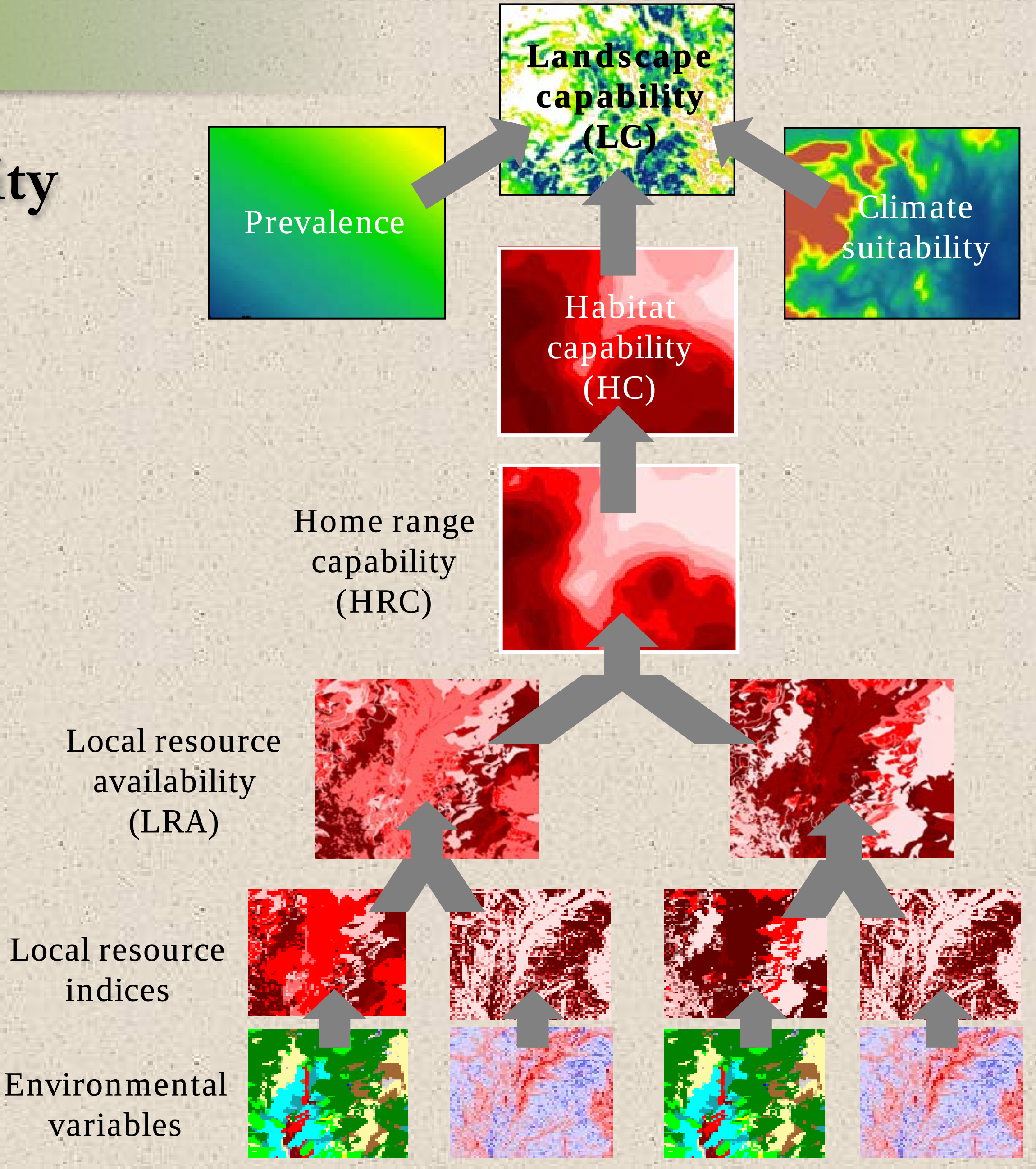
Landscape Assessment

Species

- **Landscape capability index**
  - Spatially-explicit
  - Multi-scale
  - Expert/empirically -derived
  - Synthesis of habitat capability, climate suitability, and prevalence
  - Statistically validated



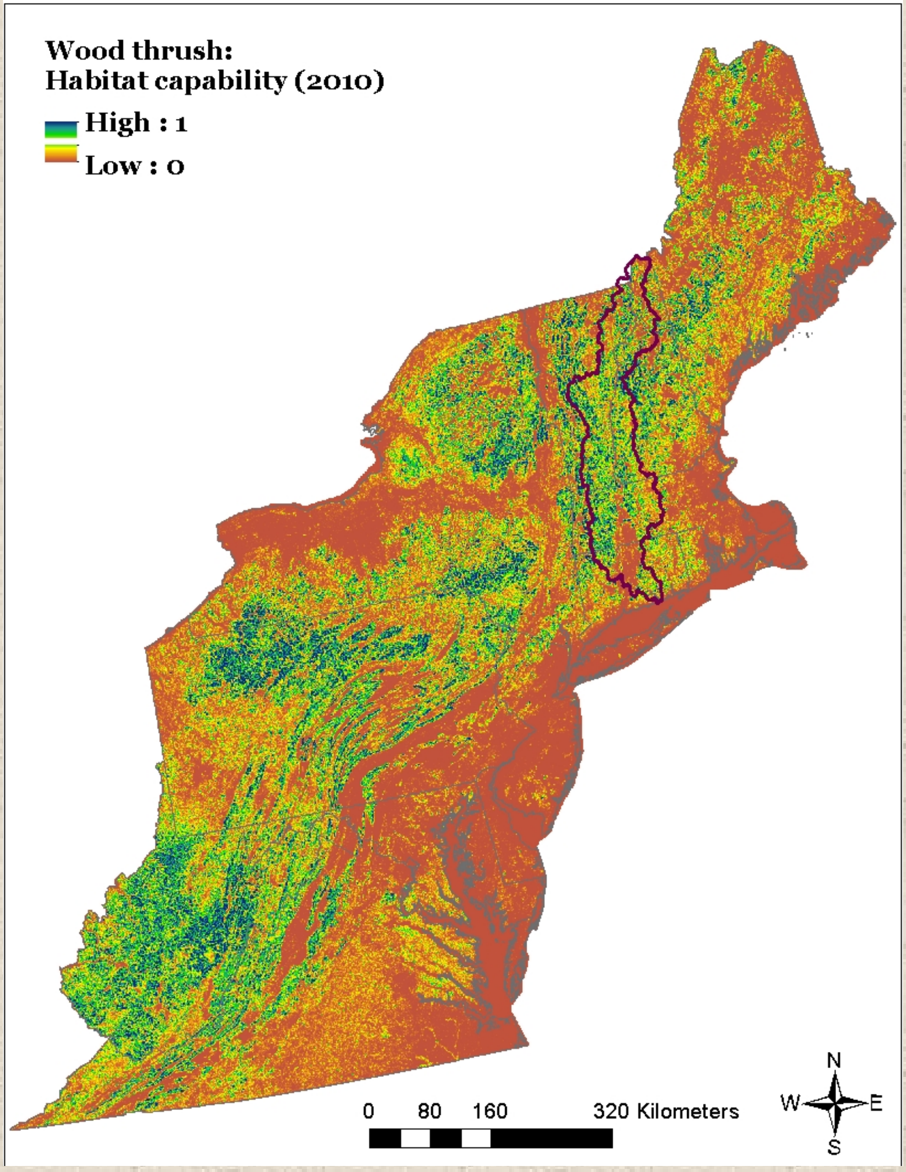
Landscape Assessment

Species

- **Habitat capability index**

Where is the *capable habitat* in 2010, 2030 or 2080 without regard to climate suitability and species' prevalence?

Wood thrush



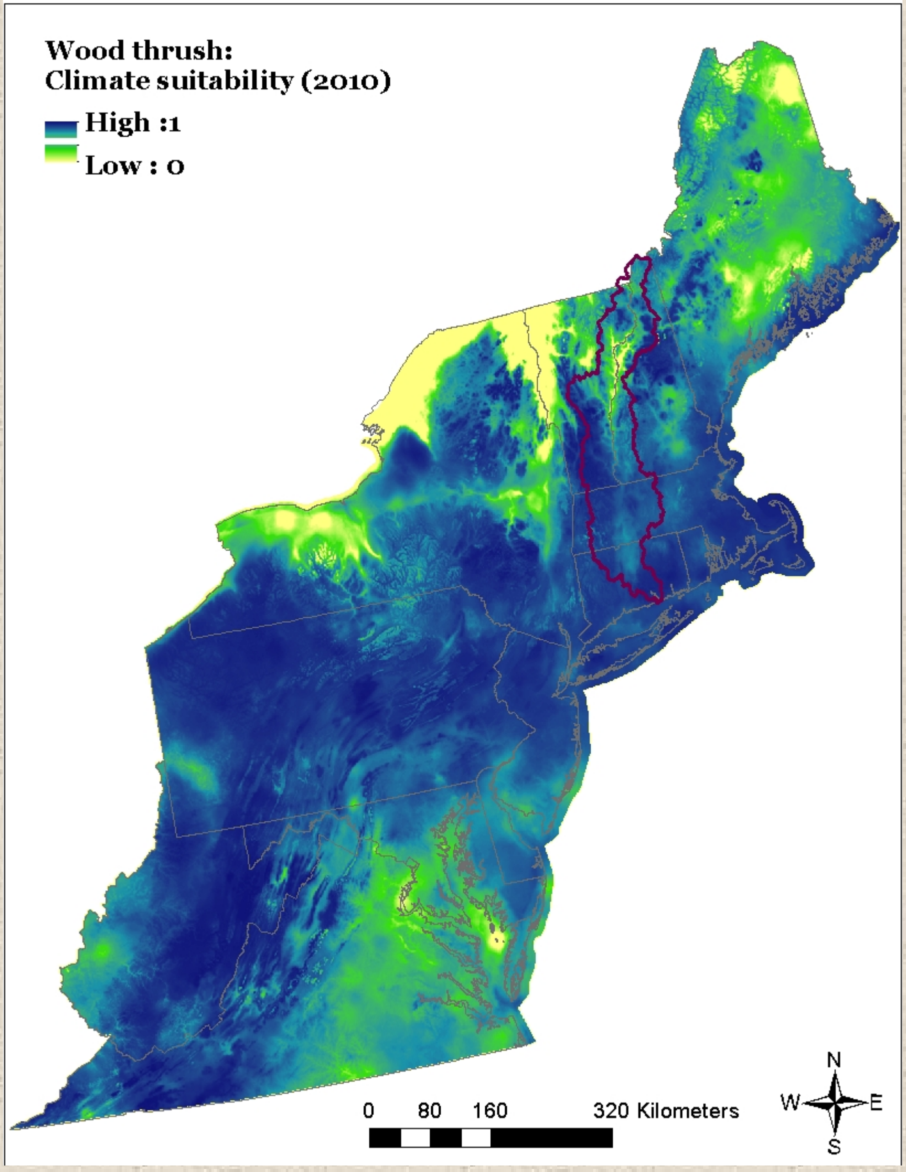
Landscape Assessment

Species

- **Climate suitability index**

Where is the *suitable climate* in 2010, 2030 or 2080 without regard to habitat and species' prevalence?

Wood thrush



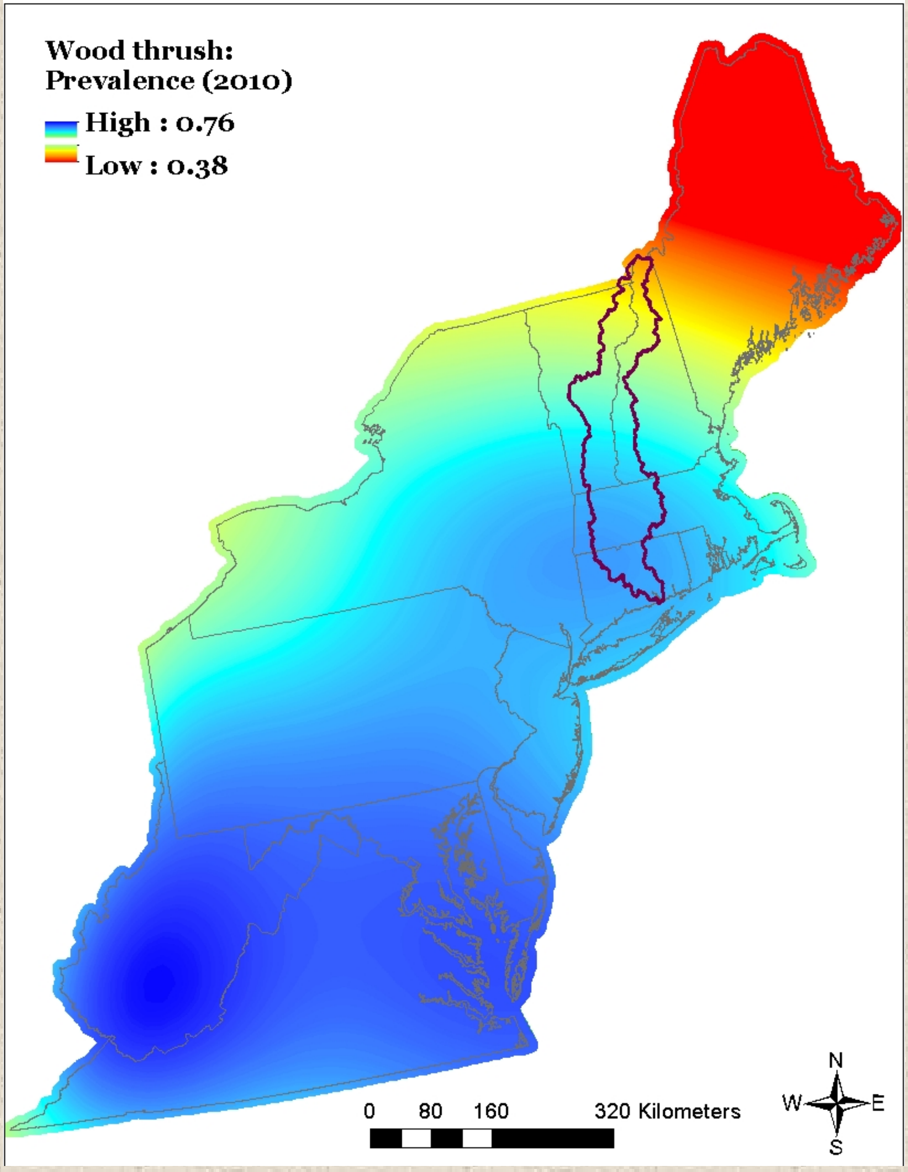
Landscape Assessment

Species

- **Prevalence index**

Where is the species most *prevalent* in 2010, without explicit regard to habitat and climate suitability

Wood thrush



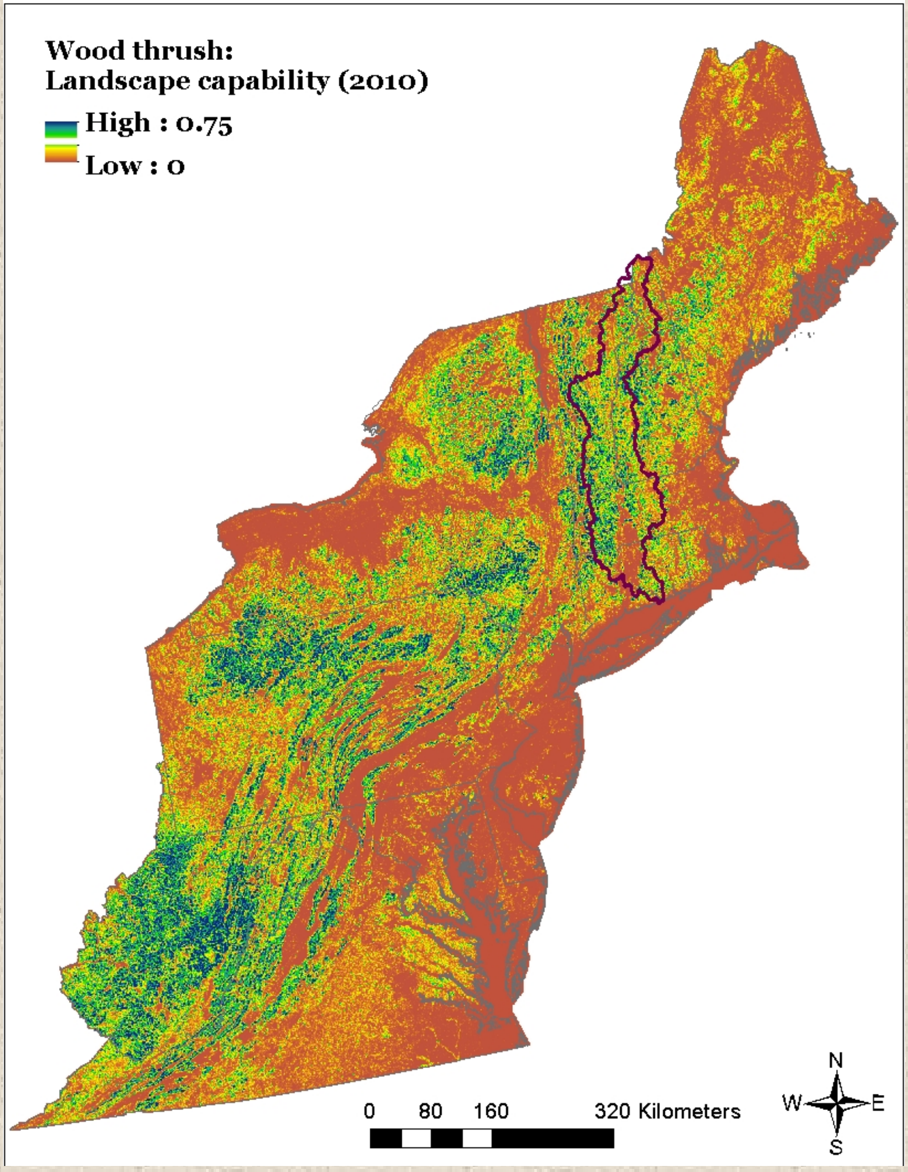
Landscape Assessment

Species

- **Landscape capability index**

Where is the species' most likely to *occur* in 2010, 2030 or 2080 based on habitat capability, climate suitability and prevalence?

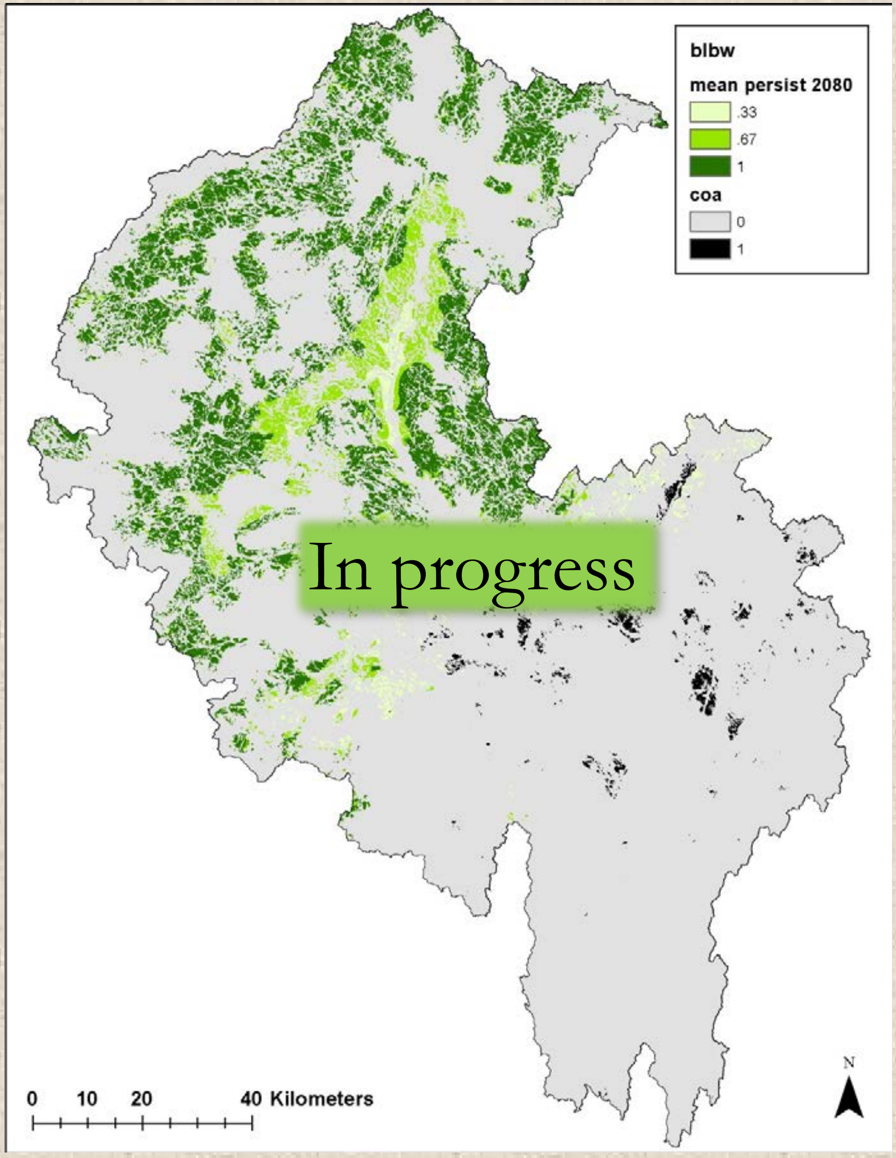
Wood thrush



Landscape Assessment

Species

- **Landscape Change Vulnerability**
  - *Climate vulnerabilty*... proportional change in LC due to climate change
  - *Habitat vulnerability*… proportional change in LC due to land use



Landscape Assessment

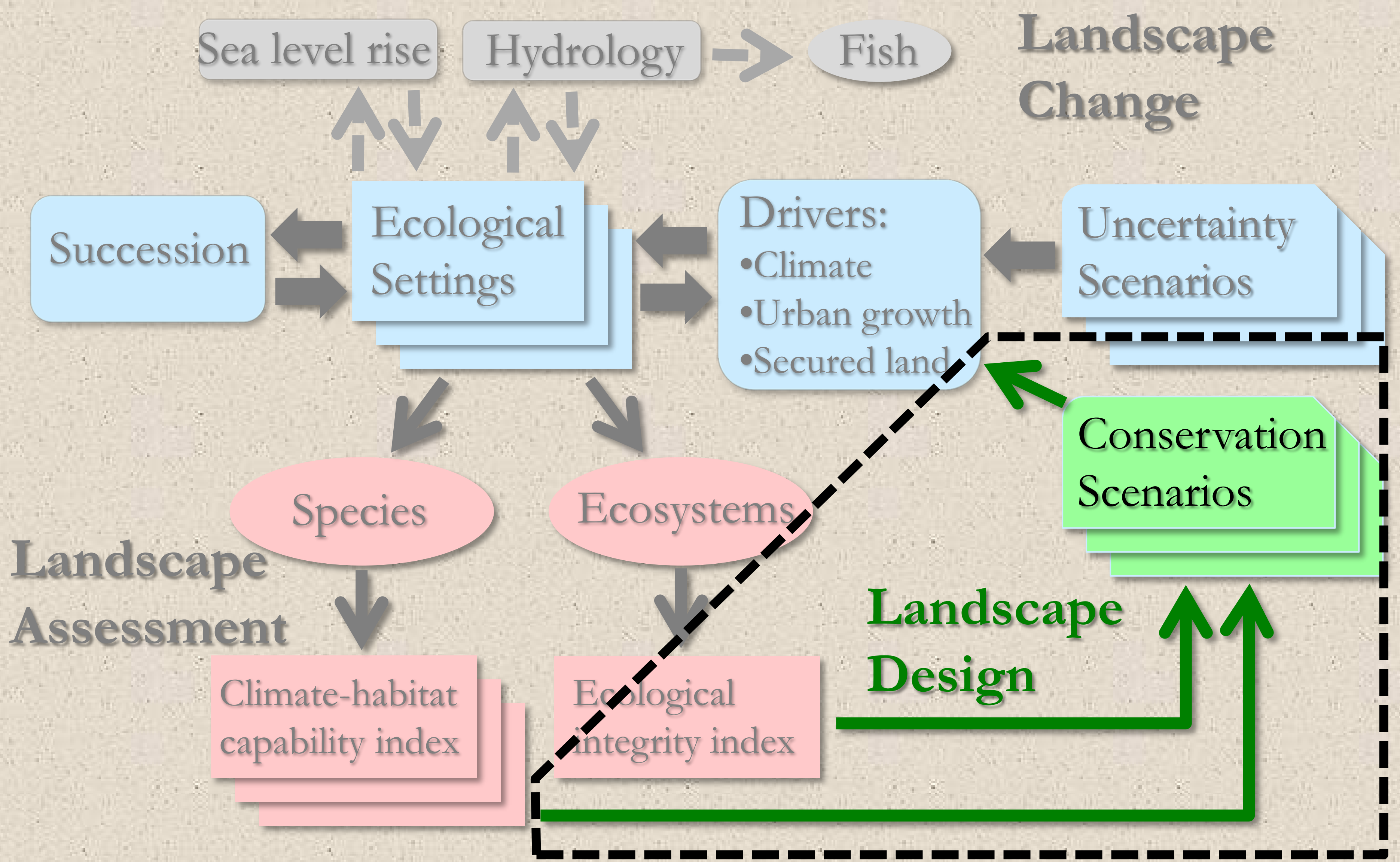
Species

Representative species:

- American woodcock
- Black bear
- Blackburnian warbler
- Blackpoll warbler
- Brook trout*
- Eastern meadowlark
- Louisiana waterthrush
- Marsh wren
- Moose
- Northern waterthrush
- Ruffed grouse
- Wood duck
- Wood turtle
- Wood thrush

- American black duck (B)
- American black duck (NB)
- American oystercatcher
- Bicknell's thrush
- Box turtle
- Brown-headed nuthatch
- Cerulean warbler
- Common loon
- Diamondback terrapin
- Ovenbird
- Prairie warbler
- Red-shouldered hawk
- Saltmarsh sparrow
- Sanderling – migratory
- Snowshoe hare
- Snowy egret
- Virginia rail

LCAD Model



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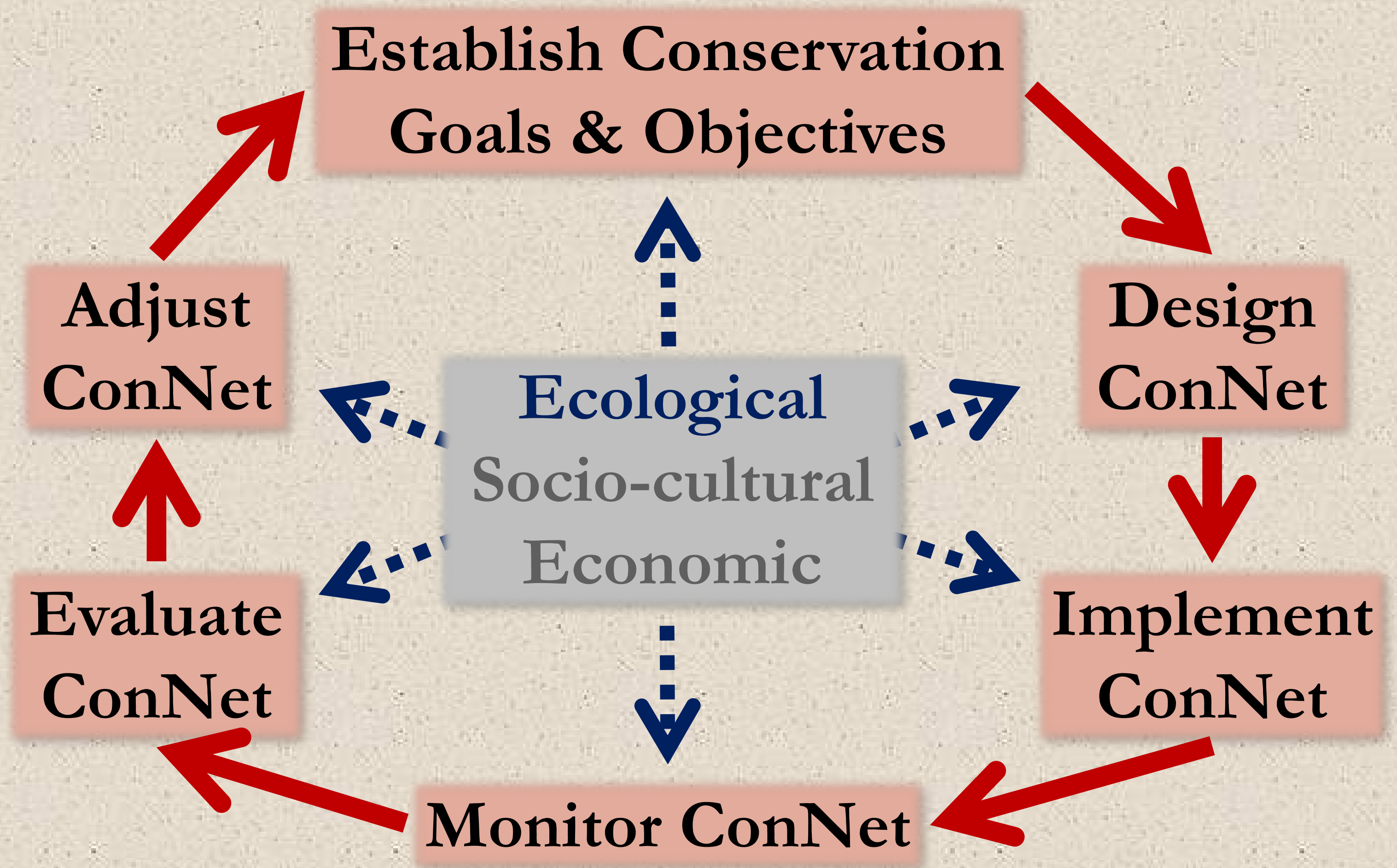
Adaptive Landscape Conservation Design



Landscape Conservation Design

The Design Step

Design Steps:

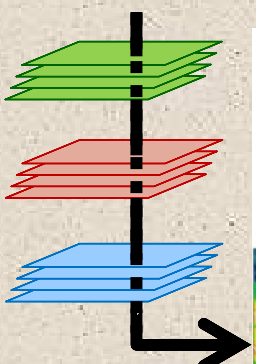
1. Select (tiered) *core* areas
2. Prioritize within/among cores
3. Create core area *buffers*
4. Delineate *corridors* among cores
5. Prioritize within/among corridors
6. Determine *management* needs
7. Identify *restoration* opportunities

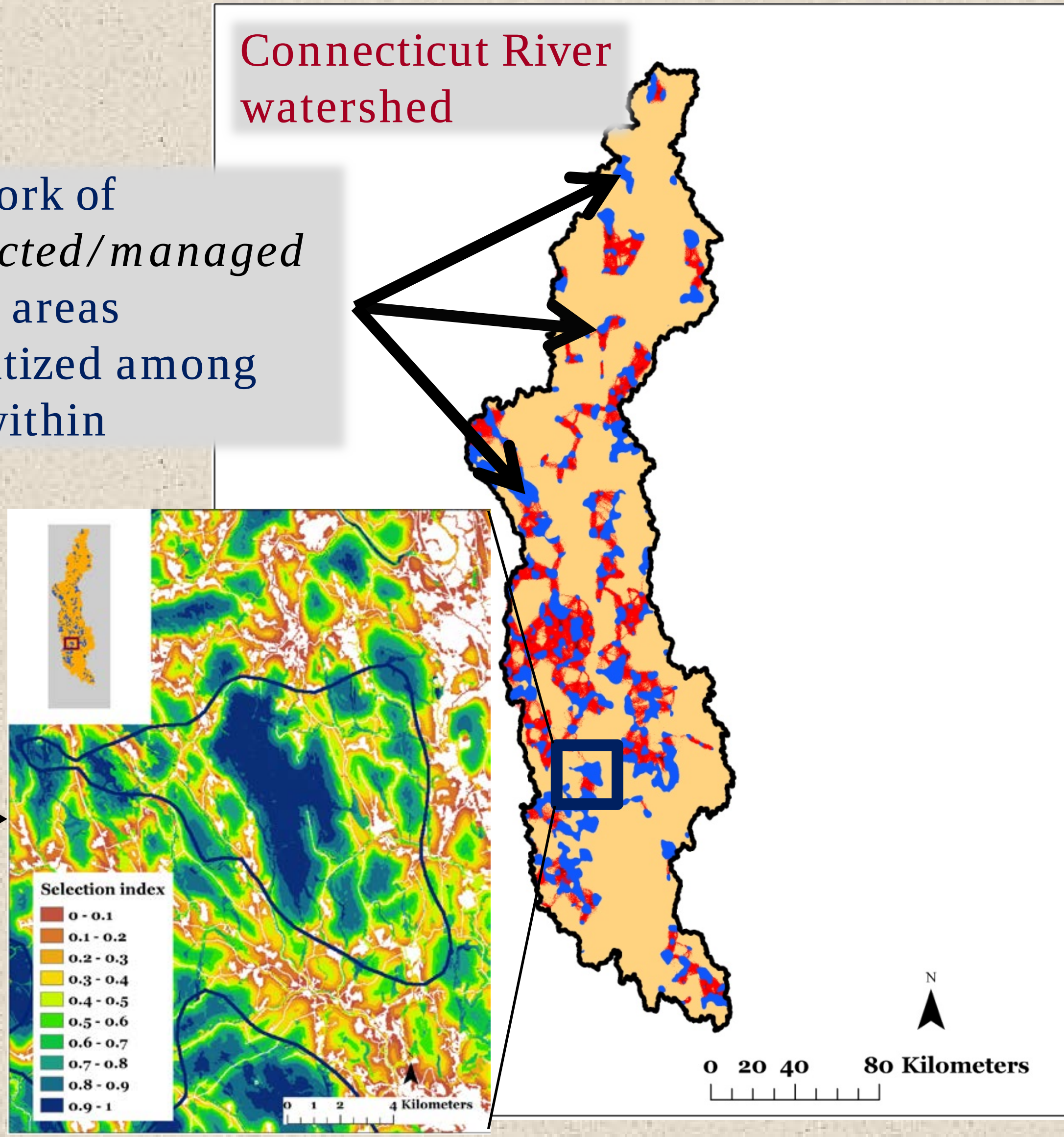
- Field verification at all steps
- Socio-cultural and economic considerations at all steps

Landscape Conservation Design

What does it look like?

Network of *protected/managed* **Core** areas prioritized among and within





Landscape Conservation Design

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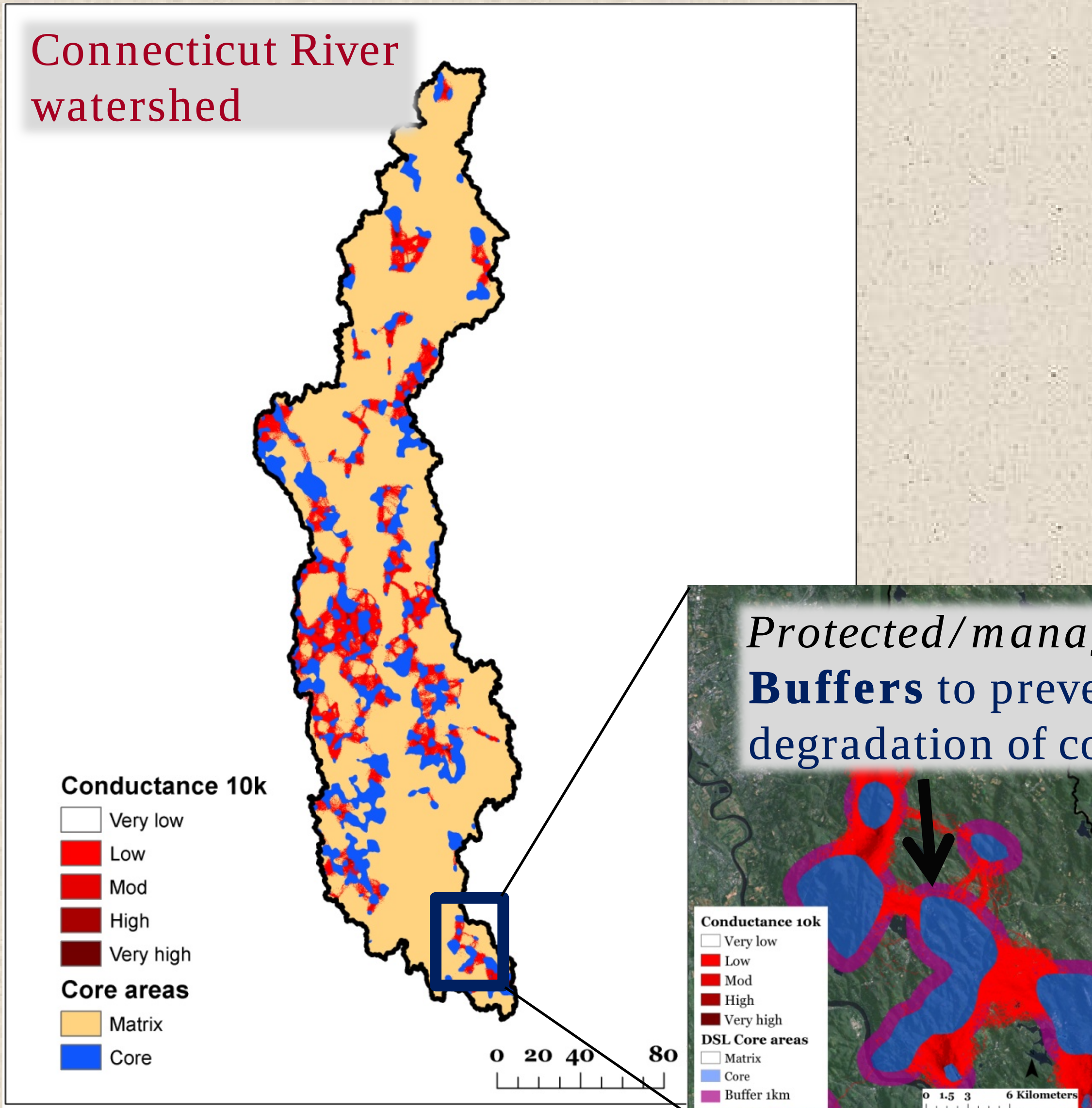
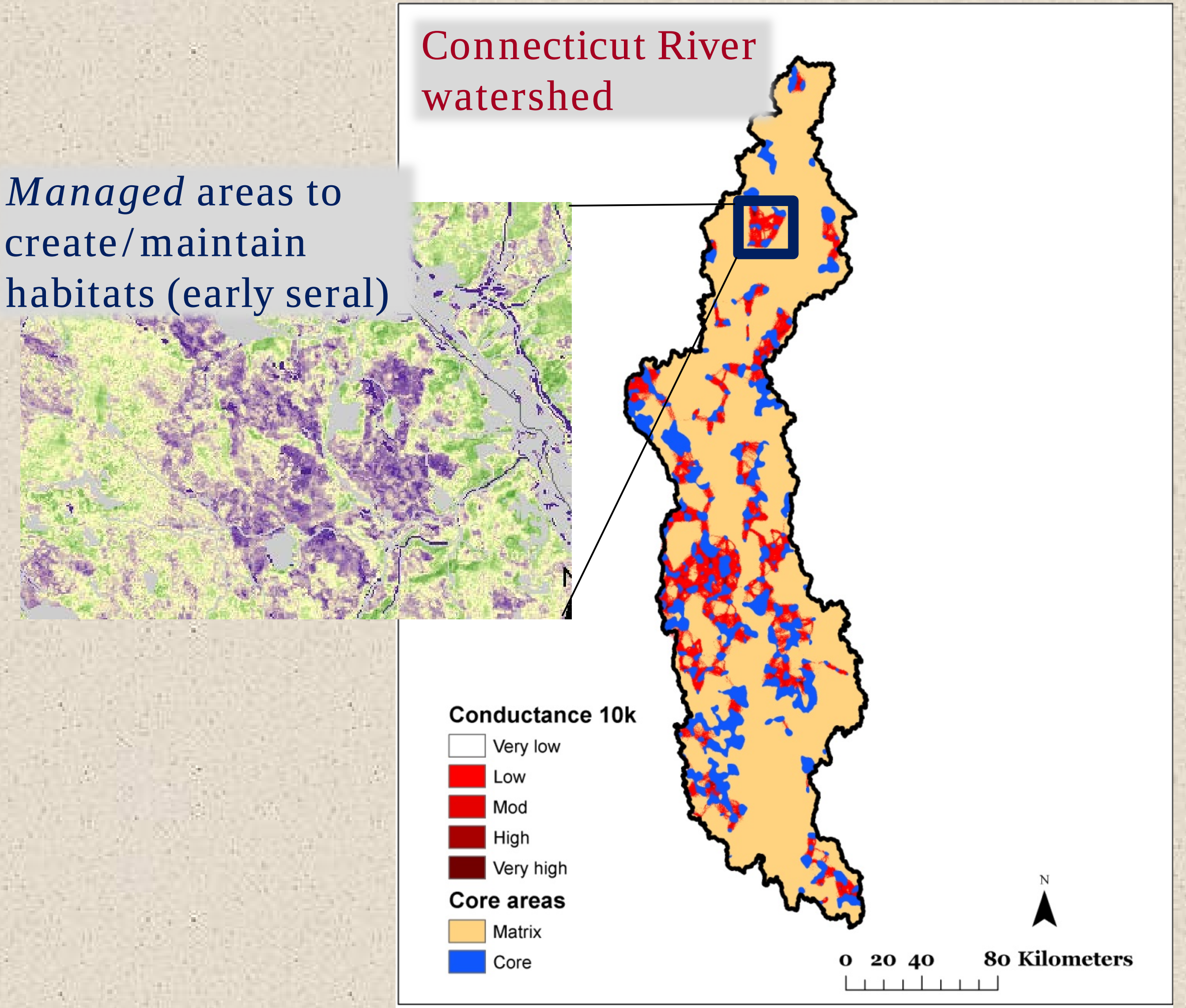


Landscape Conservation Design

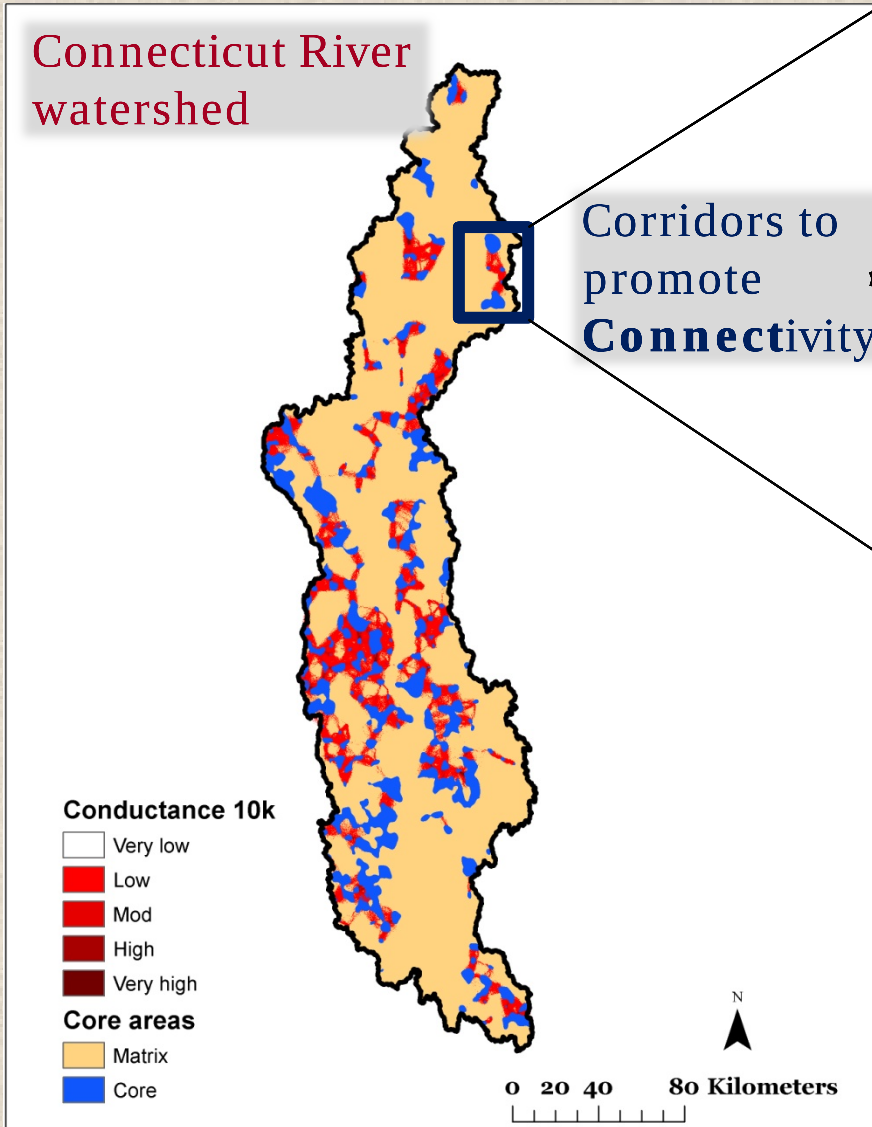
What does it look like?

Managed areas to create/maintain habitats (early seral)

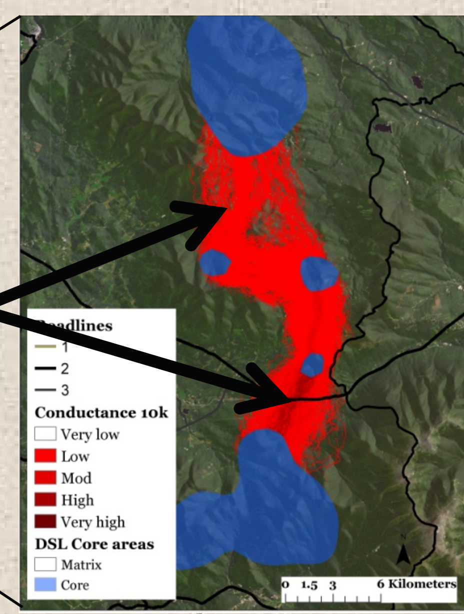


Landscape Conservation Design

What does it look like?



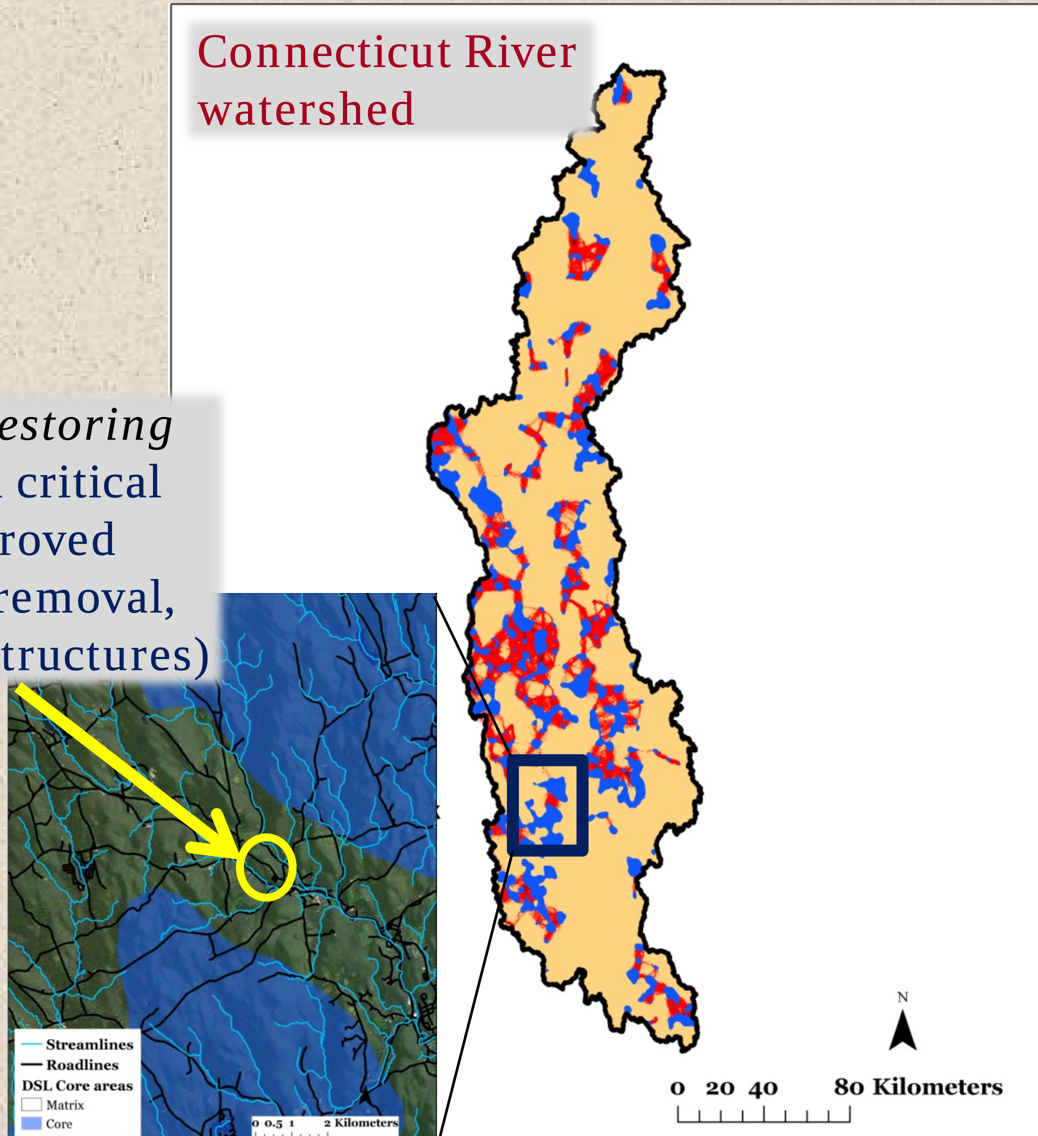
Corridors to promote **Connect**ivity



Landscape Conservation Design

What does it look like?

Priorities for *restoring* connectivity in critical locations (improved culverts, dam removal, road passage structures)



Next Steps (phase 3)

1. Expand LCD to other landscapes
2. Develop DSS to facilitate interactive LCD
3. Improve coastal ecological integrity assessment

3. Improve landscape change model (e.g., timber harvest)
4. Improve spatial data inputs (e.g., development, culvert crossing scores)
5. Expand/improve integrity metrics (e.g., non-natives)
6. Improve integration with SLR and fisheries models
7. Expand scope to include marine environment
8. Improve species models
9. Run more change scenarios

Next Steps (phase 3)

1. LCD DSS

- Develop a stand alone software tool for LCD based on the process being piloted in the Connecticut River watershed
- Integrates the DSL (and other) products in a way that best informs conservation design and makes it accessbile to practitioners

- Staff required:
  - PI (4 weeks)
  - Compton (52 weeks)
  - Plunkett (30 weeks)
  - Grand (30 weeks)
  - Programmer (52 weeks)
- Timeframe: 2 years in two phases
- Budget: $320k; $160/year

Next Steps (phase 3)

2. Habitat management and restoration

a) Early seral habitat

- Compile spatial data on existing early seral management and create model for prioritizing early seral creation

- Staff required:
  - Compton (26 weeks)
  - Plunkett (4 weeks)
  - Grand (4 weeks)
  - Deluca (26 weeks)

b) Agricultural conversion

- Create model to prioritize restoration of agricultural lands to wetland or forest

- Timeframe: 1 or 2 years

- Budget: $104k ($70k LCC)

Next Steps (phase 3)

3. Timber harvest

- Develop a timber harvest disturbance model
- Low-end: Implement major treatment types by ownership/region/forest type within LCAD framework
- High-end: fully integrate RMLands vegetation treatment model

- Staff required:
  - PI (2/4 weeks)
  - Compton (0/52 weeks)
  - Plunkett (26/32 weeks)
  - Grand (4/26 weeks)
  - Deluca (26/26 weeks)
  - Programmer (0/52 weeks)
- Timeframe: 1 or 2 years
- Budget: $100k/$355k ($66k /$320k LCC)

For More Information

- Project website:

  www.umass.edu/landeco/research/dsl/dsl.html

<u>Links to products</u>:

- Overview
- Technical docs
- Presentations
- Results

<u>Feedback</u>:

- Manager online survey

- Personal contact: mcgarigalk@eco.umass.edu 413-577-0655