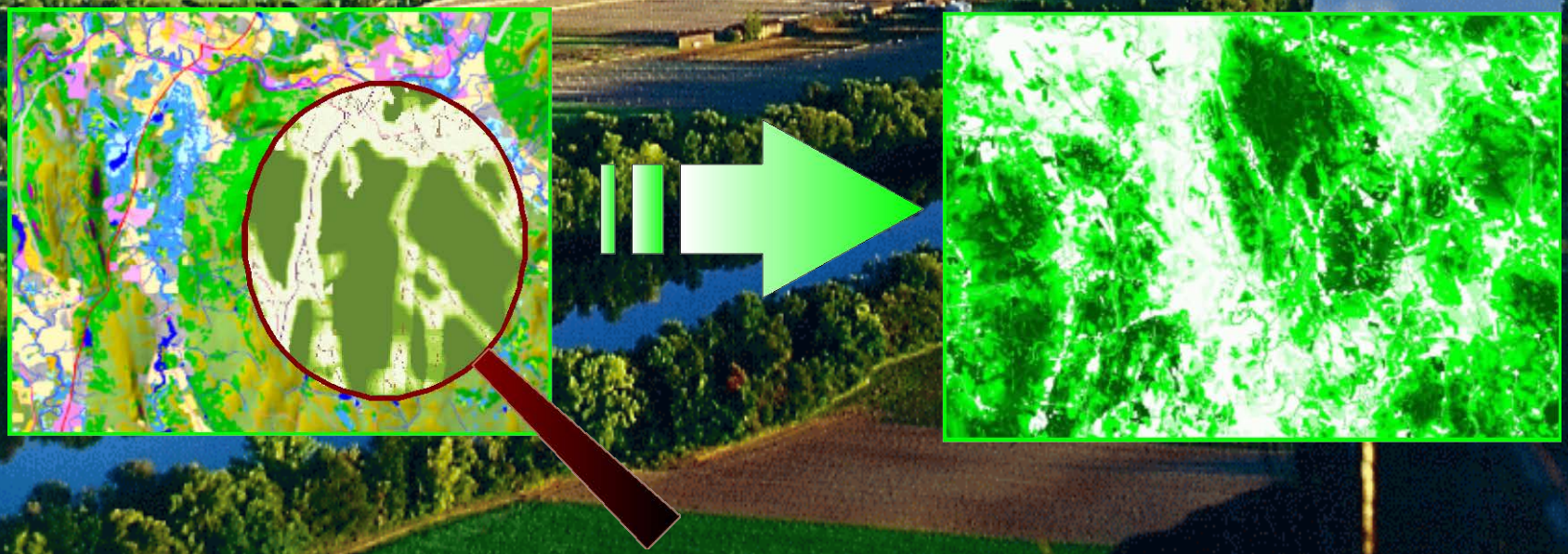
Designing Sustainable Landscapes in the Northeast

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

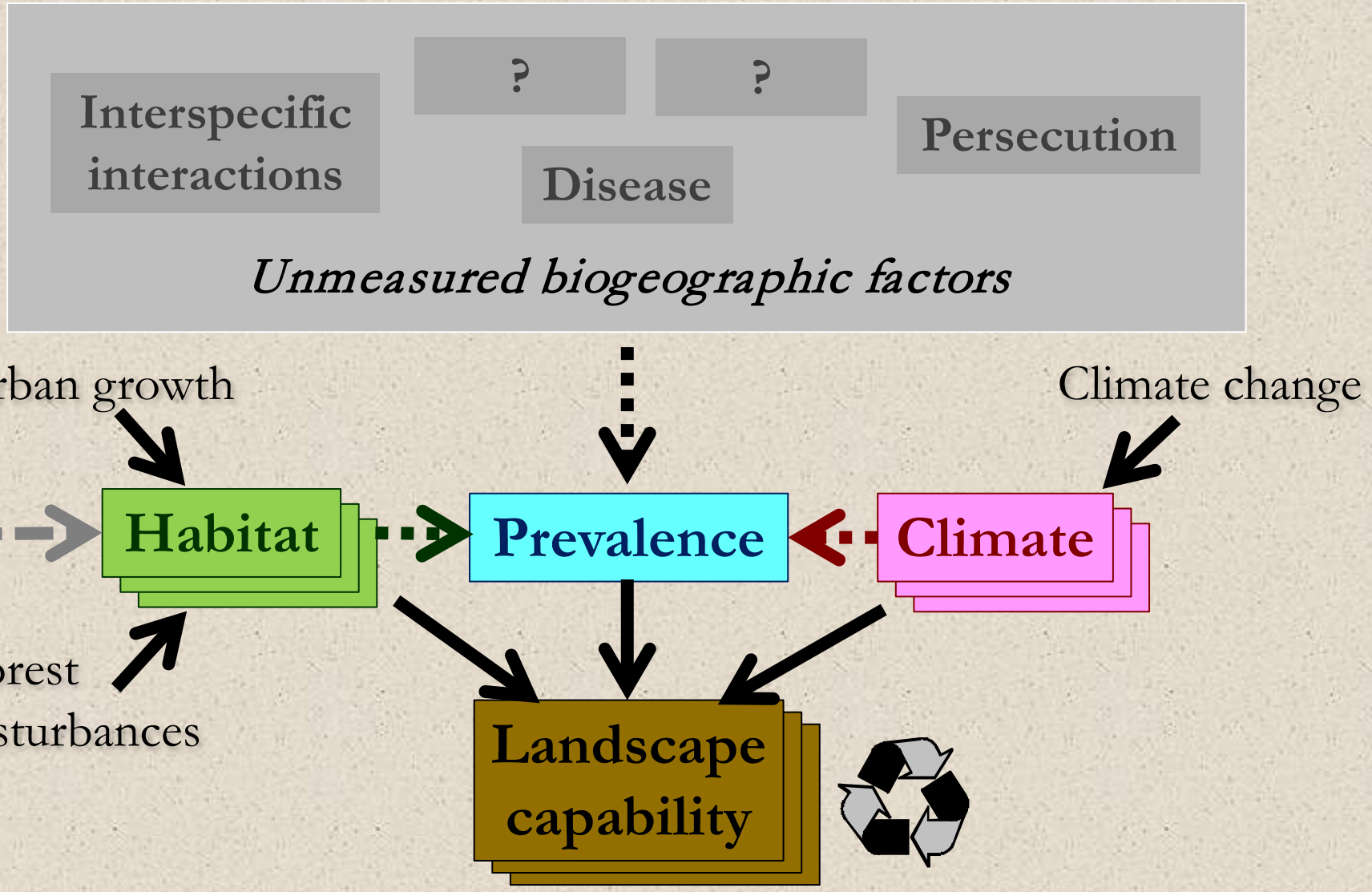
LCD Terrestrial Subgroup

June 12, 2014



Landscape Capability

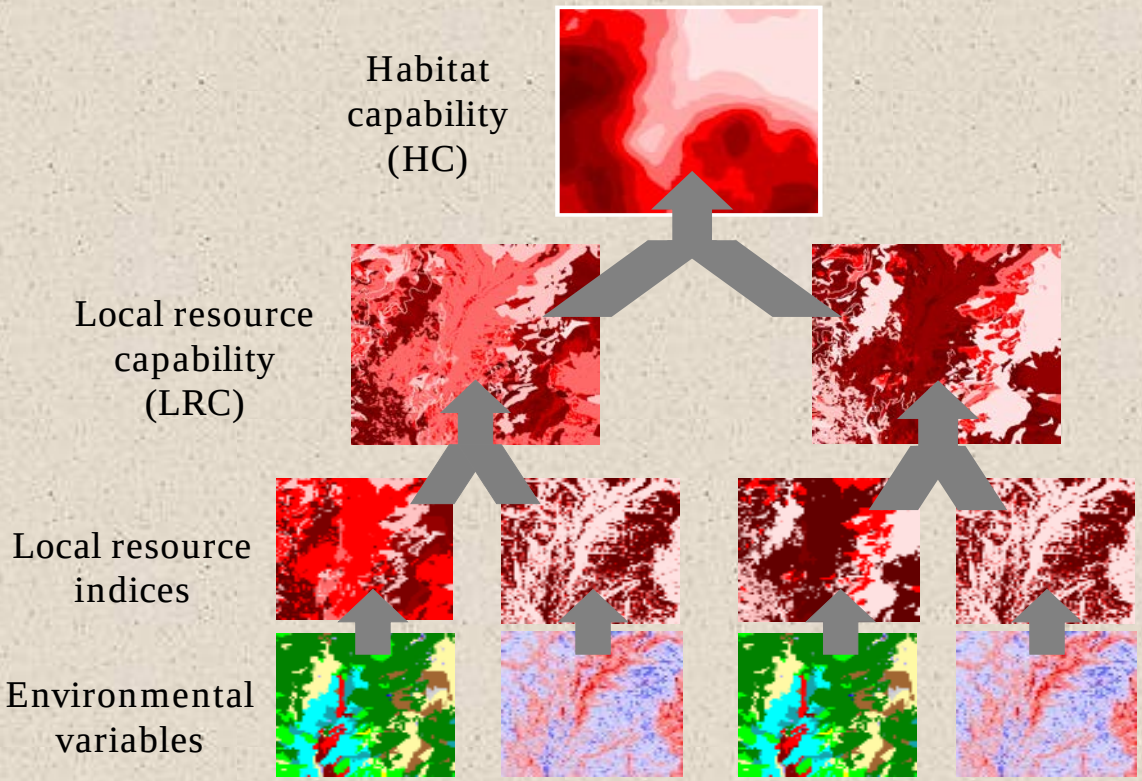
Conceptual framework



Habitat Capability

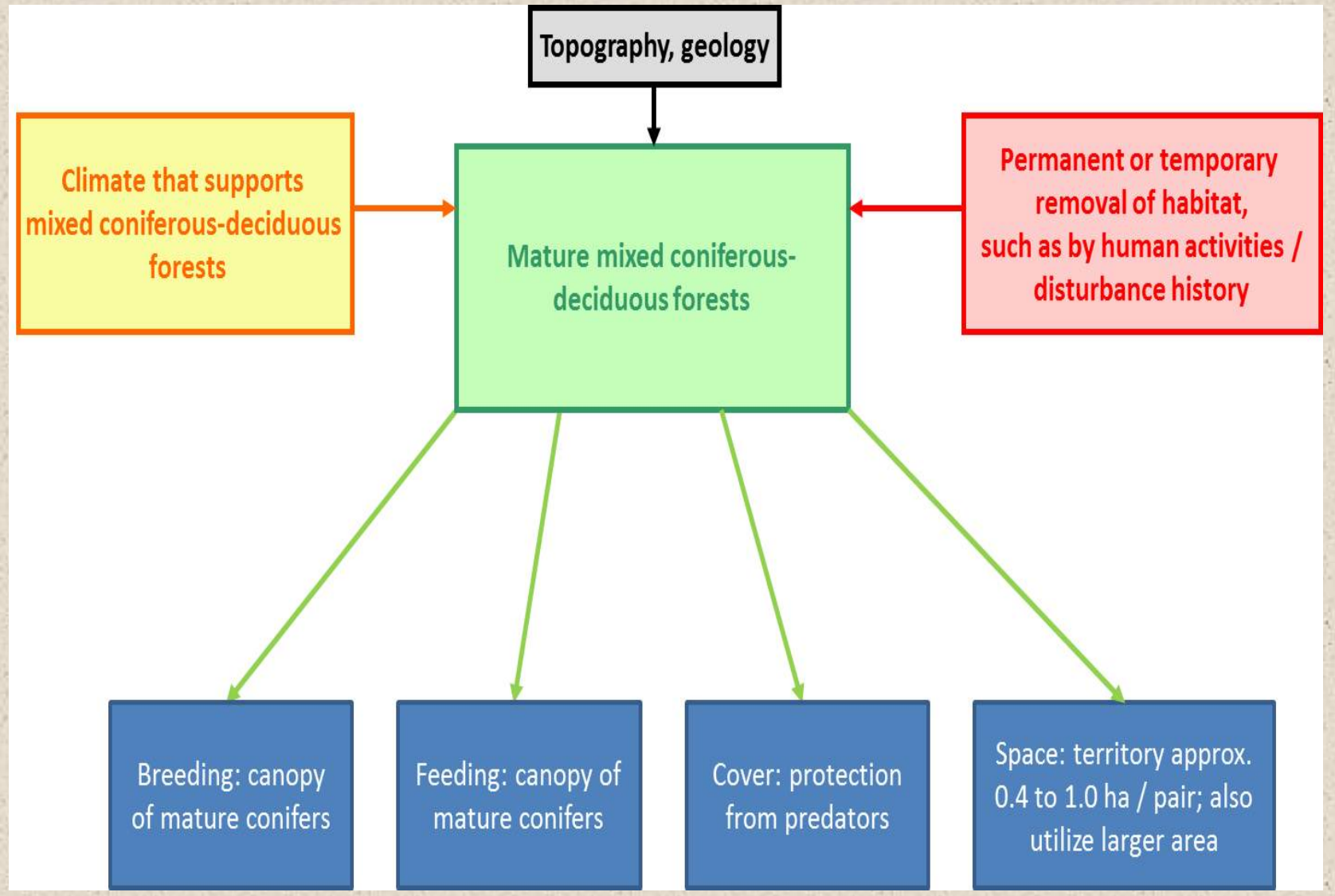
HABIT@ modeling framework

- Spatially-explicit
- Multi-scale
- Expert/empirically -derived
- Integration of local resource quantity, quality and accessibility



Habitat Capability

blbw habitat requirements



Habitat Capability

blbw HABIT@ model

Habitat Capability

eame HABIT@ model

Habitat Capability (HC)

LRC: Breeding

$$exp\left(\frac{3 \cdot ln(LRB1 \cdot LRB2) + 1 \cdot ln(LRB3) + 3 \cdot ln(LRB4)}{7}\right) \cdot LRB5 \cdot LRB6$$

LRB1 Ecological system for breeding

LRB2 Proximity to perch sites (edges)

LRB3 Topographic wetness

LRB4 Habitat extent

LRB5 Small extent development intensity

LRB6 Large extent development intensity

Airport grasslands

ESM+

ESM+

Wetness

ESM+

ESM+

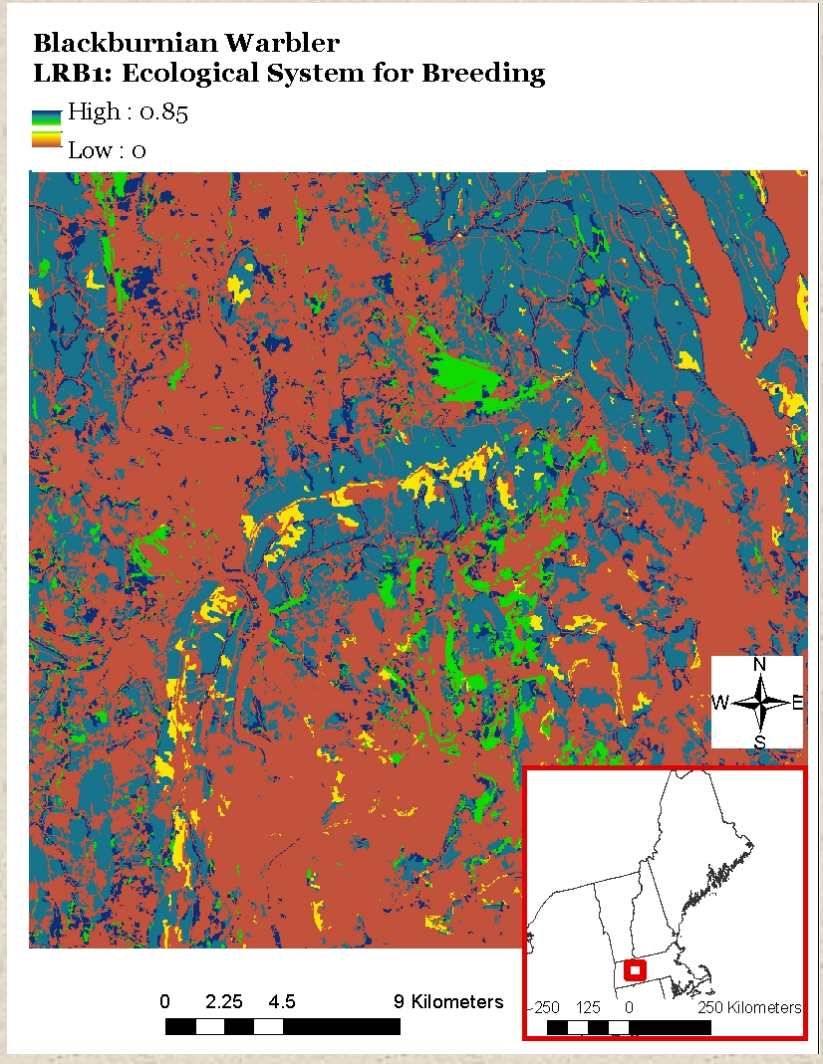
ESM+

Habitat Capability

blbw HABIT@ model

- **LRB1: Ecological system for breeding**

Ecological System Description	LRB1 (breeding habitat value)
Central and Southern Appalachian Spruce-Fir Forest	1
Eastern Boreal Floodplain	1
Laurentian-Acadian Northern Hardwood Forest (high conifer variant)	1
Acadian Low Elevation Spruce-Fir-Hardwood Forest	1
N. Appalachian-Acadian Conifer-Hardwood Acidic Swamp (all variants)	1
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp (all variants)	1
Appalachian Hemlock-Northern Hardwood Forest (moist-cool)	0.85
Appalachian Hemlock-Northern Hardwood Forest (typic)	0.75
Acadian Sub-boreal Spruce Flat	0.7
Laurentian-Acadian Pine-Hemlock-Hardwood Forest (all variants)	0.7
Laurentian-Acadian Northern Hardwood Forest (typic)	0.7
Appalachian Hemlock-Northern Hardwood Forest (drier)	0.65
Laurentian-Acadian Northern Hardwood Forest (moist-cool)	0.5
North-Central Appalachian Acidic Swamp (all variants)	0.5
Laurentian-Acadian Floodplain Forest	0.3
Appalachian Dry Oak-Pine Forest	0.3
Laurentian-Acadian Red Oak-Northern Hardwood Forest	0.3
NE Interior Dry-Mesic Oak Forest (moist-cool)	0.3
Southern Appalachian Northern Hardwood Forest	0.3
Southern Appalachian Montane Pine Forest and Woodland	0.3
Southern Appalachian Low-Elevation Pine Forest	0.3
Central Appalachian Dry Oak-Pine Forest	0.3

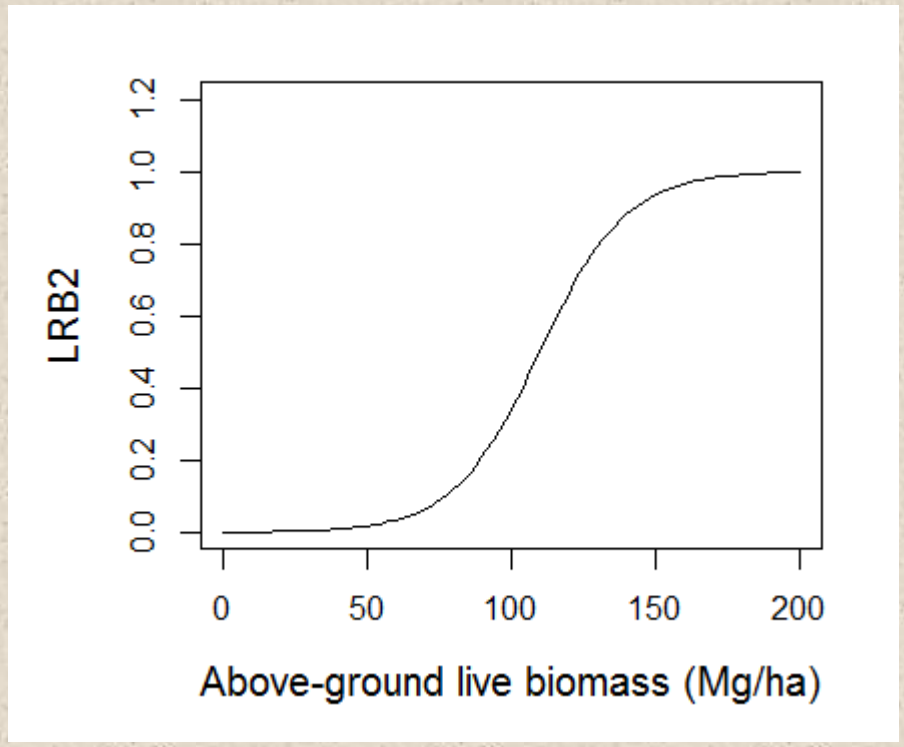


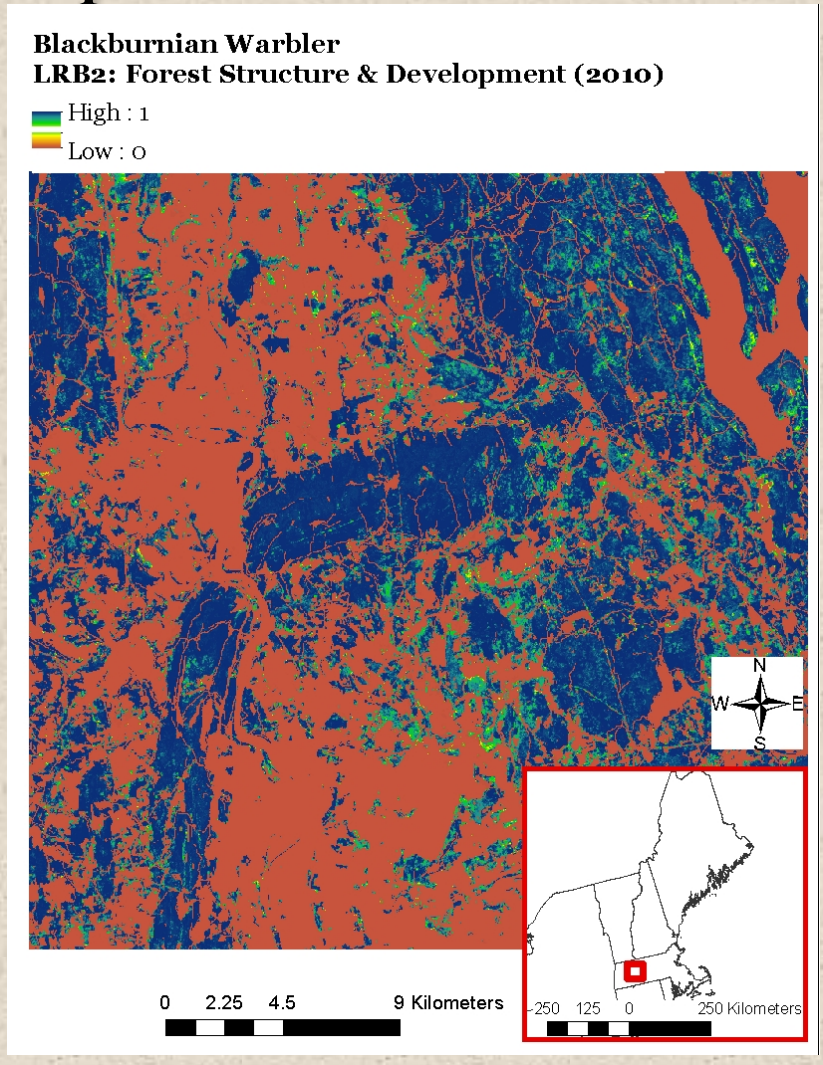
Habitat Capability

blbw HABIT@ model

- **LRB2: Forest structure & development**

= logistic function of biomass



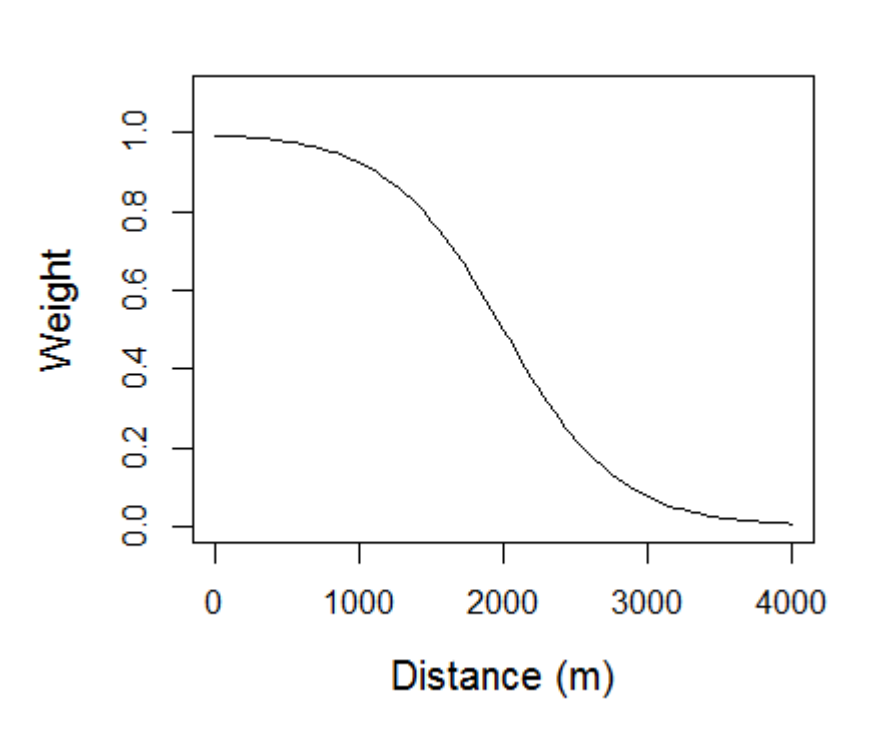


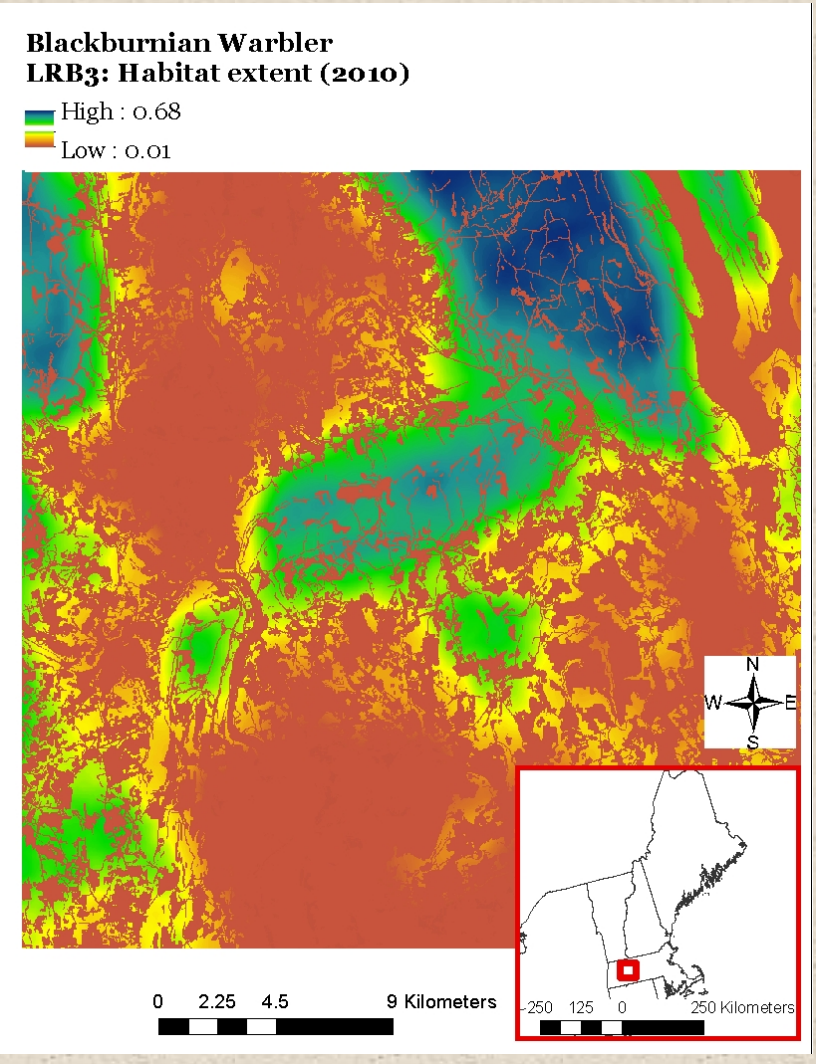
Habitat Capability

blbw HABIT@ model

- **LRB3: Habitat extent**

= kernel weighted intensity of LRB1



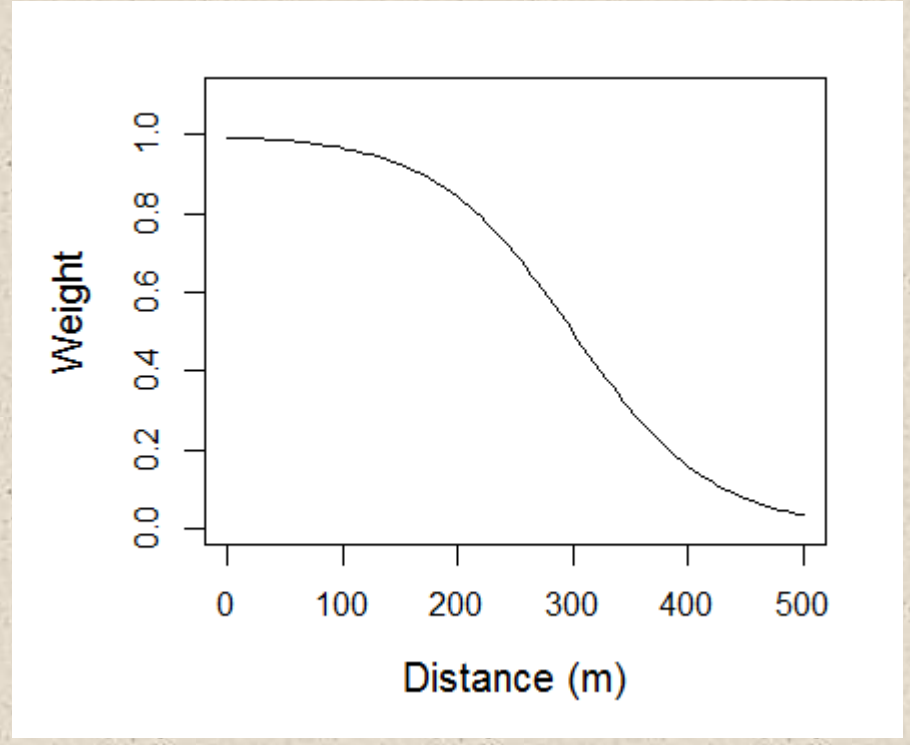


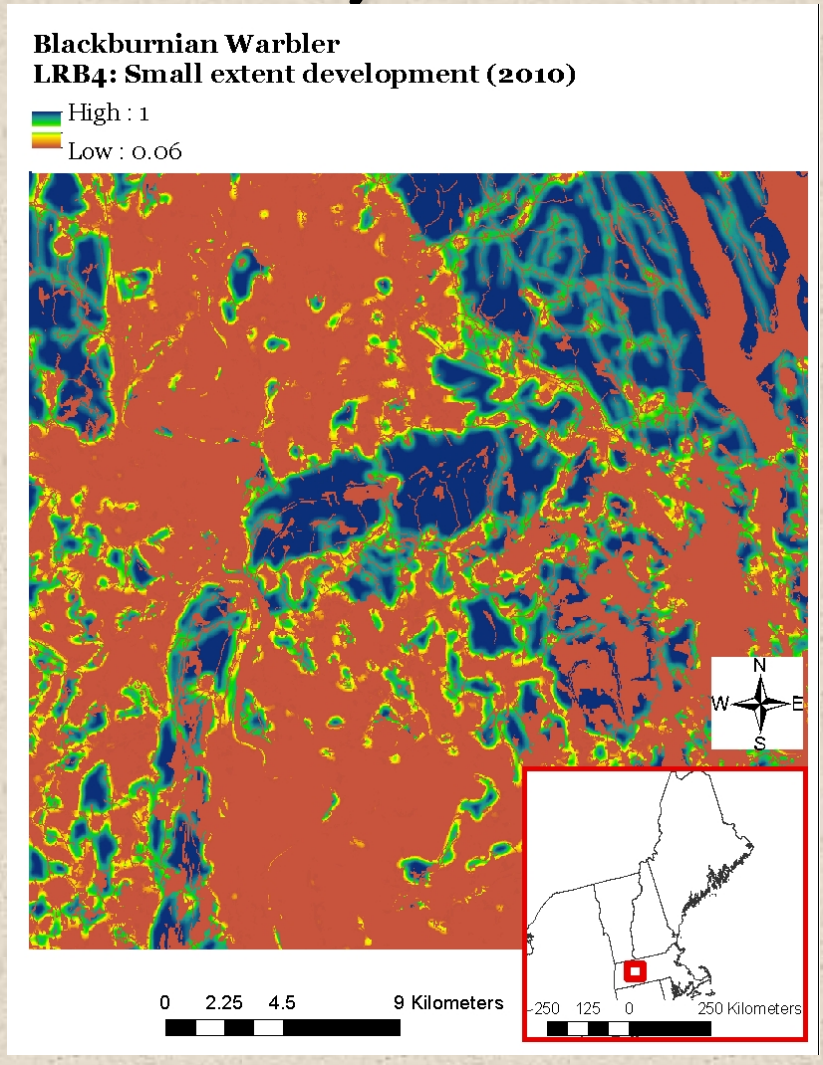
Habitat Capability

blbw HABIT@ model

- **LRB4: Small extent development intensity**

= 1 - kernel weighted intensity of development



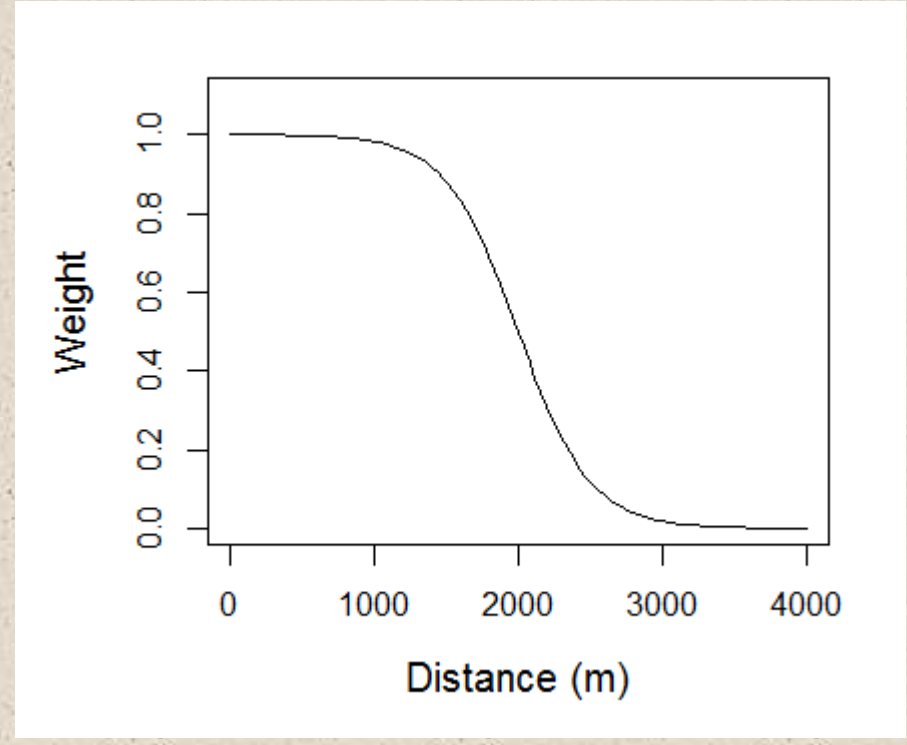


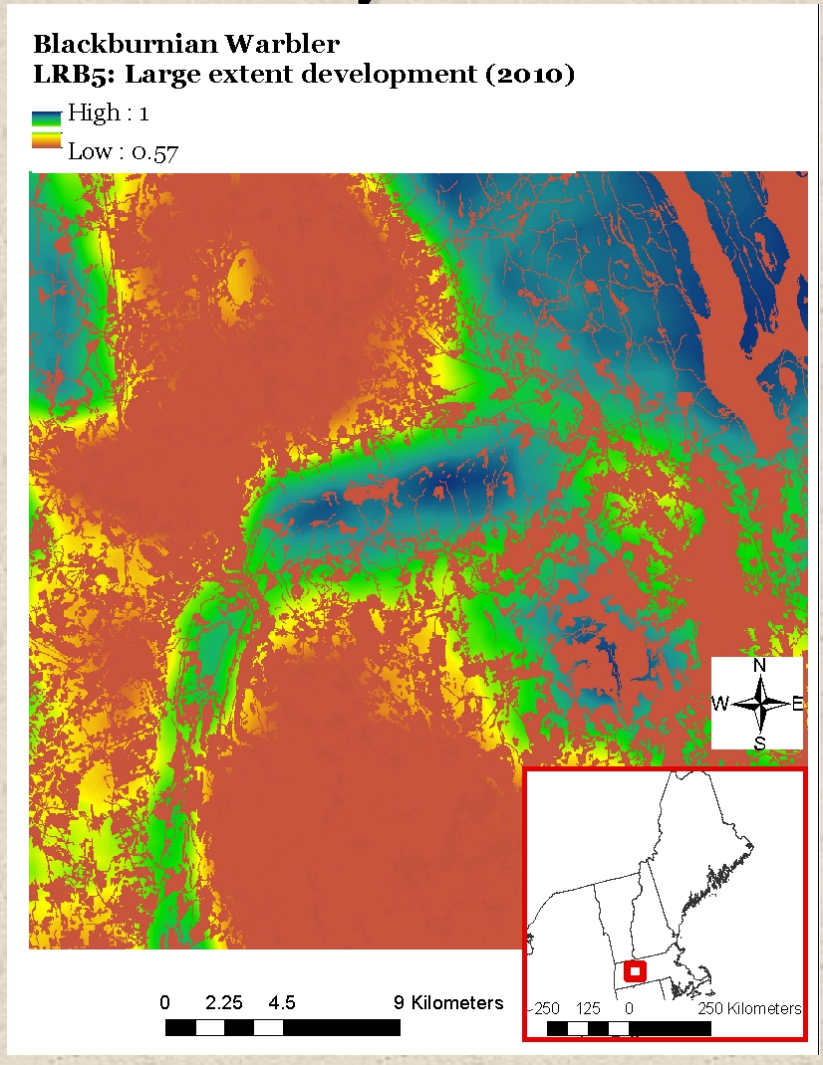
Habitat Capability

blbw HABIT@ model

- **LRB5: Large extent development intensity**

= 1 - kernel weighted intensity of development



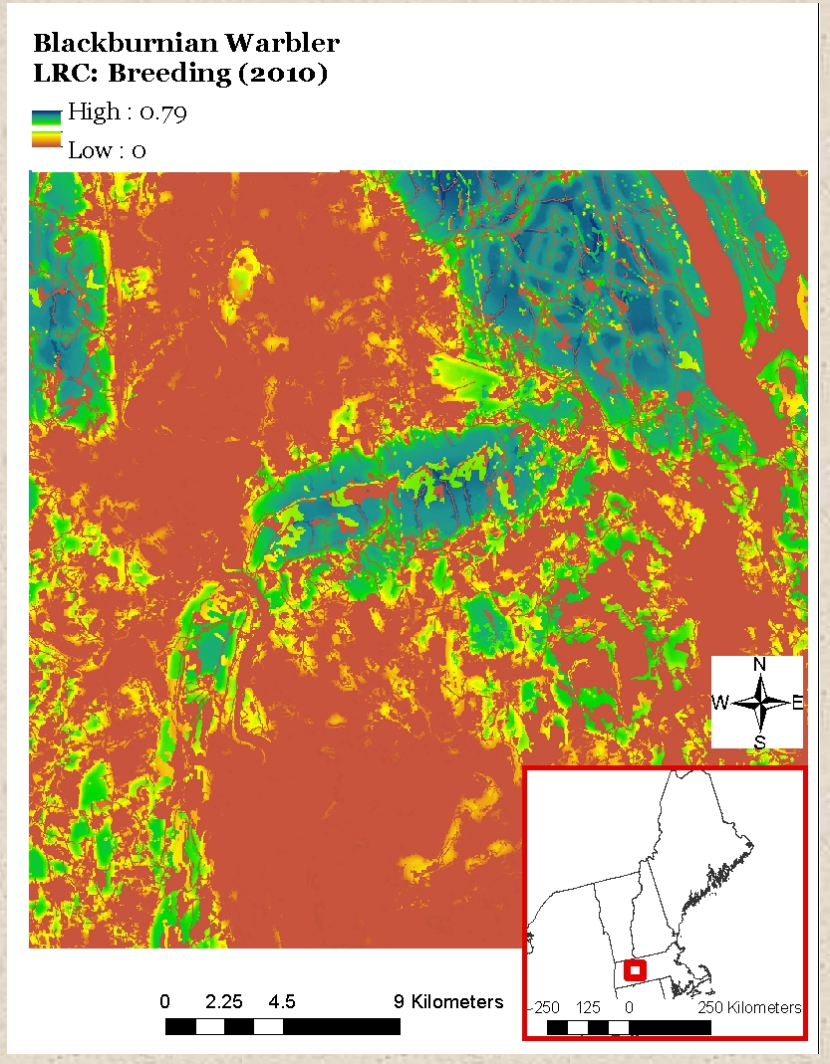


Habitat Capability

blbw HABIT@ model

- **LRC: Breeding**

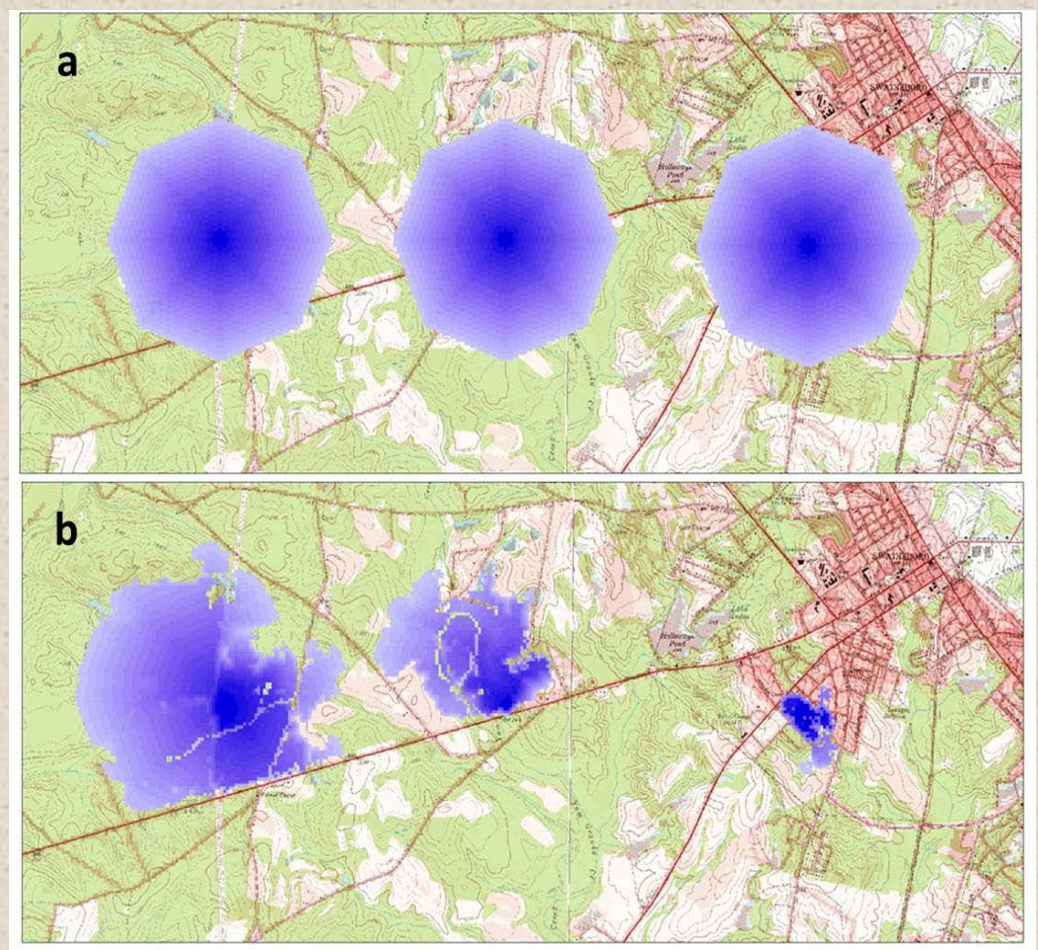
$$exp\left(\frac{3\cdot ln(LRB1)+1\cdot ln(LRB2)+3\cdot ln(LRB3)}{7}\right)\cdot LRB4\cdot LRB5$$



Habitat Capability

blbw HABIT@ model

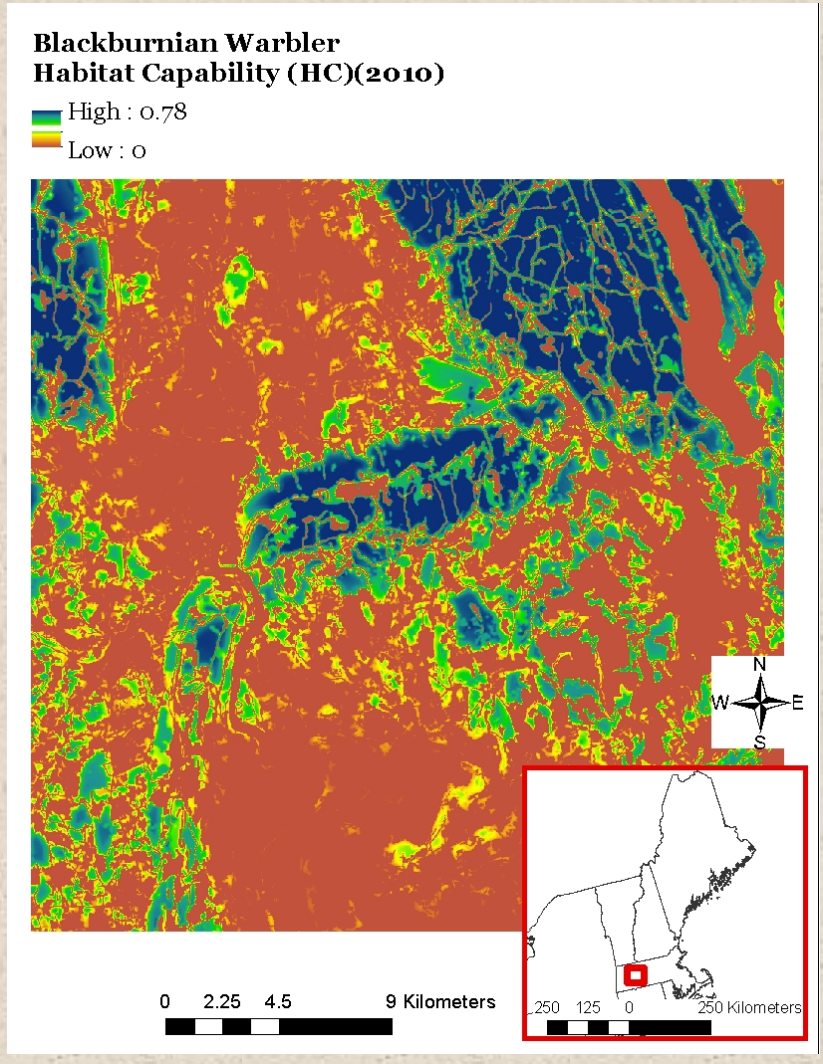
- **Habitat Capability (HC)**
  - For each focal cell:
  - Build a *homerange kernel* (resistant kernel based on resistance surface with Gaussian bandwidth = 50 m)
  - Sum kernel-weighted LRC values
  - Range 0-1



Habitat Capability

blbw HABIT@ model

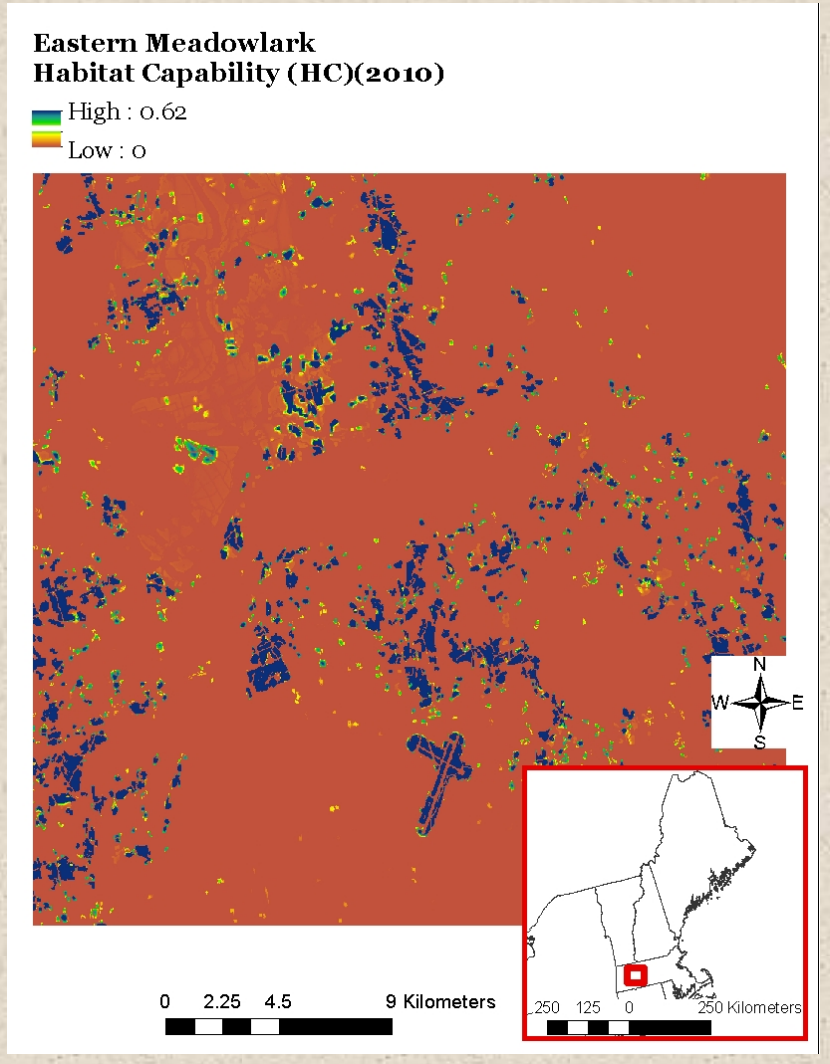
- **Habitat Capability (HC)**
  - For each focal cell:
  - Build a *homerange kernel* (resistant kernel based on resistance surface with Gaussian bandwidth = 50 m)
  - Sum kernel-weighted LRC values
  - Range 0-1



Habitat Capability

eame HABIT@ model

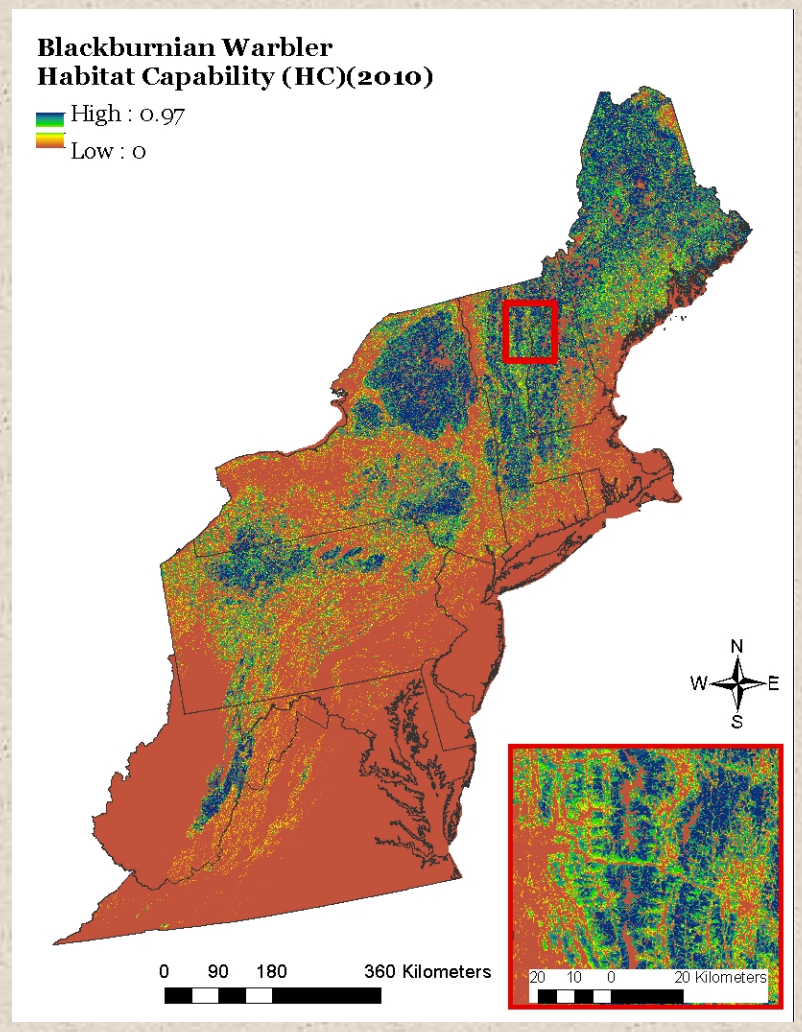
- **Habitat Capability (HC)**
  - For each focal cell:
  - Build a *homerange kernel* (resistant kernel based on resistance surface with Gaussian bandwidth = 50 m)
  - Sum kernel-weighted LRC values
  - Range 0-1

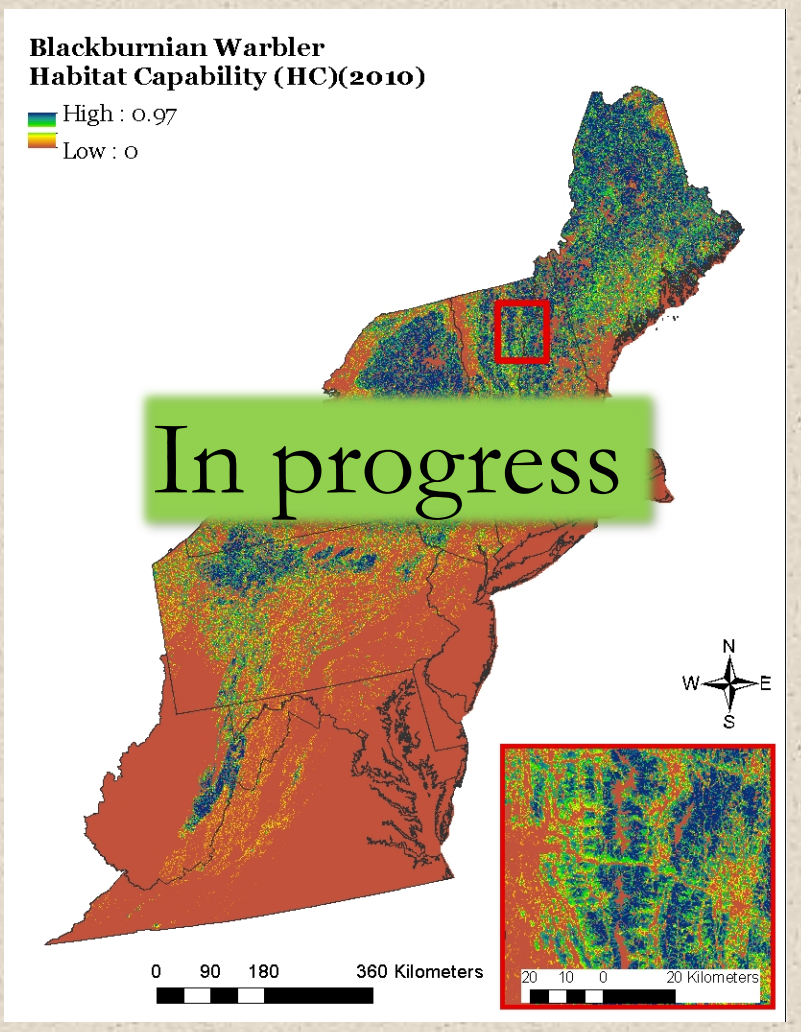


Habitat Capability

blbw HABIT@ model

- Current HC vs Future HC

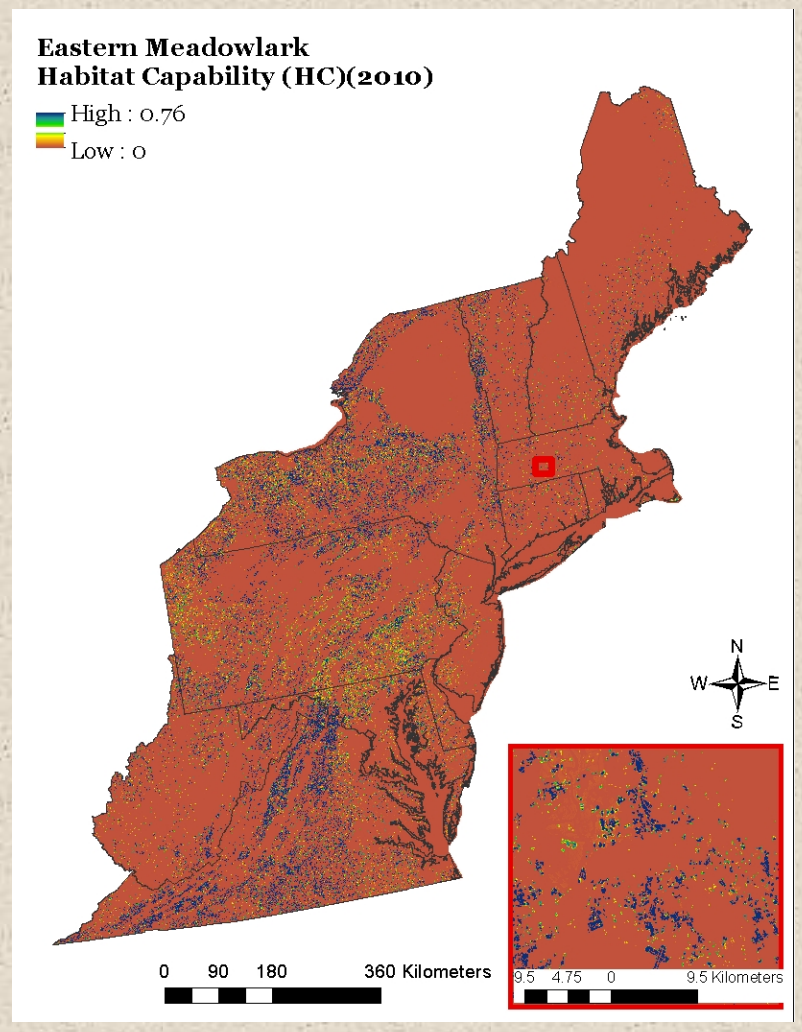


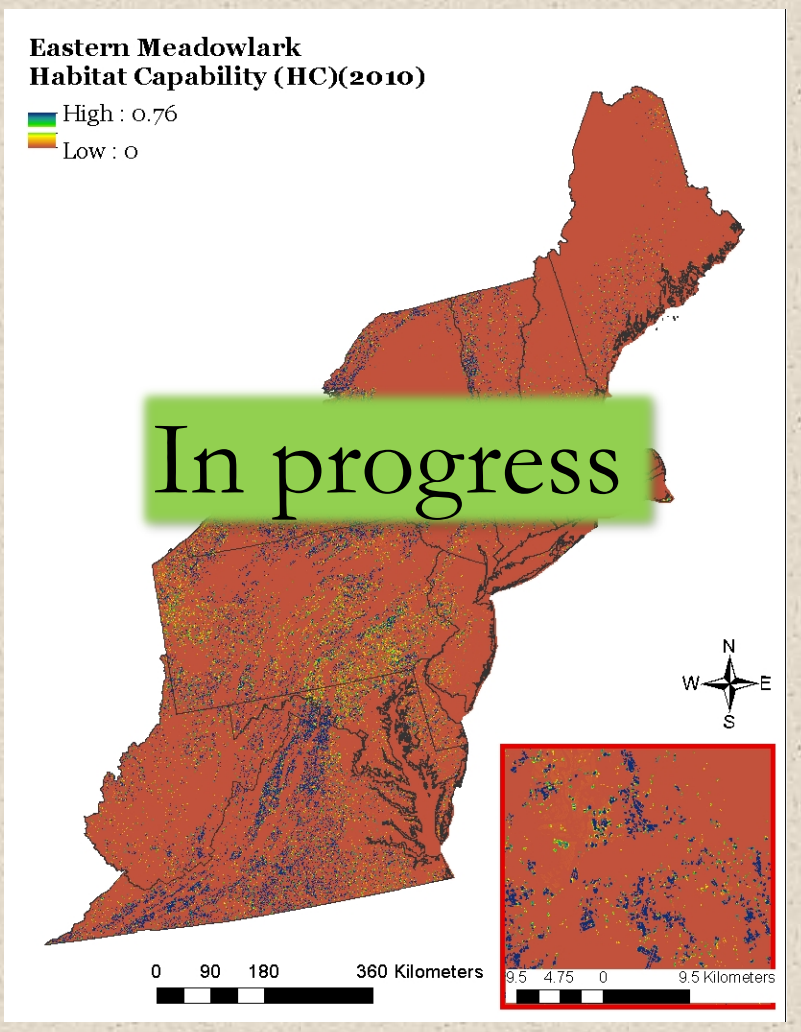


Habitat Capability

eame HABIT@ model

- Current HC vs Future HC

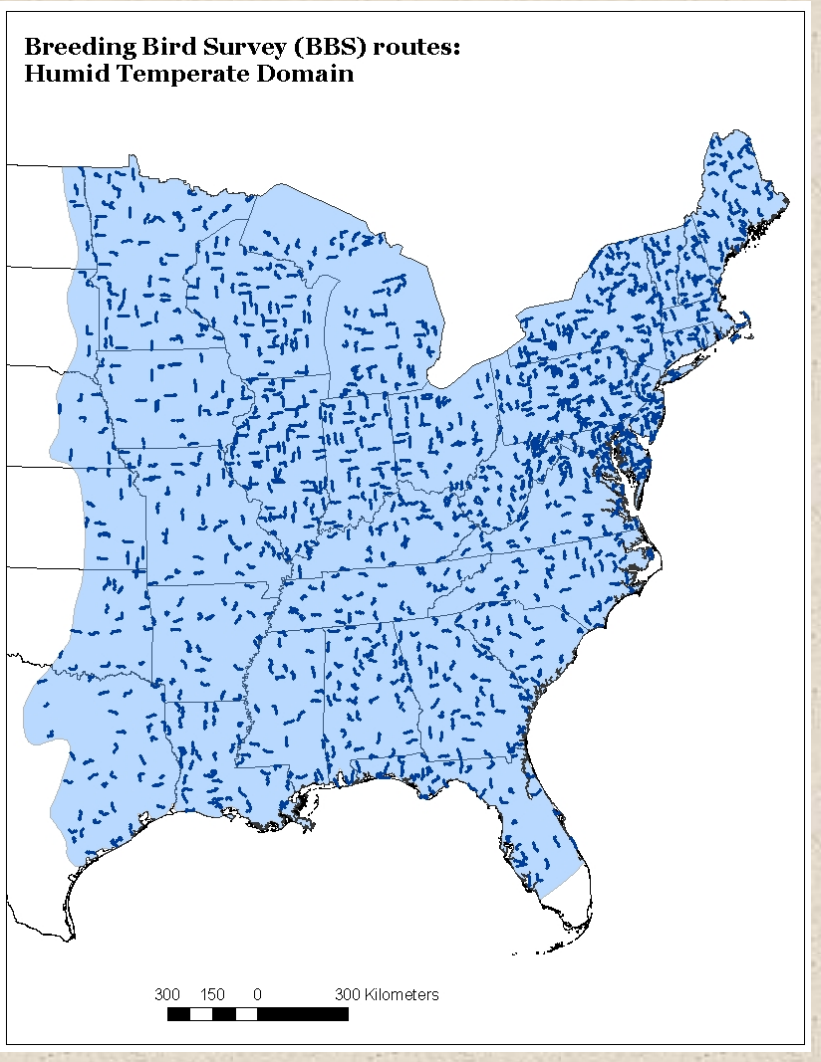




Climate Suitability

Climate niche modeling framework

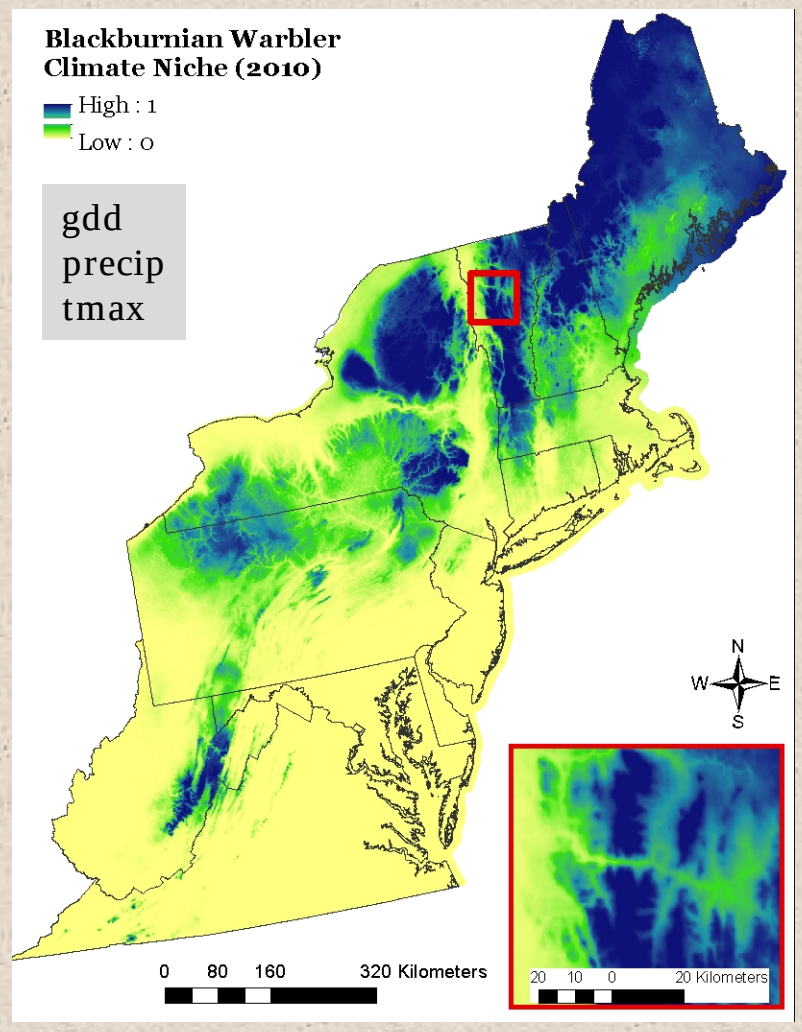
- Multiple logistic regression
- Presence/absence data (BBS)
- Humid temperate domain
- Suite of climate predictors
- All subsets model selection:
  - Achieve sensitivity of 95-98%
  - Minimize commission error
- Climate Niche (CN):
  - Continuous: Pr(suitable climate)
- Climate niche envelope (CNE):
  - Binary: (cutpoint that minimizes commission error)

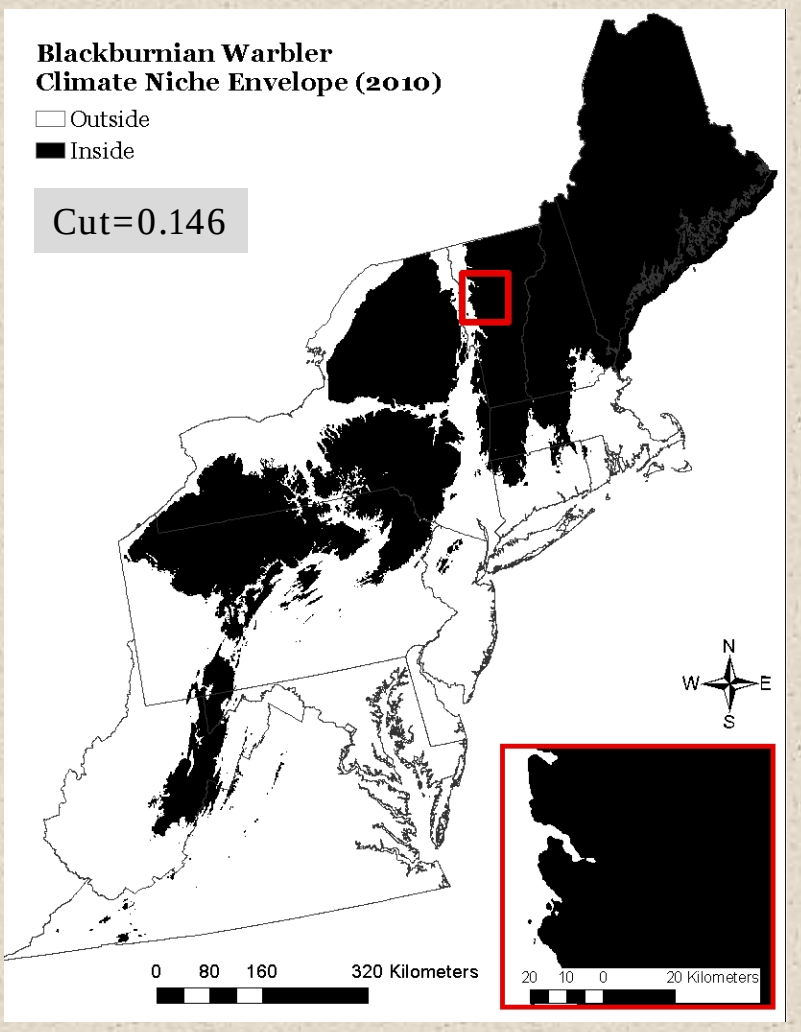


Climate Suitability

blbw climate niche model

- Climate Niche (CN) & CN Envelope (CNE)

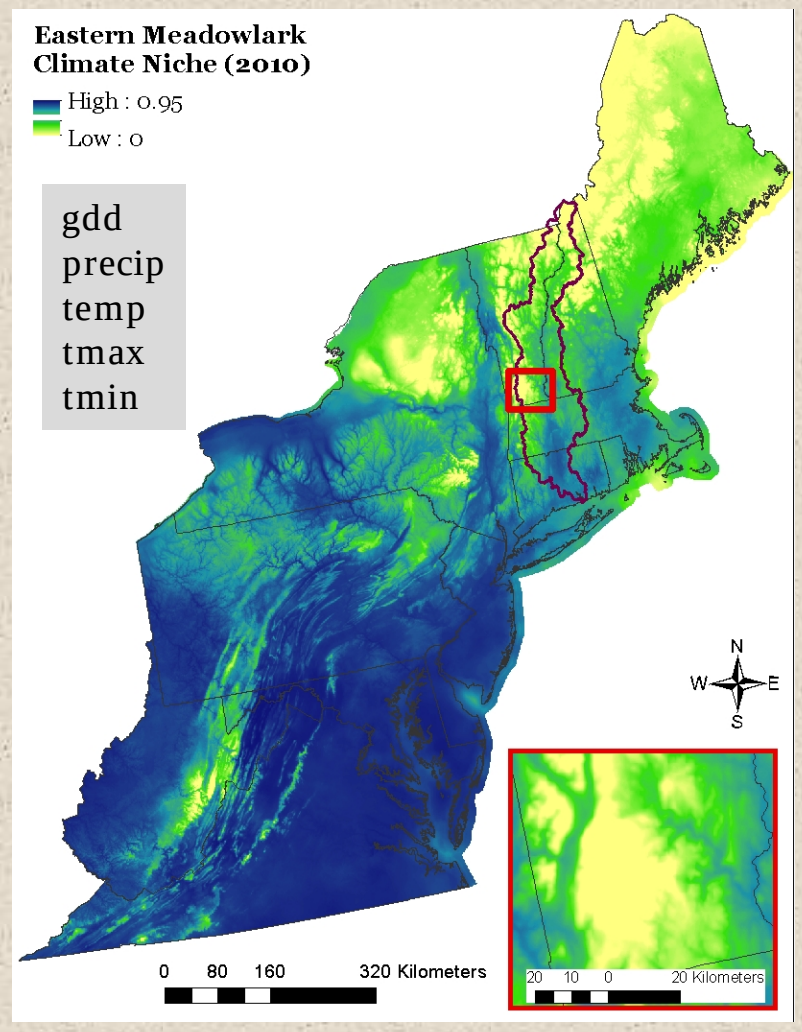


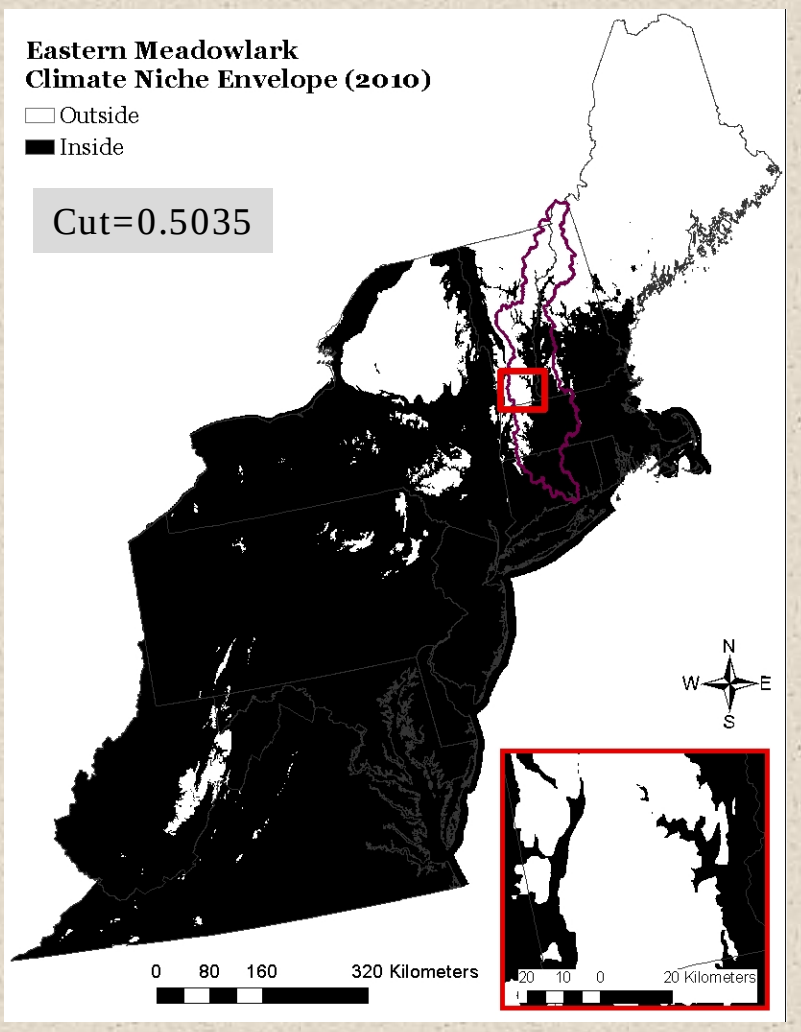


Climate Suitability

blbw climate niche model

- Climate Niche (CN) & CN Envelope (CNE)

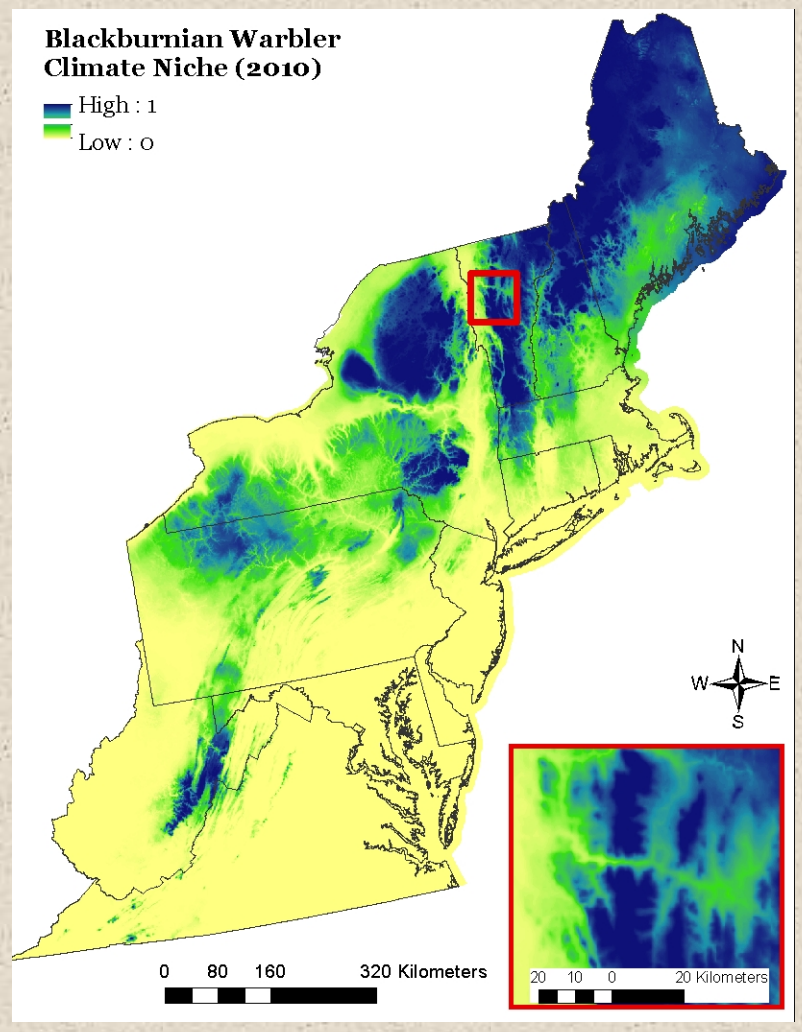


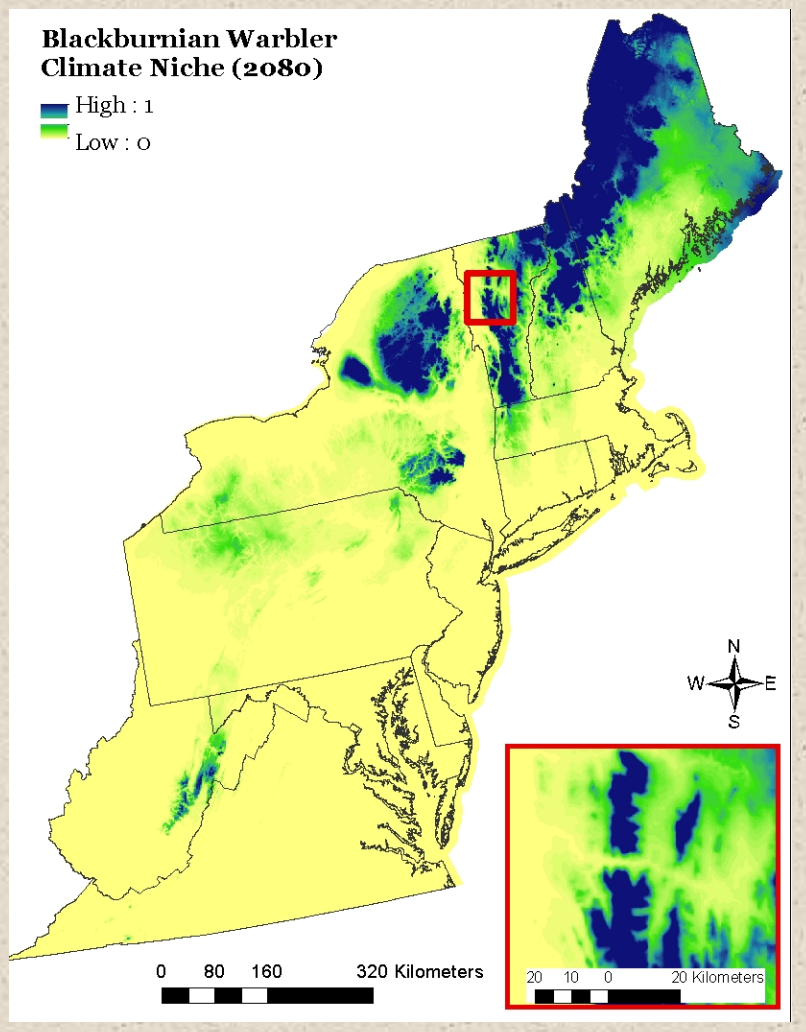


Climate Suitability

blbw climate niche model

- Current CN vs future CN

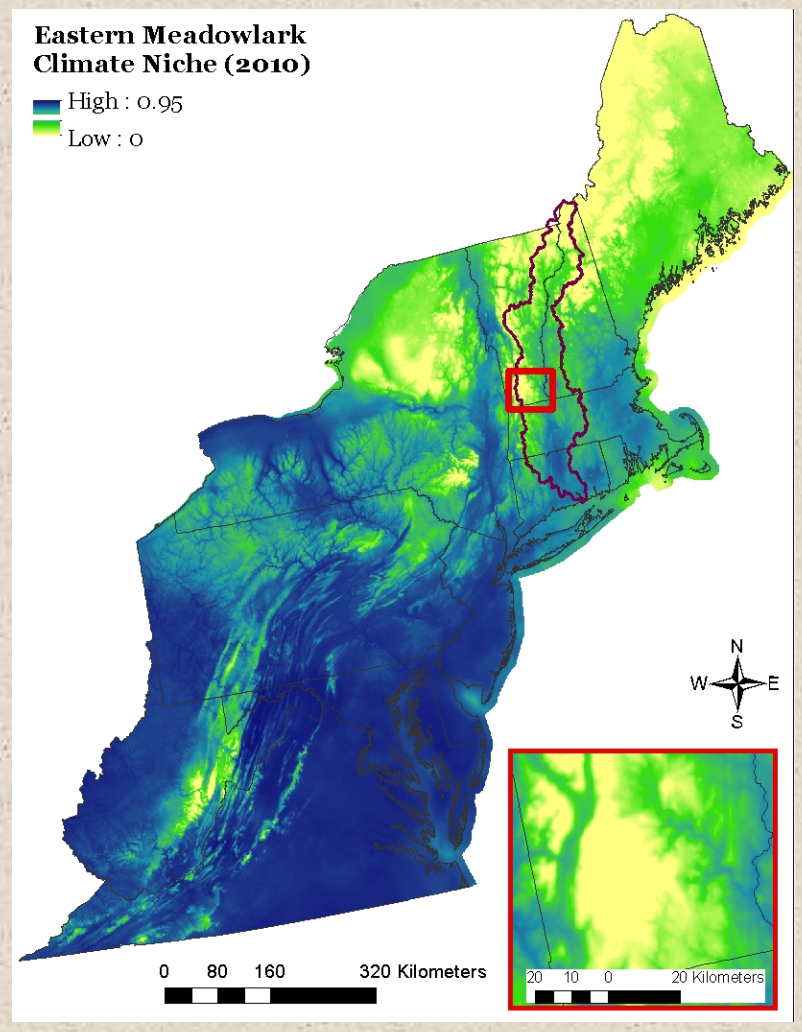


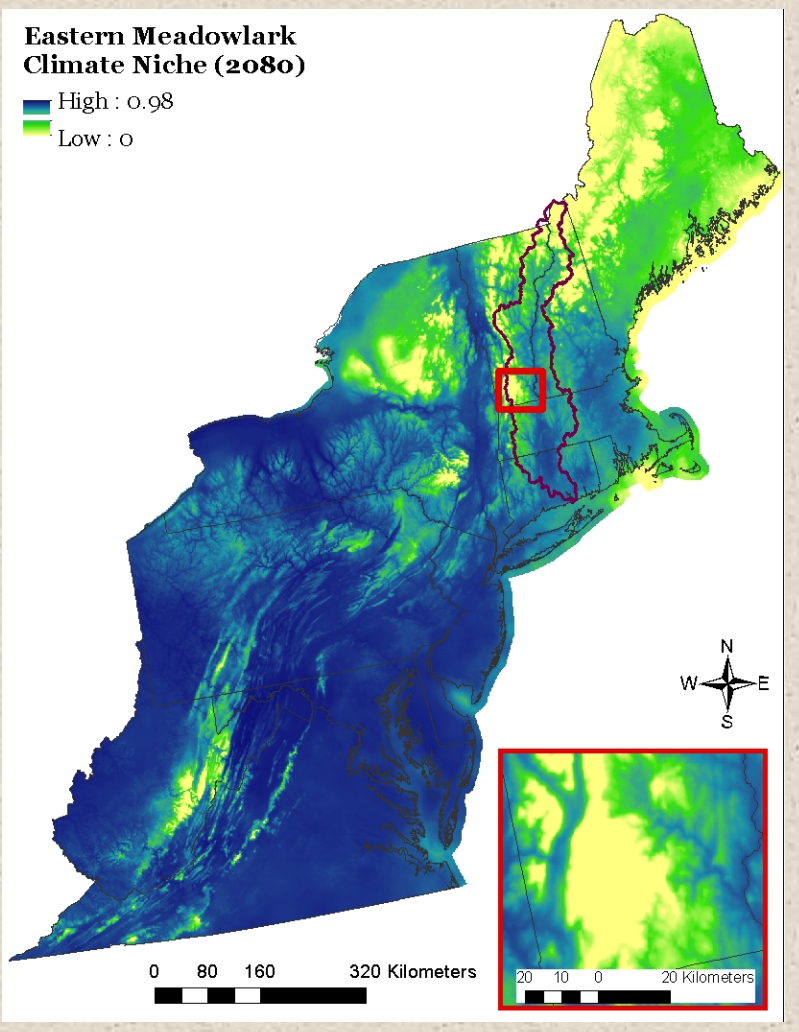


Climate Suitability

blbw climate niche model

- Current CN vs future CN



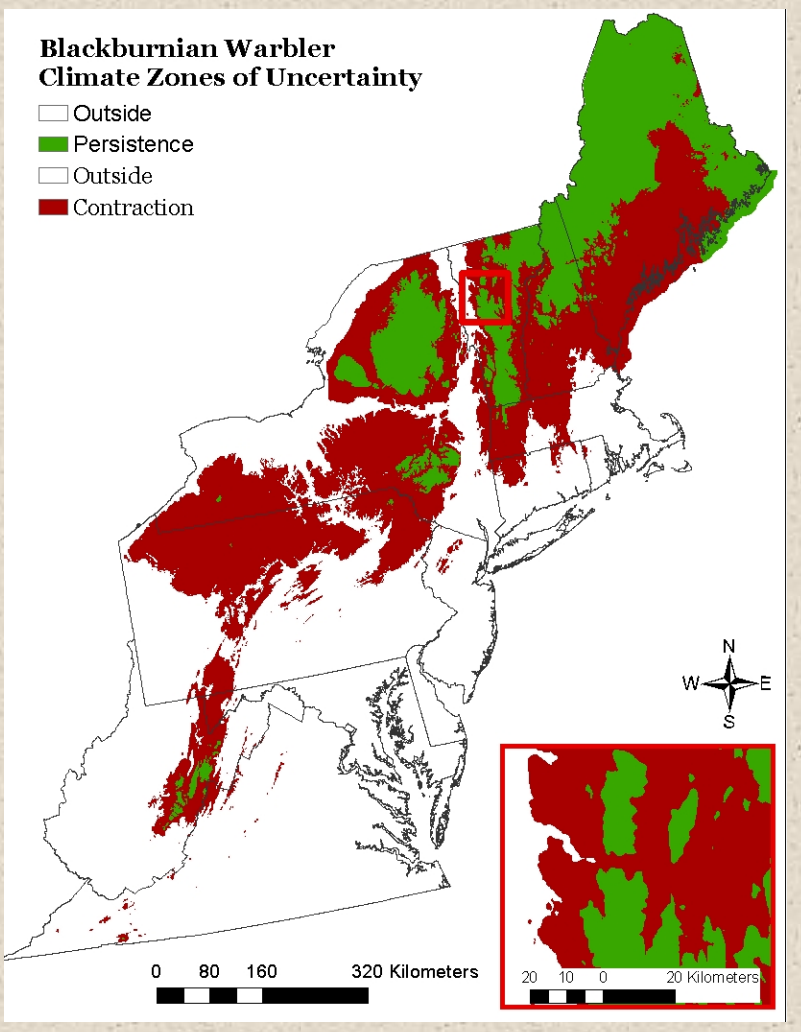


Climate Suitability

blbw climate niche model

- **Climate Zones of Uncertainty**

  - *Zone of Persistence*... within 2010 CNE and 2080 CNE
  - *Zone of Contraction*... within 2010 CNE but outside 2080 CNE
  - *Zone of Expansion*... Within 2080 CNE but outside 2010 CNE

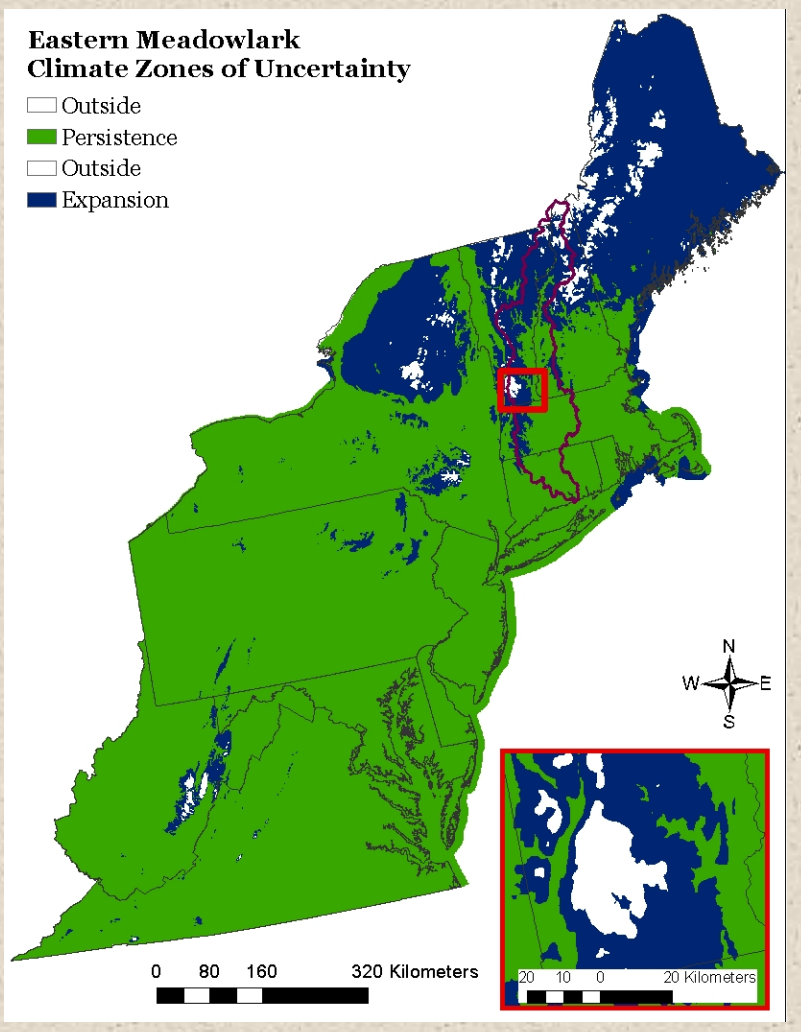


Climate Suitability

blbw climate niche model

- **Climate Zones of Uncertainty**

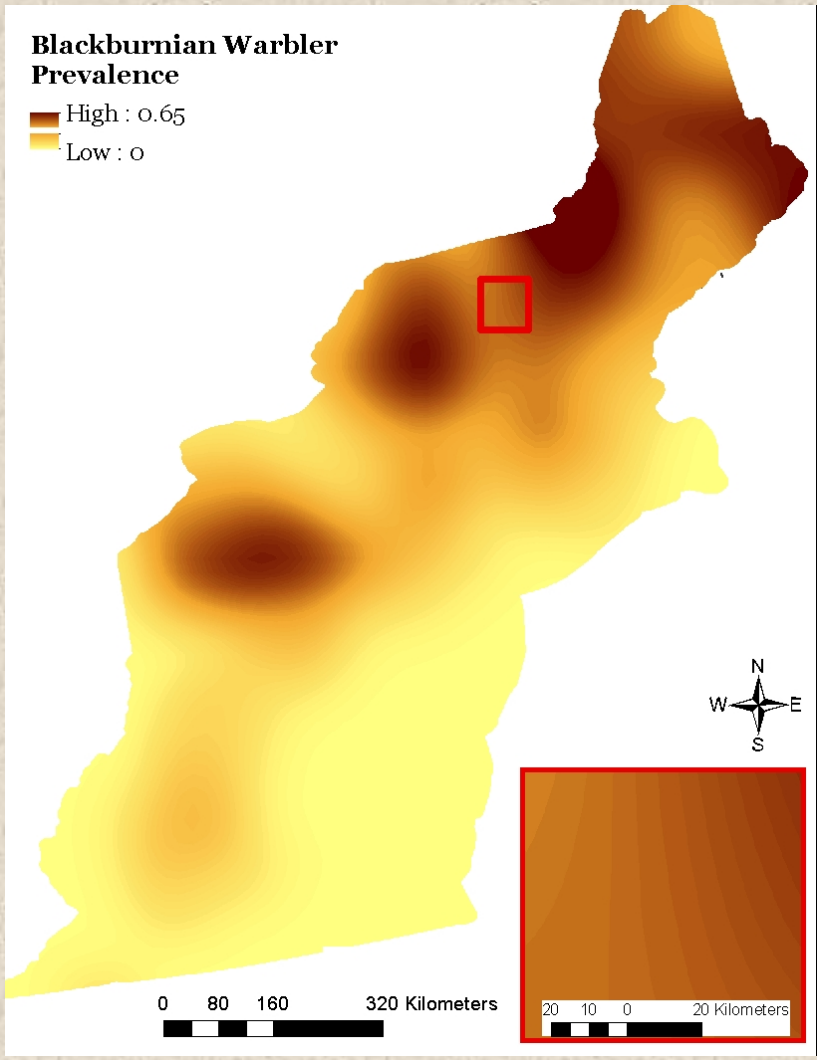
  - *Zone of Persistence*... within 2010 CNE and 2080 CNE
  - *Zone of Contraction*... within 2010 CNE but outside 2080 CNE
  - *Zone of Expansion*... Within 2080 CNE but outside 2010 CNE



Prevalence

Prevalence modeling framework

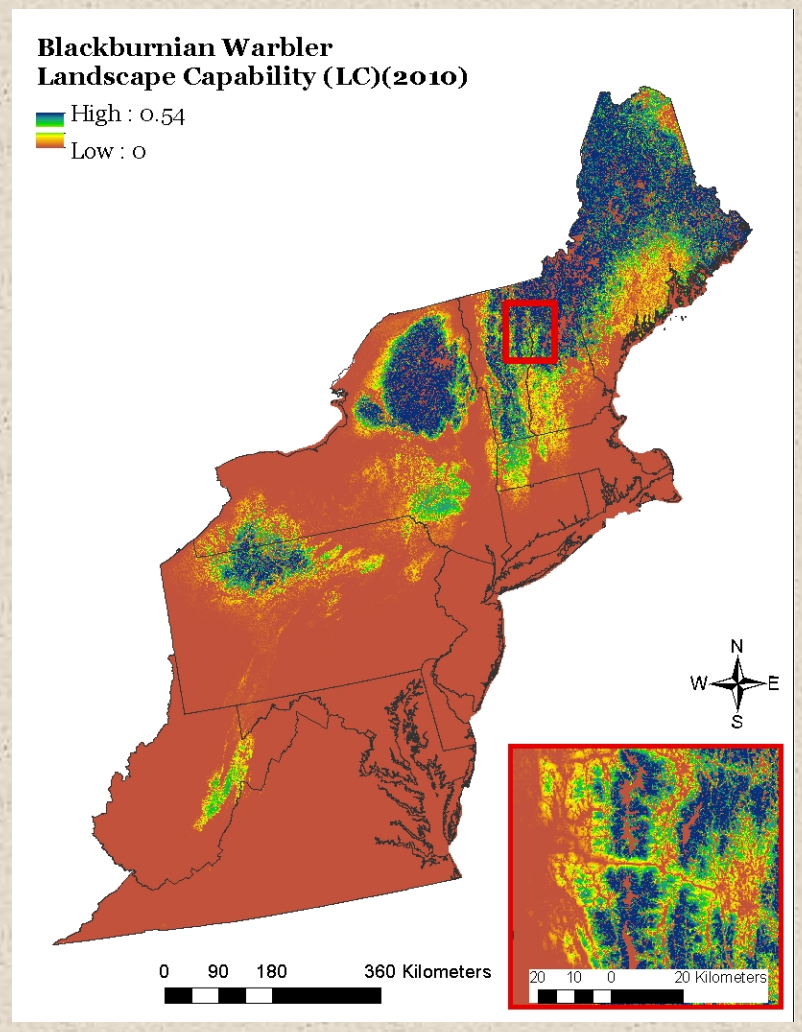
- Presence data (BBS)
- Proportional presence on each route segment (~8 km)
- Region subdivided into 20 km square cells
- Guassian distance-weighted (5 km bandwidth) interpolation of proportional presence
- Static: 2010 only

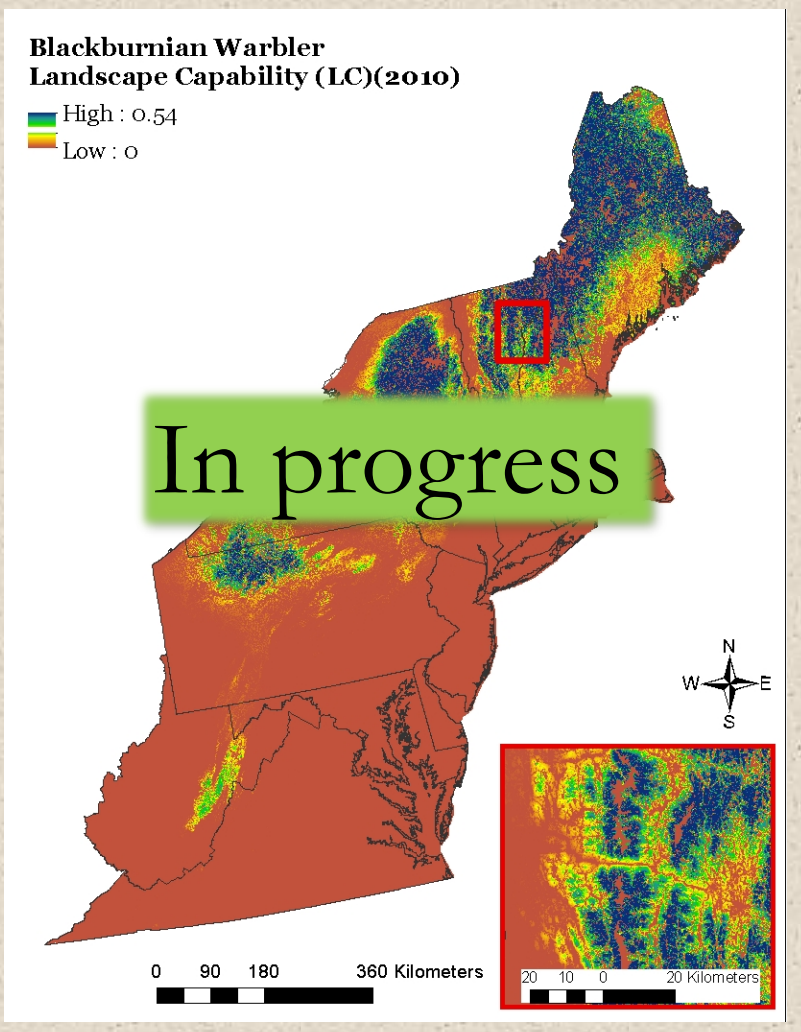


Landscape Capability

$$LC = HC \cdot CN \cdot Prevalence$$

- **Current LC vs future LC**

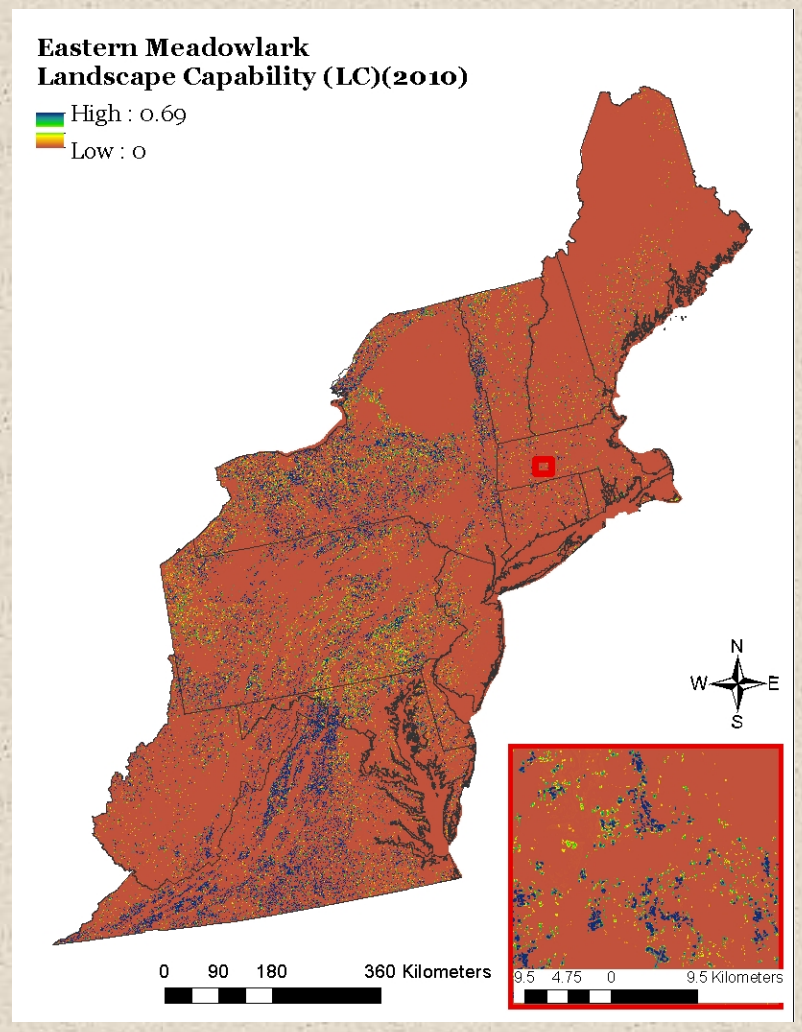


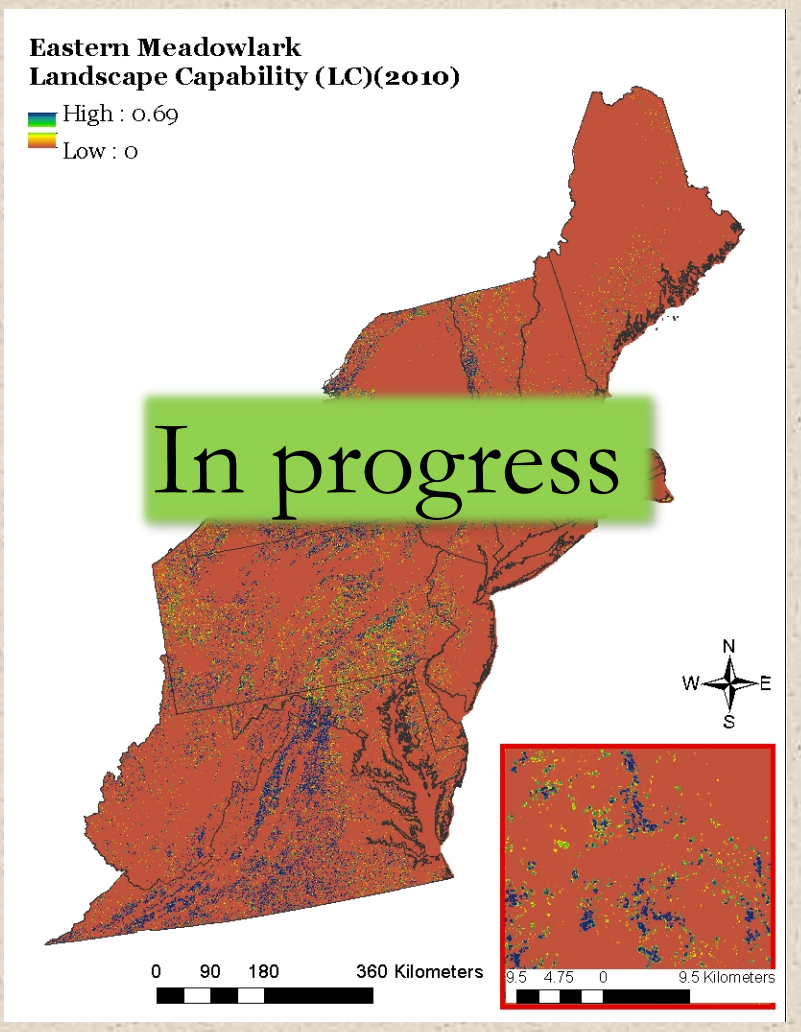


Landscape Capability

$$LC = HC \cdot CN$$

- Current LC vs future LC





Landscape Change Assessment

Non-spatial indices

1. **Climate response…** percent change in LC due to climate change
2. **Habitat response…** percent change in LC due to vegetation disturbance
3. **Climate & habitat response…** percent change in LC due to both climate & vegetation disturbance

Species	Current (2010) Landscape Capability (LC)	Landscape Change Response (2080) (%)		
		Climate	Habitat	Climate & Habitat
Blackburnian warbler	1,808,392	**-94.3**	tbd	tbd
Eastern meadowlark	660,206	17.4	tbd	tbd

Landscape Change Assessment

Spatial indices

- Grids depicting relative magnitude of persistence, vulnerability or expansion of landscape capability due to climate change, habitat change or both
- Quantile scaled non-zero values within project area
- Useful in LCD for prioritizing areas for species conservation accounting for potential future change

1. Persistence
2. Climate persistence
3. Climate vulnerability*
4. Climate expansion*
5. Habitat persistence
6. Habitat vulnerability

*Perhaps useful mainly in visualizing changes

Landscape Change Assessment

Spatial indices

1. **Persistence…** places with persistent high LC (current high LC and where climate and habitat conditions are expected to persist)

   = (current LC + future LC) / 2

Subject to the influence of future stochastic vegetation disturbances (or lack of)

In progress

Landscape Change Assessment

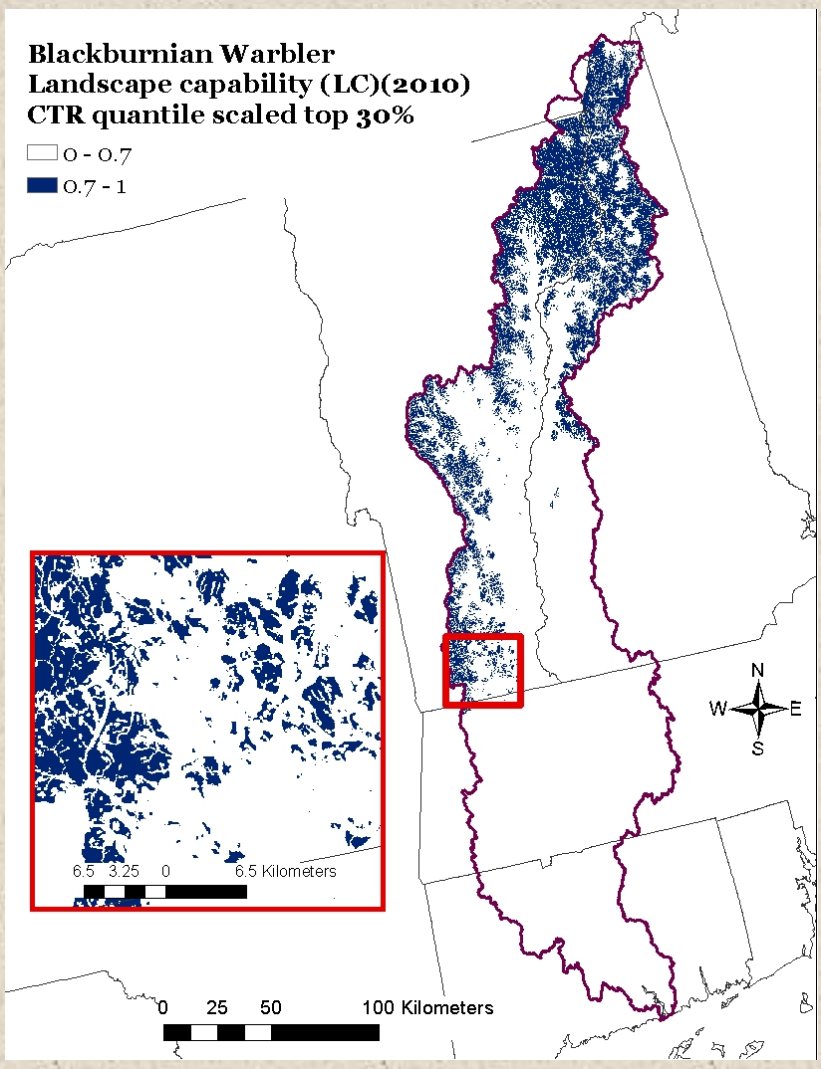
Spatial indices

2. Climate persistence…

places with high current LC that are most likely to maintain climate suitability over time

= (current LC + future LC.climate*) / 2

* Holds HC constant



Not subject to the influence of future stochastic vegetation disturbances (or lack of)

Landscape Change Assessment

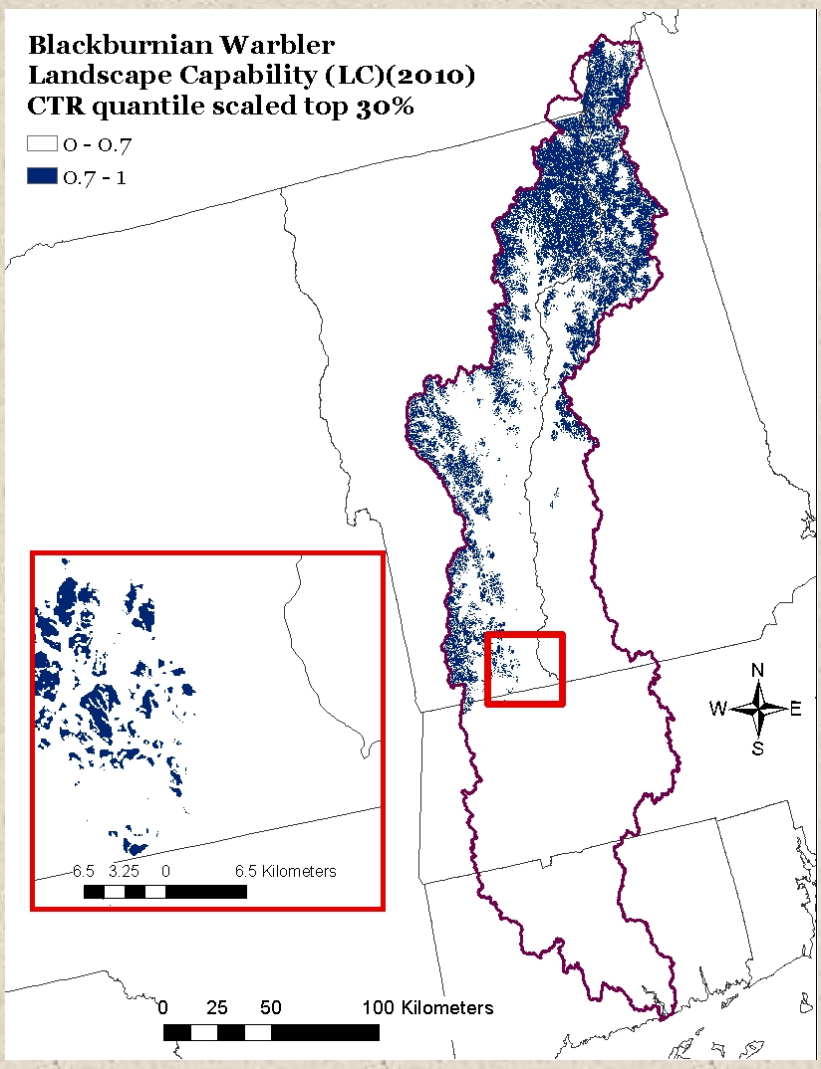
Spatial indices

3. Climate vulnerability…

places with high current HC that are most likely going to be outside the future CNE

= within zone of <u>contraction</u>,
(1 - current CN) · current HC · prev

<u>Not</u> subject to the influence of future stochastic vegetation disturbances (or lack of)



Landscape Change Assessment

Spatial indices

4. Climate expansion…

places with greatest likelihood of occurrence under a range shift scenario

= within zone of <u>expansion</u>, Future LC

Subject to the influence of future stochastic vegetation disturbances (or lack of)

In progress

Landscape Change Assessment

Spatial indices

5. Habitat persistence…

places with high current LC that are most likely to maintain habitat capability over time

= (current LC + future LC.habitat*) / 2

* Holds CN constant

Subject to the influence of future stochastic vegetation disturbances (or lack of)

In progress

Landscape Change Assessment

Spatial indices

6. Habitat vulnerability…

places with high current LC that are most likely to undergo future habitat loss or degradation

= (current LC – future LC.habitat*)** · current LC

* Holds CN constant
** Positive deltas only

Subject to the influence of future stochastic vegetation disturbances (or lack of)

In progress

For More Information

- **Project website:**

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

Feedback:

- Manager online survey

Links to products:

- Overview
- Technical docs
- Presentations
- Results

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