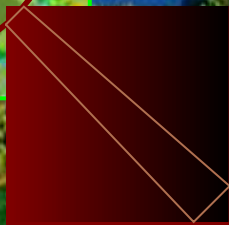
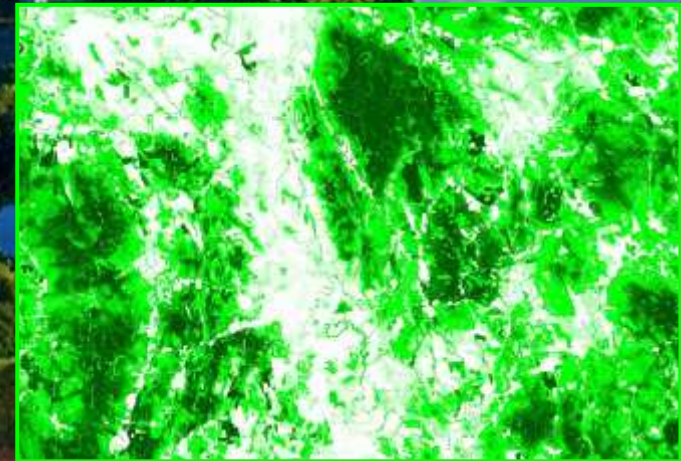
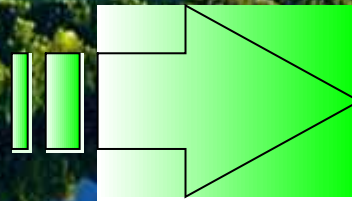
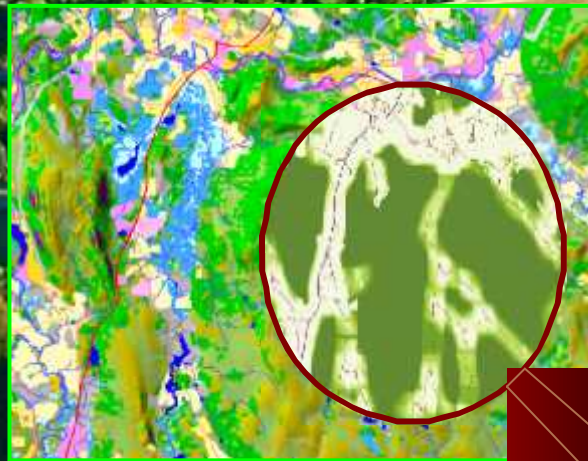


# Providing Science and Tools in Support of the North Atlantic Landscape Conservation Cooperative: *Designing Sustainable Landscapes for Wildlife*

USFWS Seminar February 23, 2012  
Hadley, Massachusetts





# The UMass Team



Brad



Ethan



Bill



Kevin



Joanna



Liz

## *Contributors:*

Scott Schwenk

Curt Griffin

Scott Jackson

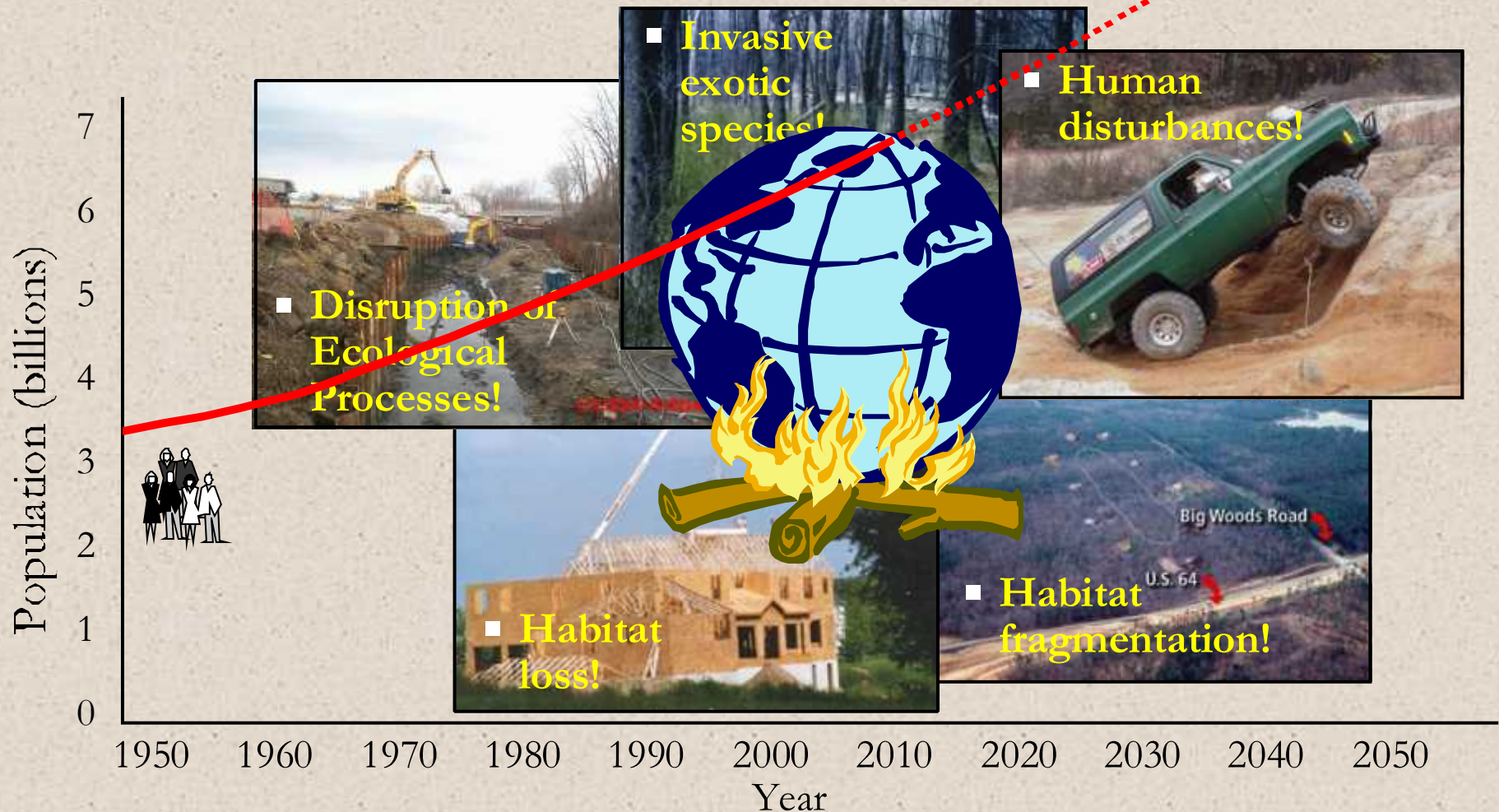
Carly Chandler

Janice Zepko

Katie Blake

# Purpose & Need

Conservation of biodiversity faces many **challenges** associated with human activity





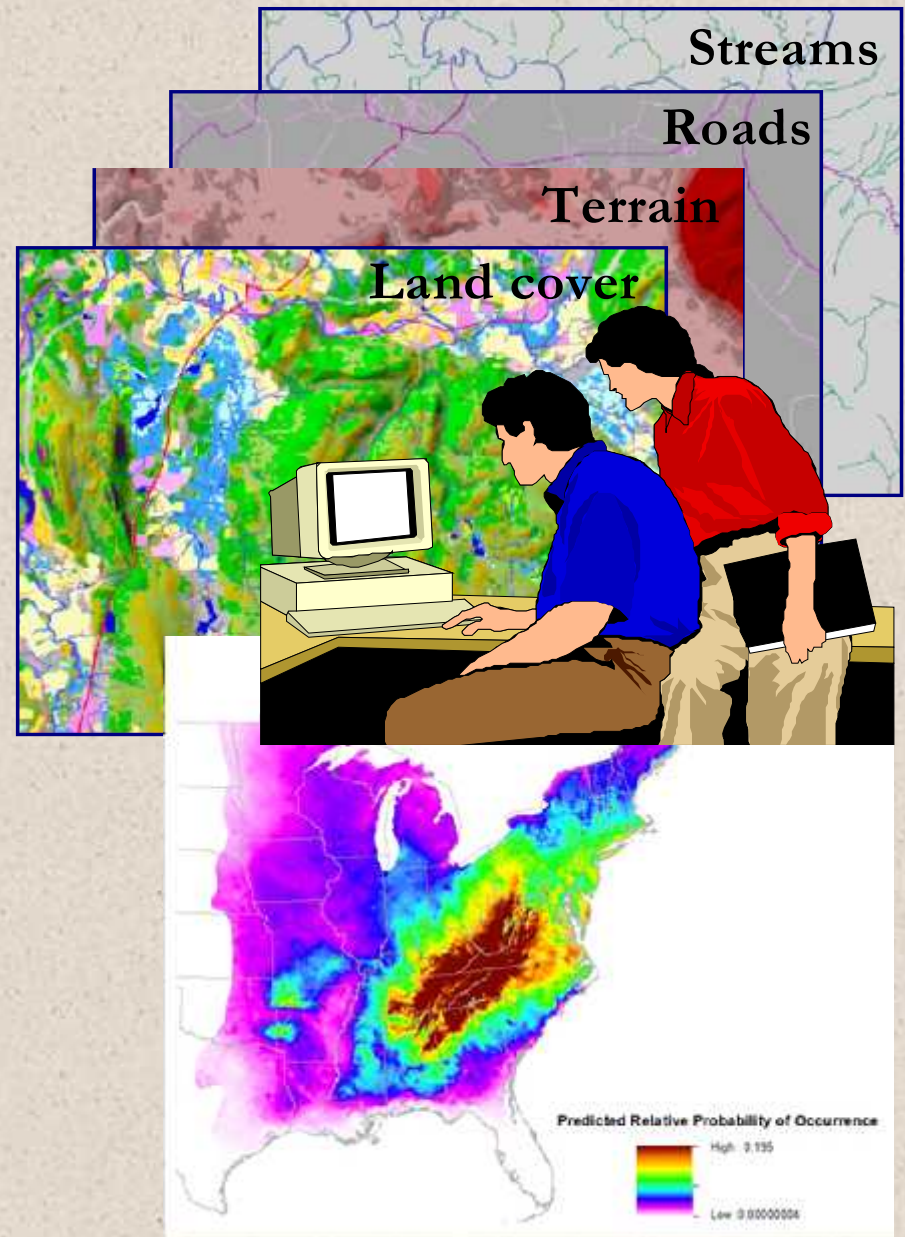
# Purpose & Need

Solutions to these challenges will require:

- Multiscale approaches
- Integration of complex multivariate spatial data
- Anticipation of future changes

---

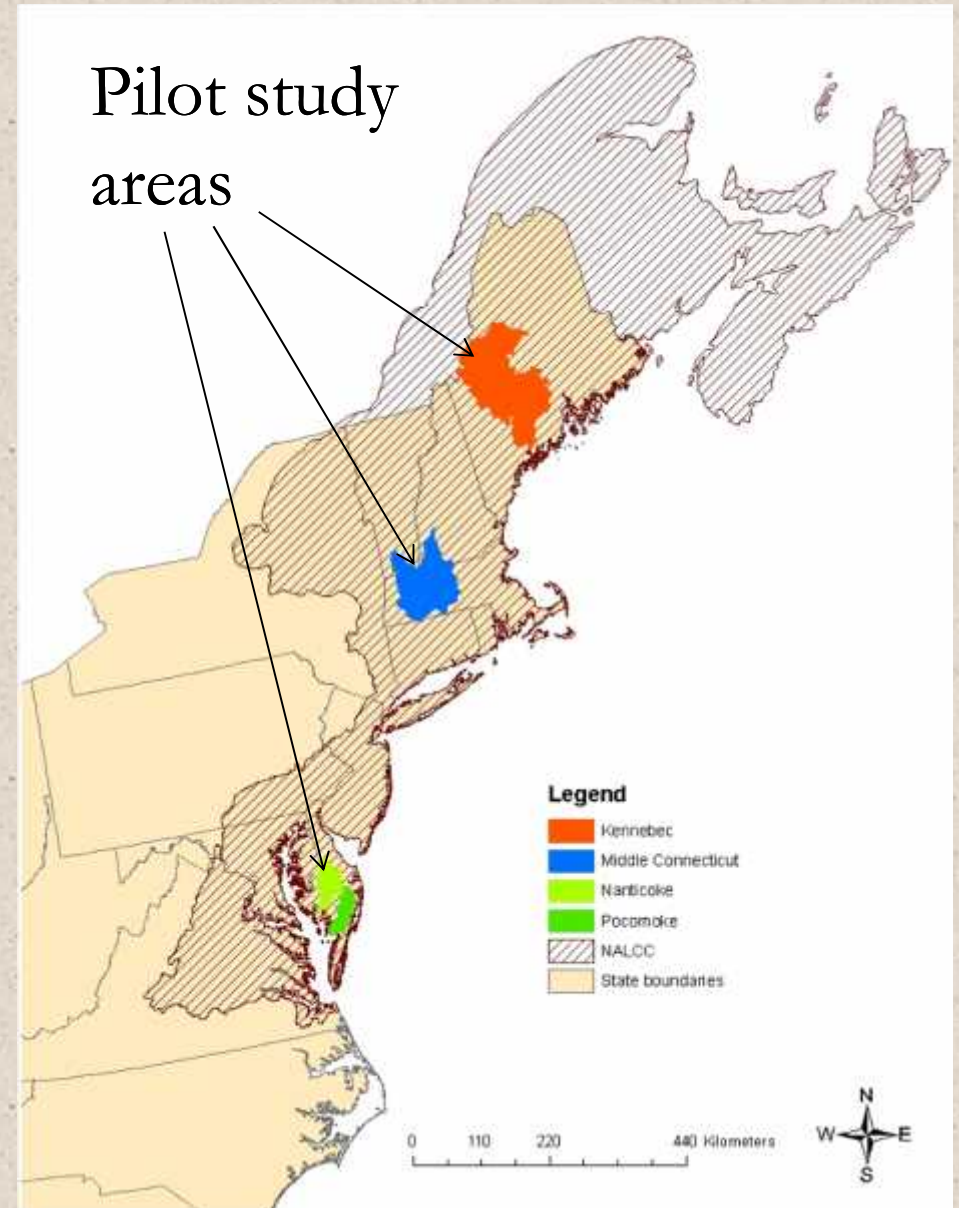
...not to mention lots of socio-economic and political will



# Purpose & Need

The **purpose** of this project is to:

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





# Purpose & Need

The **purpose** of this 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**

- **Change**

# Purpose & Need

The **purpose** of this 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**

- **Change**
- **Assessment**

# Purpose & Need

The **purpose** of this 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**

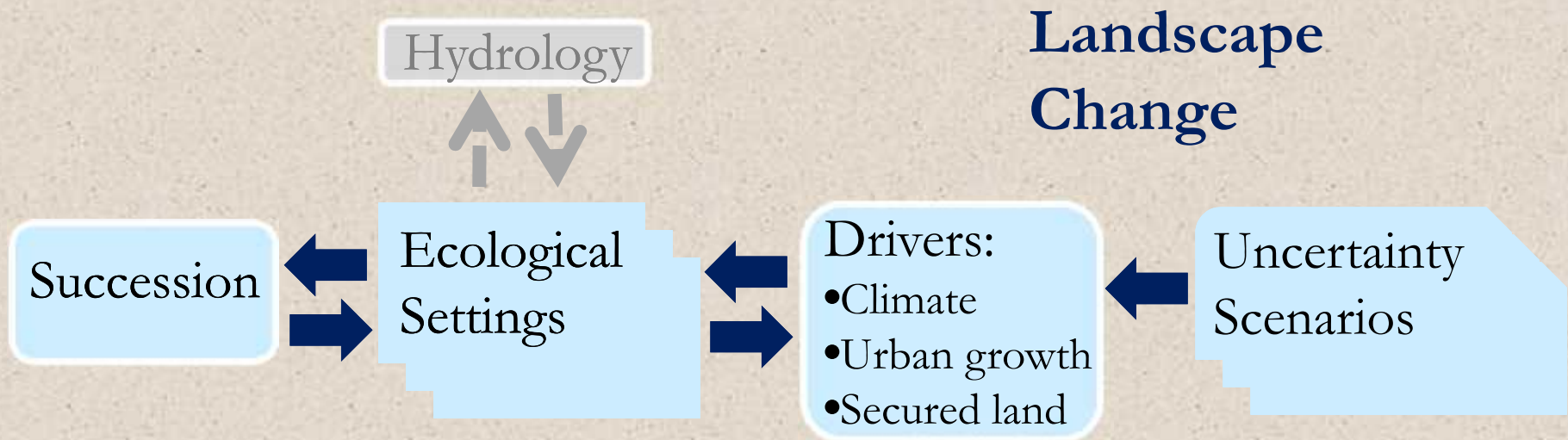
- **Change**
- **Assessment**
- **Design**

**LCAD Model**



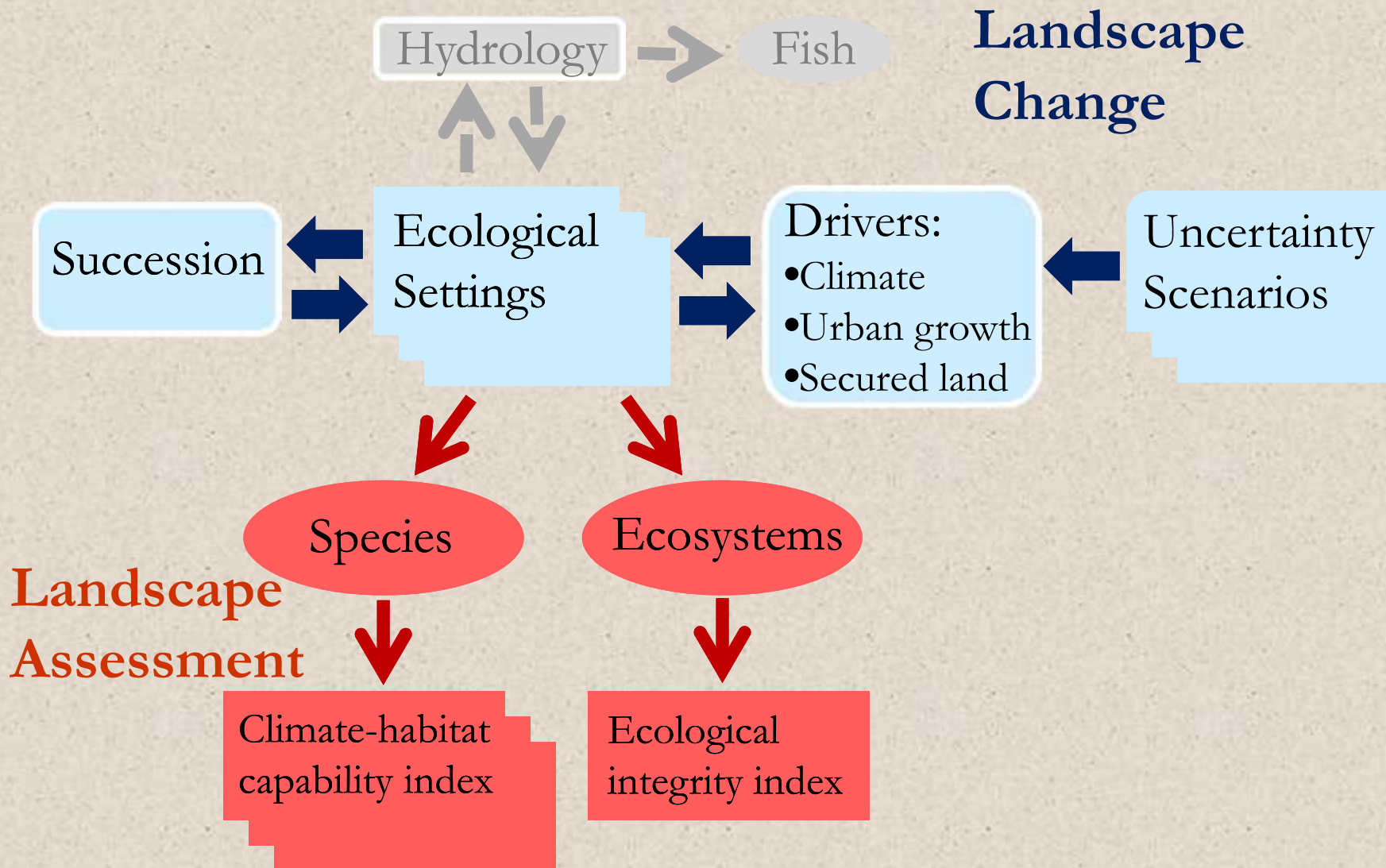
# The Approach

## LCAD model



# The Approach

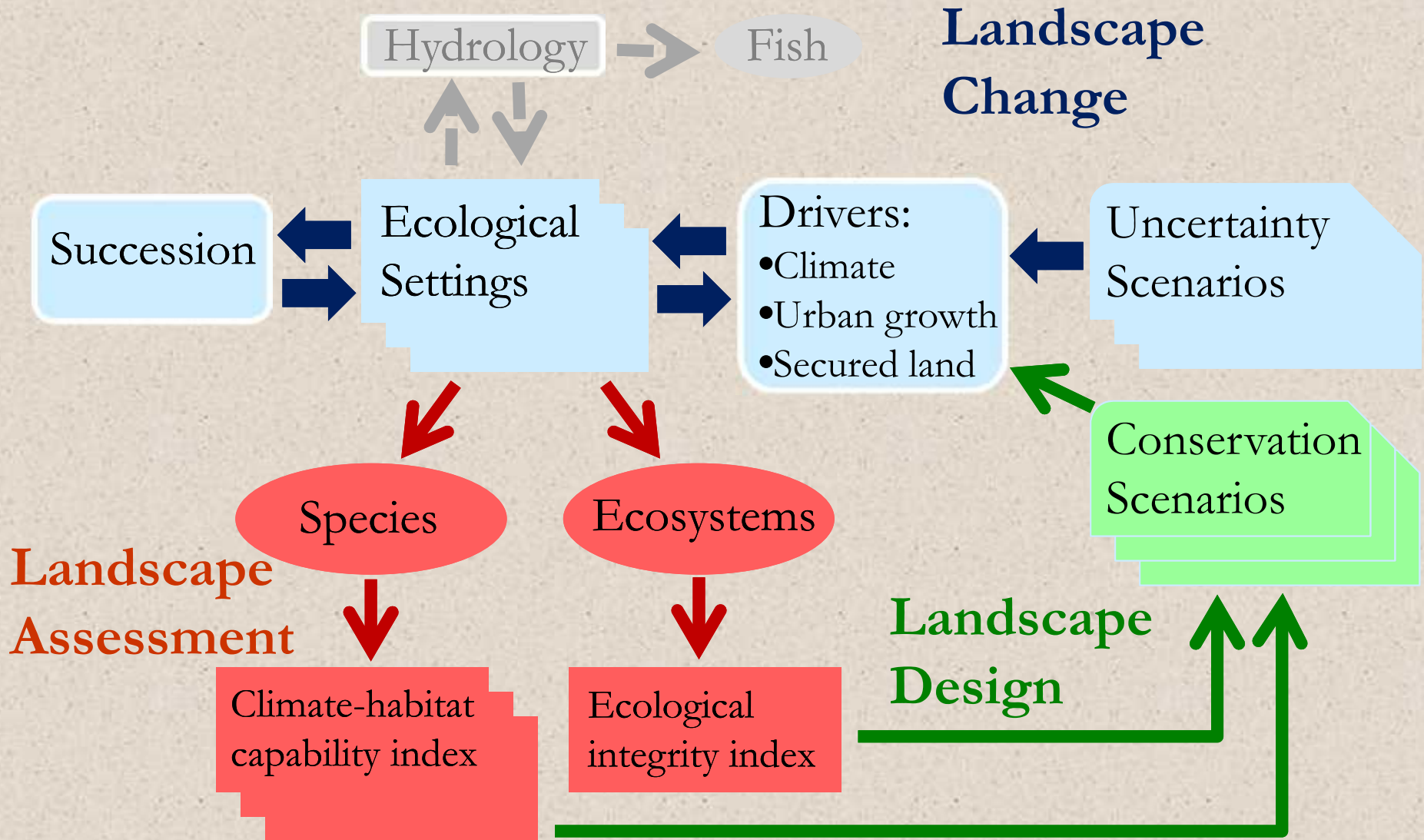
## LCAD model





# The Approach

## LCAD model



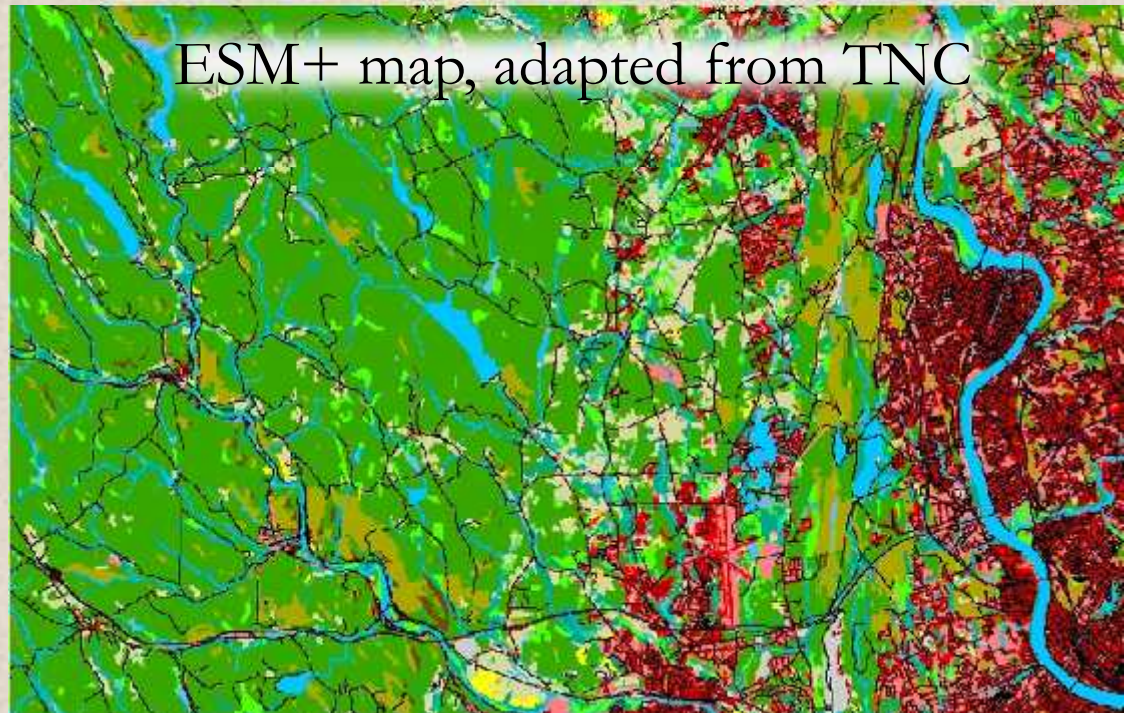
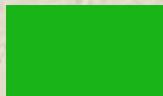
# The Approach

## Ecological Systems

“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)

Appalachian  
hemlock-northern  
hardwood forest:  
typic





# The Approach

## Settings data

“GIS layers including a broad but parsimonious suite of biophysical variables representing the natural and anthropogenic environment at each location (cell) at each timestep.”

### Abiotic:

- Temperature (2)
- Energy (1)
- Moisture & hydrology (3)
- Chemical substrate (1)
- Physical disturbance (2)

### Vegetation:

- Potential dominant life form
- Above-ground biomass
- Tree diameter (qmd)
- Stem density

### Anthropogenic:

- Traffic
- Development
- Impervious
- Barriers

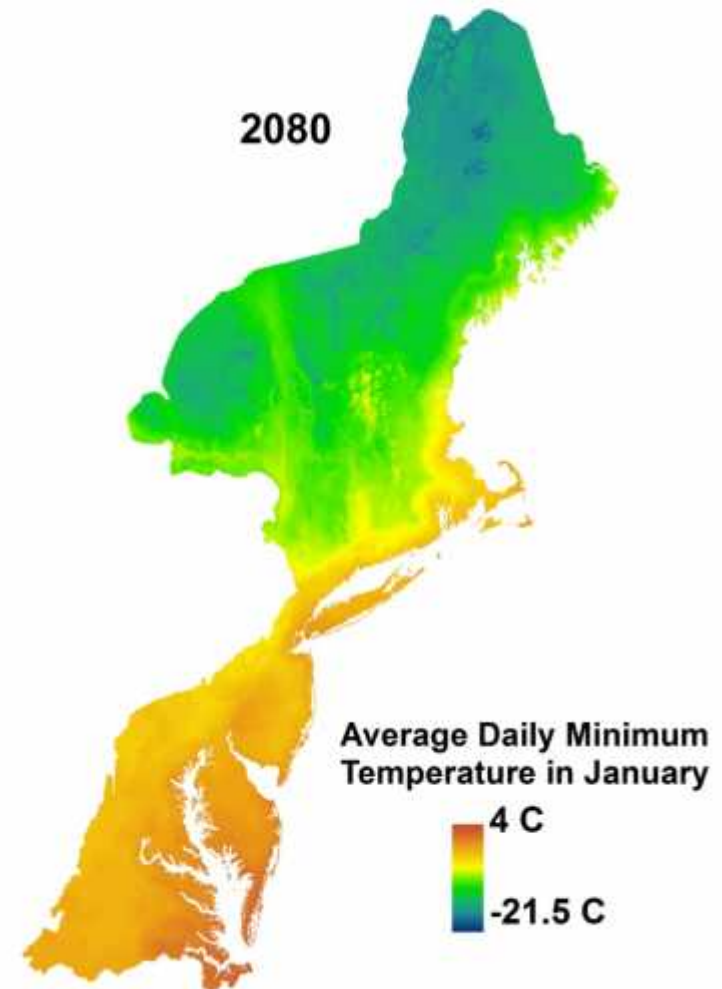
# The Approach

## Landscape Change

### *Drivers*

- **Climate change**
  - 3 SRES scenarios (B1, A1B, A2)
  - Ensemble of 16 GCM's (36 total runs)
  - Statistical (BCSD) downscaling to 12 km
  - $\Delta$ PRISM (800 m)
  - Resampled (30 m)
  - GDD,  $T_{\min}$ ,  $P_{\text{annual}}$

Projected mean daily minimum temperature in January under the SRES A2 Scenario





# The Approach

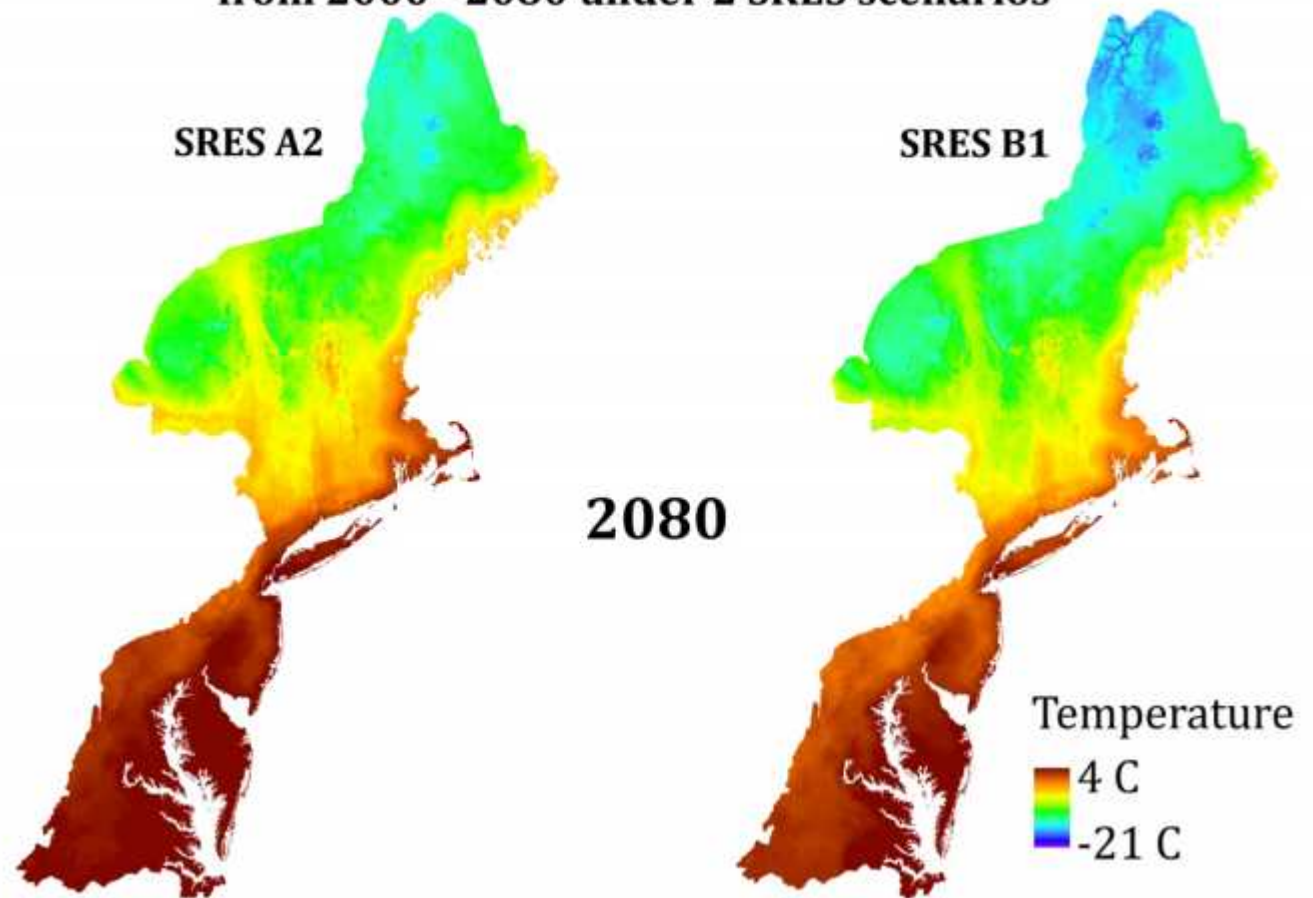
## Landscape Change

### *Drivers*

- Climate change scenarios



Projected average minimum temperature in January  
from 2000 - 2080 under 2 SRES scenarios

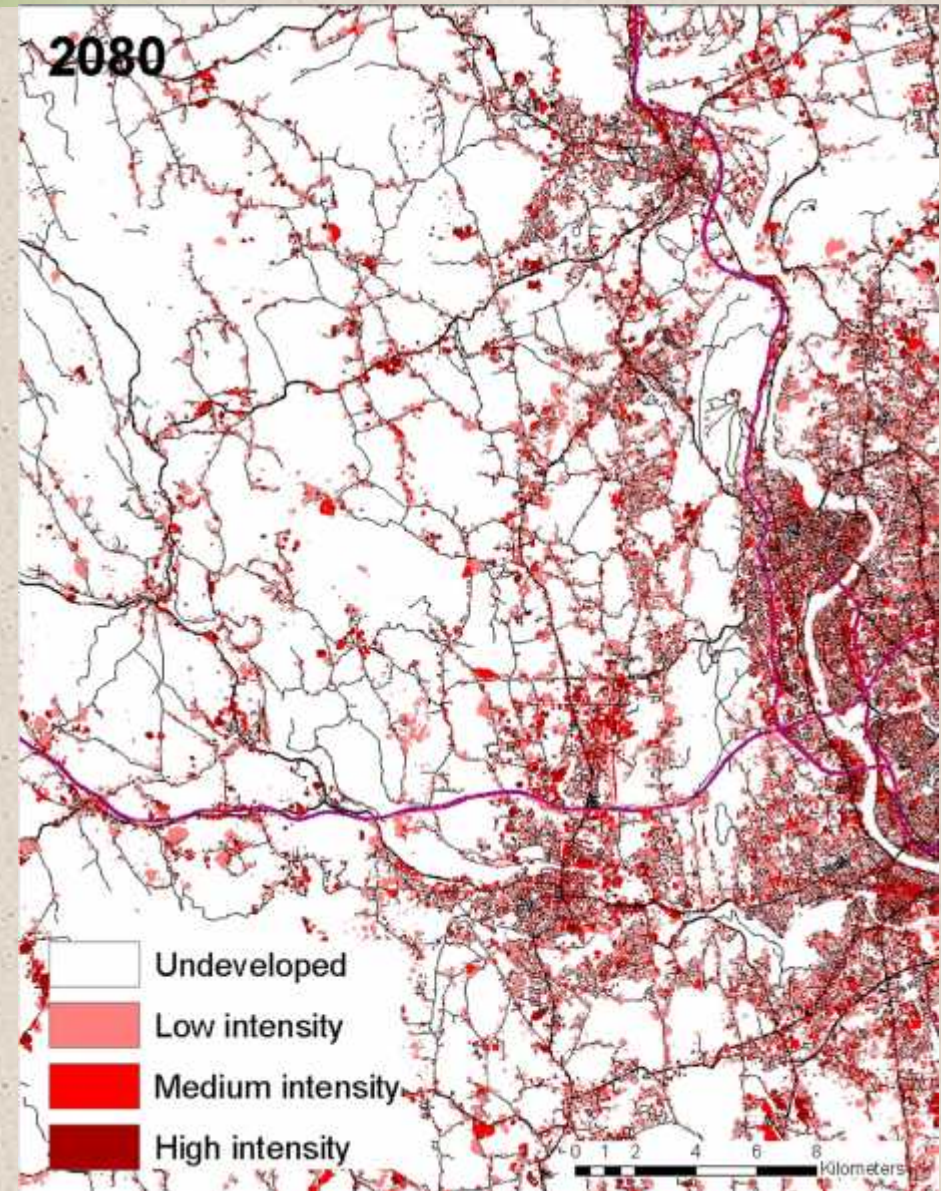


# The Approach

## Landscape Change

### *Drivers*

- **Urban growth**
  - Multi-stage statistical model for stochastically allocating amount and pattern of development at each timestep.
  - User-defined scenarios to vary total amount and sprawliness of growth relative to historical patterns.





# The Approach

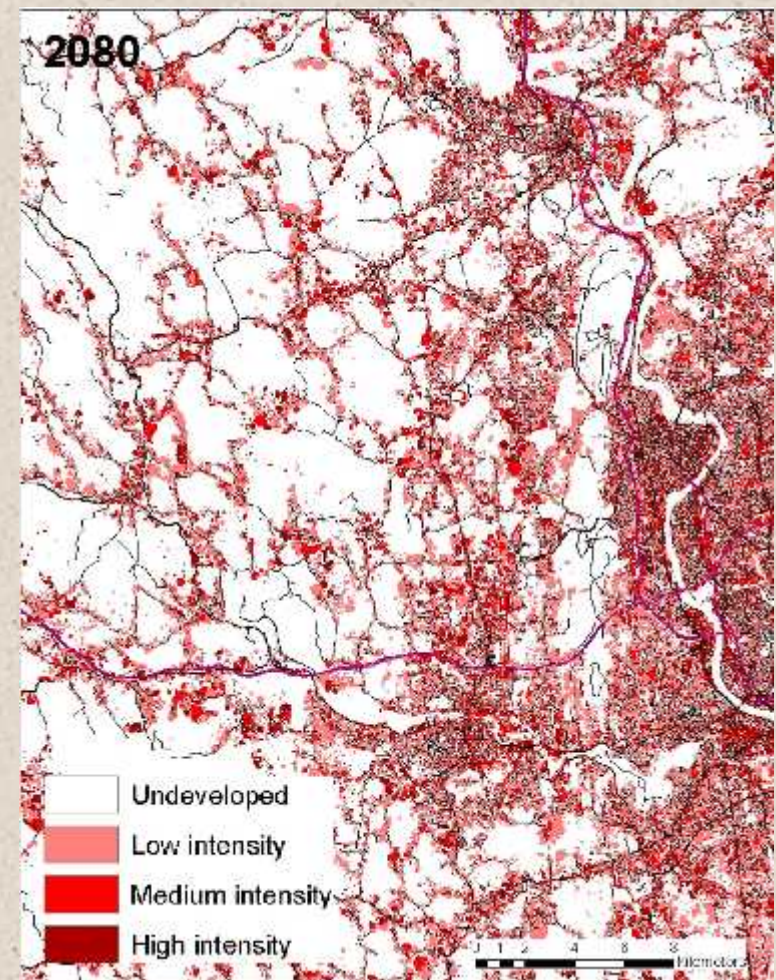
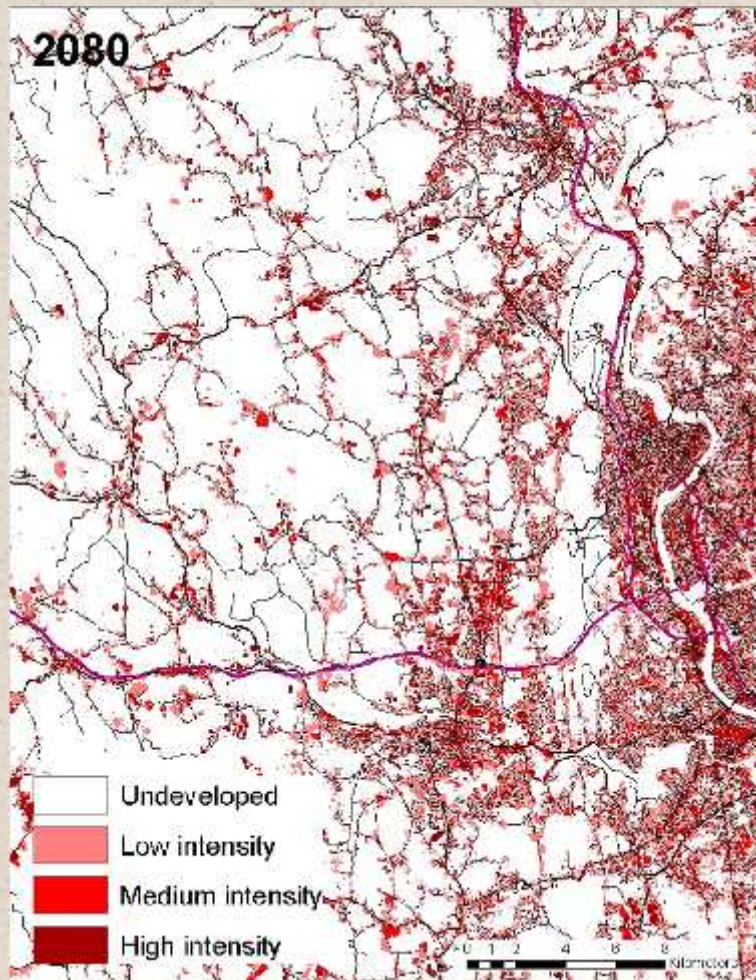
## Landscape Change

### *Drivers*

- Urban growth scenarios

Baseline growth (1%)

Double growth (2%)





# The Approach

## Landscape Change

### *Drivers*

- **Vegetation disturbances**
  - Timber harvest
  - Wind, ice, fire, flood
  - Insect outbreaks
  - Others

---

...for the interim, we currently model generic disturbances



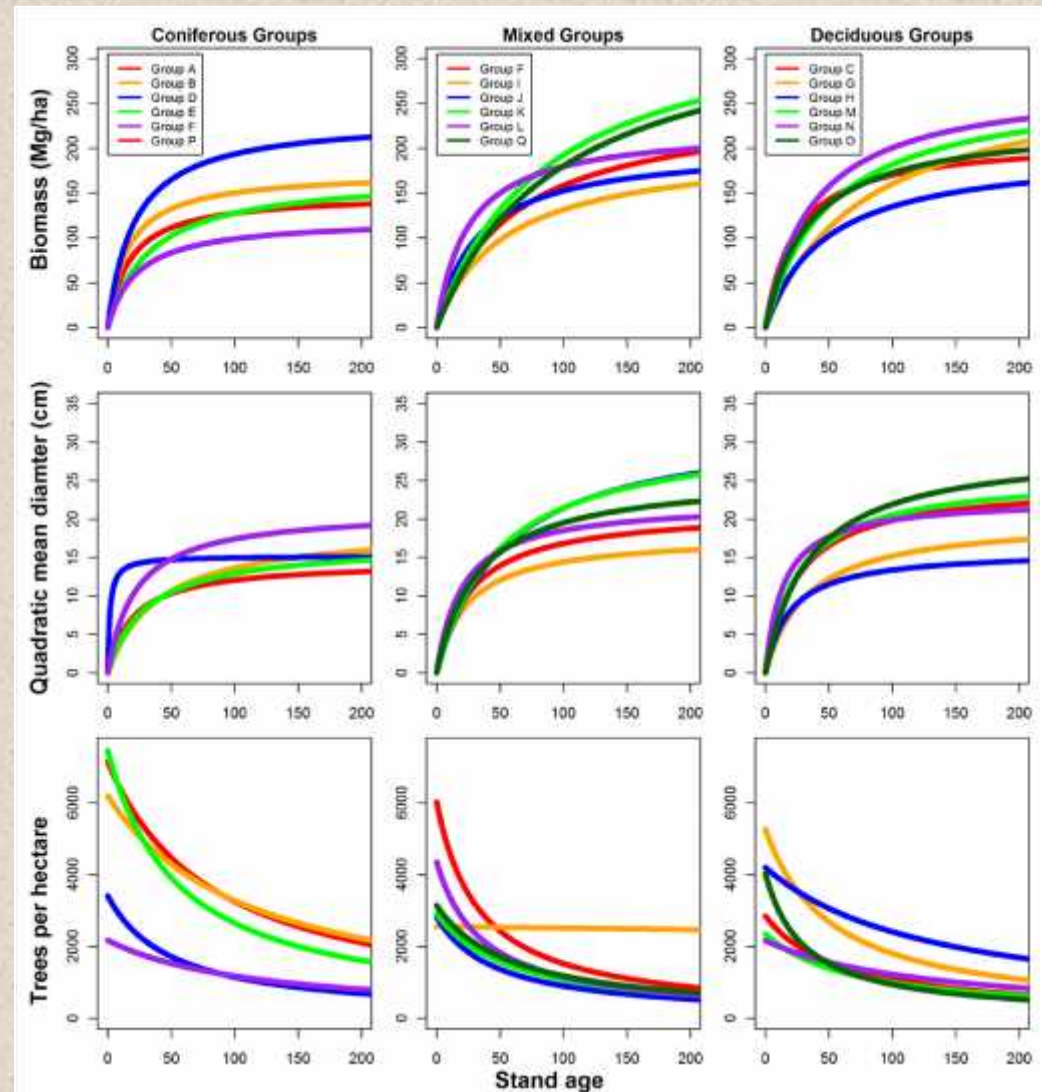


# The Approach

## Landscape Change

### *Succession*

- Growth trajectories for select vegetation attributes derived from statistical models of FIA point data.
- Current condition of cells based on imputation of FIA stand age.

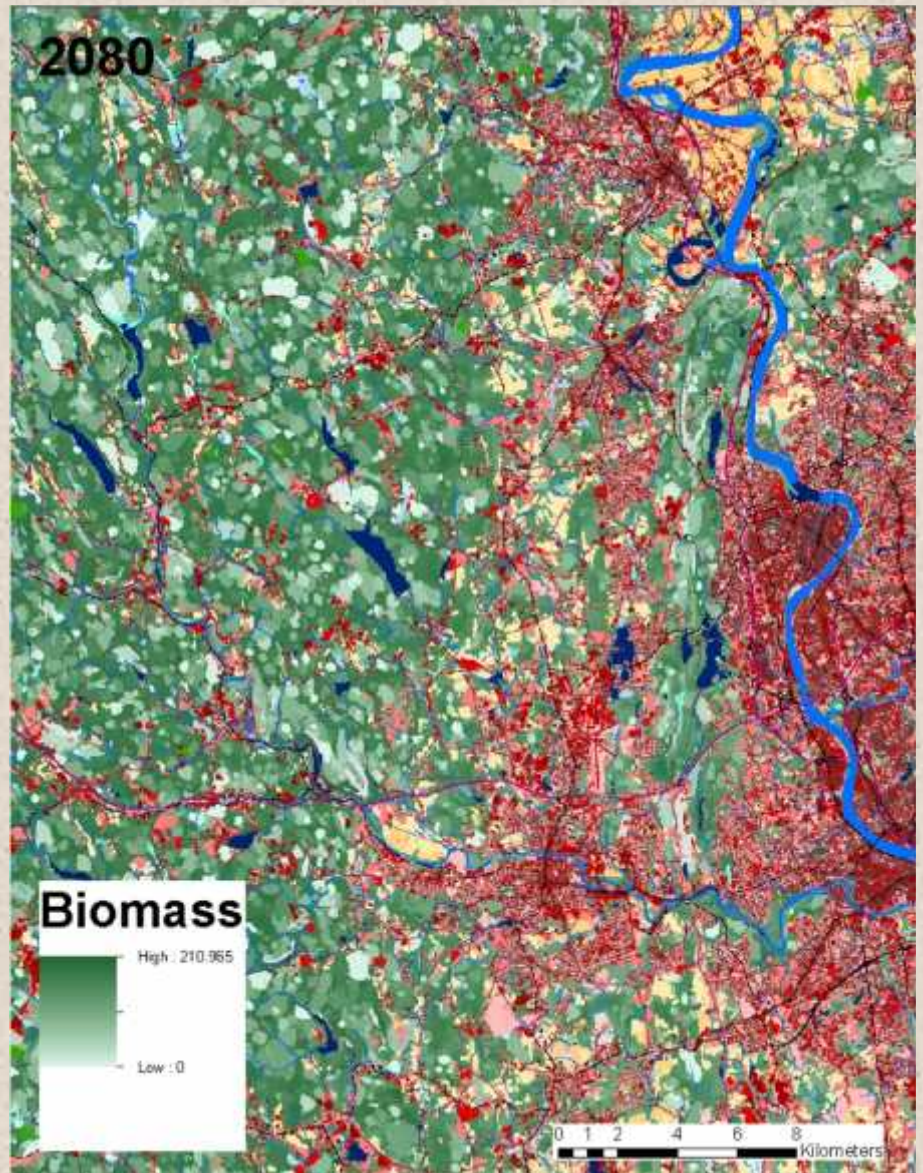




# The Approach

## Landscape Change

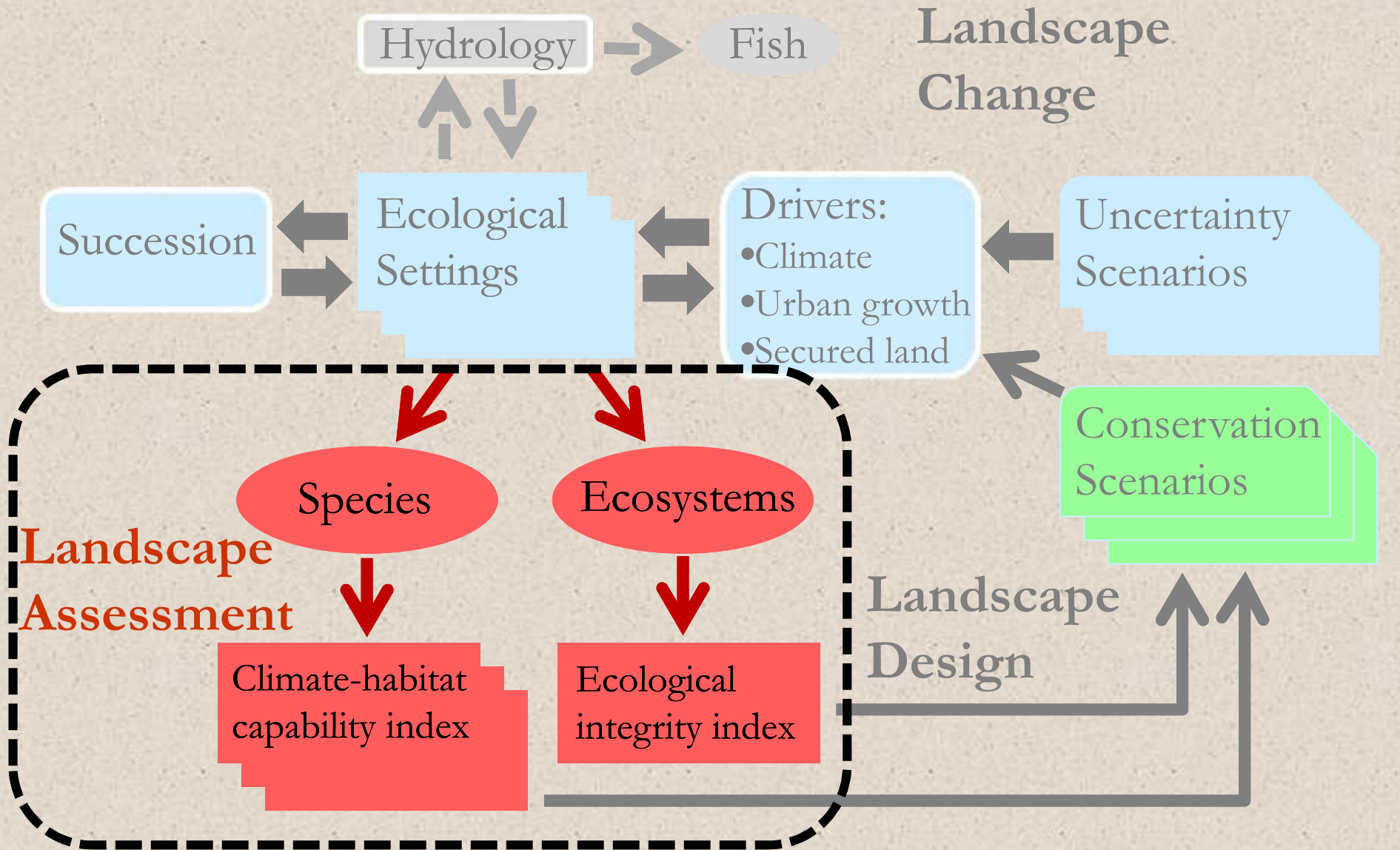
- Put it all together and you get a stochastic, dynamic landscape change simulation.
- Simulation run many times under various scenarios (e.g., SRES climate change scenarios) to capture future uncertainty.





# The Approach

## LCAD model



# The Approach

## Landscape Assessment

### *Coarse filter*

Our coarse filter is based on the concept of *ecological integrity* applied to the suite of *ecological systems*



Coarse filter

High  
Integrity



Low  
Integrity



- *Ecological integrity* refers to the capability of an area to sustain ecological functions over the long term, especially in the face of disturbance and stress.

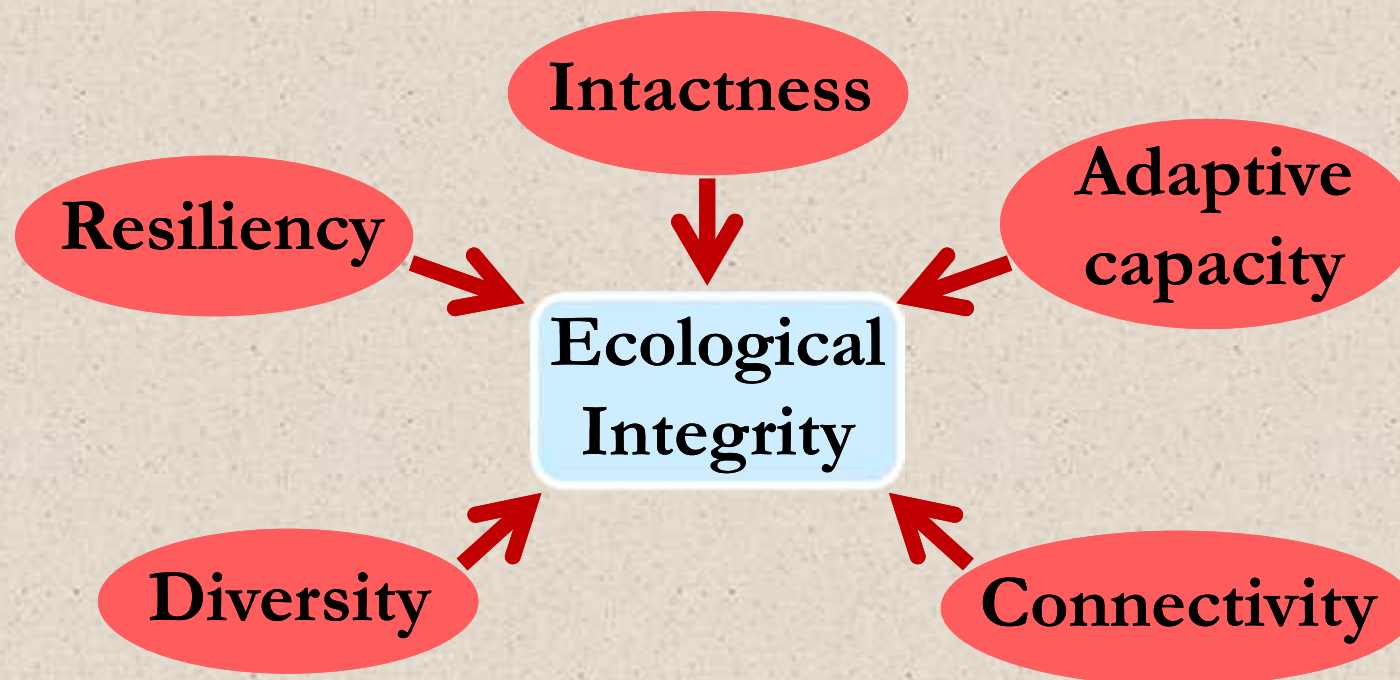


# The Approach

## Landscape Assessment

### *Coarse filter*

“An *integral landscape* has a green infrastructure containing a **diversity** of **connected** ecosystems with high **intactness**, **resiliency** and **adaptive capacity**.”



# The Approach

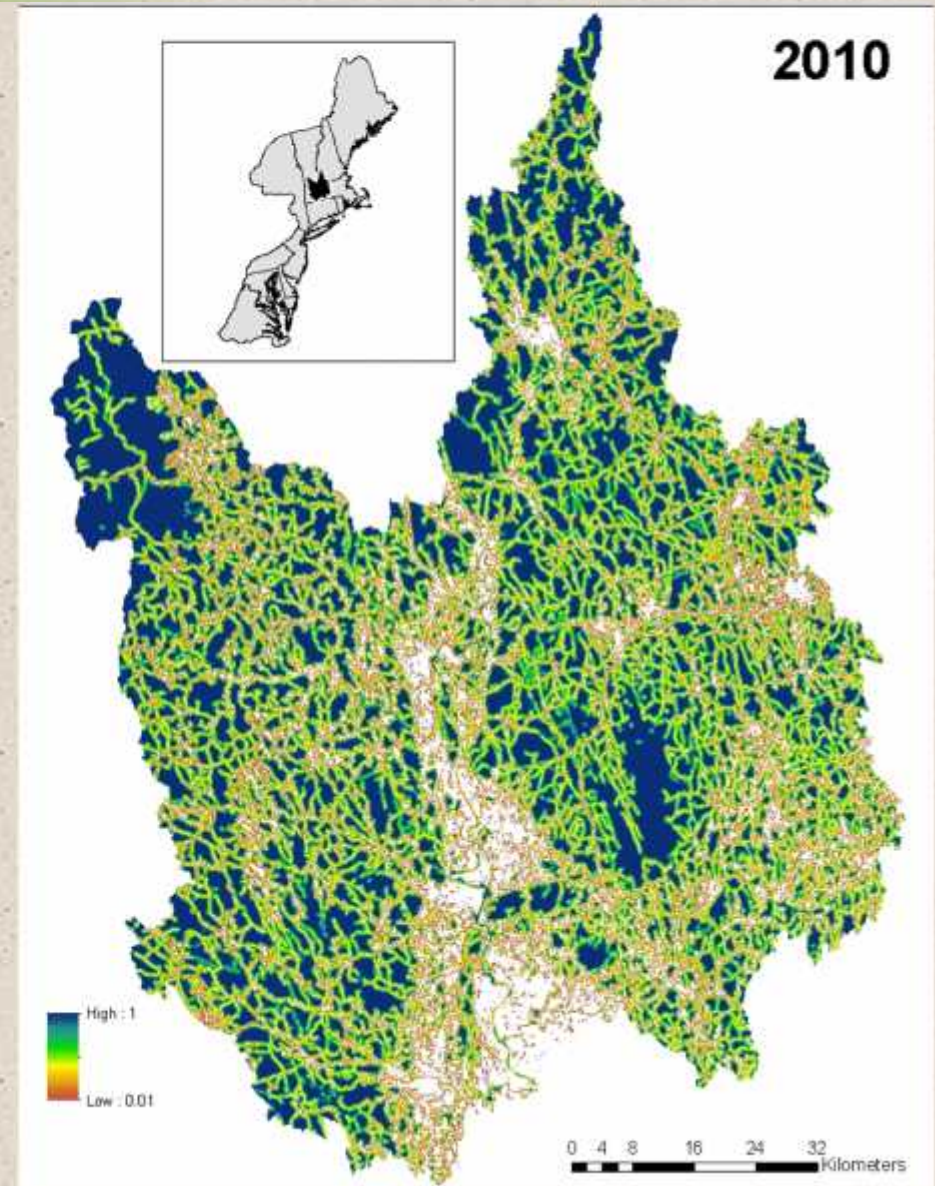
## Landscape Assessment

### *Coarse filter*

- Local indices
  - Intactness (14)
  - Resiliency (3)
  - Adaptive capacity (1)

What is the level of *potential edge predators* at each cell for a given timestep?

## Edge predators





# The Approach

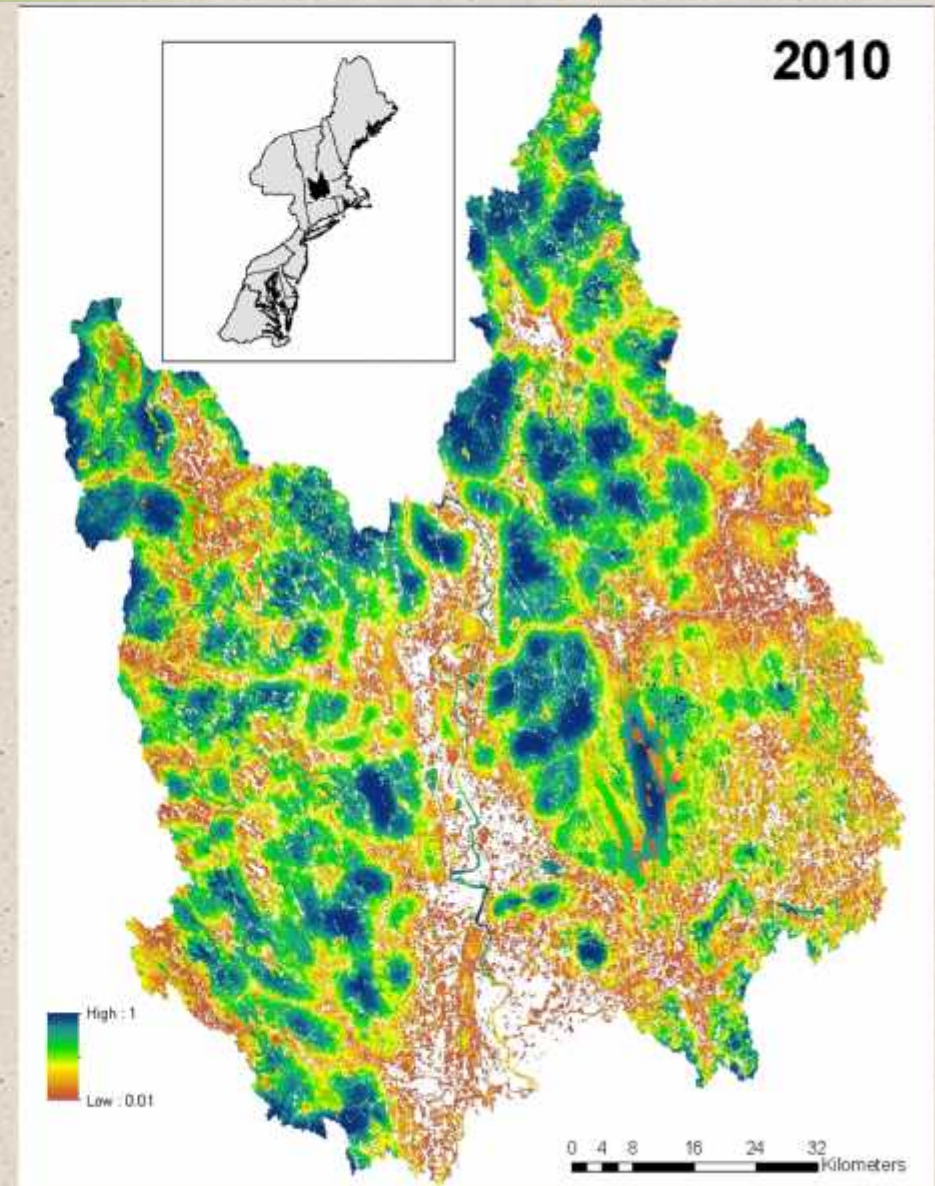
## Landscape Assessment

### *Coarse filter*

- Local indices
  - Intactness (14)
  - Resiliency (3)
  - Adaptive capacity (1)

What is the level of *connectedness* at each cell for a given timestep?

## Connectedness



# The Approach

## Landscape Assessment

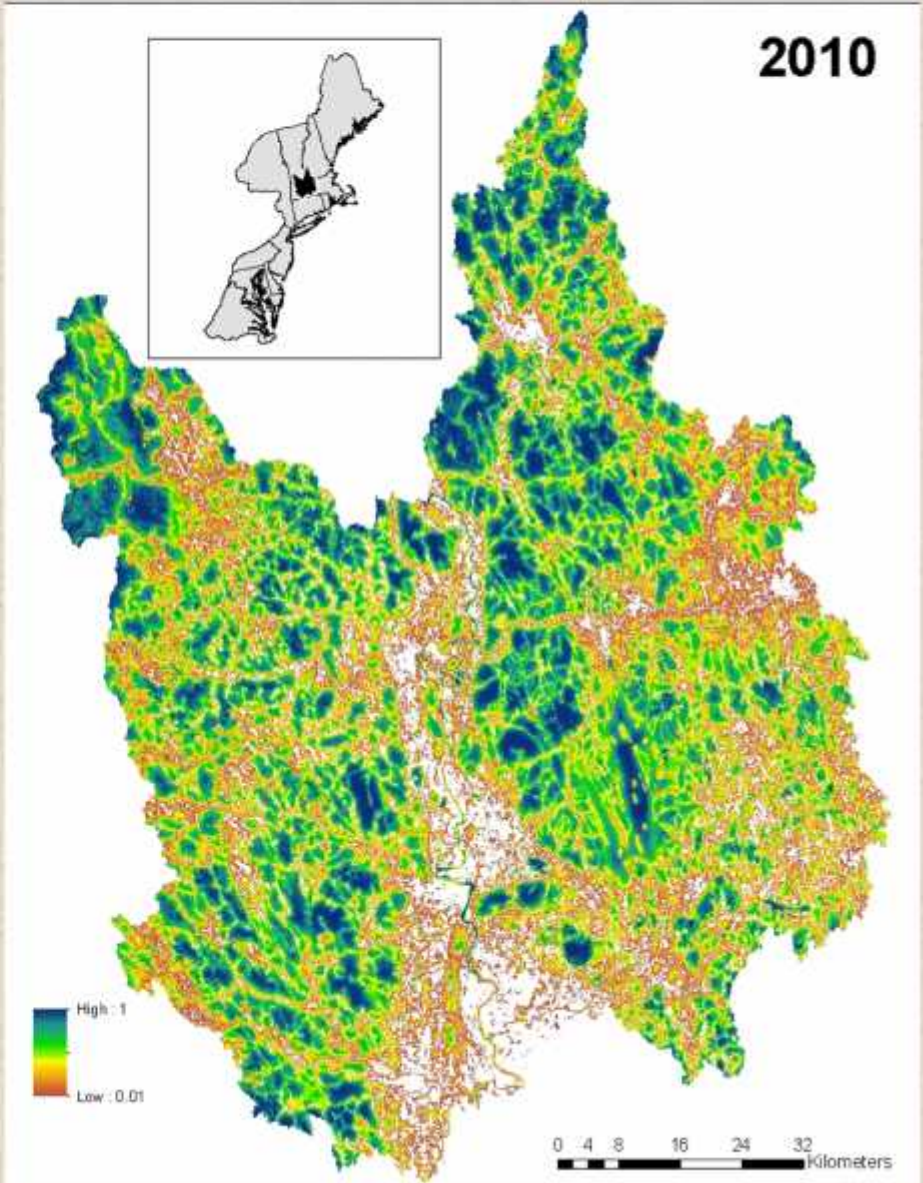
### *Coarse filter*

- Local composite index of ecological *integrity*

What is the *overall ecological integrity* of the cell for a given timestep?

IEI

2010





# The Approach

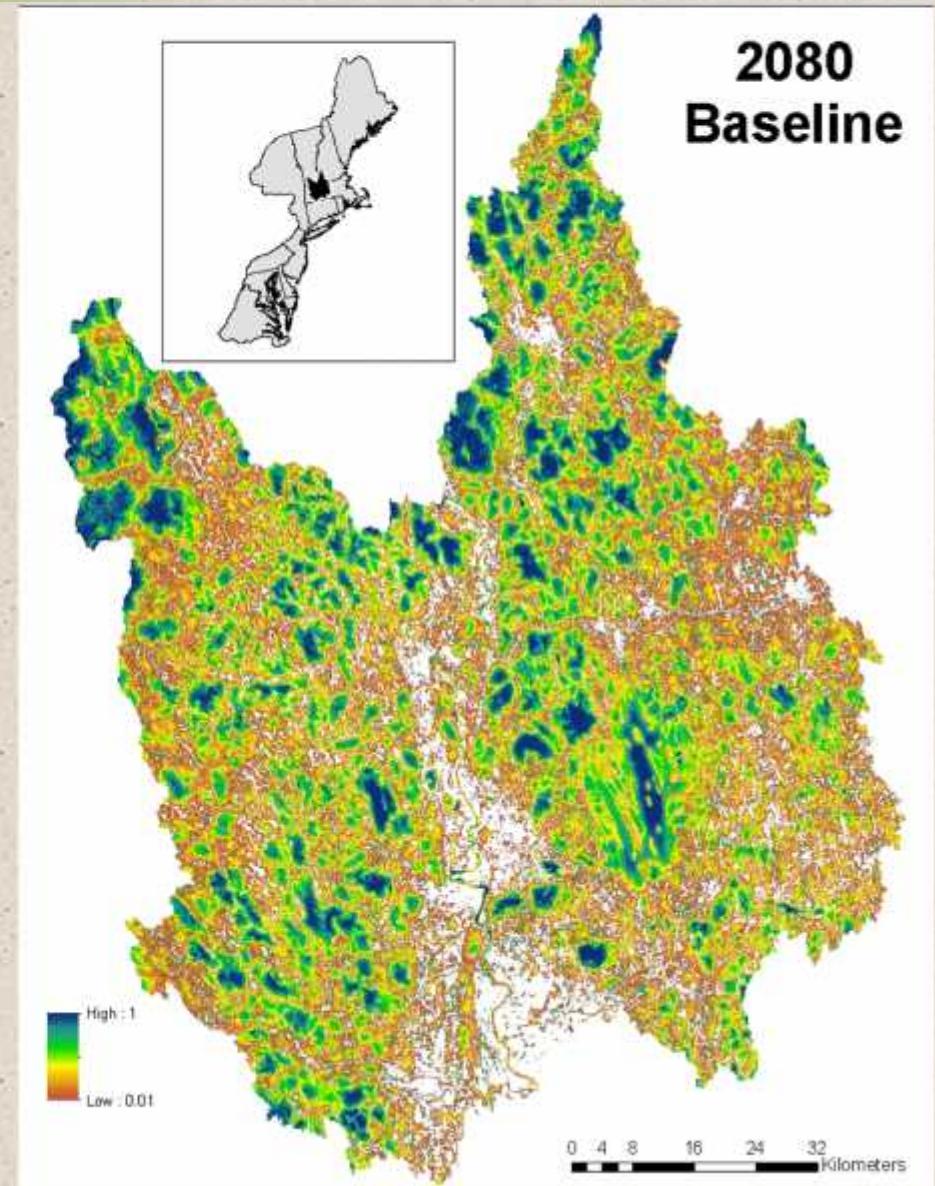
## Landscape Assessment

### *Coarse filter*

- Local composite index of ecological *integrity*

What is the *overall ecological integrity* at each cell for a given timestep under a particular scenario?

IEI





# The Approach

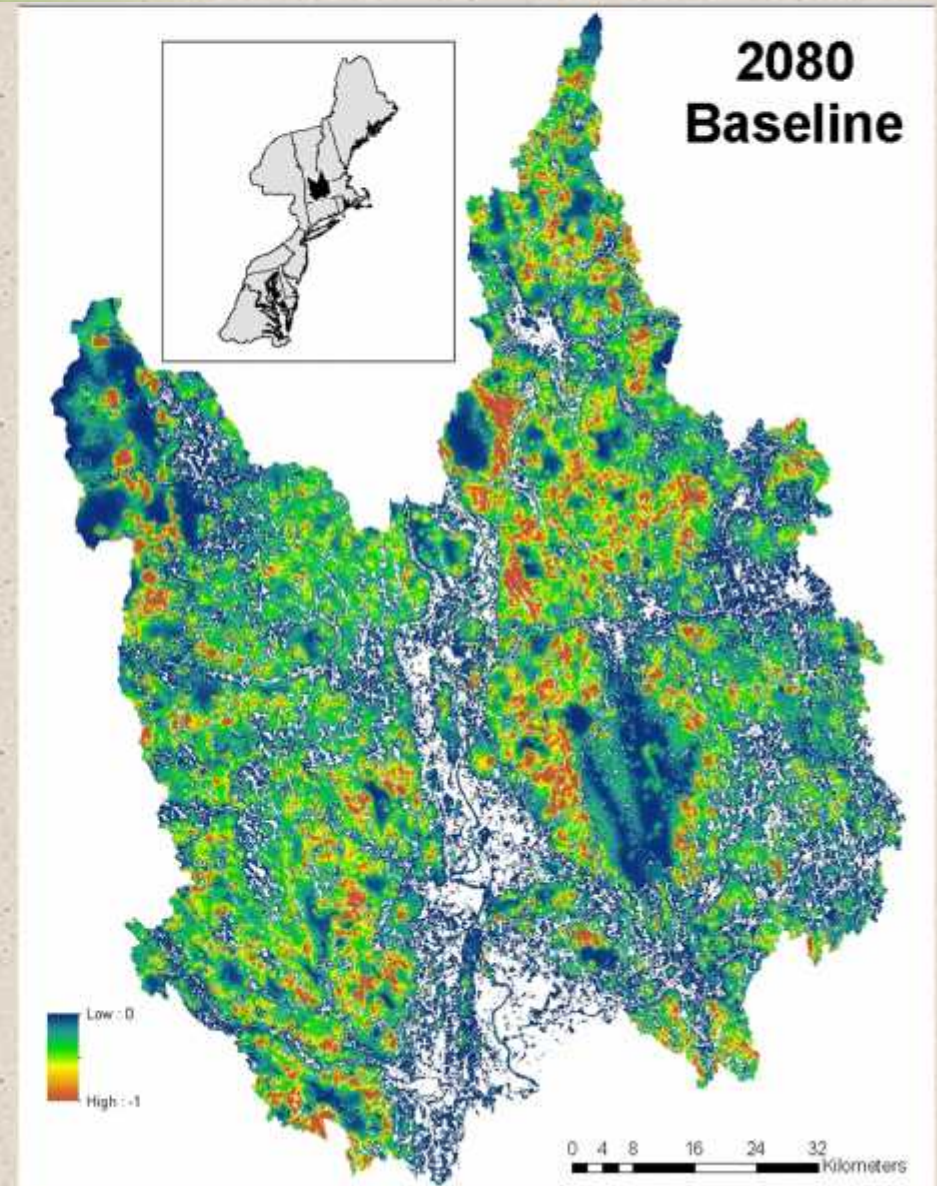
## Landscape Assessment

### *Coarse filter*

- Local composite index of ecological *impact*

What is the magnitude of change (i.e., impact) in ecological integrity at each cell between current and a future timestep under a particular scenario?

Impact





# The Approach

## Landscape Assessment

### *Coarse filter*

- Landscape ecological integrity indices

#### Ecological Integrity Impact

Community	Baseline 2080	Double 2080	Etc.
Northeastern Upland Forest	-2,477,406	-3,511,885	
Northeastern Wetland Forest	-161,562	-256,818	
Grassland and Shrubland	-14,013	-19,879	
Freshwater Marsh	-49,737	-68,400	
Lentic	-103,227	-153,419	
Lotic	-89,027	-131,138	
Peatland	-3,853	-6,203	
Cliff and Rock	-26,346	-30,375	
<b>Total</b>	<b>-2,925,171</b>	<b>-4,178,118</b>	



**Adaptive Capacity**

In progress

**Diversity**

In progress

**Connectivity**

In progress

# The Approach

## Landscape Assessment

### *Fine filter*

Our fine filter is based on the concept of *climate & habitat capability* applied to a suite of *representative species*



- *Habitat capability* refers to the ability of the environment to provide the local resources (e.g., food and cover) needed for survival and reproduction in sufficient quantity, quality and accessibility to meet the life history requirements of individuals and local populations.



# The Approach

## Landscape Assessment

### *Fine filter*

- Representative species concept



“A species whose habitat needs, ecosystem function, or management responses are similar to a group of other species.” (USFWS)

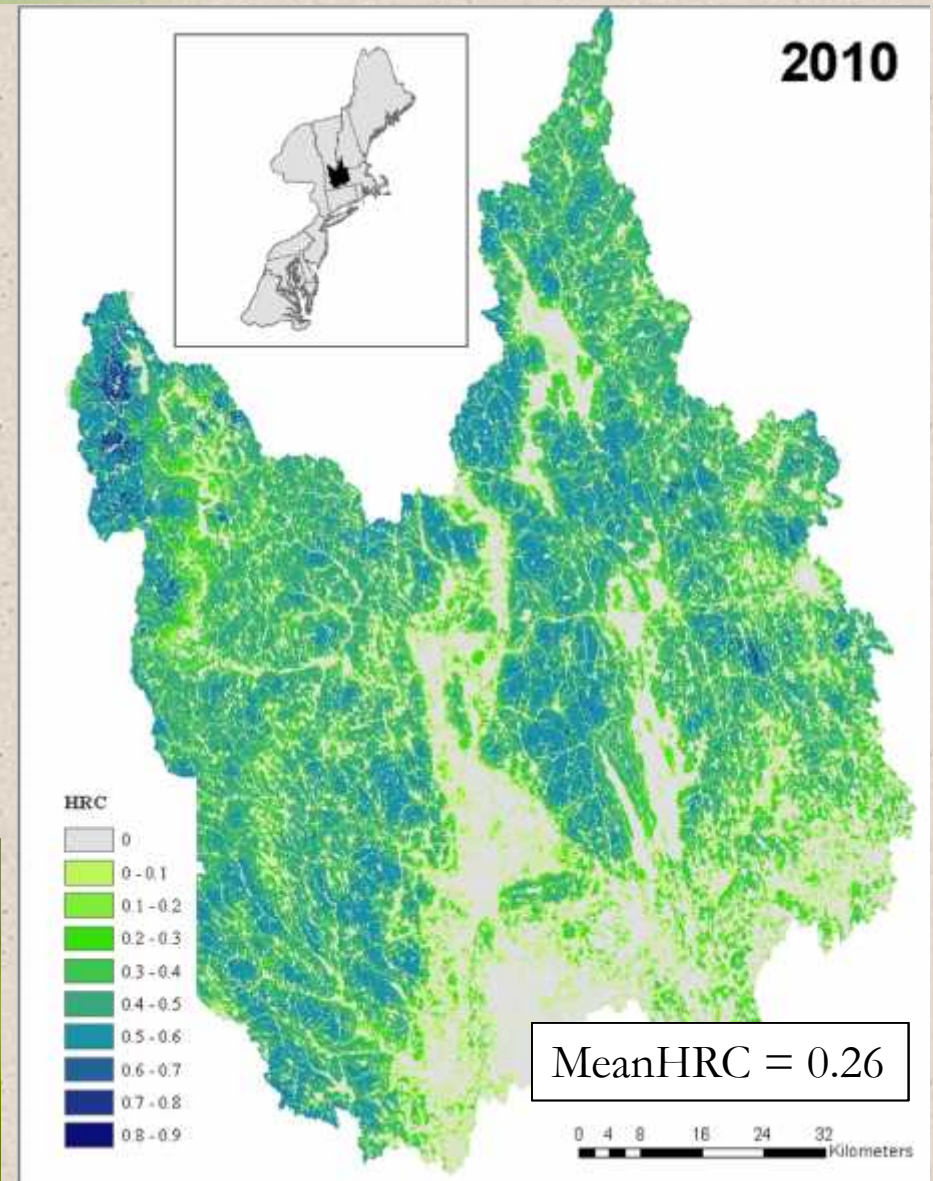


# The Approach

## Landscape Assessment

### *Fine filter*

- Habitat capability index (0-1)
  - Spatially-explicit
  - Multi-level
  - Expert-derived
  - Statistically evaluated





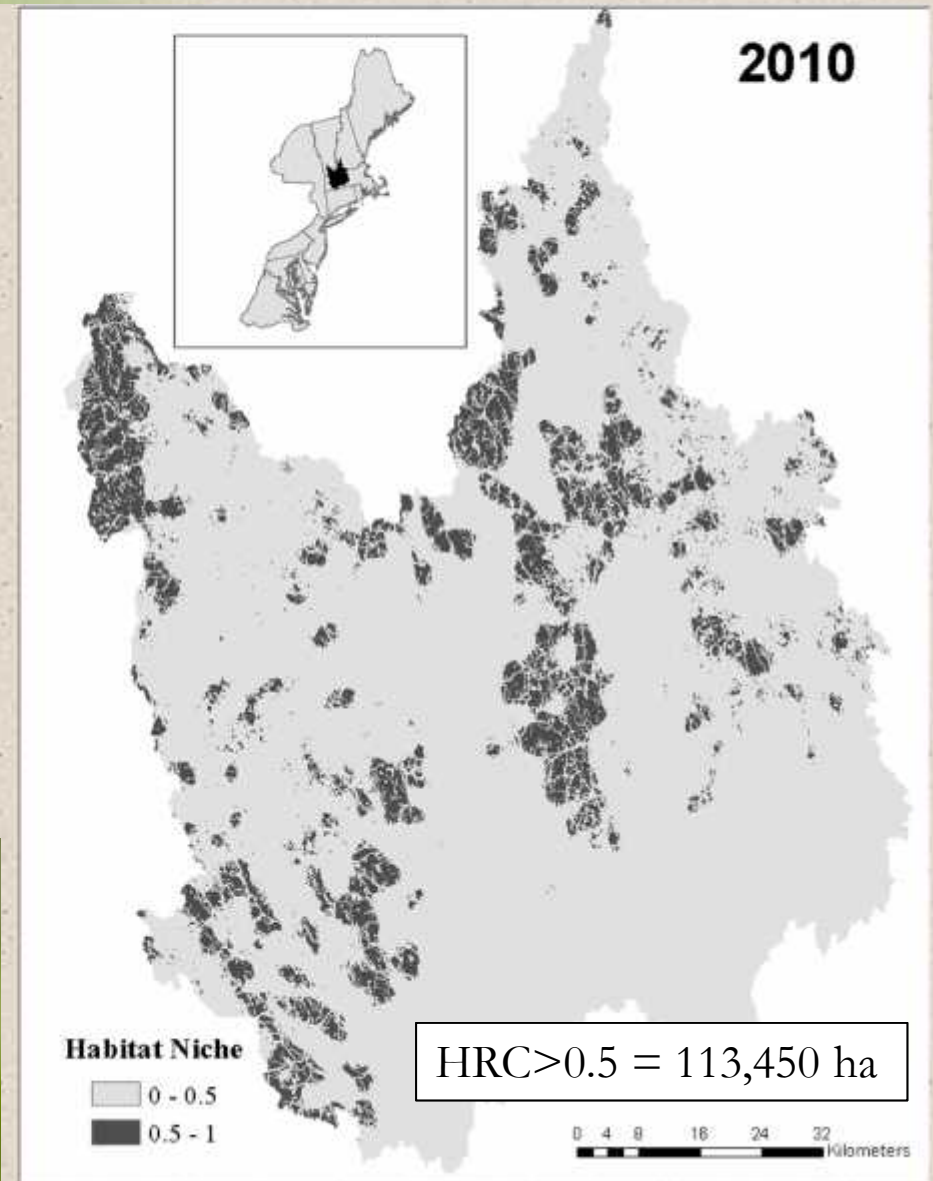
# The Approach

## Landscape Assessment

### *Fine filter*

- Habitat capability index (binary)

Where is the most capable habitat (HRC > 0.5)?



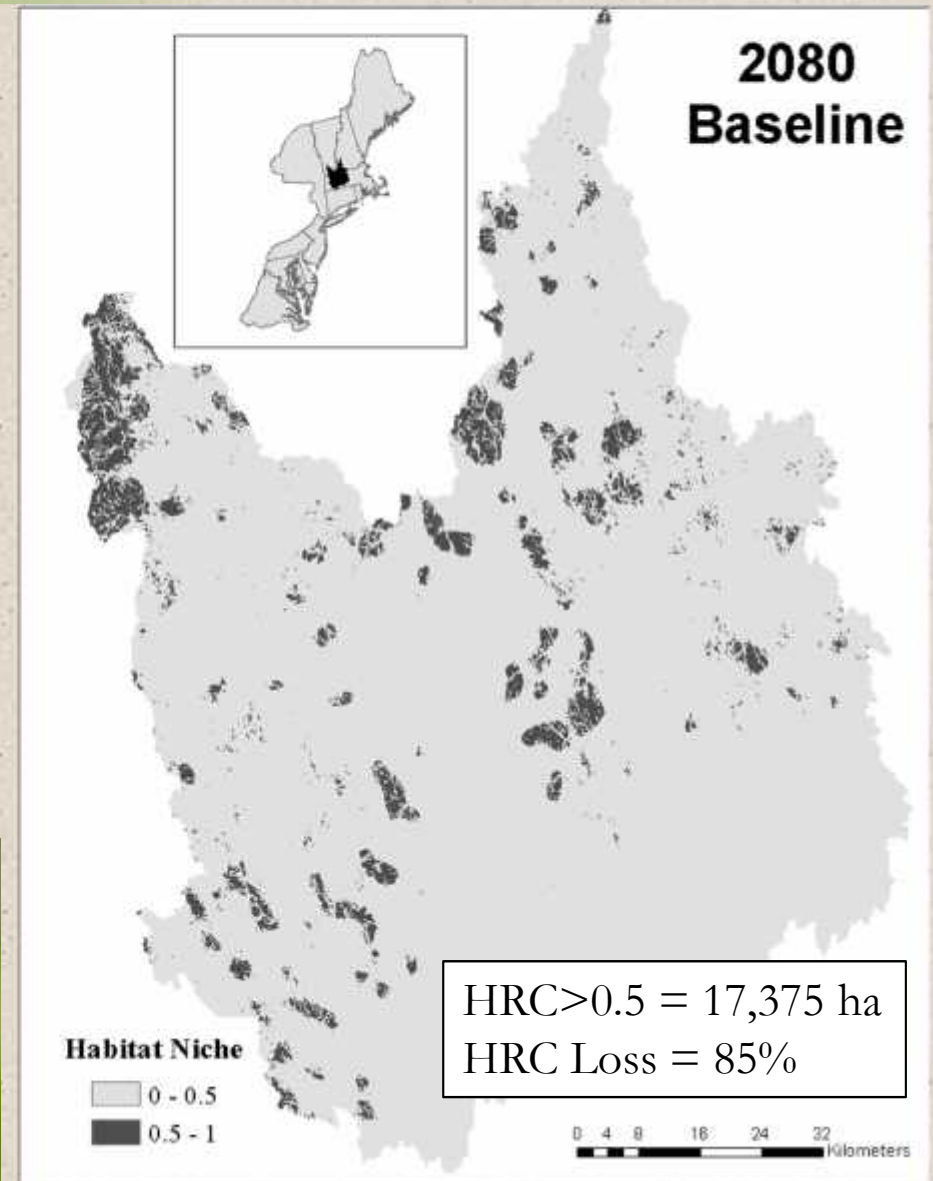
# The Approach

## Landscape Assessment

### *Fine filter*

- Habitat capability index (binary)

Where is the most capable habitat ( $HRC > 0.5$ ) in 2080 under the baseline urban growth scenario?





# The Approach

## Landscape Assessment

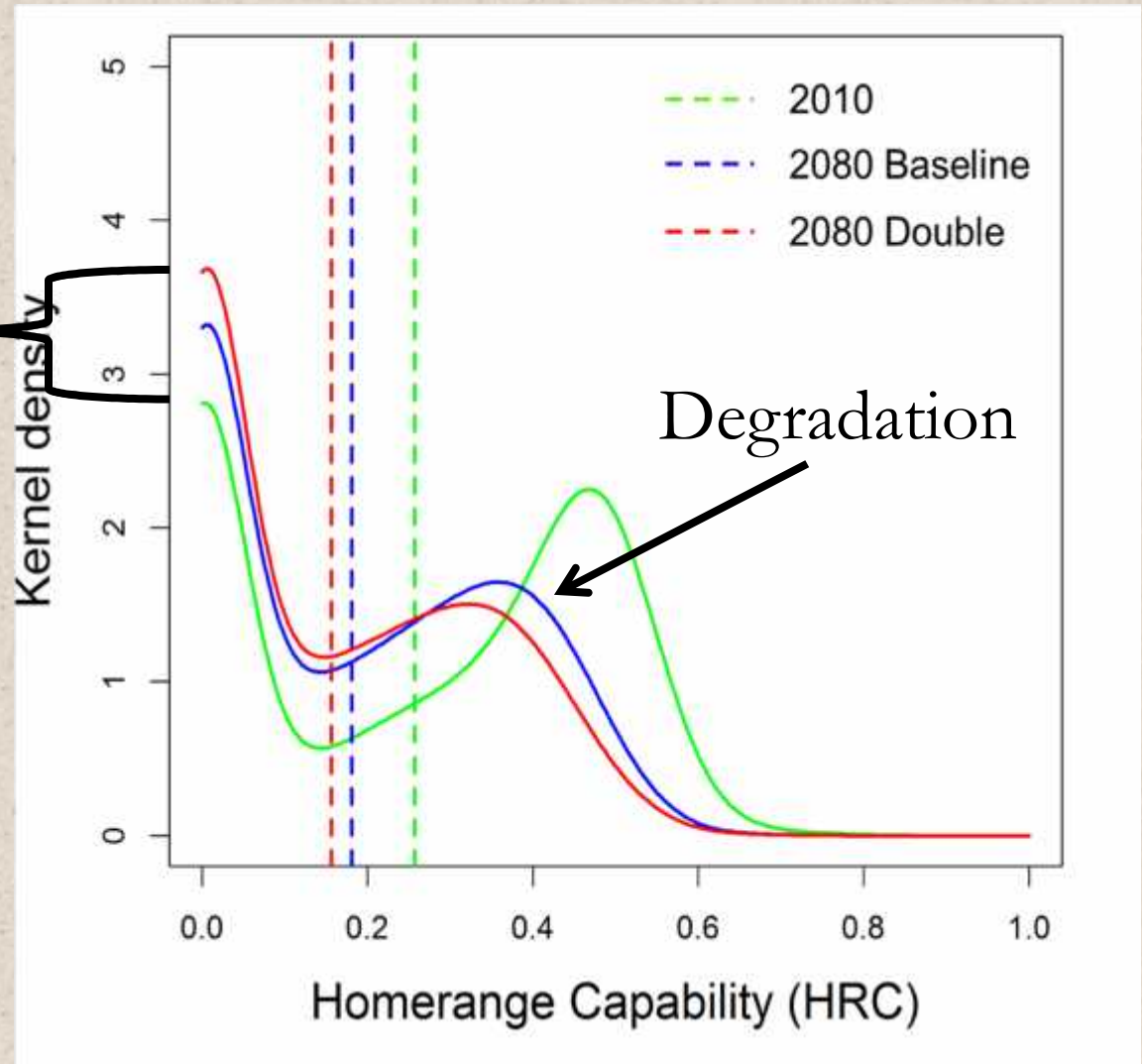
### *Fine filter*

- Habitat capability index

Direct  
habitat loss



Blackburnian warbler



# The Approach

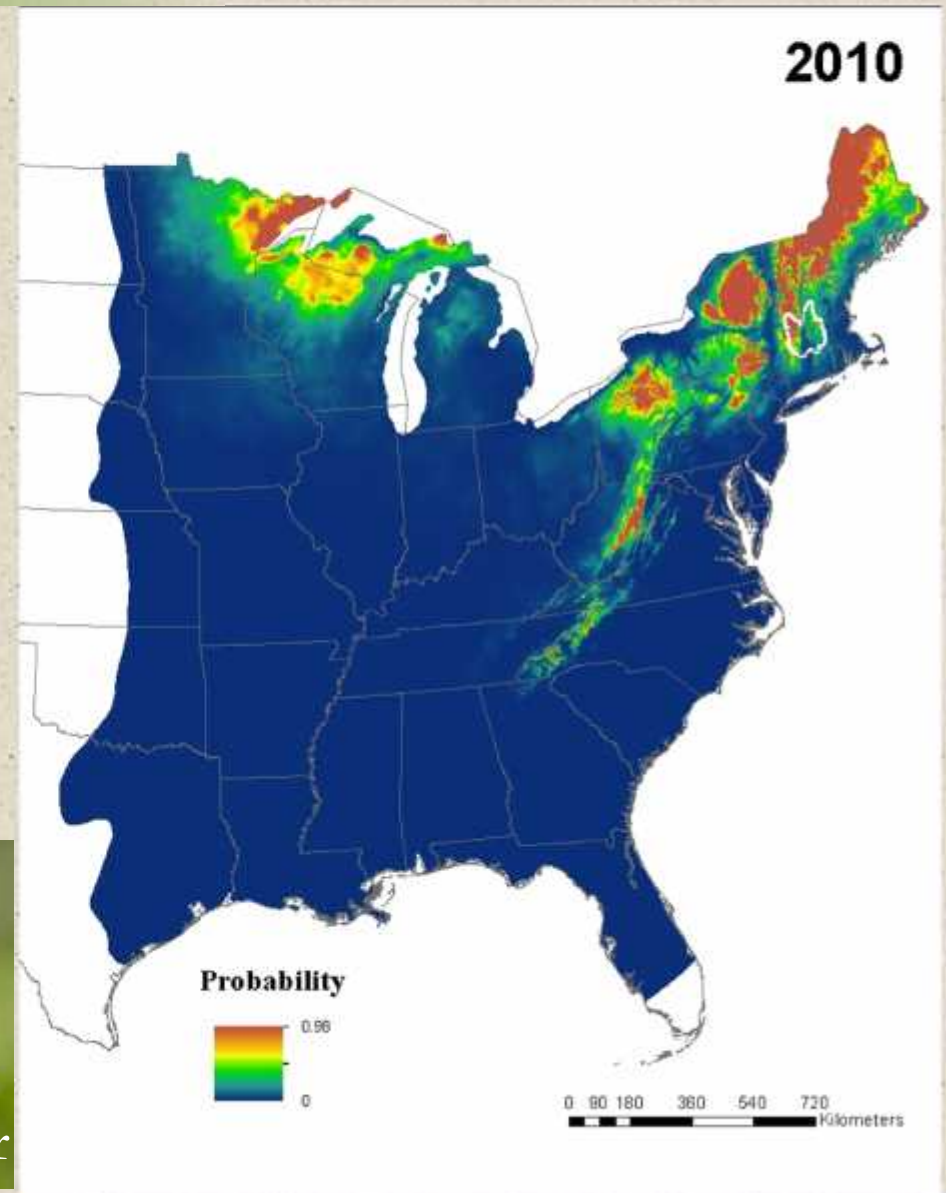
## Landscape Assessment

### *Fine filter*

- Climate suitability index (0-1)
  - Statistical model
  - Humid temperate domain



Blackburnian warbler





# The Approach

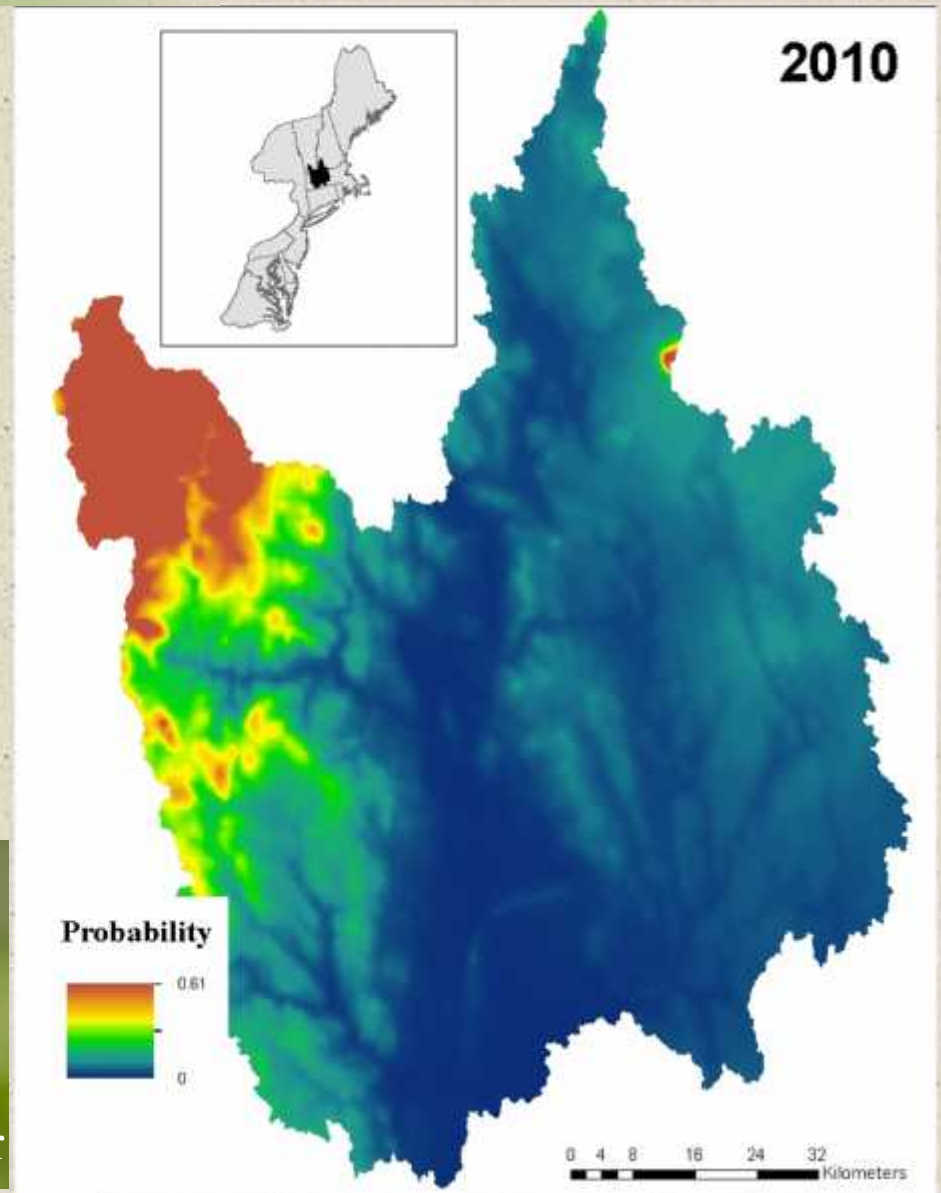
## Landscape Assessment

### *Fine filter*

- Climate suitability index (0-1)



Blackburnian warbler



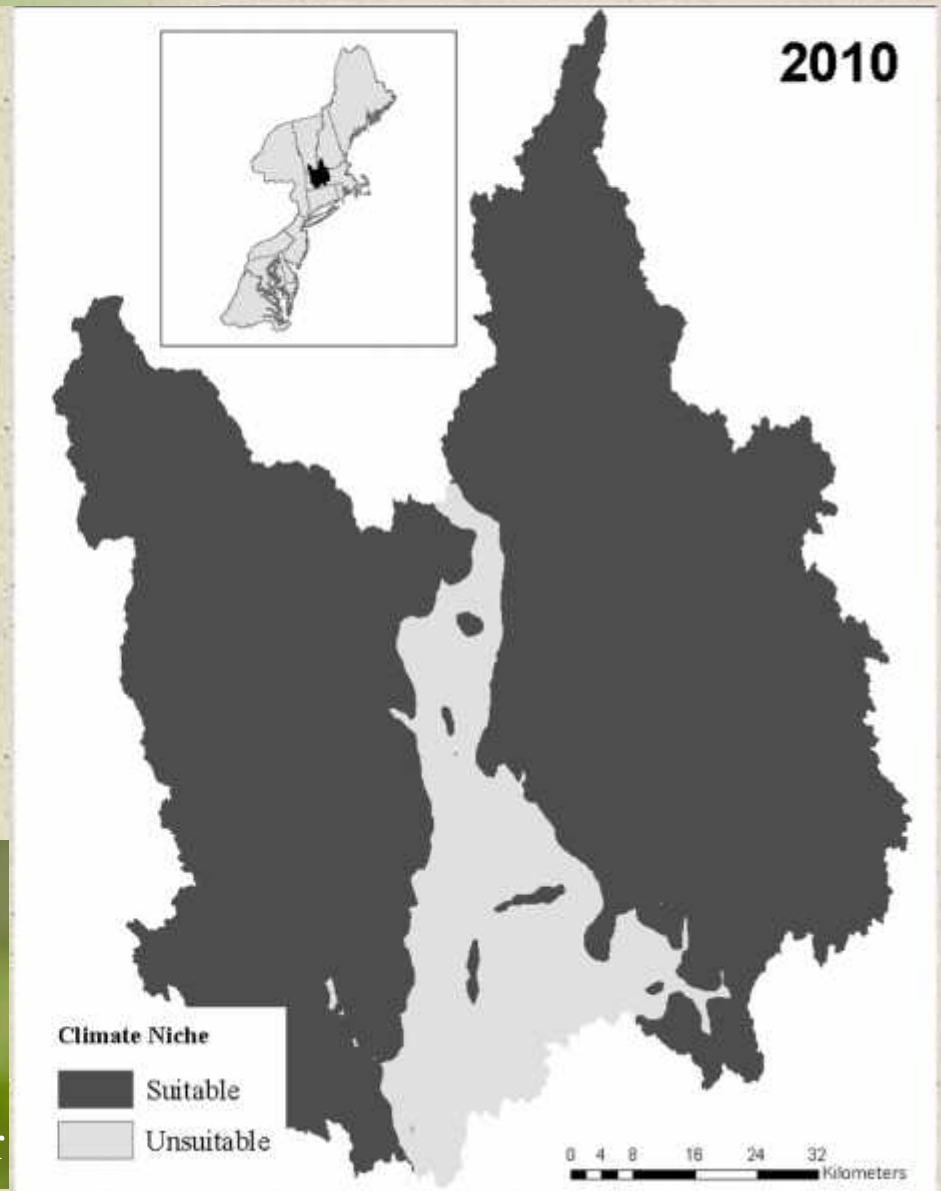
# The Approach

## Landscape Assessment

### *Fine filter*

- Climate niche envelope (binary)

What is the envelope that captures 95% of the known occurrences?





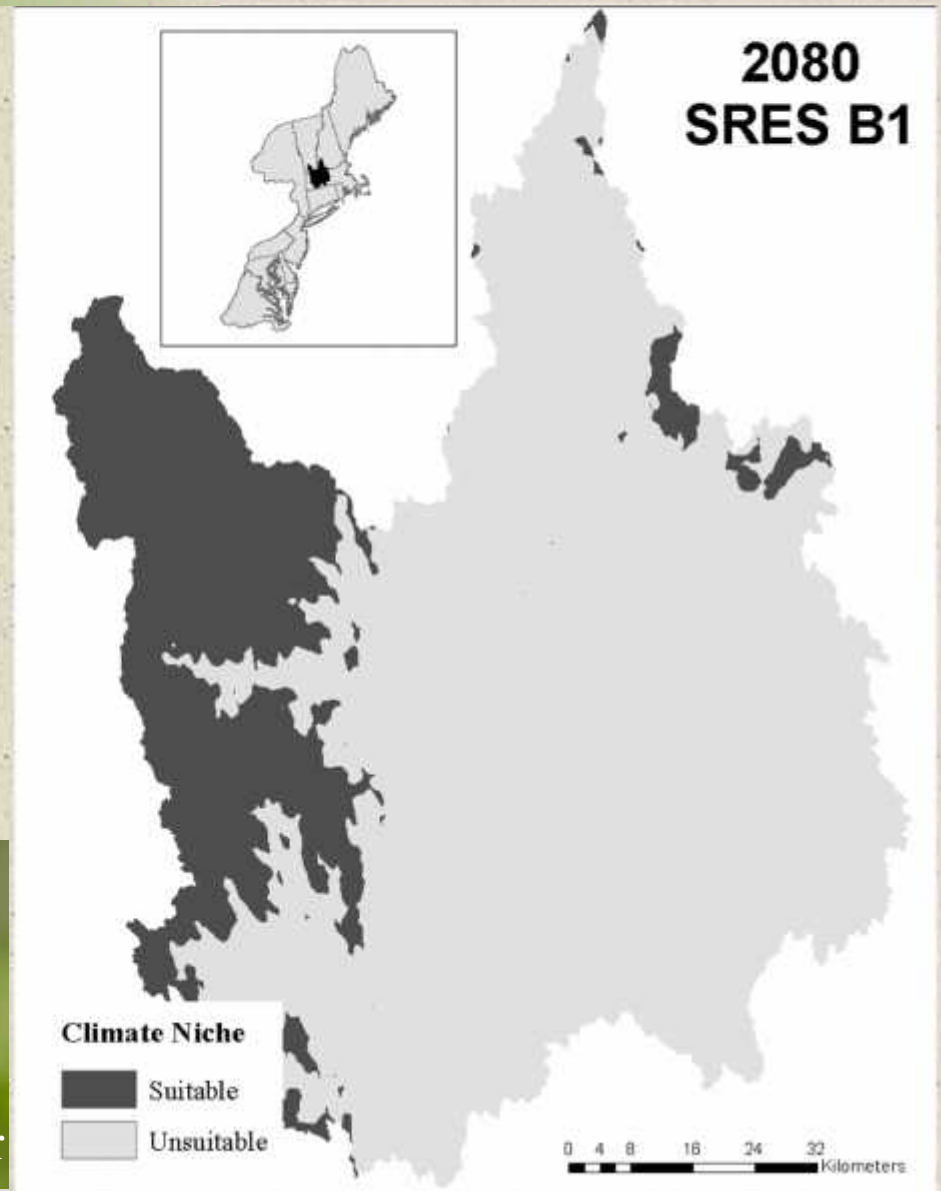
# The Approach

## Landscape Assessment

### *Fine filter*

- Climate niche envelope (binary)

Where is the climate niche envelope in 2080 under the SRES B1 scenario?



# The Approach

## Landscape Assessment

### *Fine filter*

- Climate niche envelope (binary)

How about under the SRES A2 scenario?



Blackburnian warbler





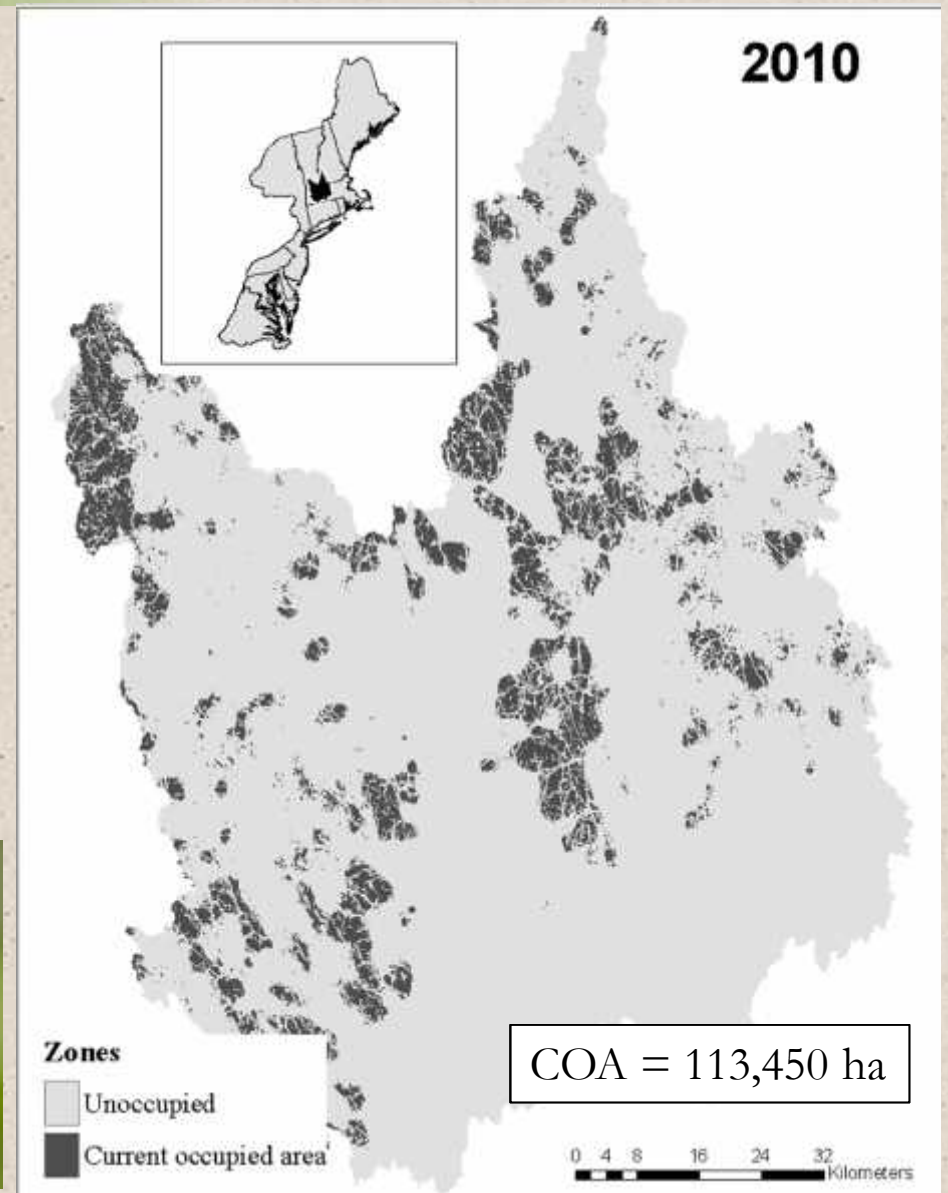
# The Approach

## Landscape Assessment

### *Fine filter*

- **Habitat-Climate uncertainty**

*Current occupied area = Predicted habitat and climate within the species' current range.*



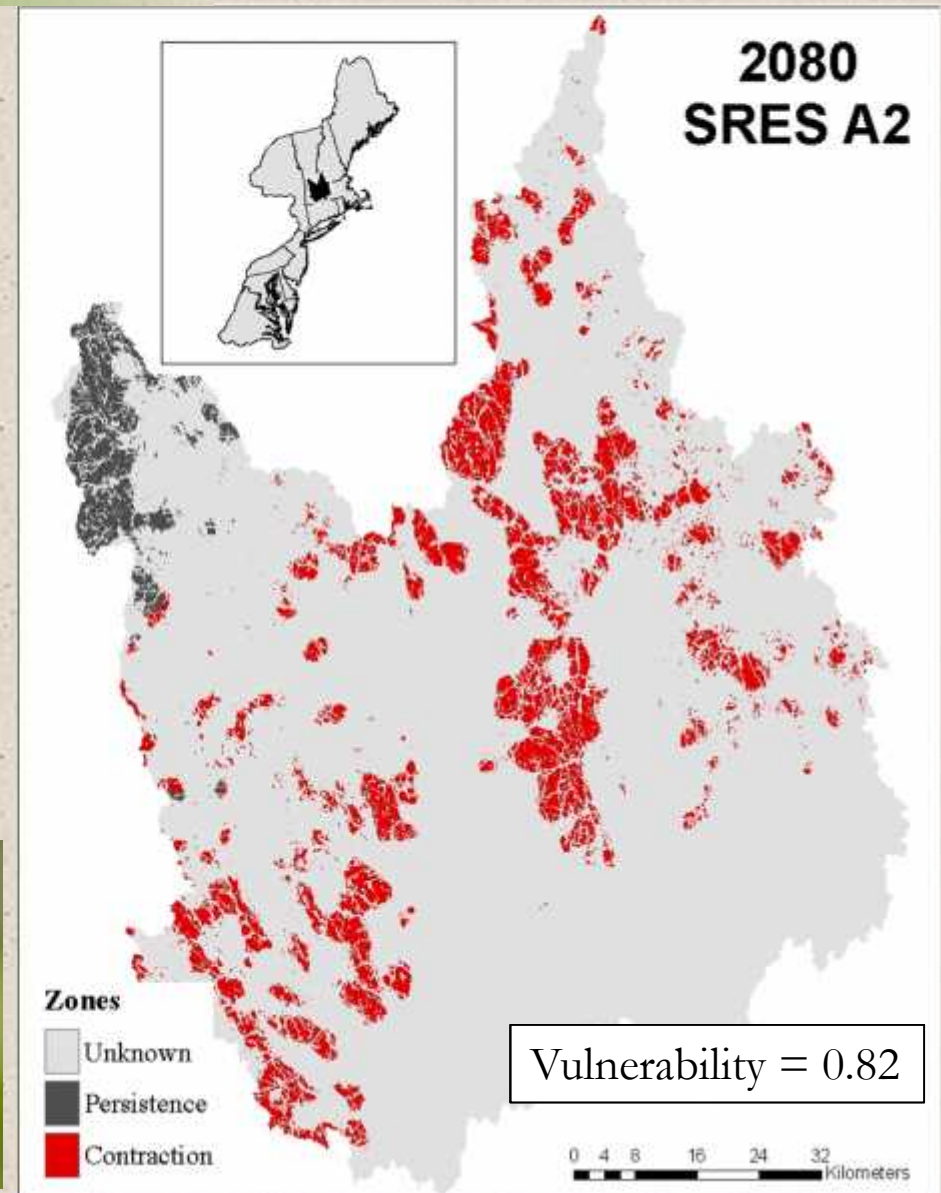
# The Approach

## Landscape Assessment

### *Fine filter*

- **Habitat-Climate uncertainty**

*Zone of Persistence* =  
Persistent future habitat  
and climate within the  
species' current range.





# The Approach

## Landscape Assessment

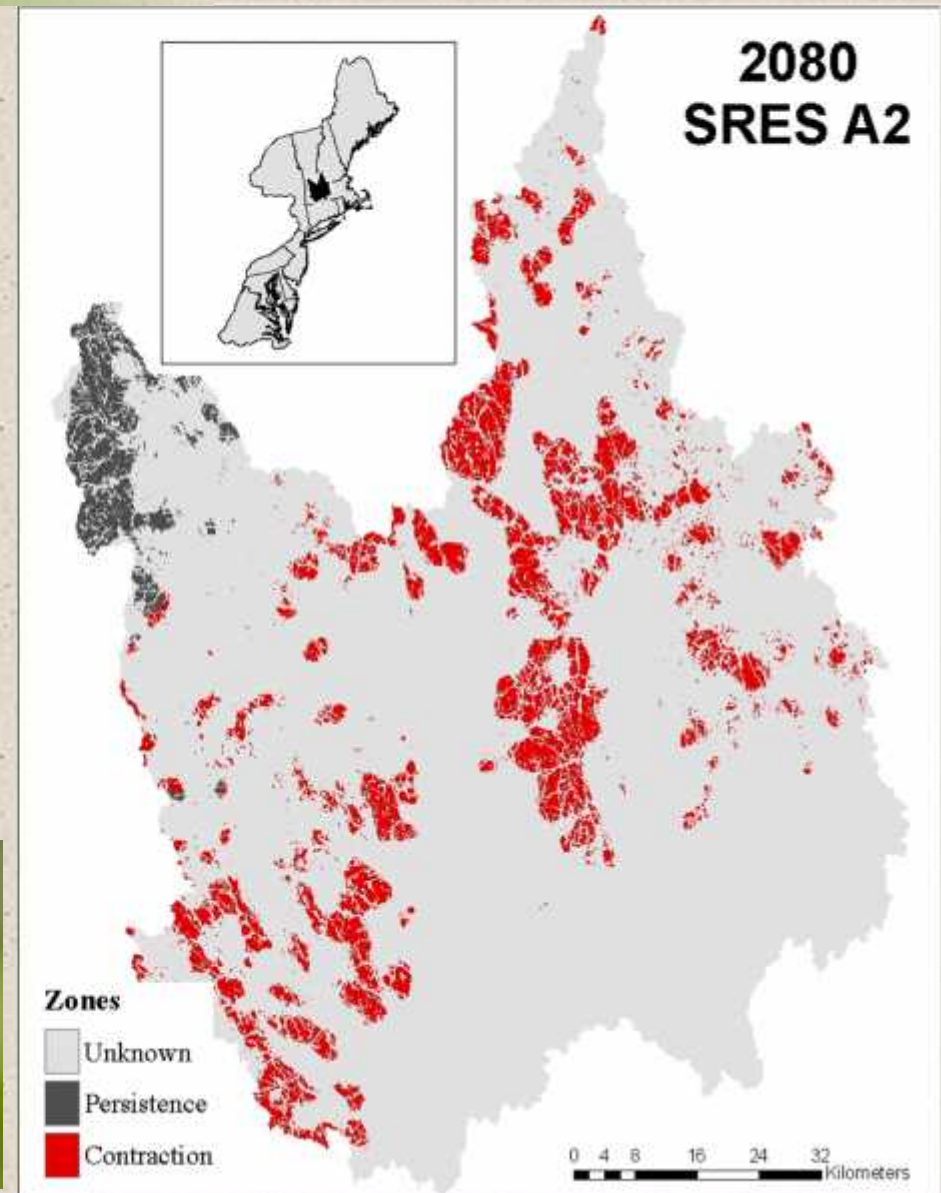
### *Fine filter*

- Habitat-Climate uncertainty

*Zone of Contraction = Persistent future habitat but no longer suitable climate within the species' current range.*



Blackburnian warbler



# The Approach

## Landscape Assessment

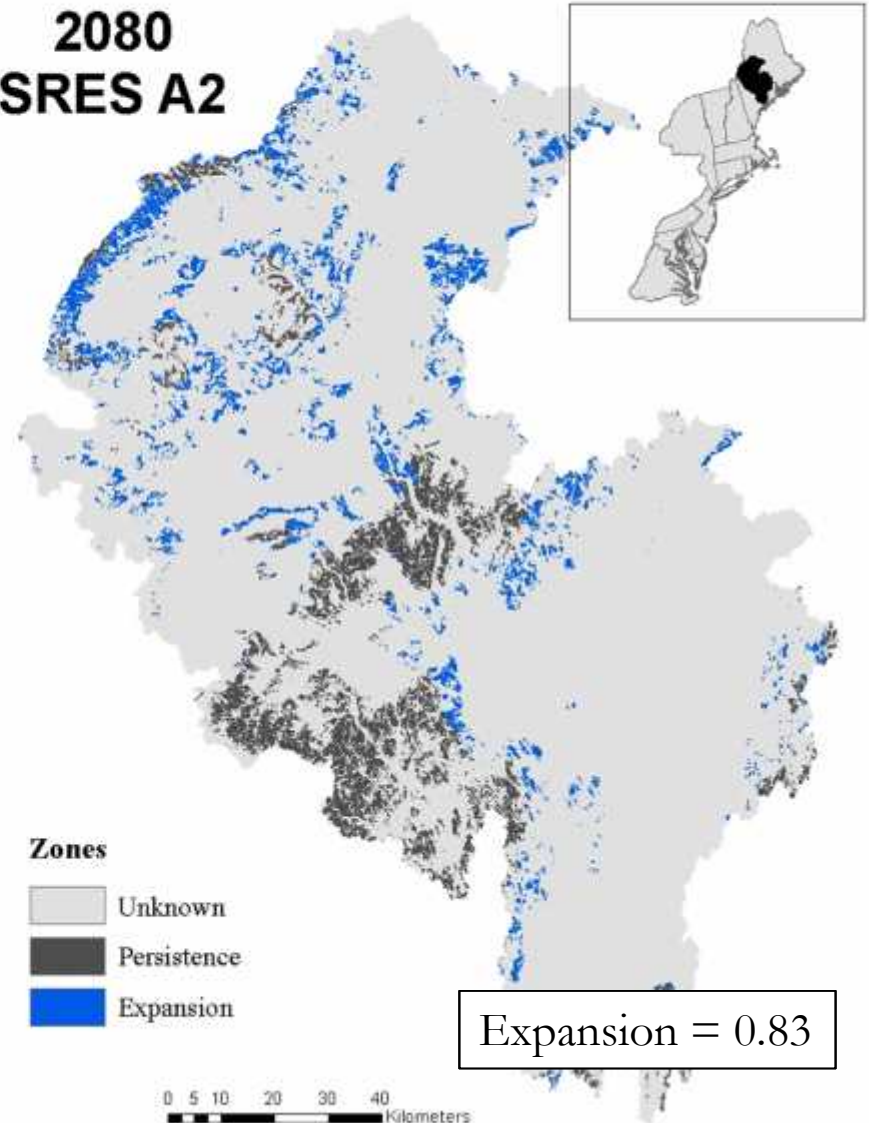
### *Fine filter*

- Habitat-Climate uncertainty

*Zone of Expansion = Future habitat and suitable climate but outside the current climate niche envelope.*



2080  
SRES A2





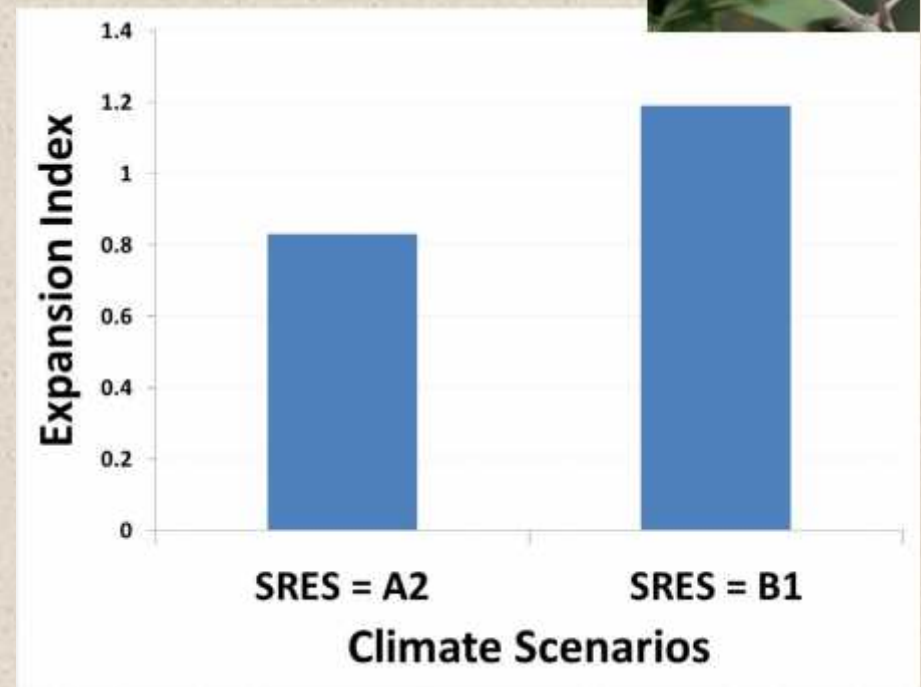
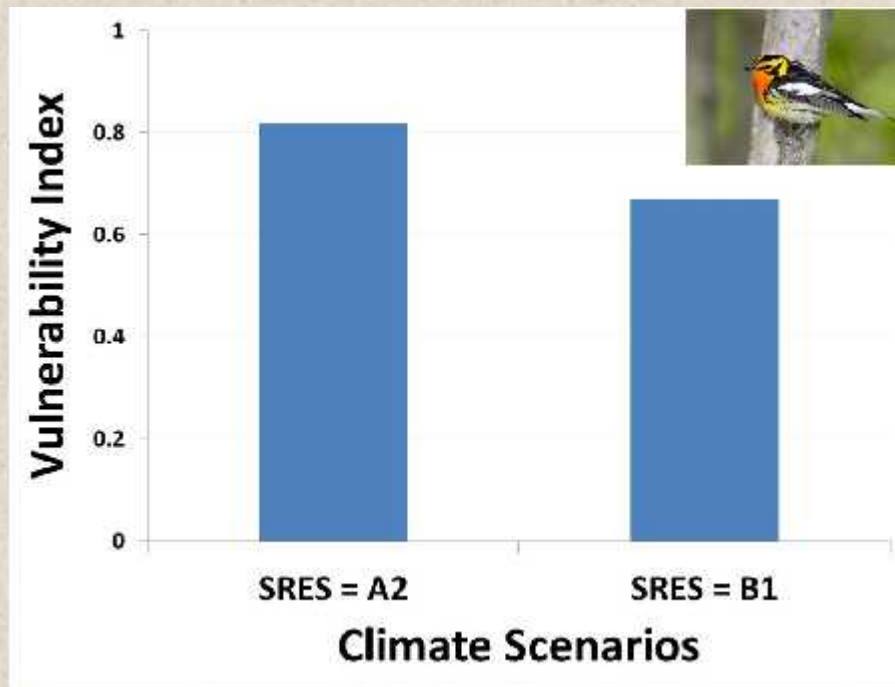
# The Approach

## Landscape Assessment

### *Fine filter*

- Habitat-Climate uncertainty

### Scenario Comparison



# The Approach

## Landscape Assessment

### *Fine filter*

- Representative species

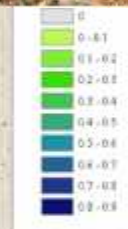
2010



Wood turtle



Blackpoll warbler



Marsh wren



Louisiana waterthrush



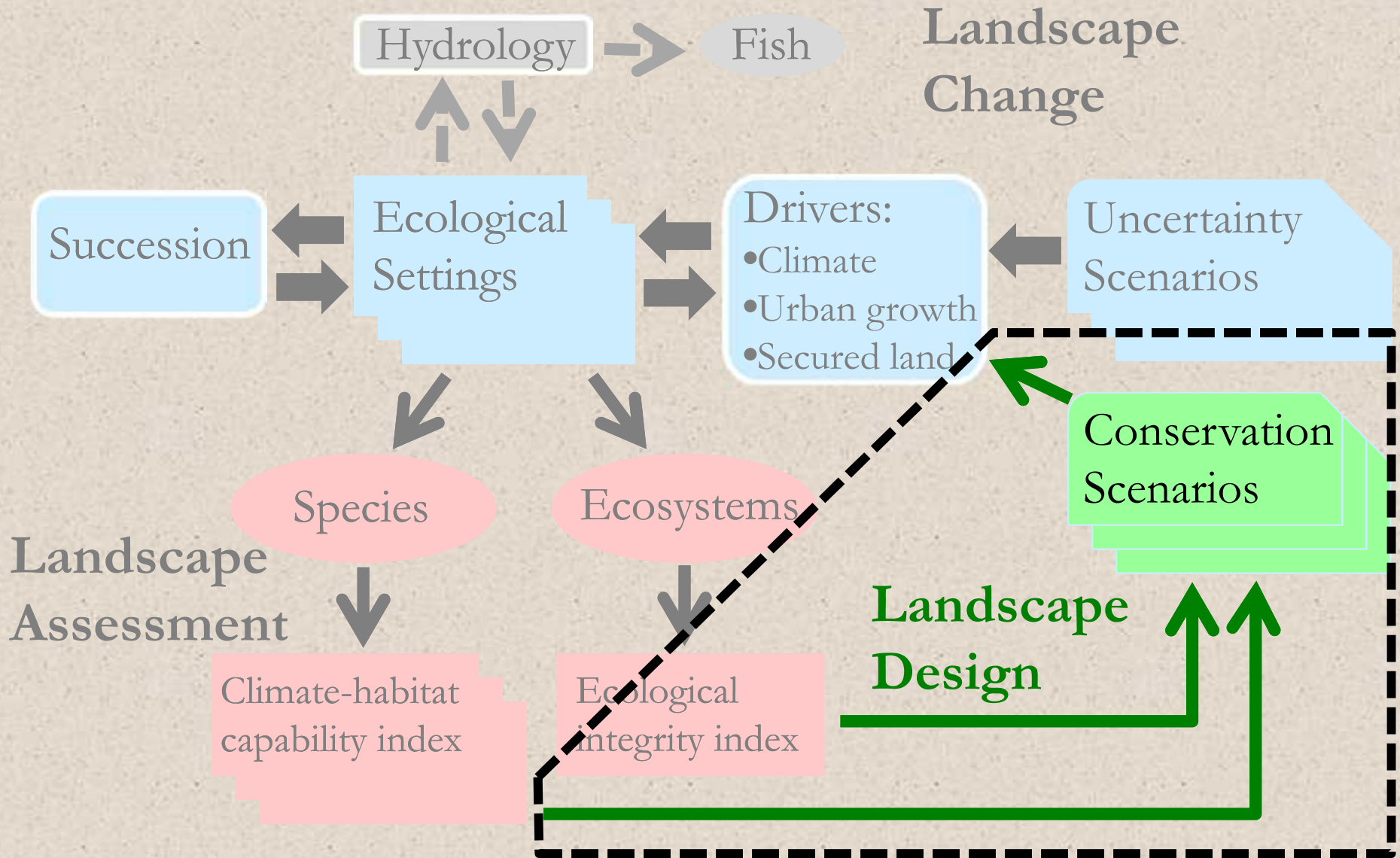
Carolinian





# The Approach

## LCAD model



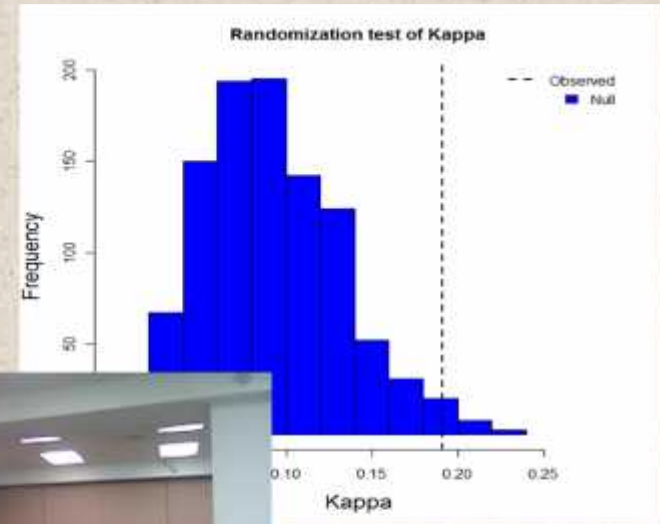
# The Approach

## Model Evaluation

...true model validation  
is not feasible

---

- Empirical assessment of model components
- Scientific steering committee
- Users gut check
- Usefulness



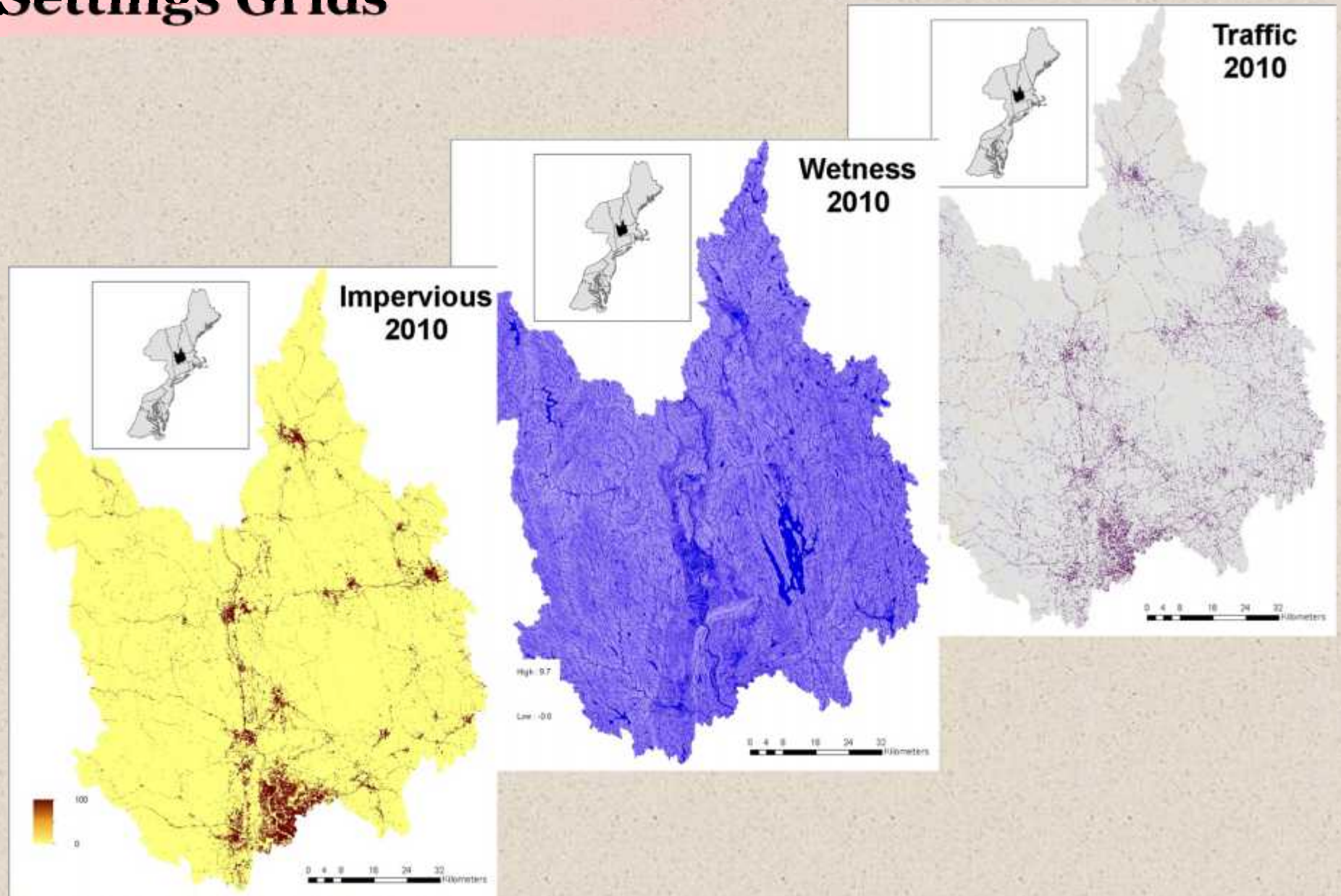
**GUT CHECK**

**Is it  
Useful?**



# Raw Data Products

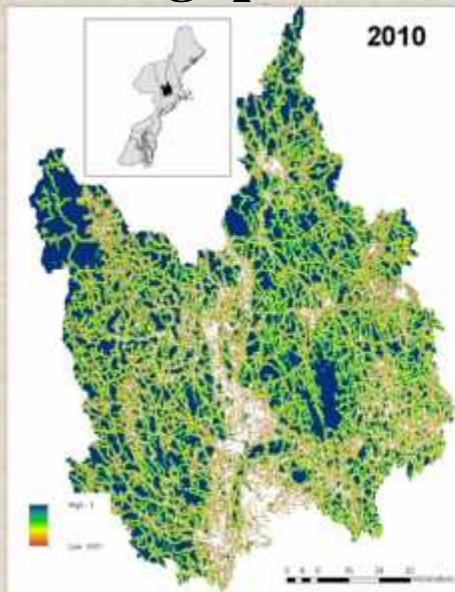
## Settings Grids



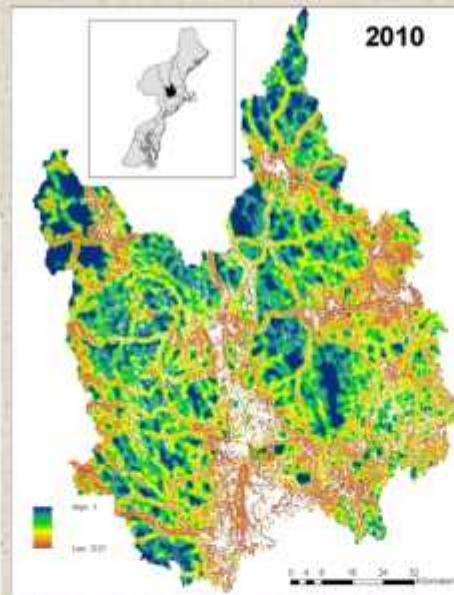
# Raw Data Products

## Integrity Grids

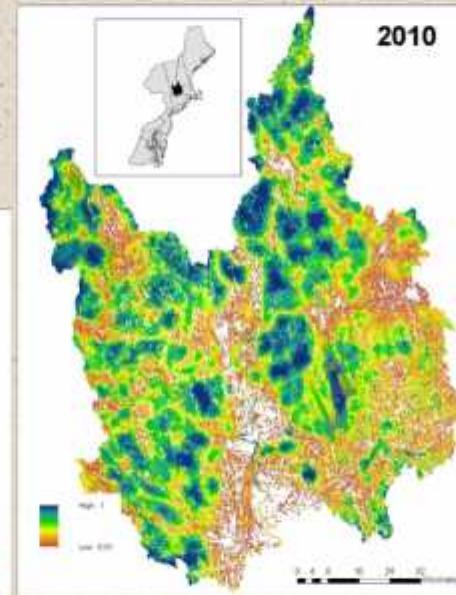
### ■ Edgepred



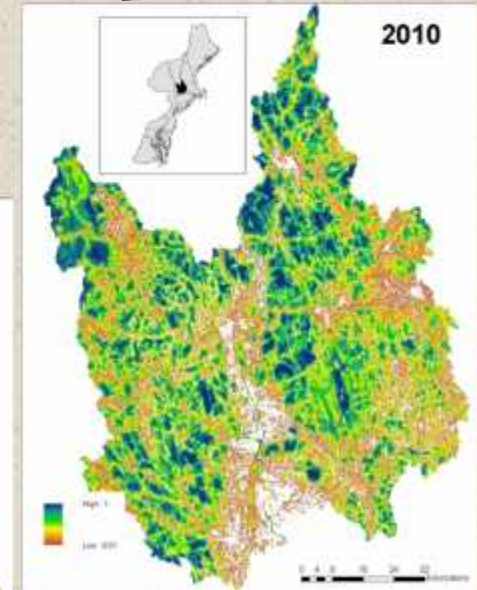
### ■ Traffic



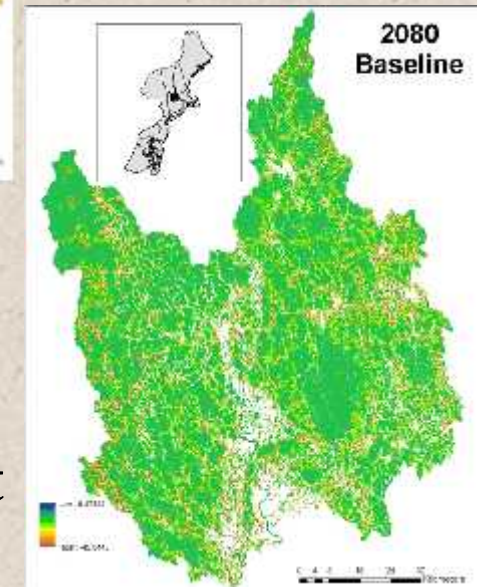
### ■ Connect



### ■ IEI



### ■ Impact

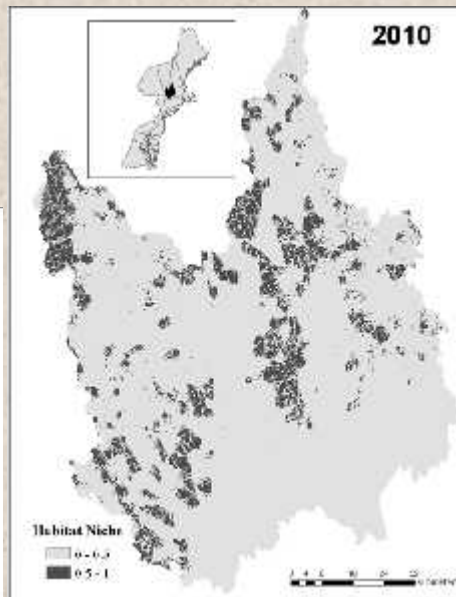
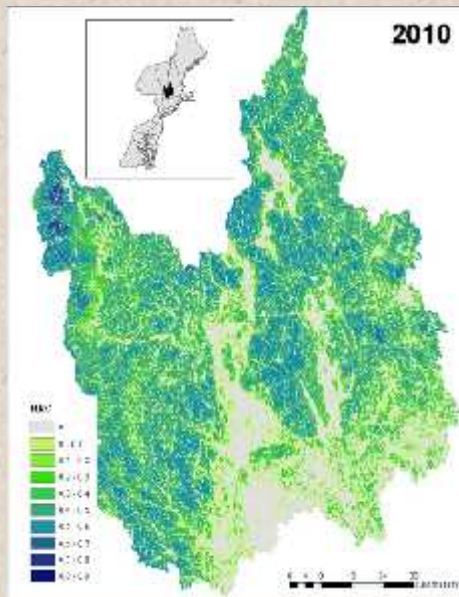




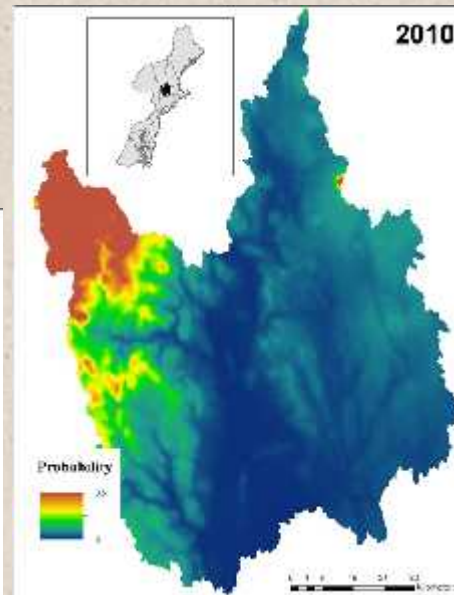
# Raw Data Products

## Species Grids

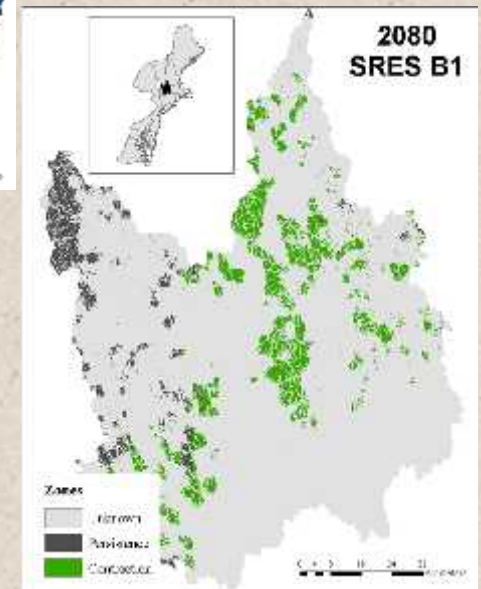
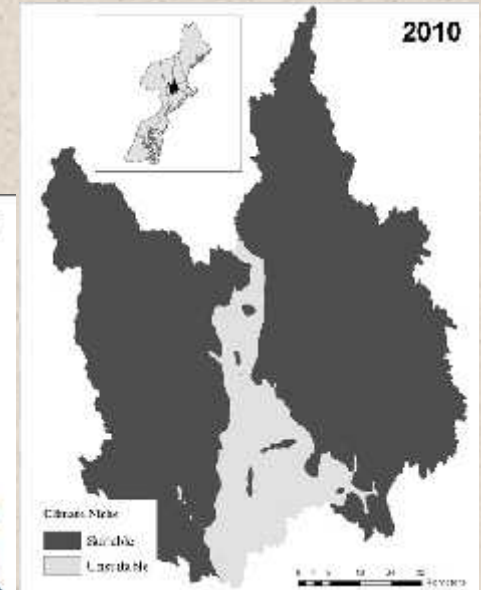
- Habitat niche



- Climate niche



- Uncertainty zones





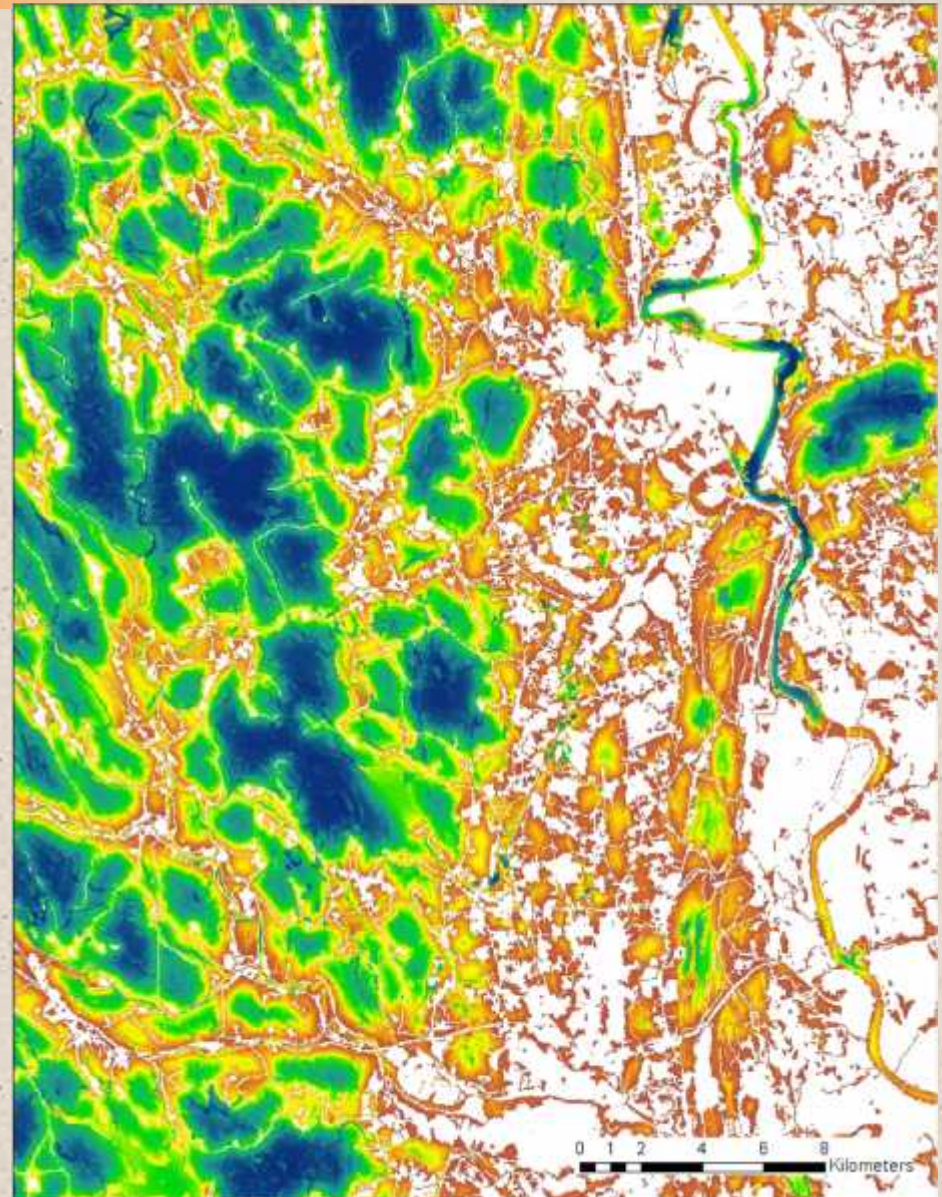
# Potential Applications

## Land Protection

- Prioritizing land for protection

What about areas with high *ecological integrity* today?

2010 IEI





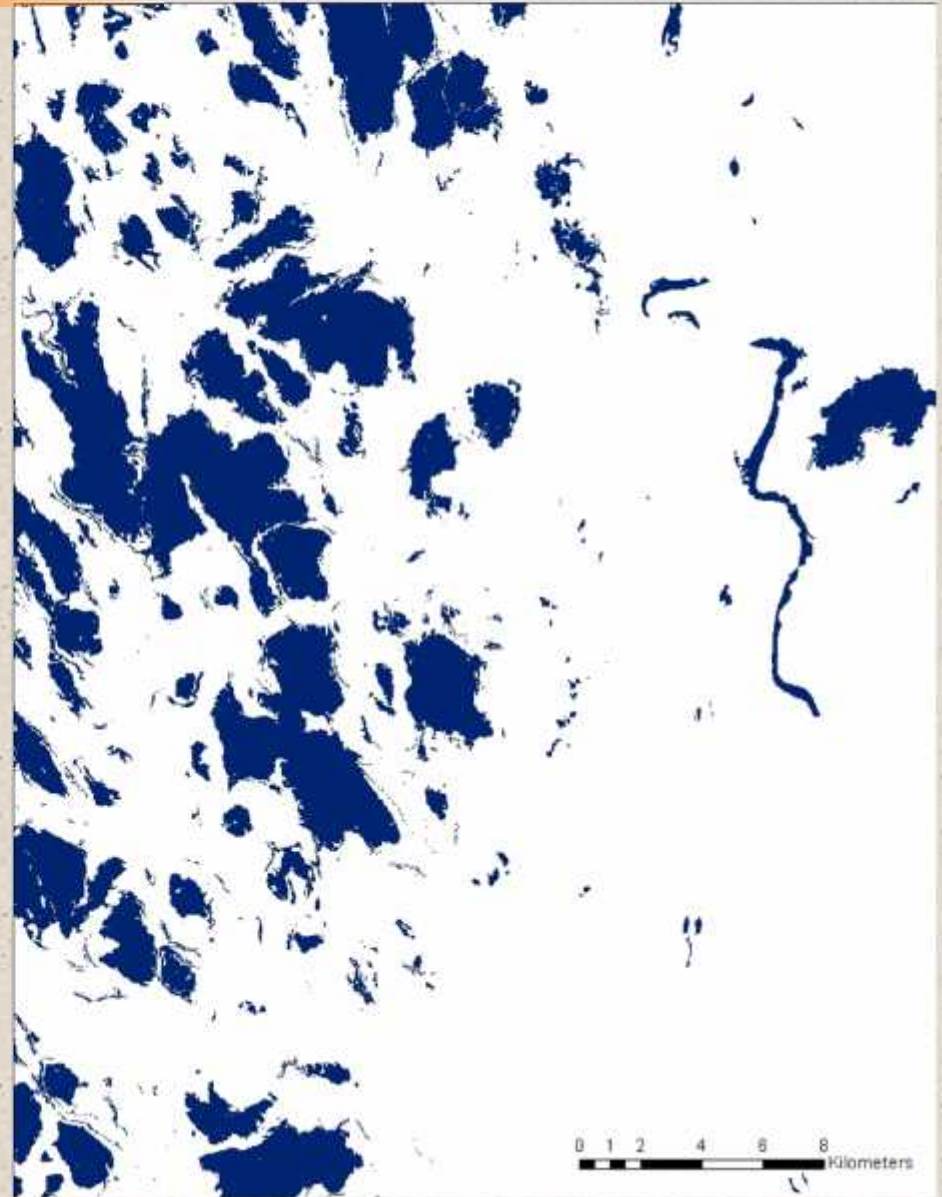
# Potential Applications

## Land Protection

- Prioritizing land for protection

What about areas with high *ecological integrity* today?

2010 Top 30% IEI



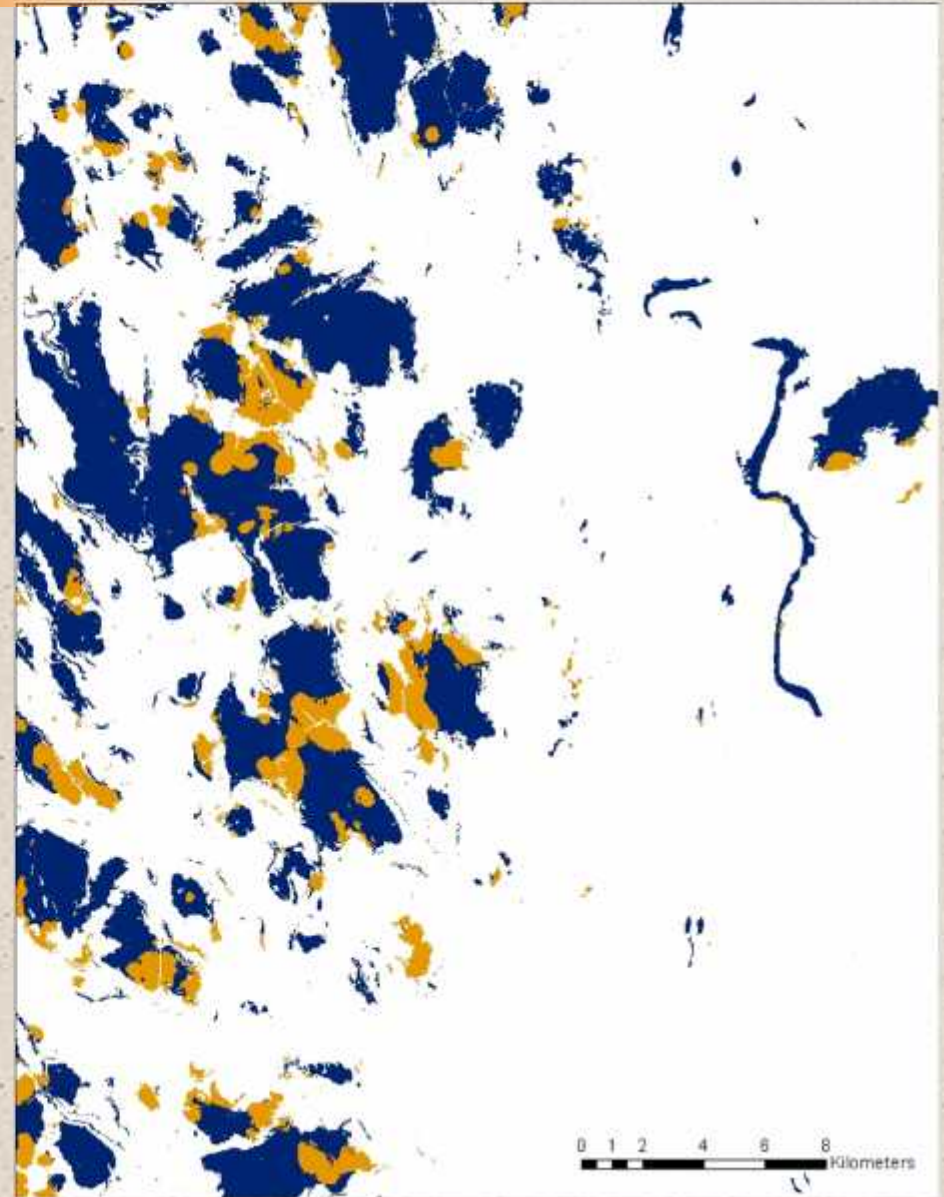
# Potential Applications

## Land Protection

- Prioritizing land for protection

What about areas most likely to be *impacted* by future development?

2080 Impact-baseline





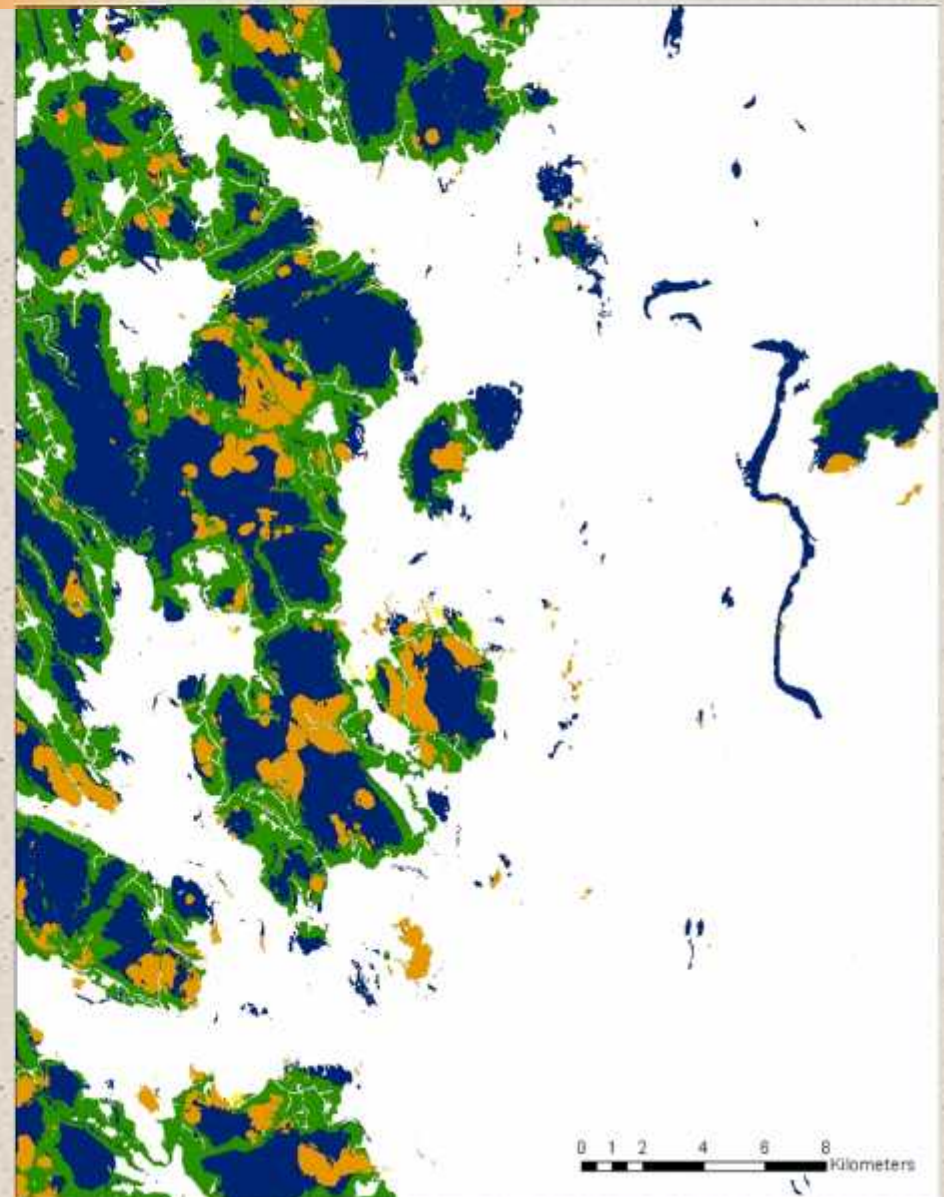
# Potential Applications

## Land Protection

- Prioritizing land for protection

What about areas with high local *connectivity*?

2010 Conductance



# Potential Applications

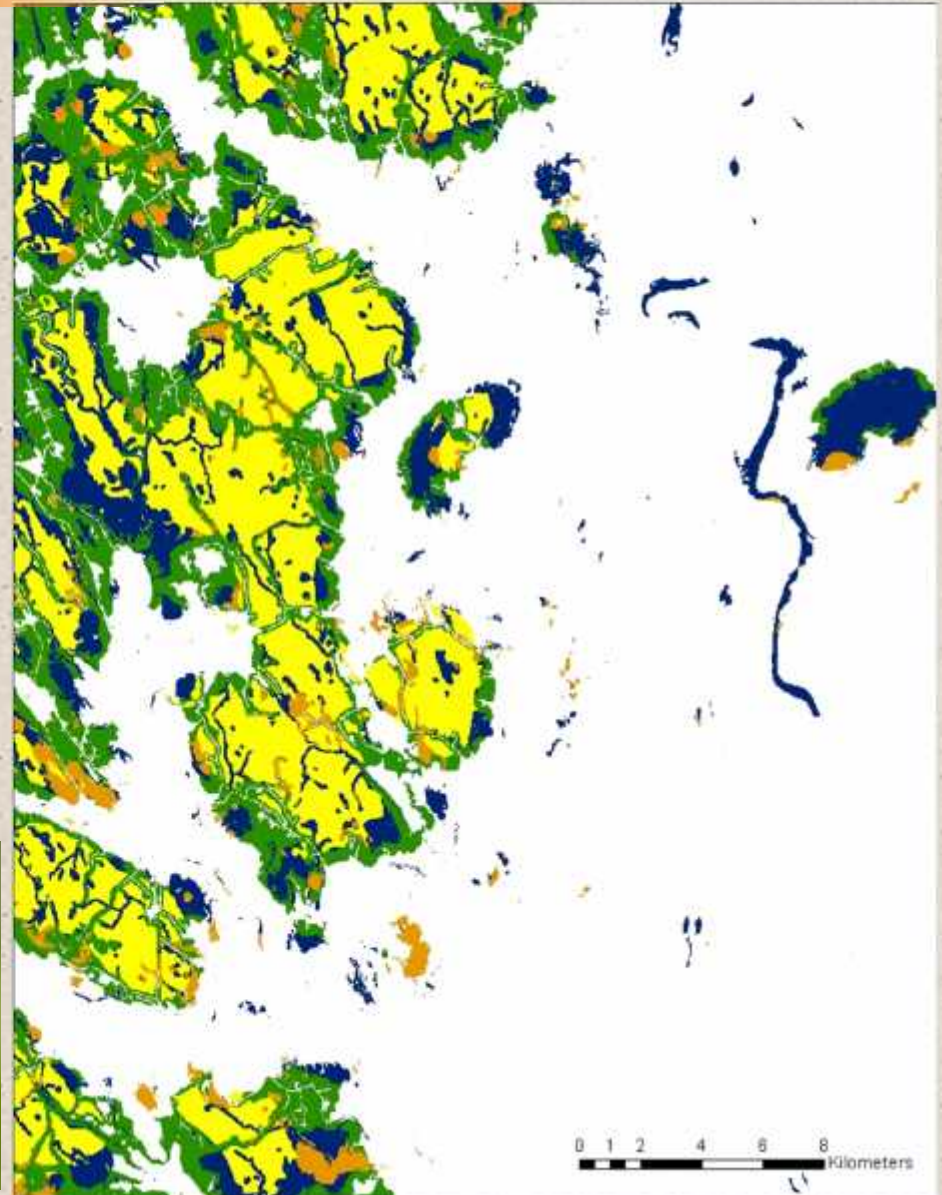
## Land Protection

- Prioritizing land for protection

What about important *habitat* for blackburnian warblers?



2010 HRC > 0.5





# Potential Applications

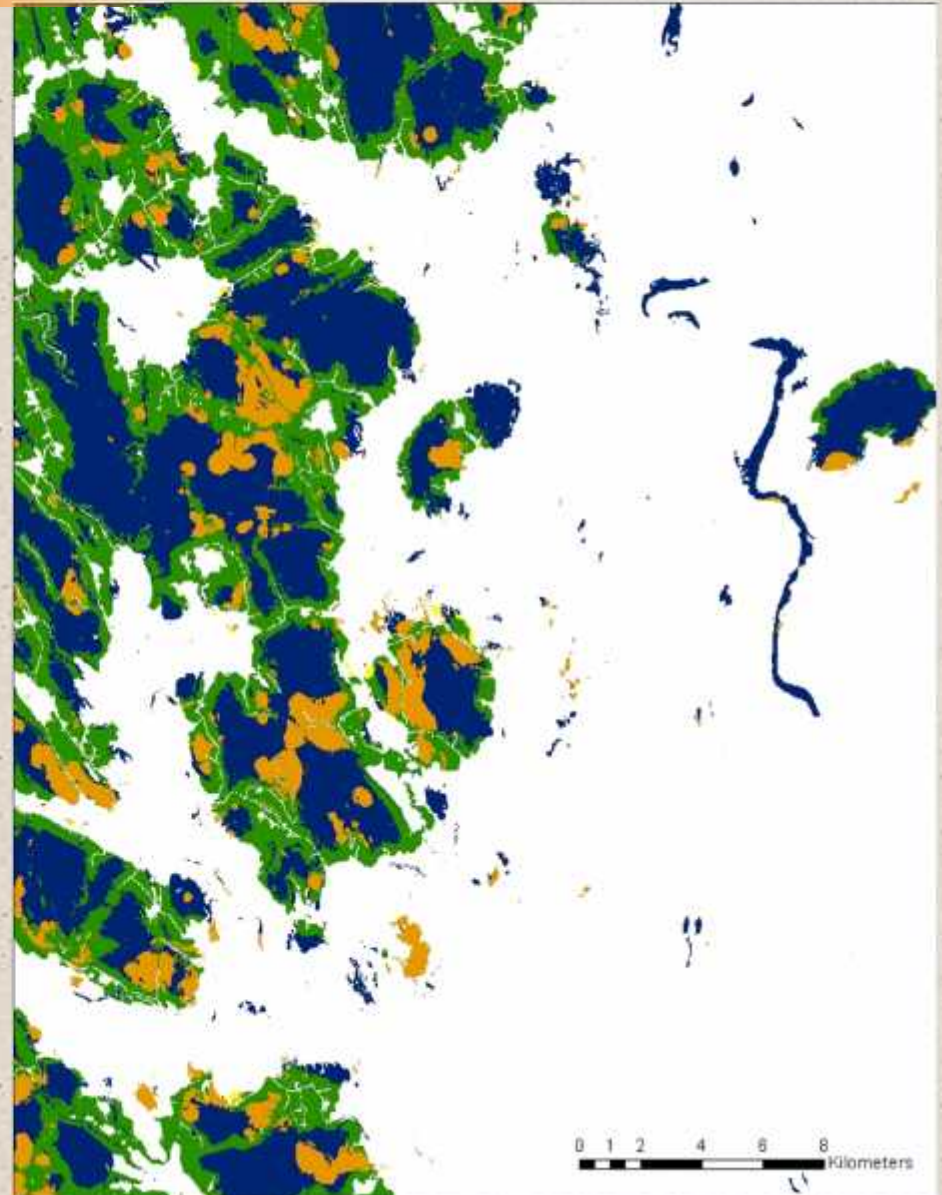
## Land Protection

- Prioritizing land for protection

What about important *habitat* for blackburnian warblers?

Does it complement the coarse filter priorities?

2010 HRC > 0.5



# Potential Applications

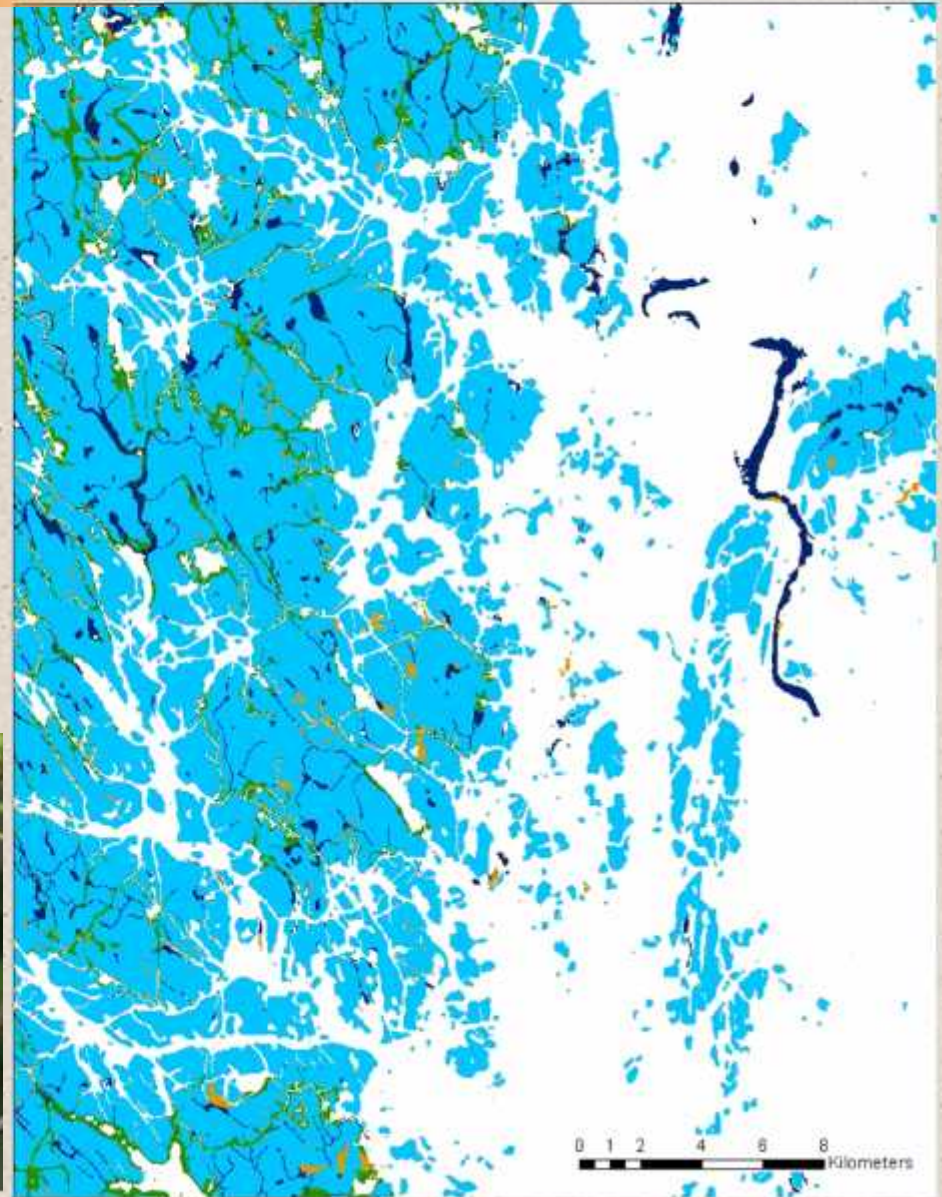
## Land Protection

- Prioritizing land for protection

What about important *habitat* for wood thrush?



2010 HRC > 0.5





# Potential Applications

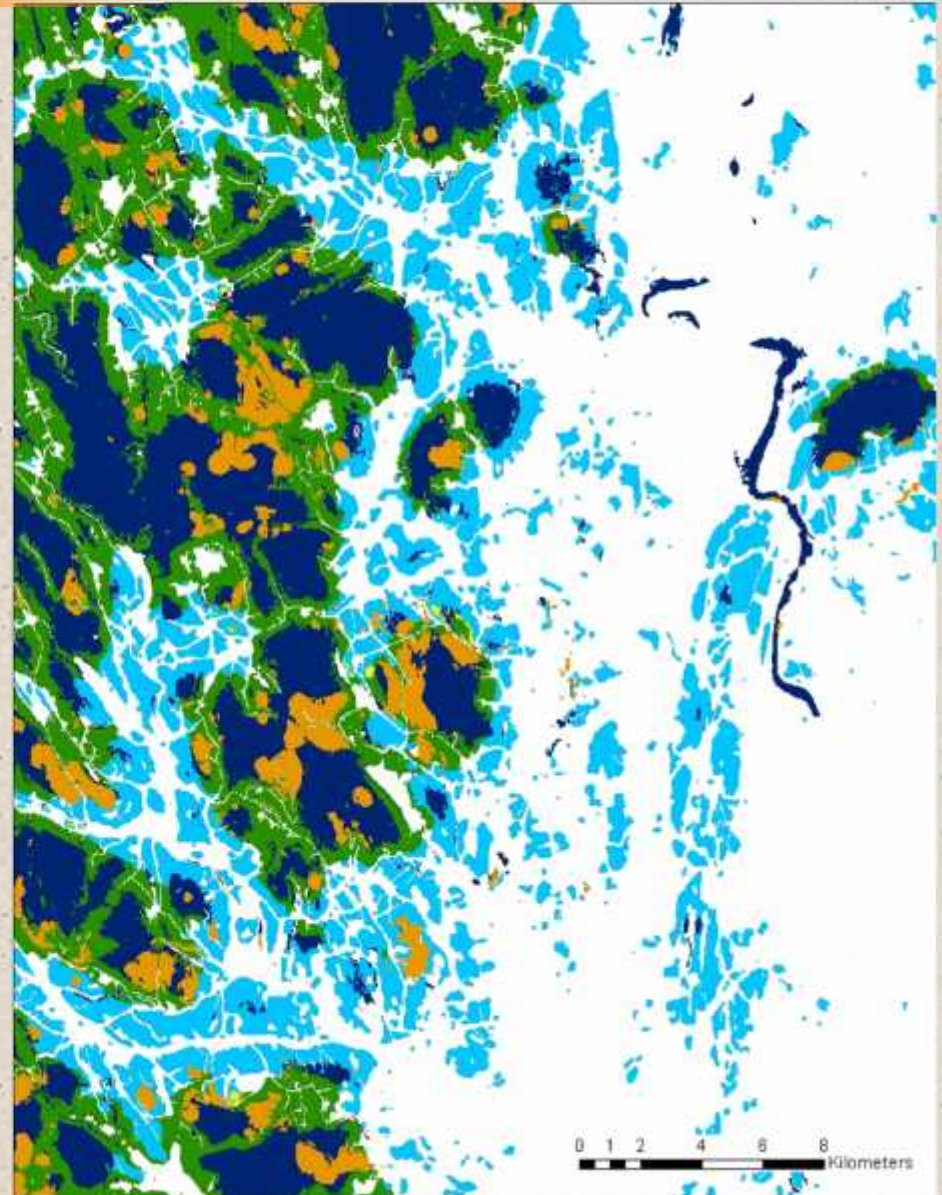
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- Prioritizing land for protection

What about important *habitat* for wood thrush?

Does it complement the coarse filter priorities?

2010 HRC > 0.5





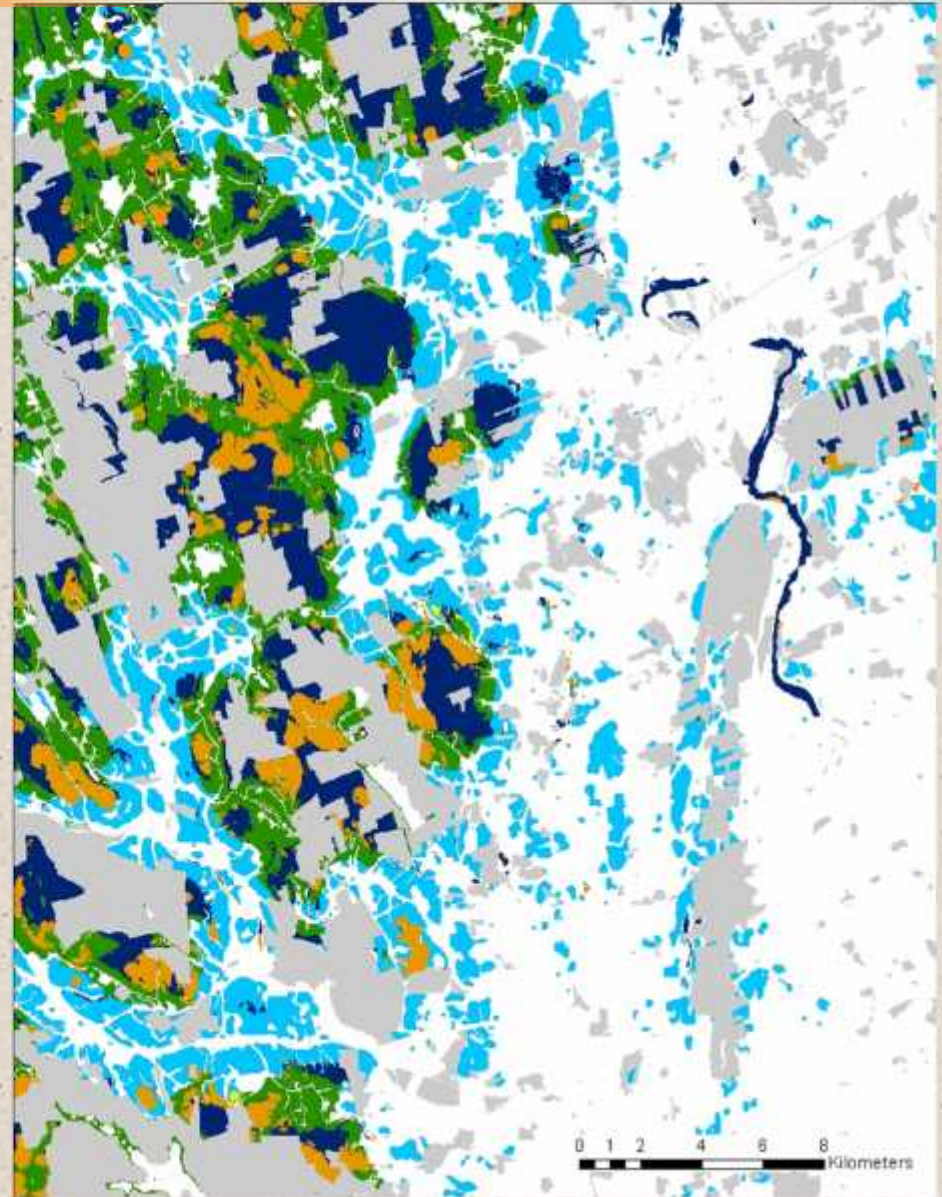
# Potential Applications

## Land Protection

- Prioritizing land for protection

What and where are the gaps in the *secured land* base?

Secured Land





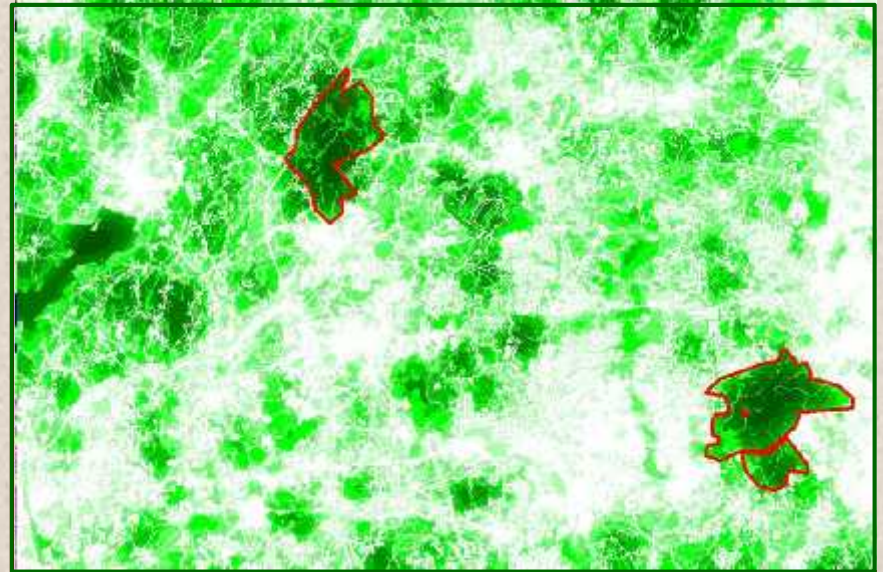
# Potential Applications

## Land Protection

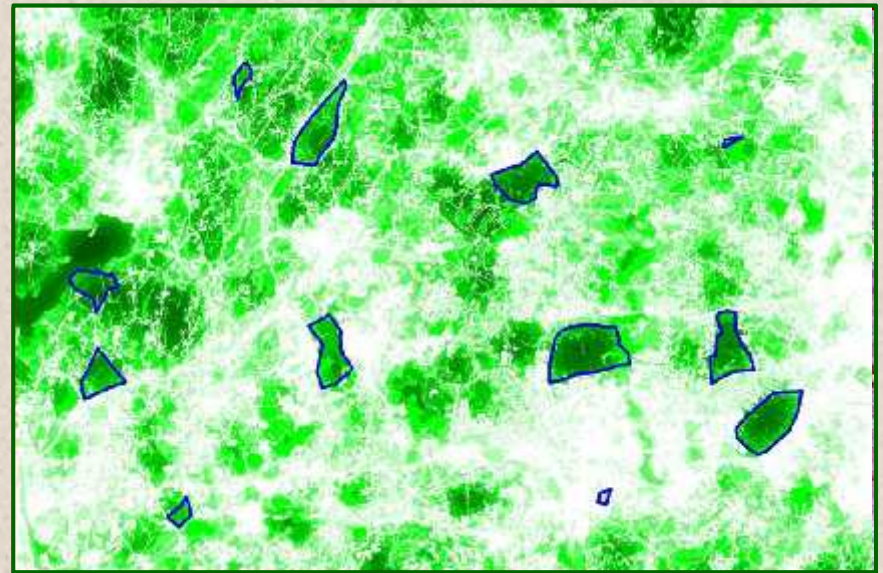
- Scenario analysis



Scenario 1



Scenario 2



# Potential Applications

## Land Management

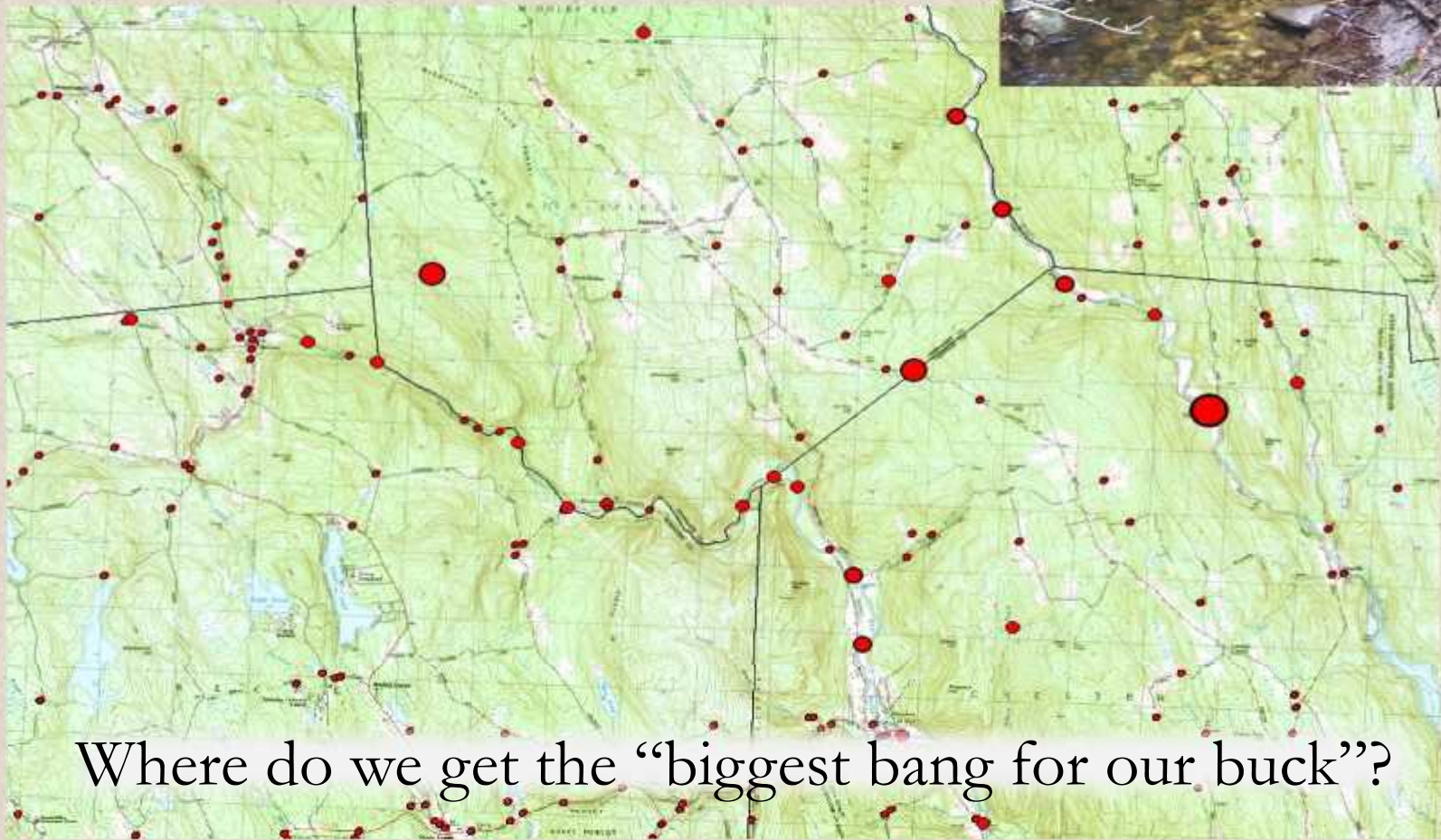
- Prioritizing representative species for management
  - How vulnerable is each species to habitat loss and climate change within your focus area?
  - What proportion of each species' current habitat within the region does your focus area provide?
  - Within the region, how important is your focus area in maintaining the persistence of each species in light of climate change?
  - What proportion of each species' current habitat is protected within the region?



# Potential Applications

## Restoration

- Prioritizing road-stream crossings to improve aquatic connectivity



Where do we get the “biggest bang for our buck”?



# Potential Applications

## Restoration

- Prioritizing locations for potential road passage structures to improve terrestrial connectivity



Where do we get the “biggest bang for our buck”?



# Potential Applications

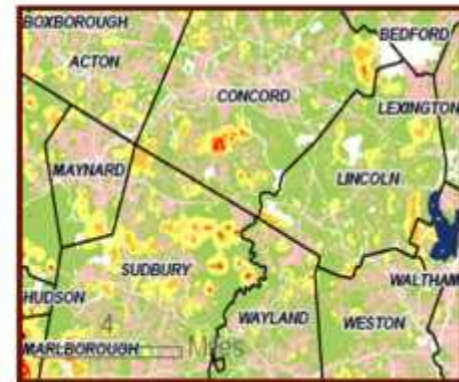
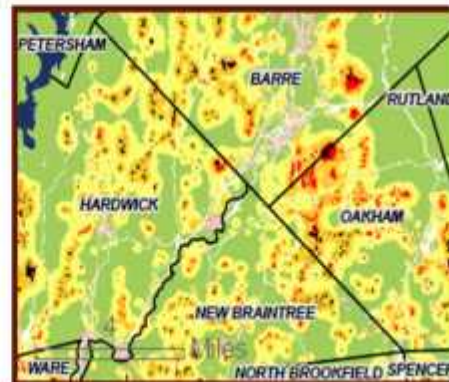
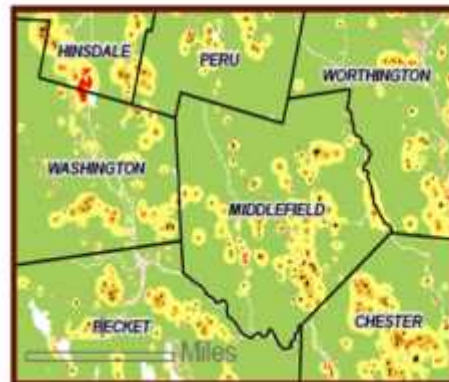
## Monitoring

Figure 3.3: Loss of ecological integrity between 1971 and 2005, a transect through Massachusetts



### Loss in IEI (1971 - 2005)

- Loss of > 0.75
- Loss of 0.5 - 0.75
- Loss of 0.25 - 0.5
- Loss of 0.1 - 0.25
- Development
- Forested/Natural



“Between 1971 and 2005, Massachusetts suffered a 23% reduction in its overall ecological integrity”





## Next Steps (phase 2 and beyond)



- Expand to NALCC and Northeast Region
- Develop additional drivers (e.g., SLR, timber harvest)
- Develop landscape design module
- Integration with other products (e.g., aquatic model, TNC products)
- Dissemination of products
- Outreach to planners & managers for applications
- Integration with other LCCs
- Improve GIS data!
- And more?



# For More Information

- Project website:

[www.umass.edu/landeco/research/nalcc/nalcc.html](http://www.umass.edu/landeco/research/nalcc/nalcc.html)



- Personal contact:

[mcgarigalk@eco.umass.edu](mailto:mcgarigalk@eco.umass.edu)

413-577-0655