Sprawl: A regional model for urban growth

North Atlantic Landscape Conservation Cooperative (LCC)
Science Seminar
Hadley, Massachusetts
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Ethan Plunkett, Kevin McGarigal, Bradley Compton,
William DeLuca, Joanna Grand, Liz Willey

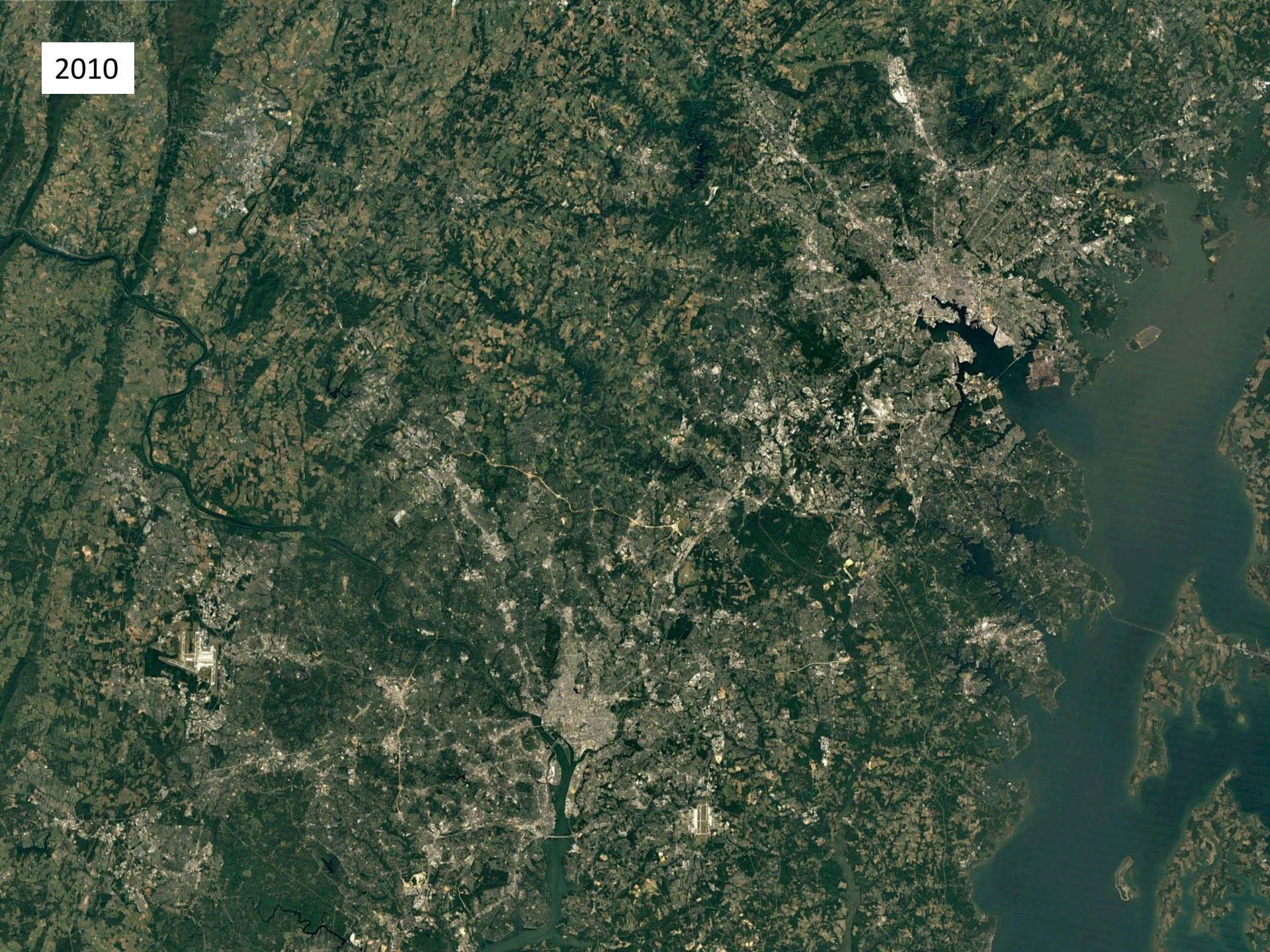

1984


1990


1995


2000


2005


2010


2016

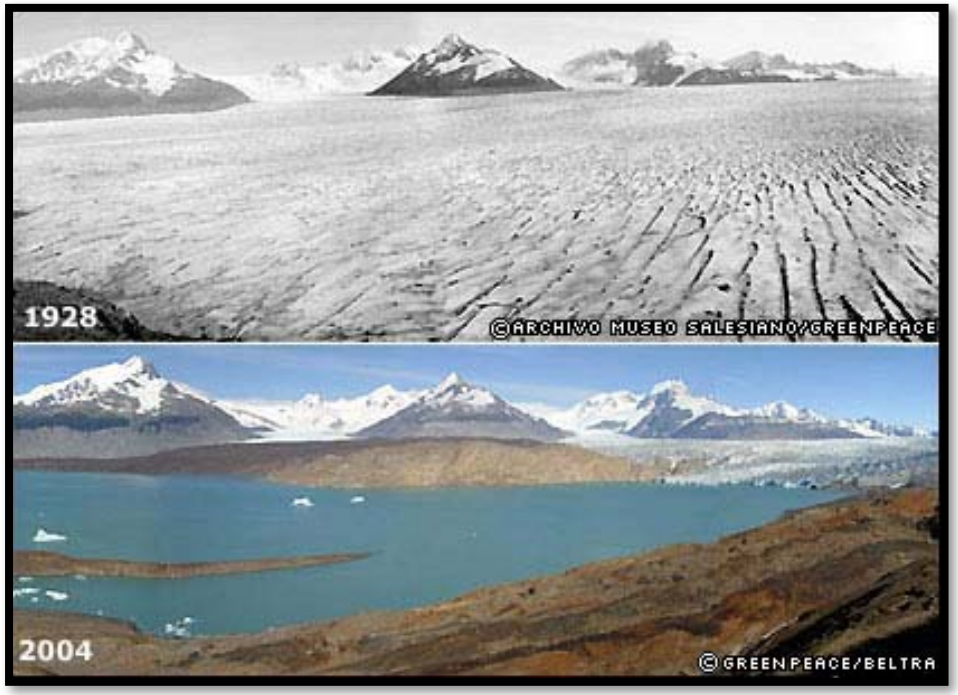

1984


2016

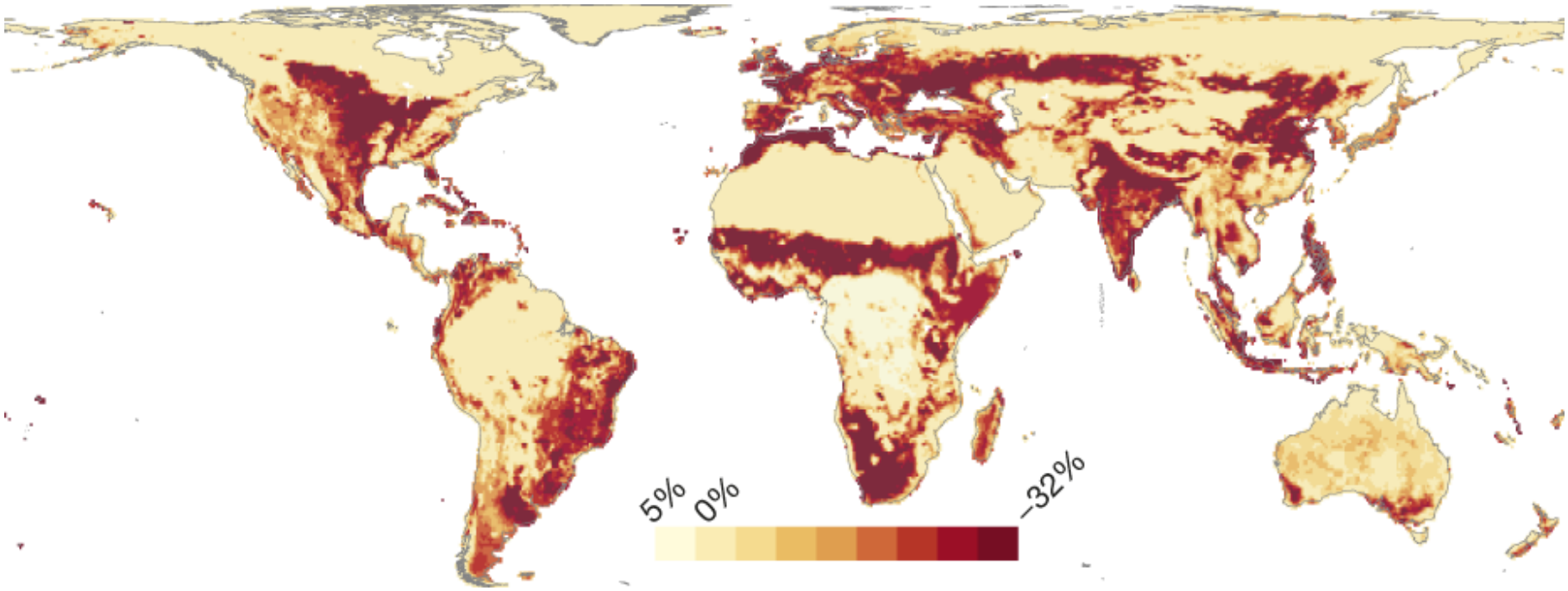
Wildlife populations at risk

"Current extinction rates are 1,000 times higher than natural background rates of extinction and future rates are likely to be 10,ooo times higher."

De Vos et al., Cons. Bio. 2014



Net change in local richness caused by land use and related pressures by 2000.



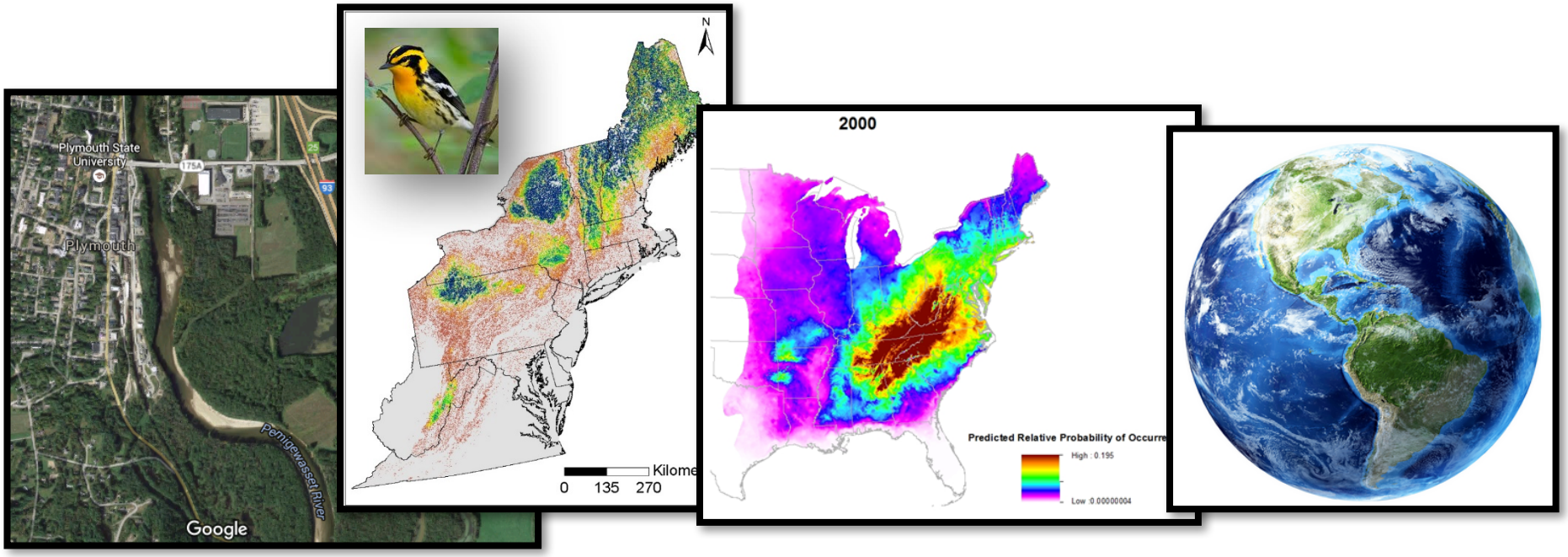
T Newbold *et al. Nature* **520**, 45-50 (2015) doi:10.1038/nature14324

nature

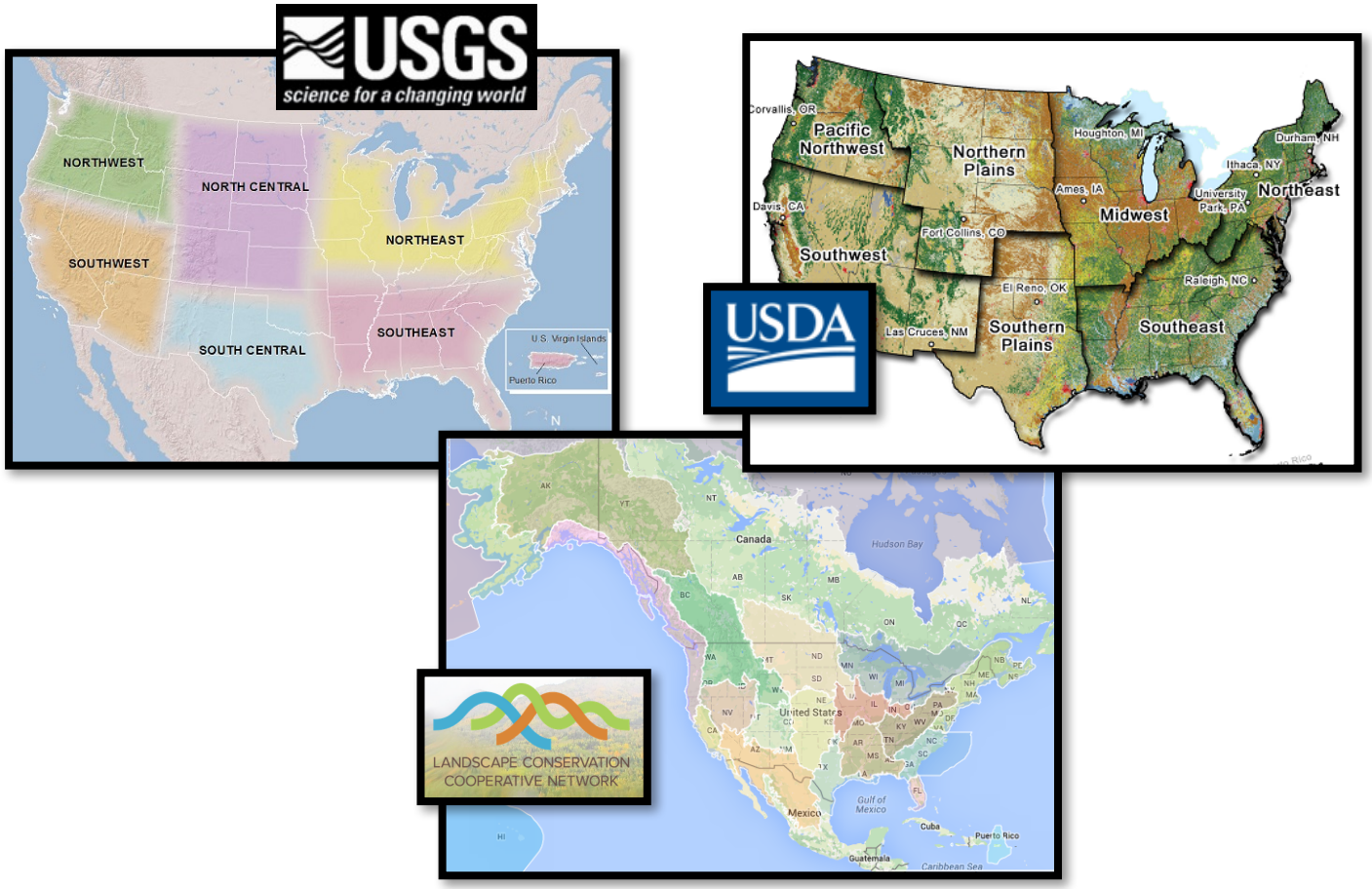
Complex conservation solutions

Expand spatial boundaries

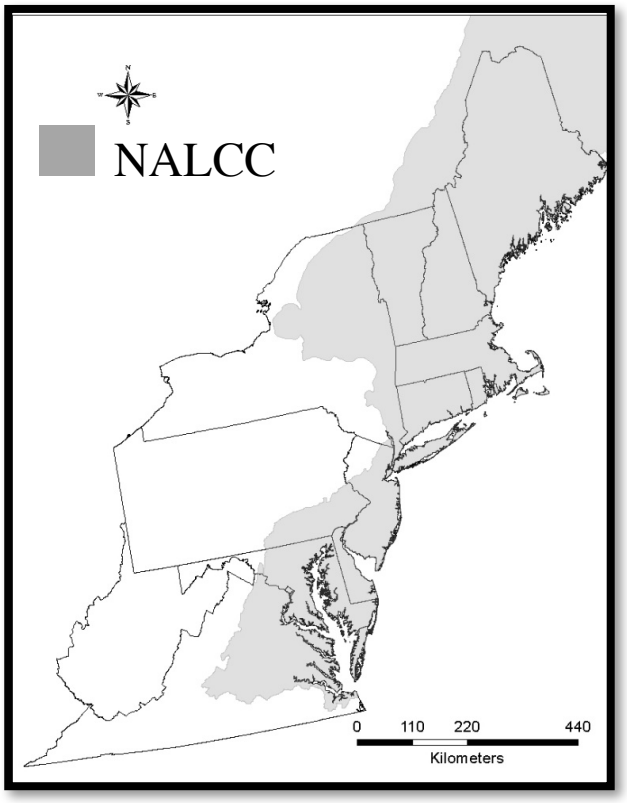
- Large-scale approaches
- Multi-scale approaches



Complex conservation solutions



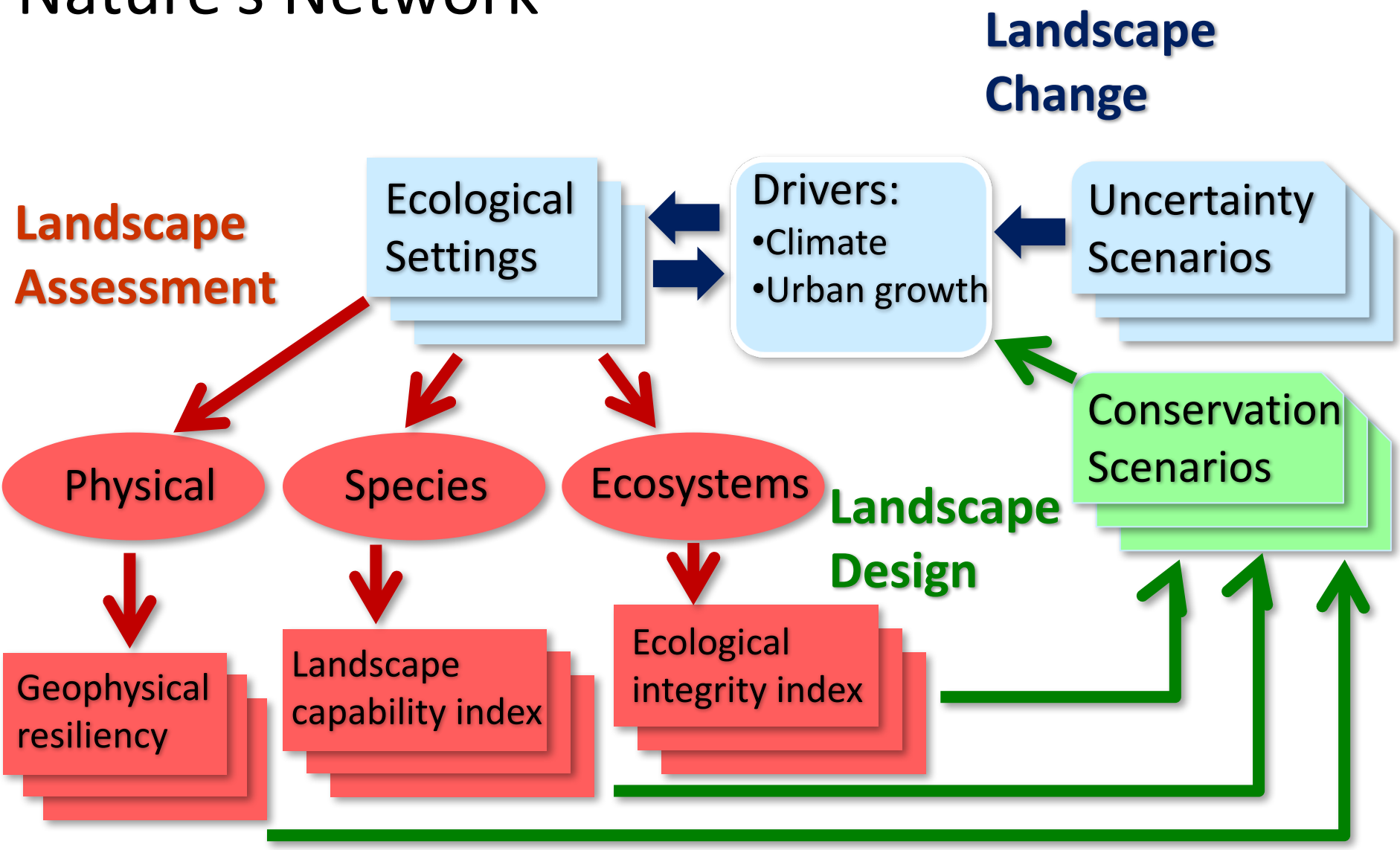
North Atlantic Landscape Conservation Cooperative



Designing Sustainable Landscapes Project

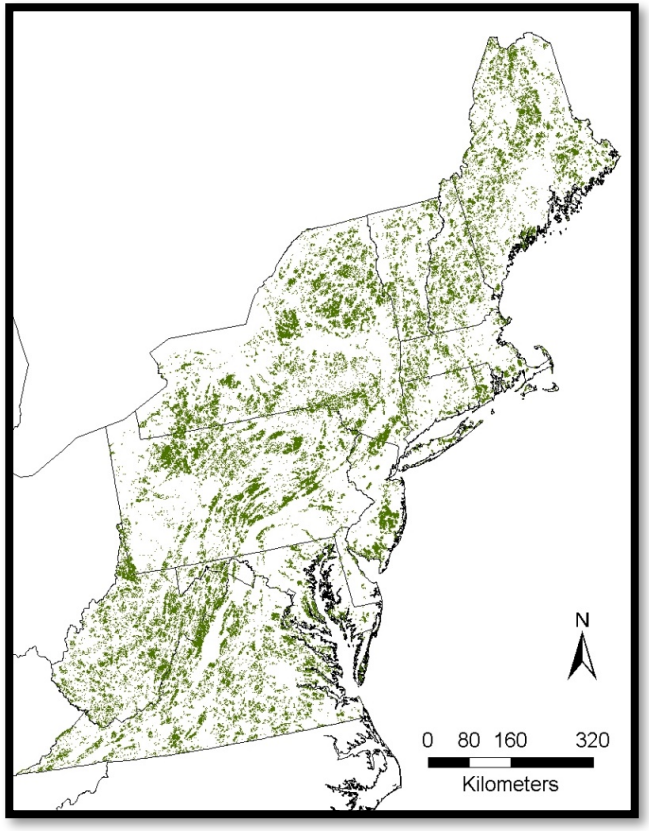
- **Assess the capability of current and potential future landscapes in the Northeast to provide integral ecosystems and suitable habitat for a suite of representative species, and provide guidance for strategic habitat conservation**

Designing Sustainable Landscapes
Nature's Network

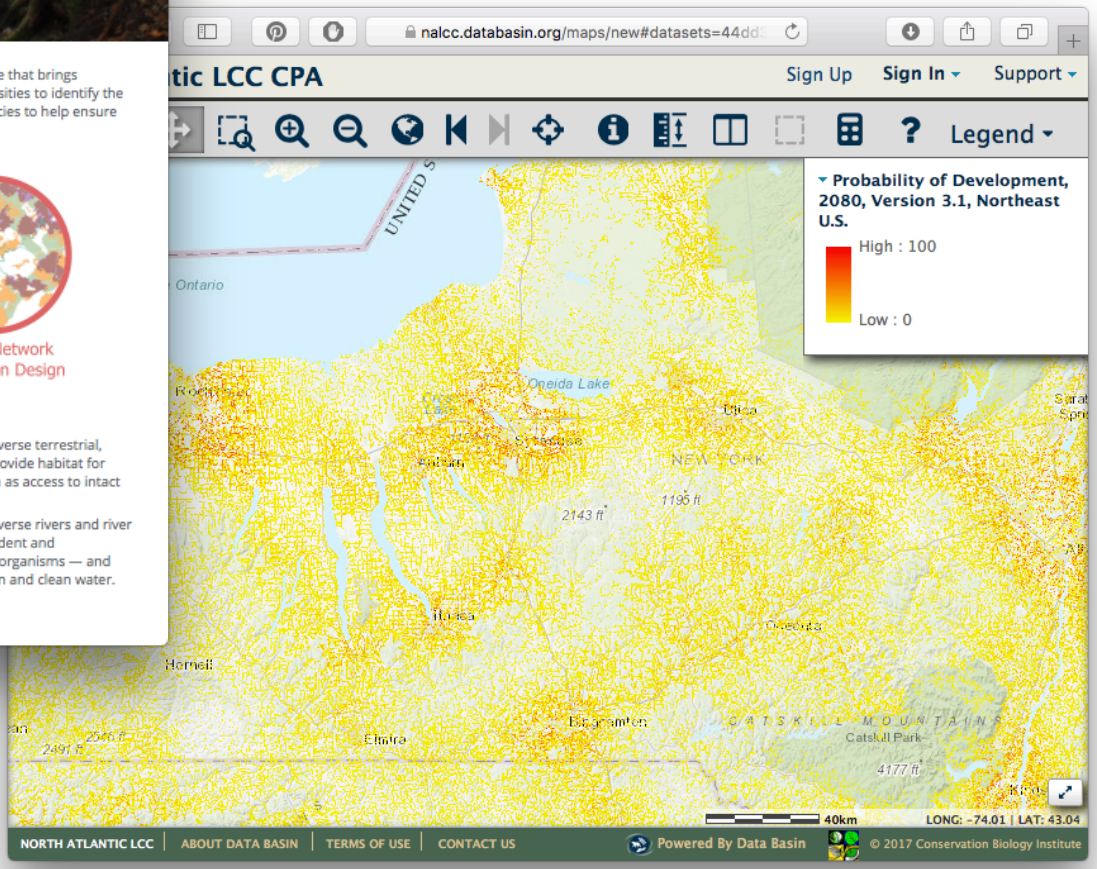


Landscape Conservation Design

Network of Core Areas and Connectors for the Northeast Region



http://naturesnetwork.org

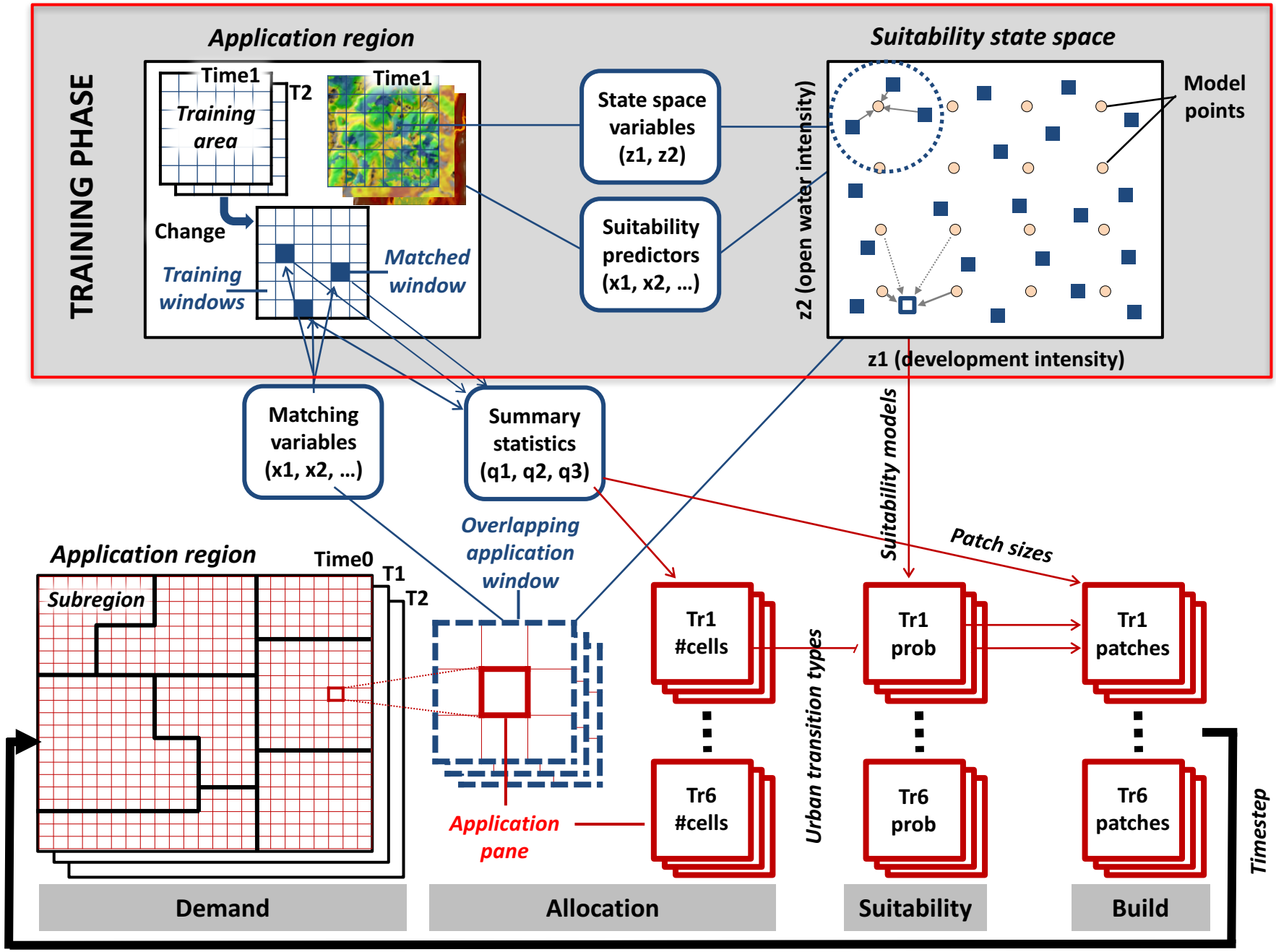


Links to probability of development

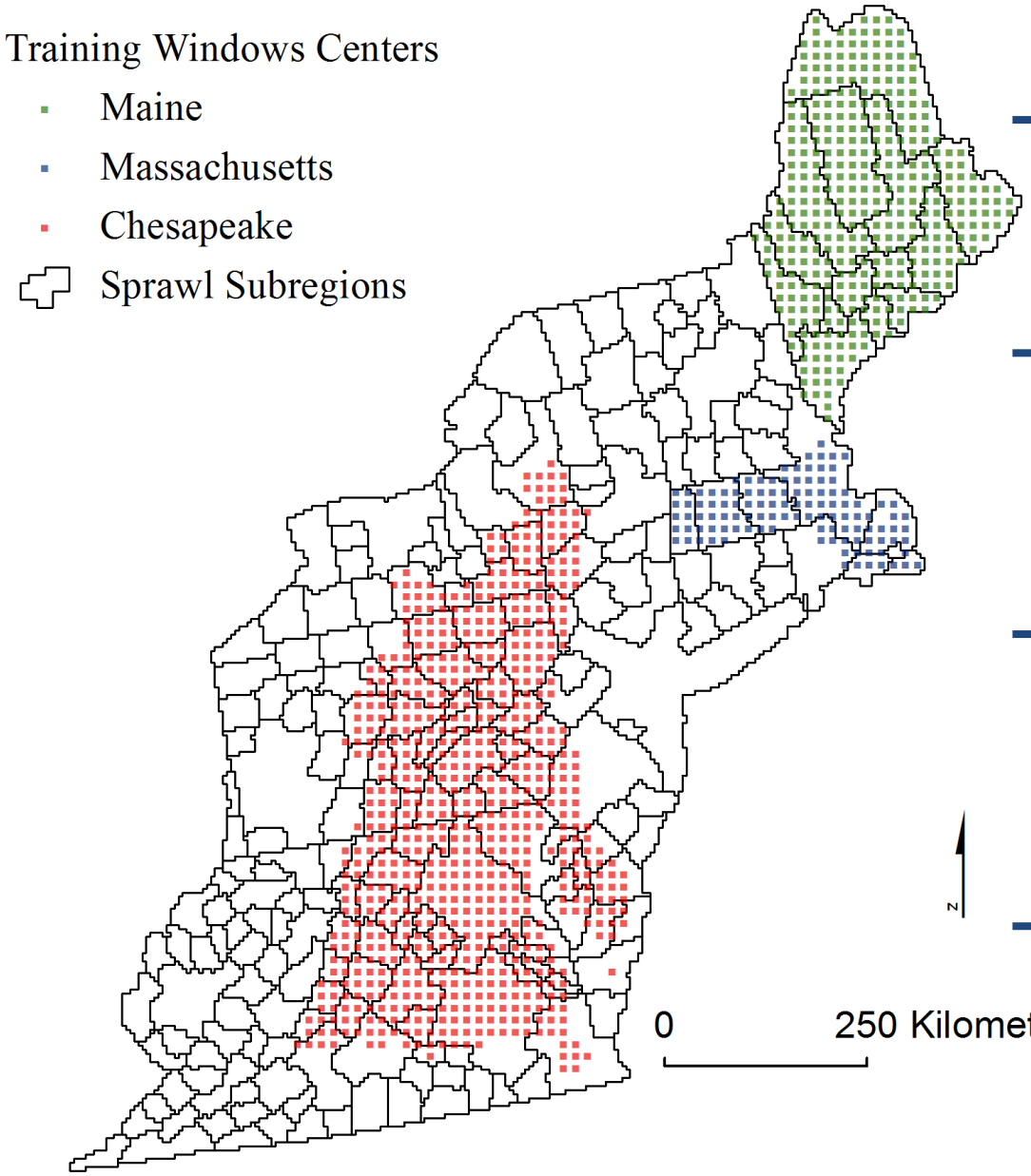
2030 - https://nalcc.databasin.org/datasets/57ce011b074049d09b86c7213f4b0558

2080 - https://nalcc.databasin.org/datasets/44dd387b0aa143b78bc51472bc9bfcf8

Urban Growth Model - Overview



Urban Growth Model – Training



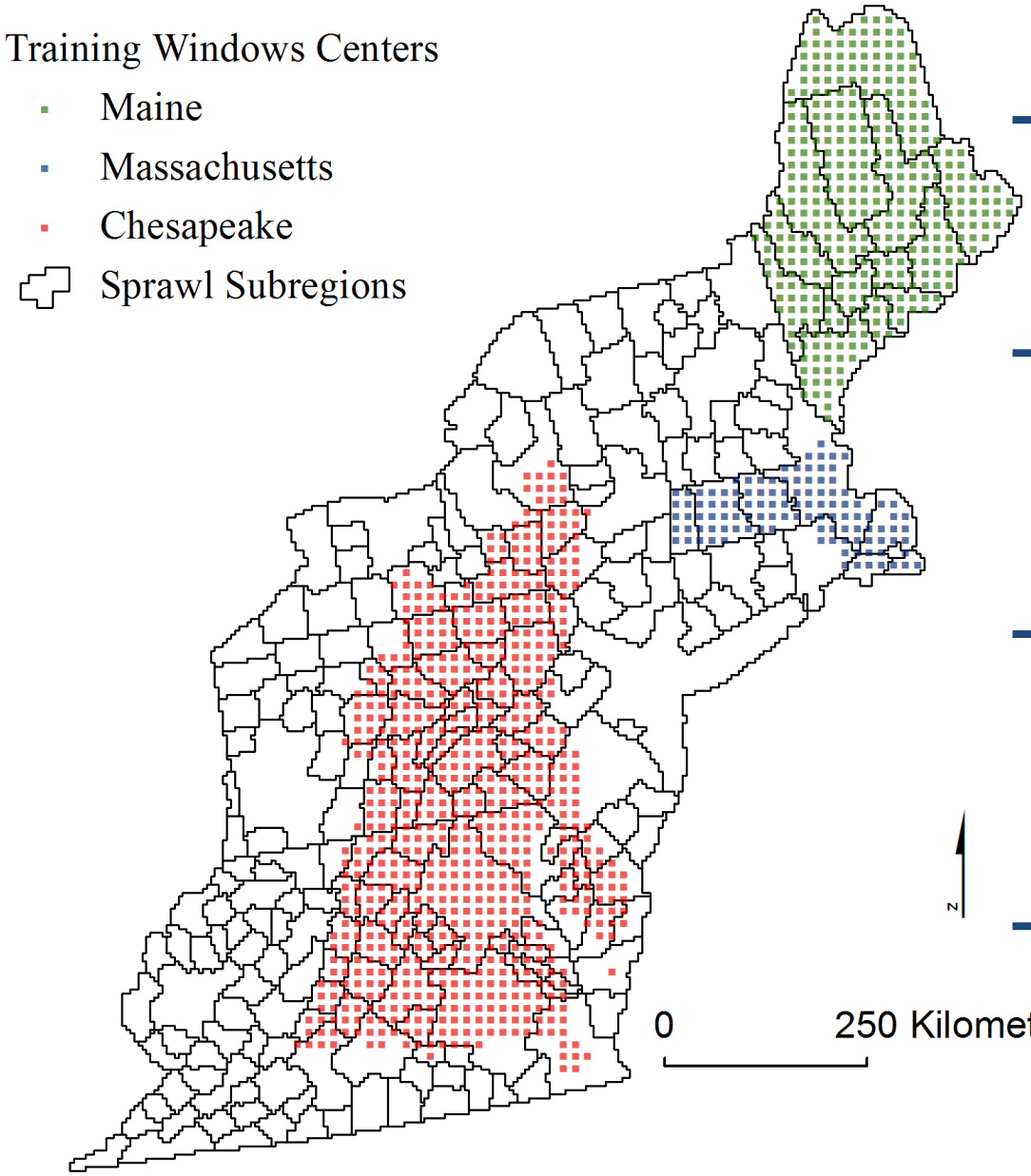
Summary statistics
Amount of growth
Patch sizes
Transition Distribution

Matching variables
Intensity of Water, Development, and Roads (12,800 m);
and Road Density

State space variables
Development intensity (12,800 m)
Open water intensity (12,800 m)

Suitability predictors
Water (100, 800, 3200 m)
Big Roads (800 m)
All Roads (3,200 m)
Development (400, 3,200 m)
Slope, Distance to roads

Urban Growth Model – Training



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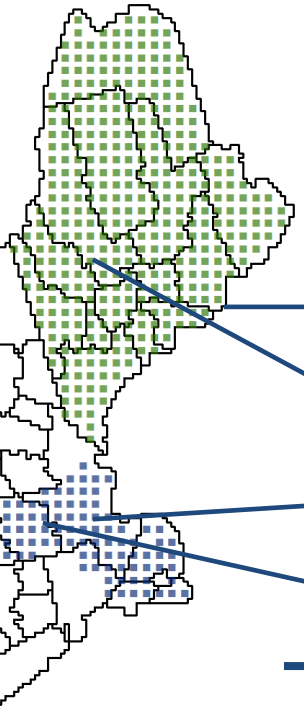

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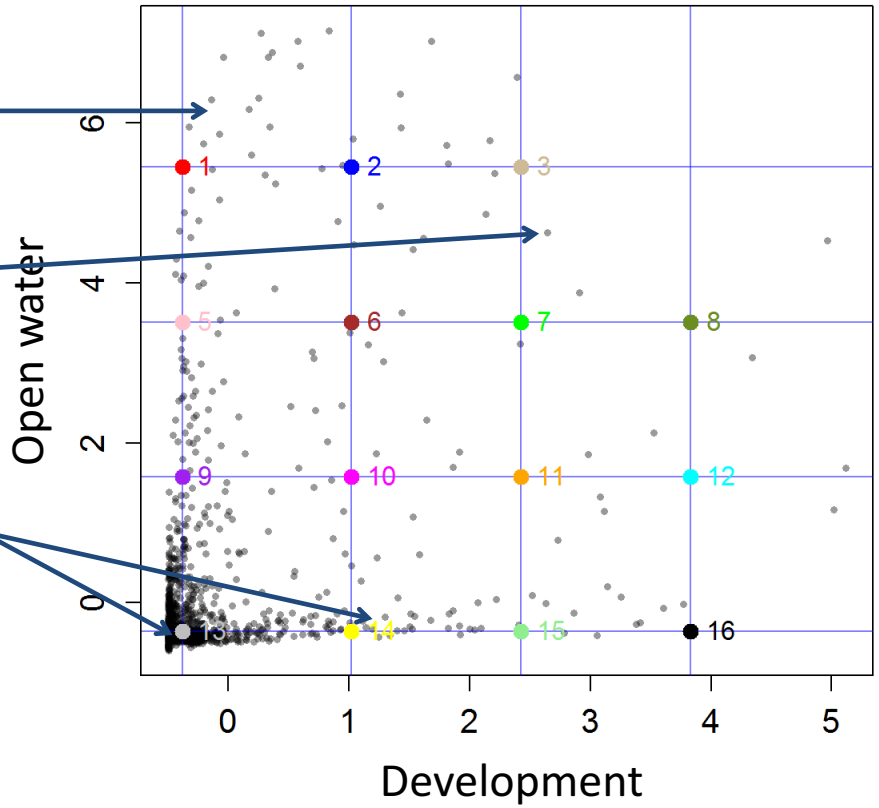
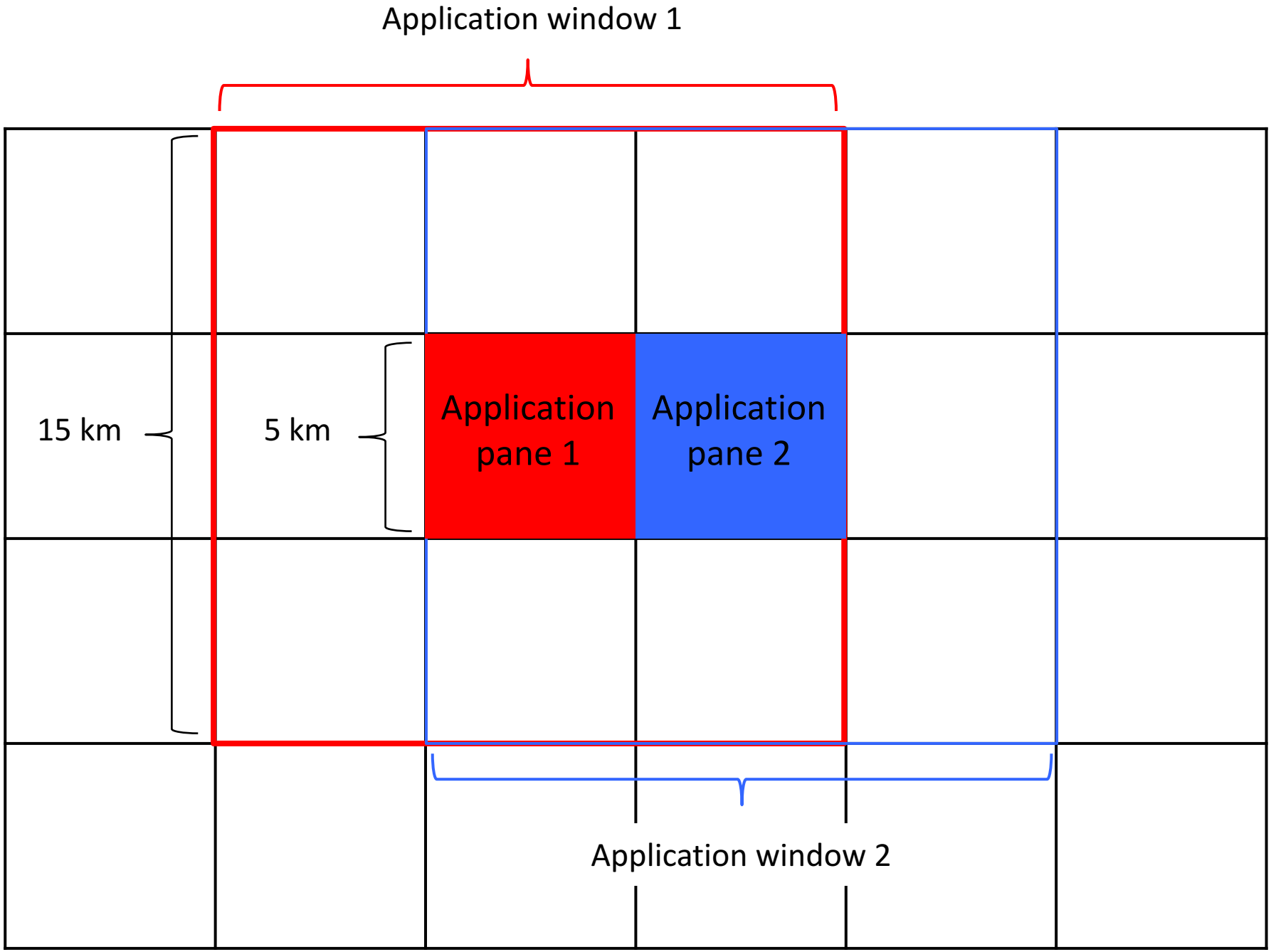
Slope, Distance to roads

250 Kilometers

Suitability state space



Urban Growth Model – Application



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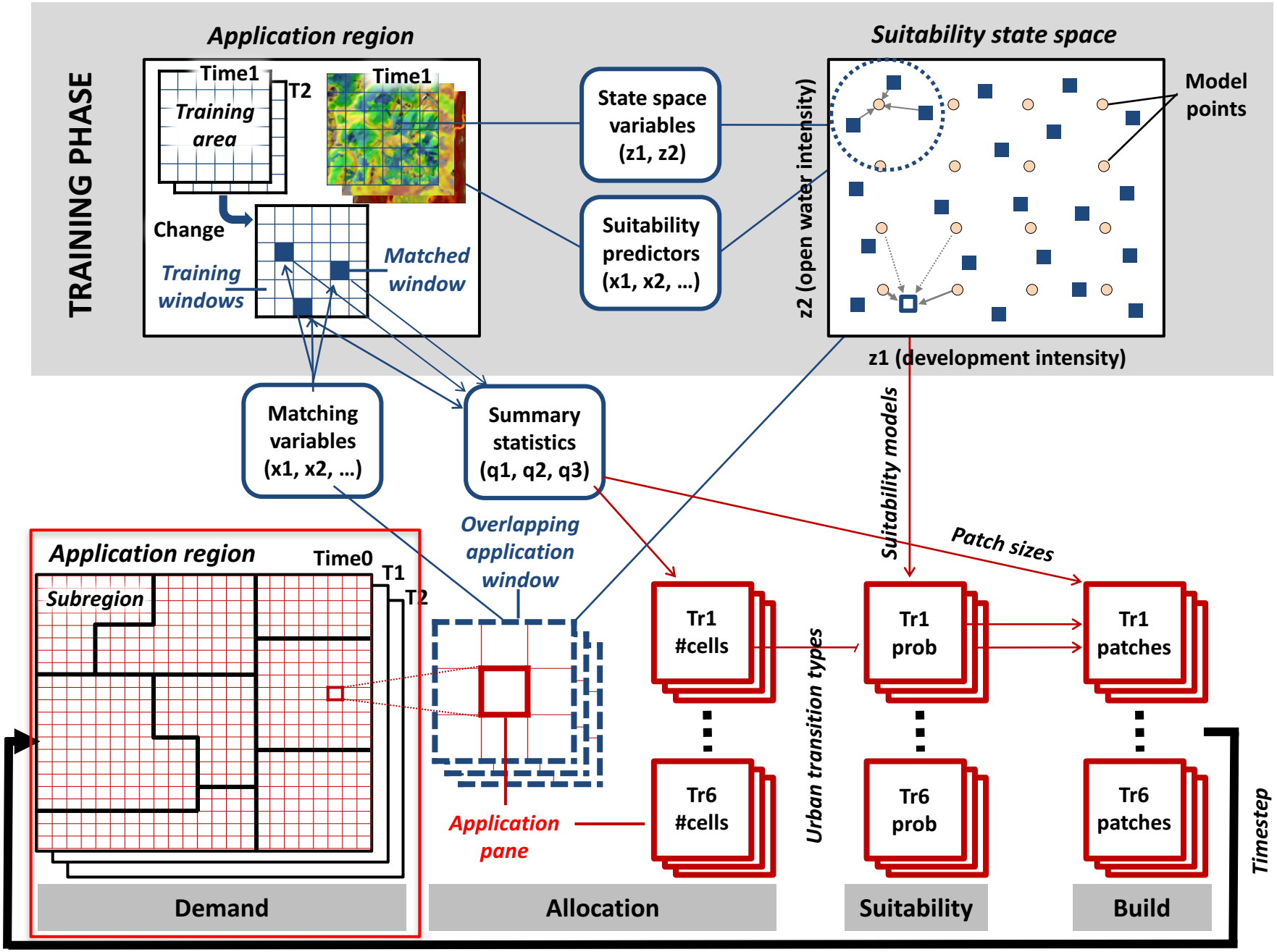
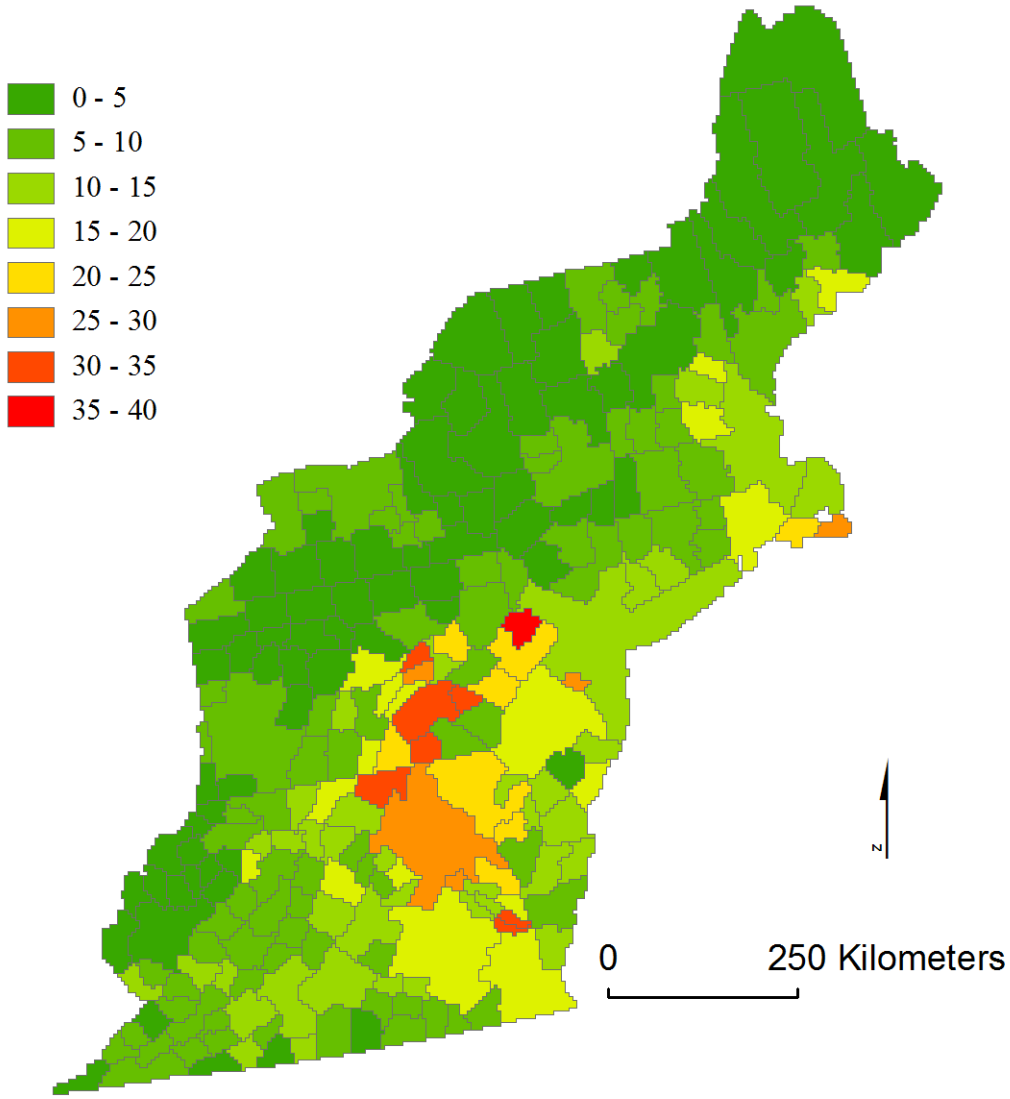


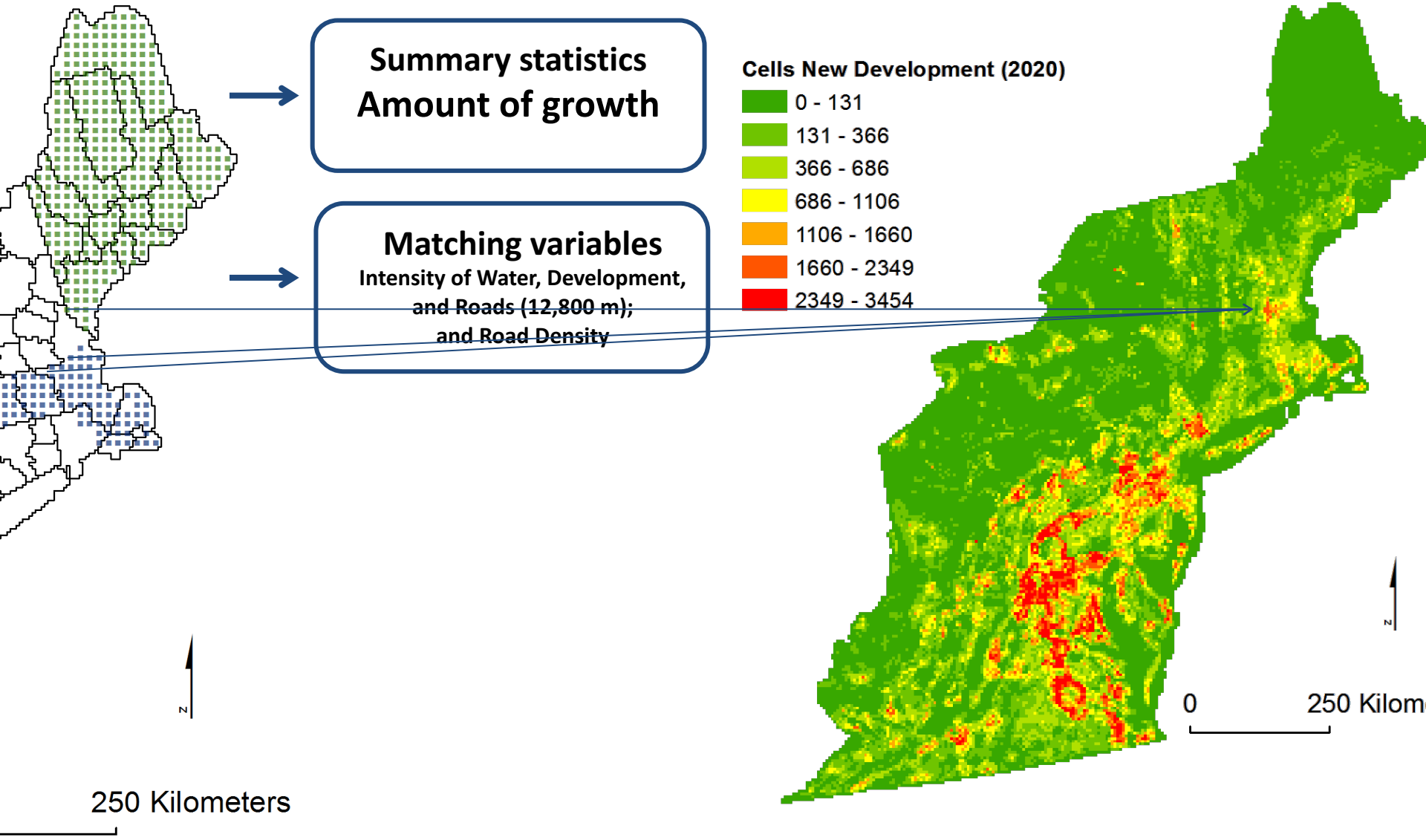
Urban Growth Model - Demand

% of land area developed between 2010 and 2080



Wear, D.N. (2011). Forecasts of county-level land uses under three future scenarios: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-141.

Urban Growth Model – Allocation



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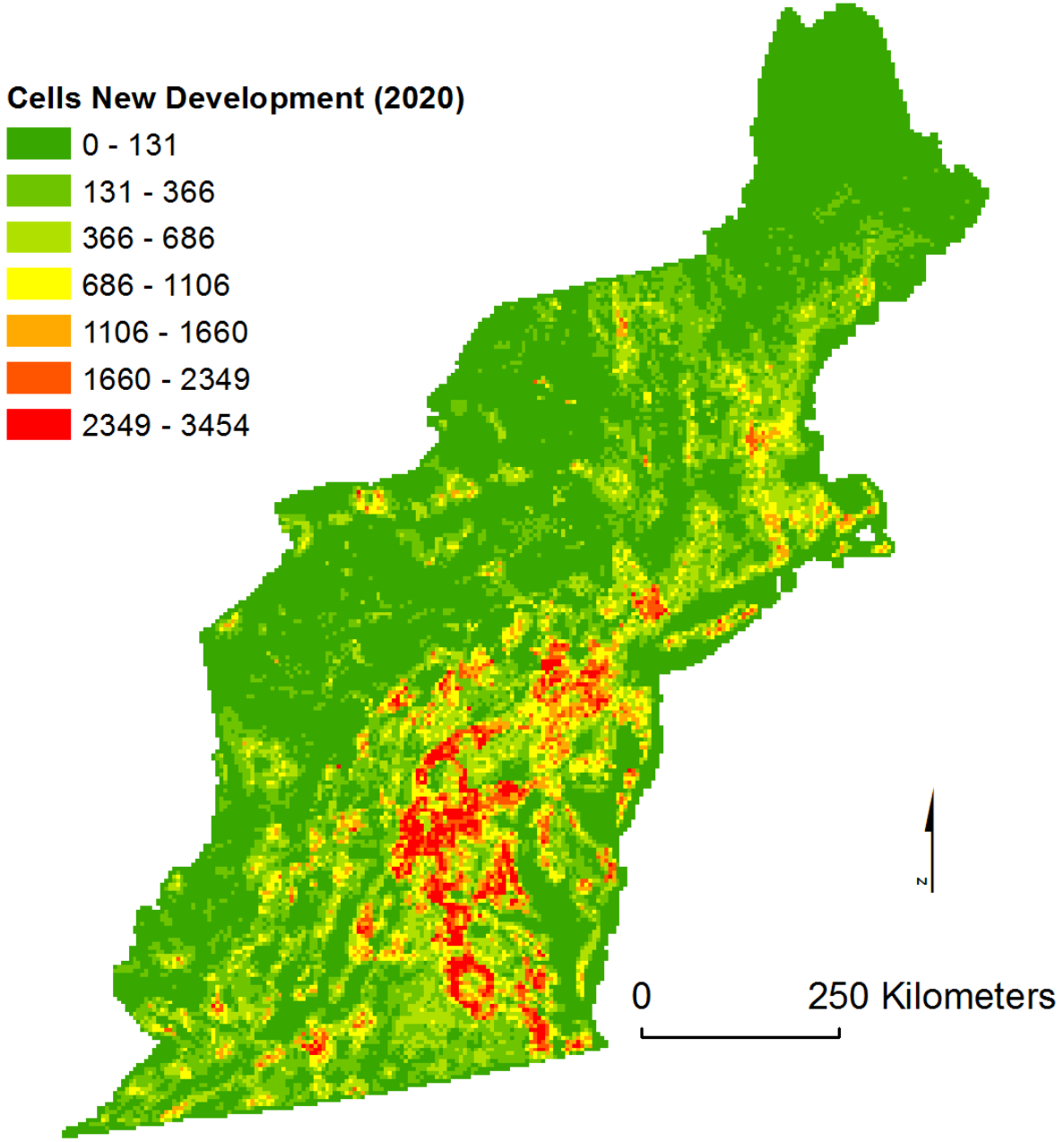
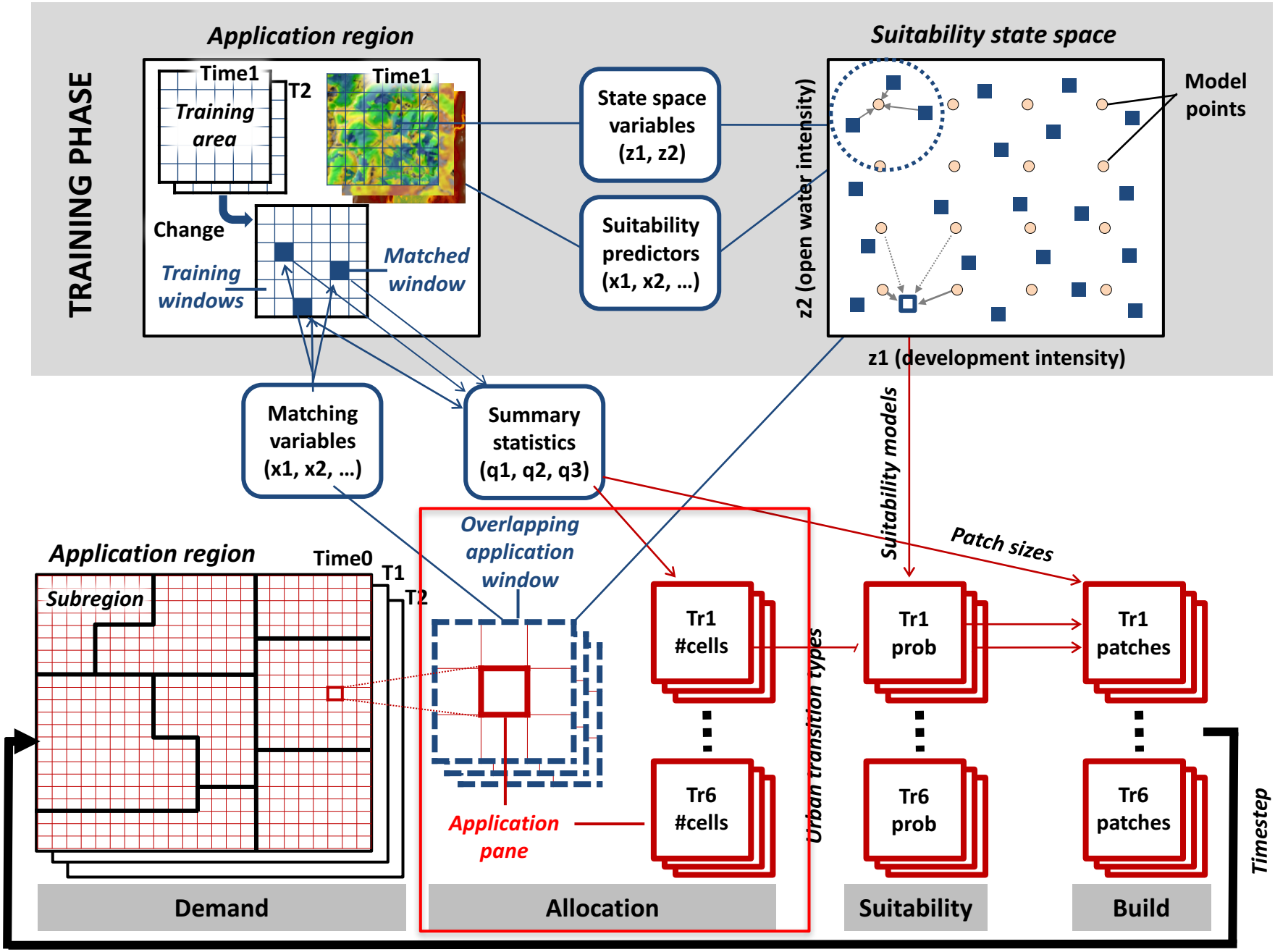
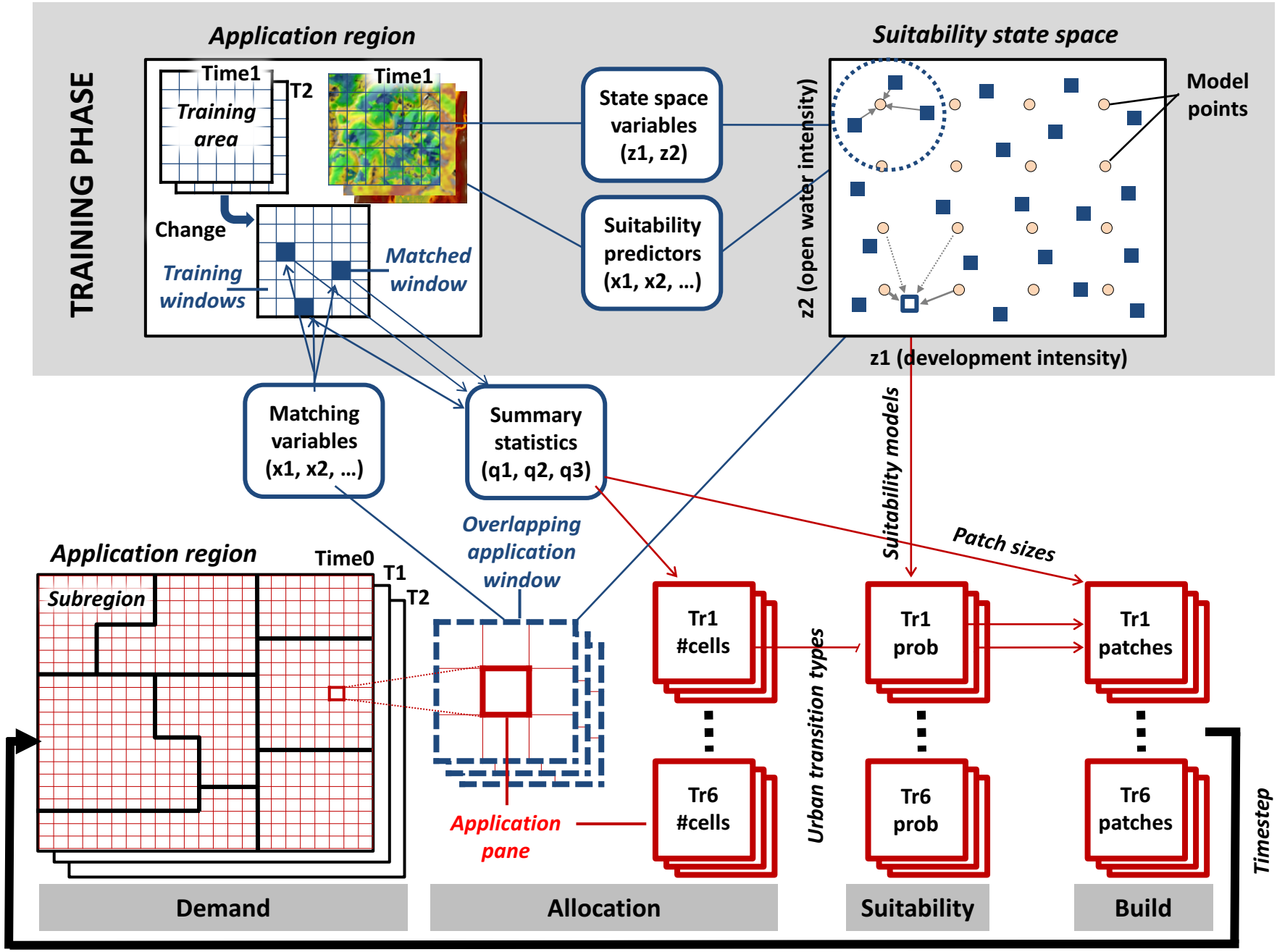


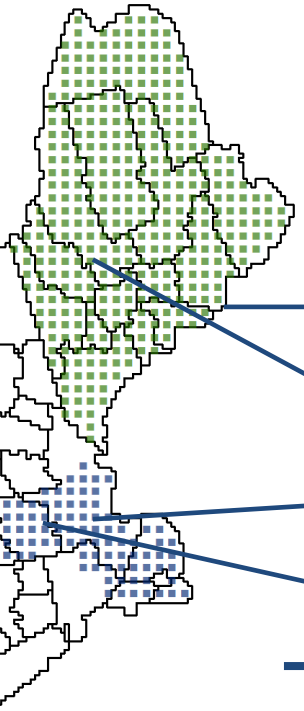
Urban Growth Model - Allocation



Urban Growth Model - Suitability



Urban Growth Model – Suitability



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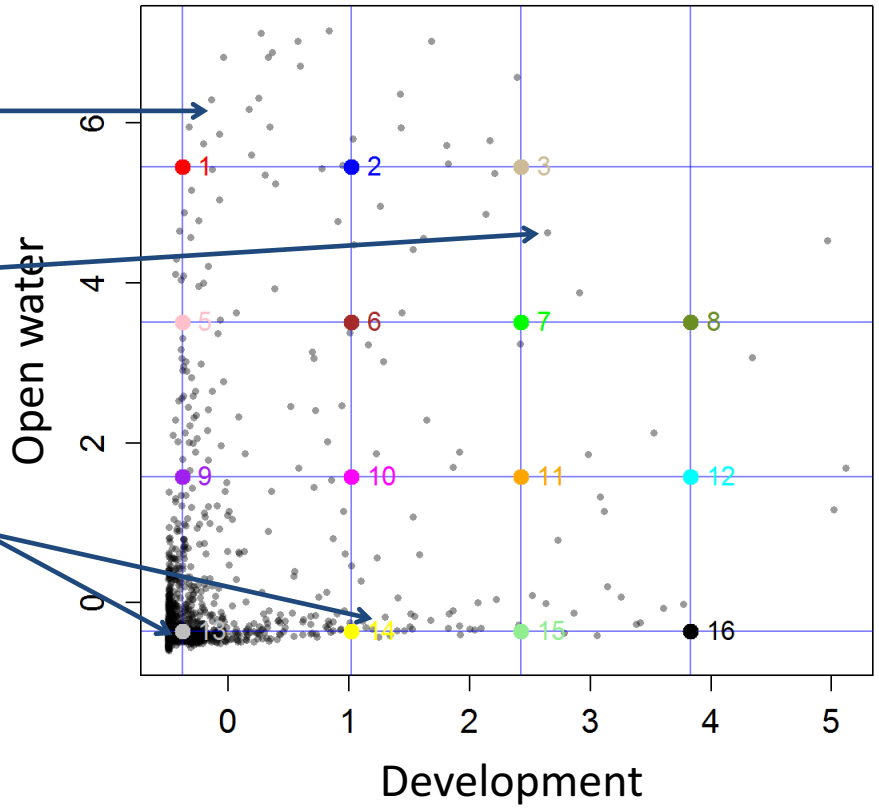

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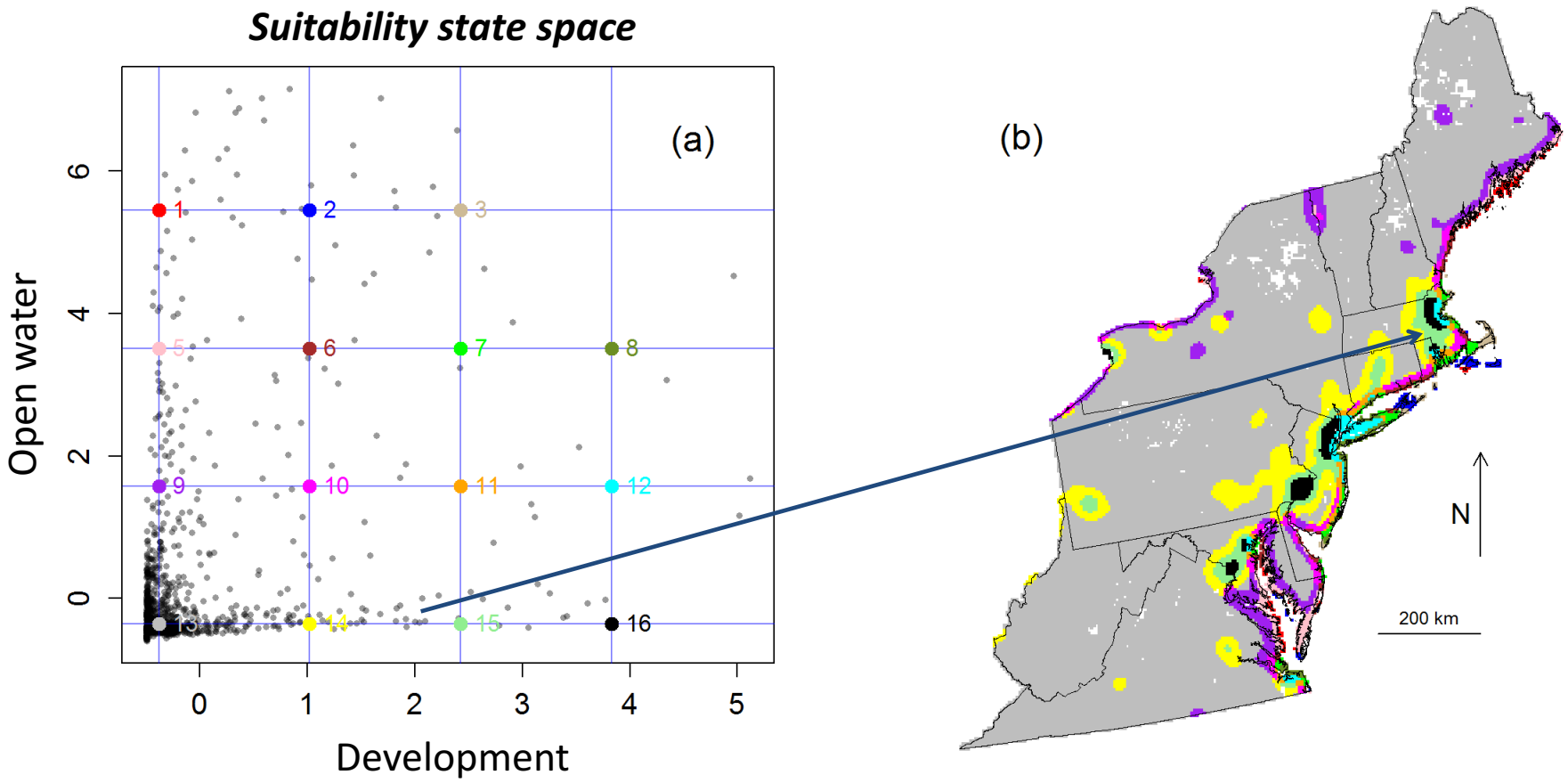
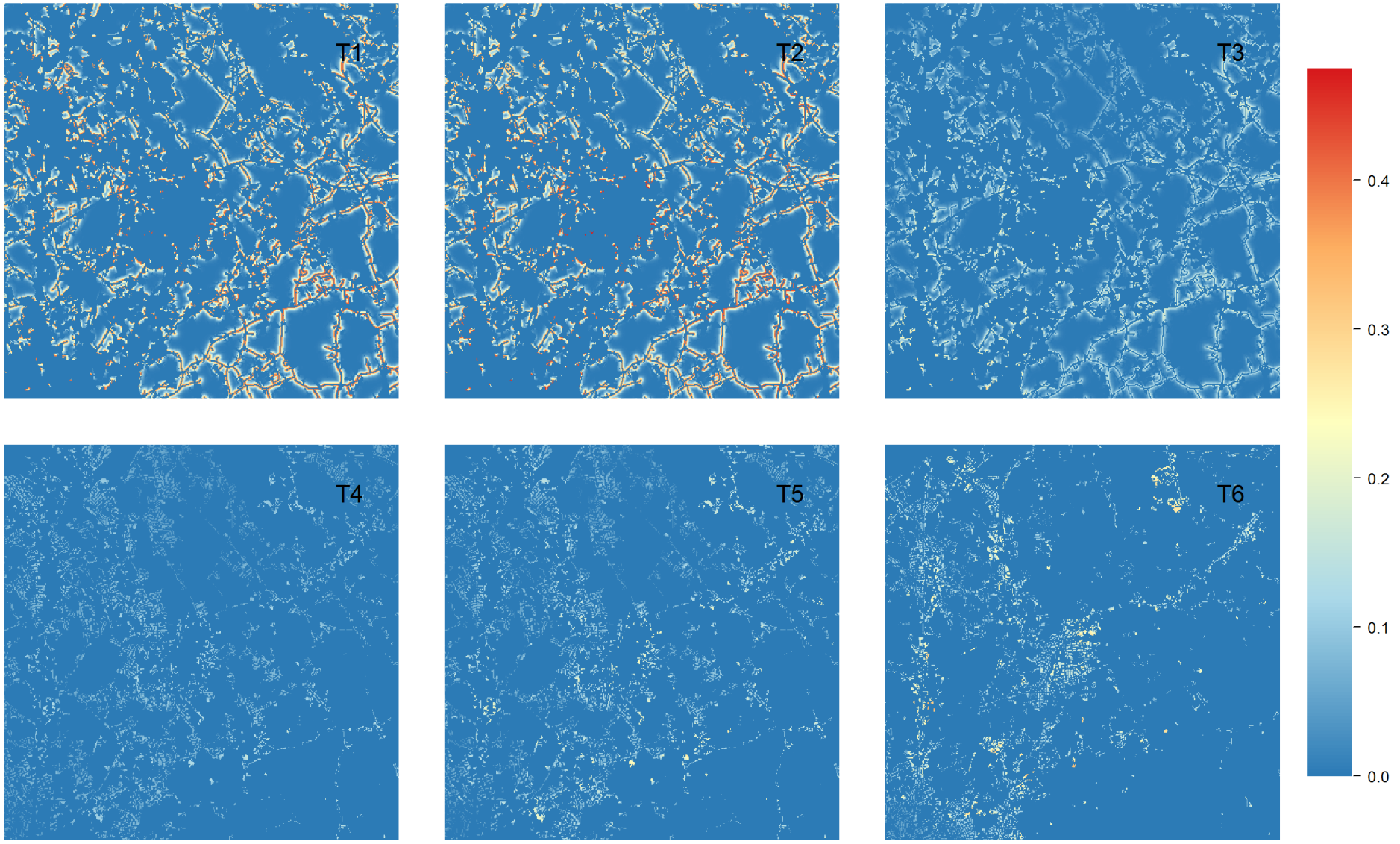
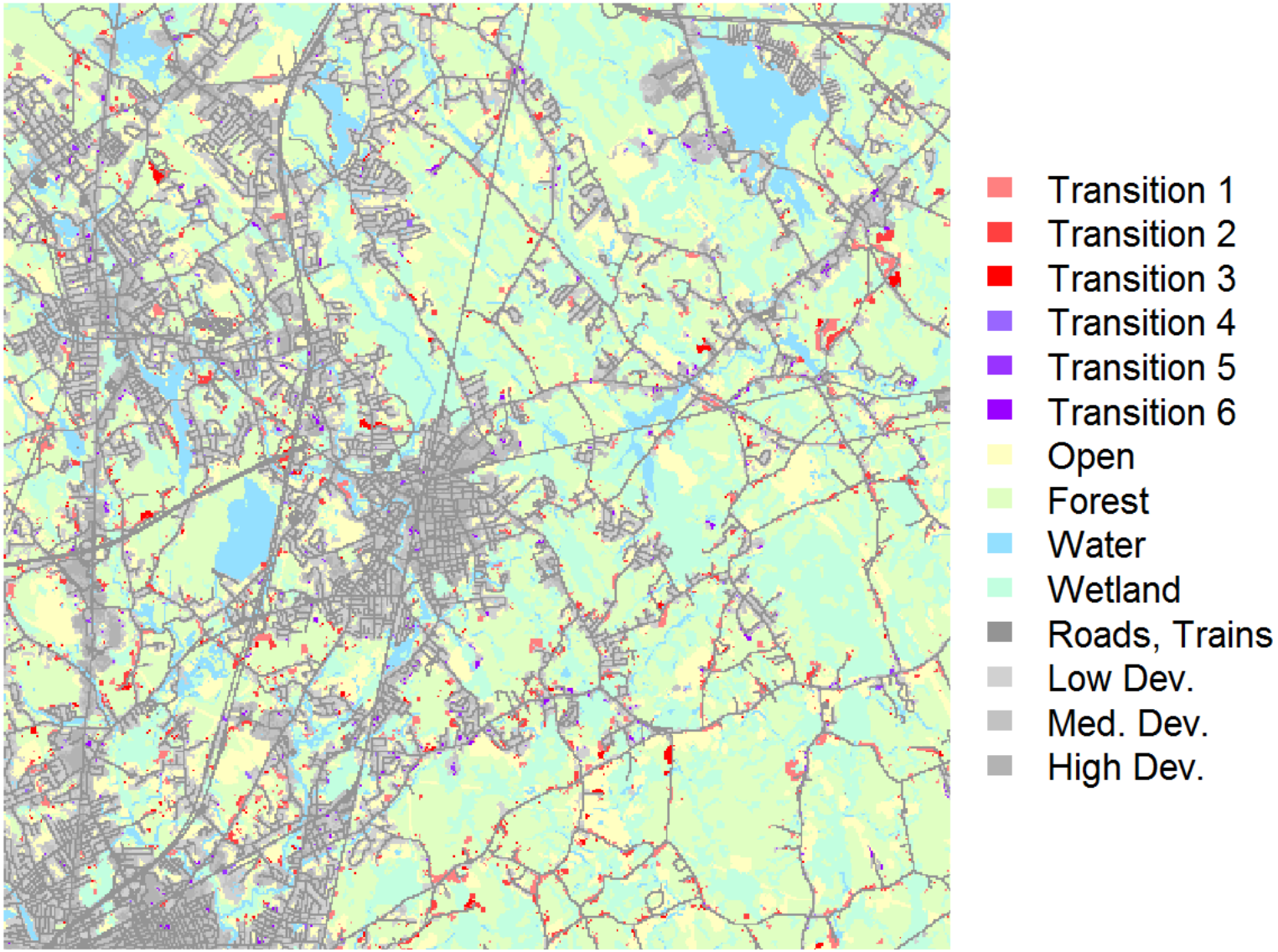


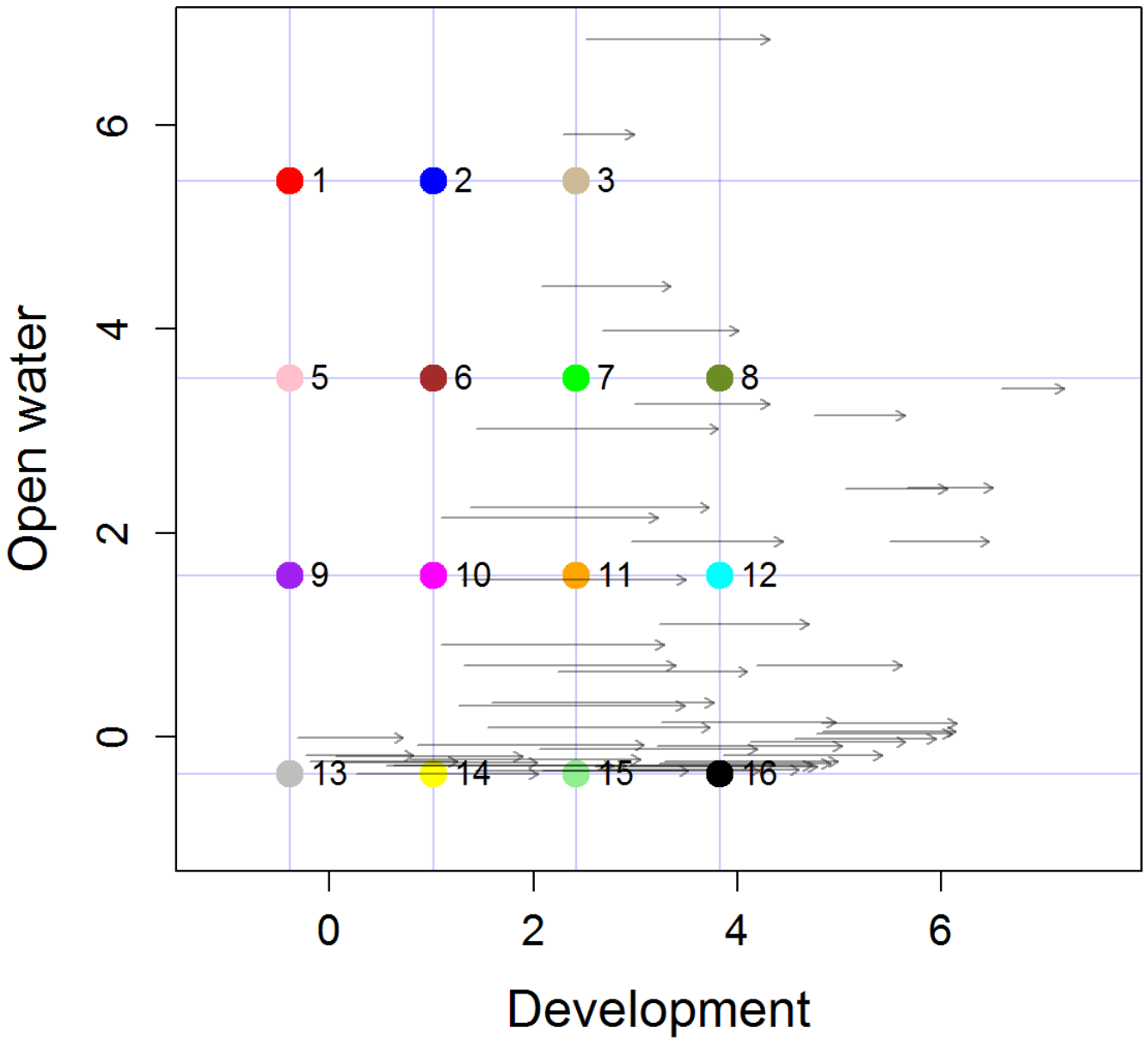
Urban Growth Model – Suitability



Urban Growth Model – Building

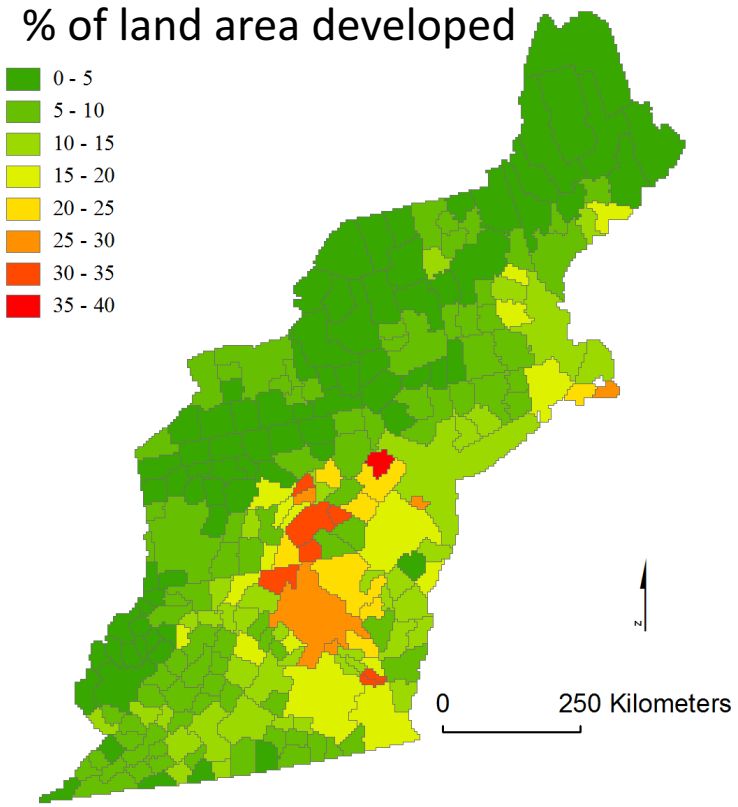


Urban Growth Model - Non-stationary

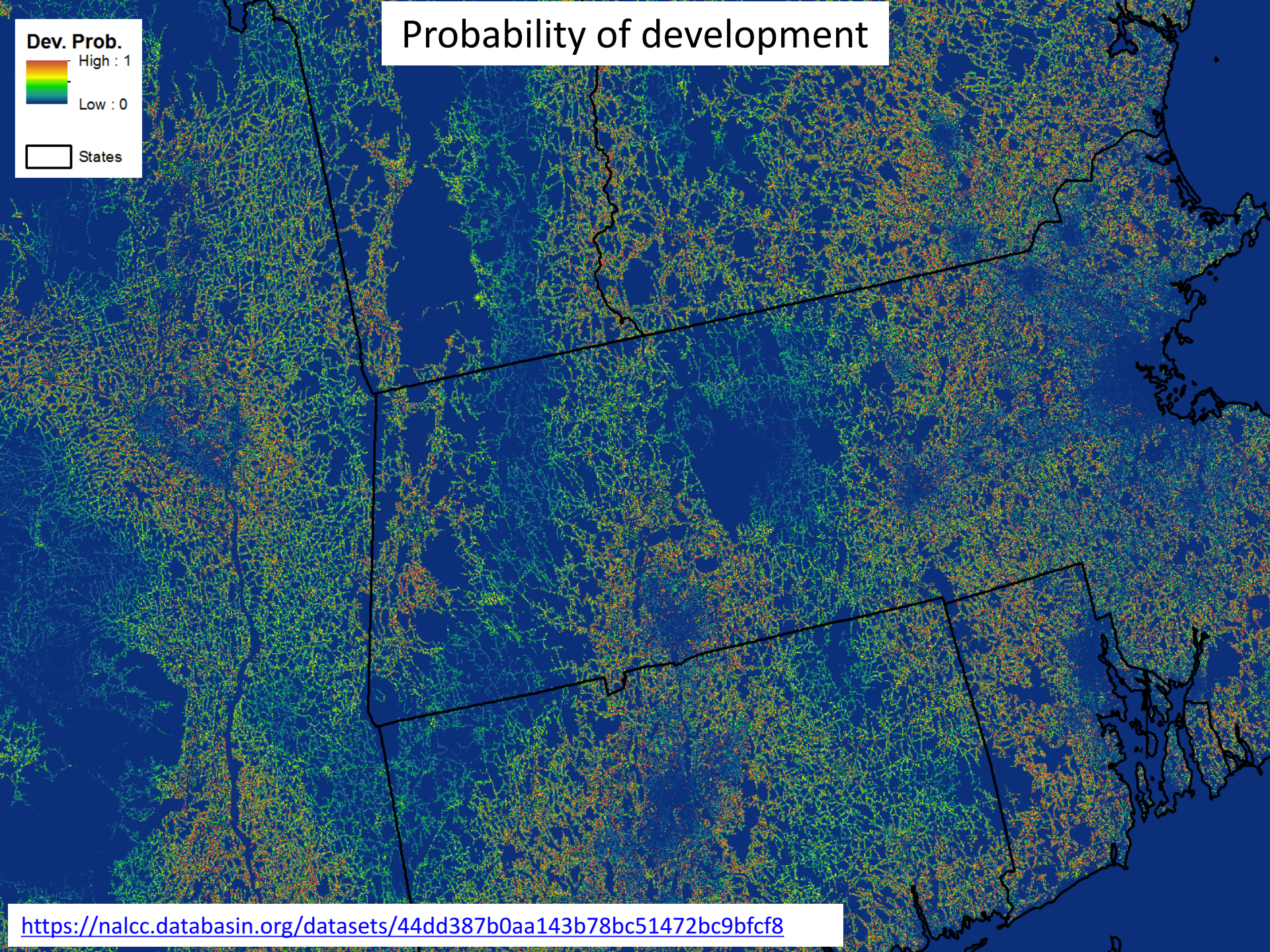


Some caveats

- It is only a model
- Output should be viewed as an urban growth scenario - at best it projects past pattern into the future
- Depends heavily on the training land cover classification
- Depends heavily on the RPA county level demand
- It does not project new road construction
- Does not include any explicit socioeconomic drivers
- No “rewilding”
- Conserved land is excluded from development
- Wetlands are excluded from development

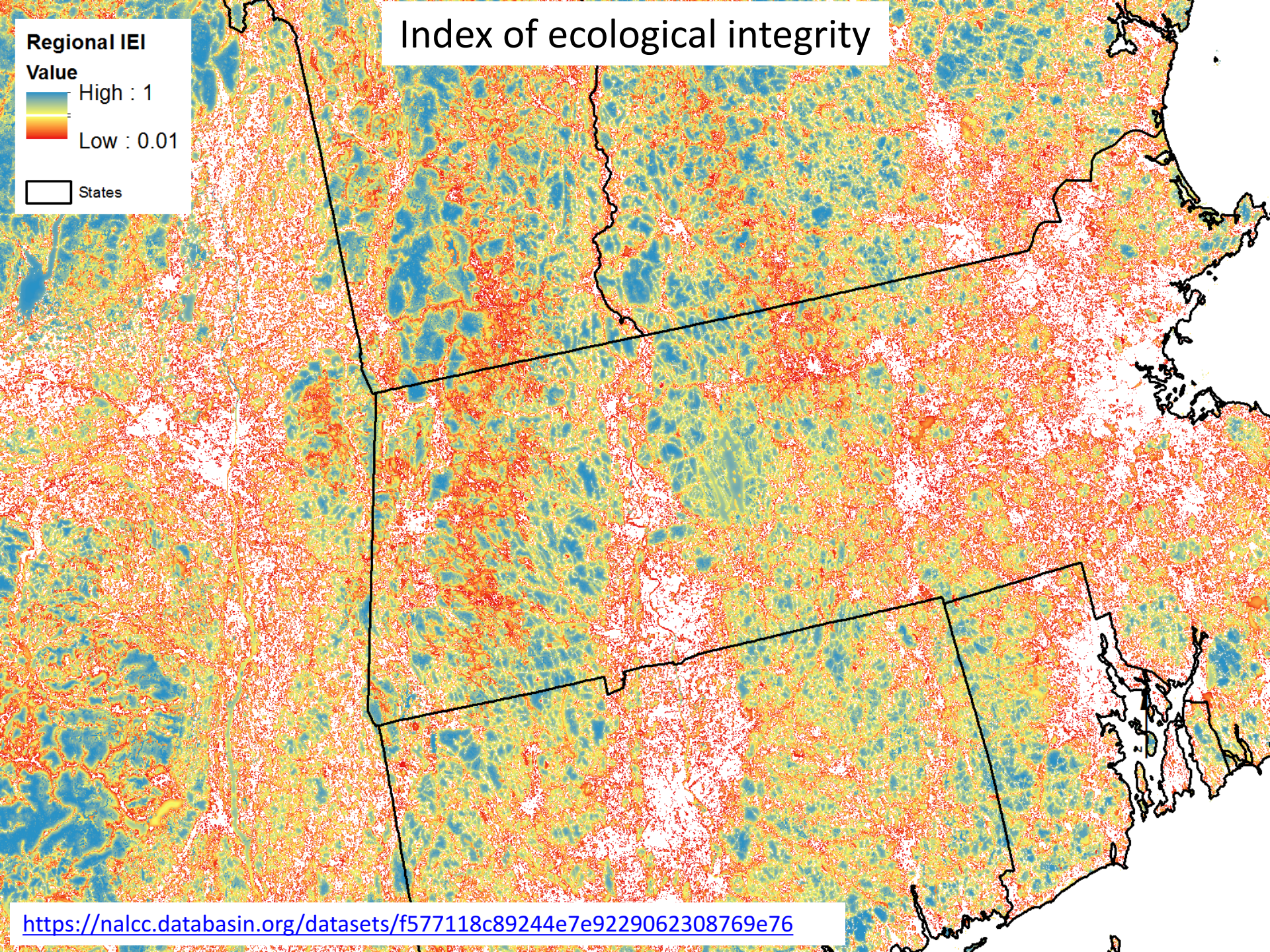


Probability of development



https://nalcc.databasin.org/datasets/44dd387b0aa143b78bc51472bc9bfcf8

Index of ecological integrity



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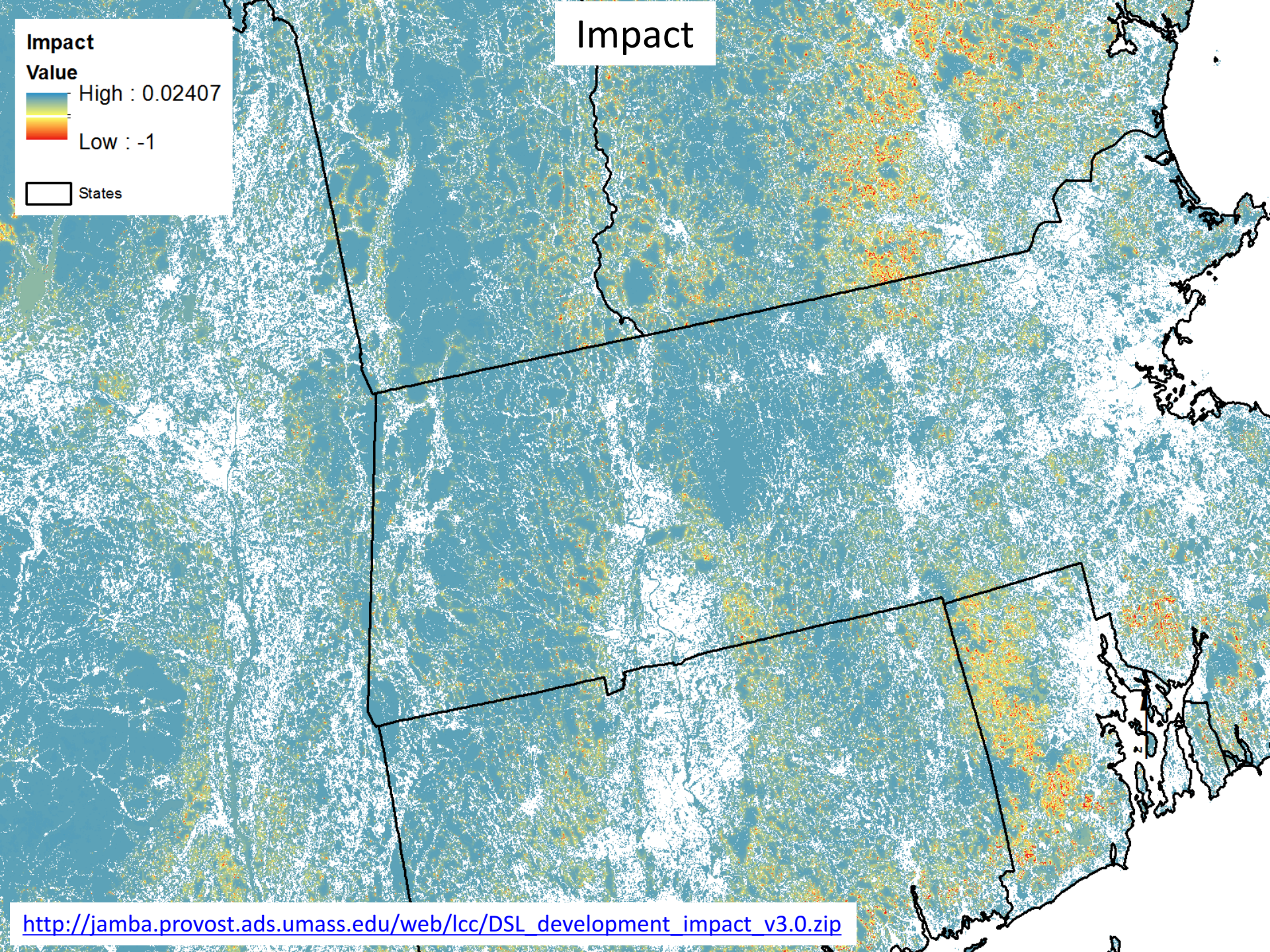
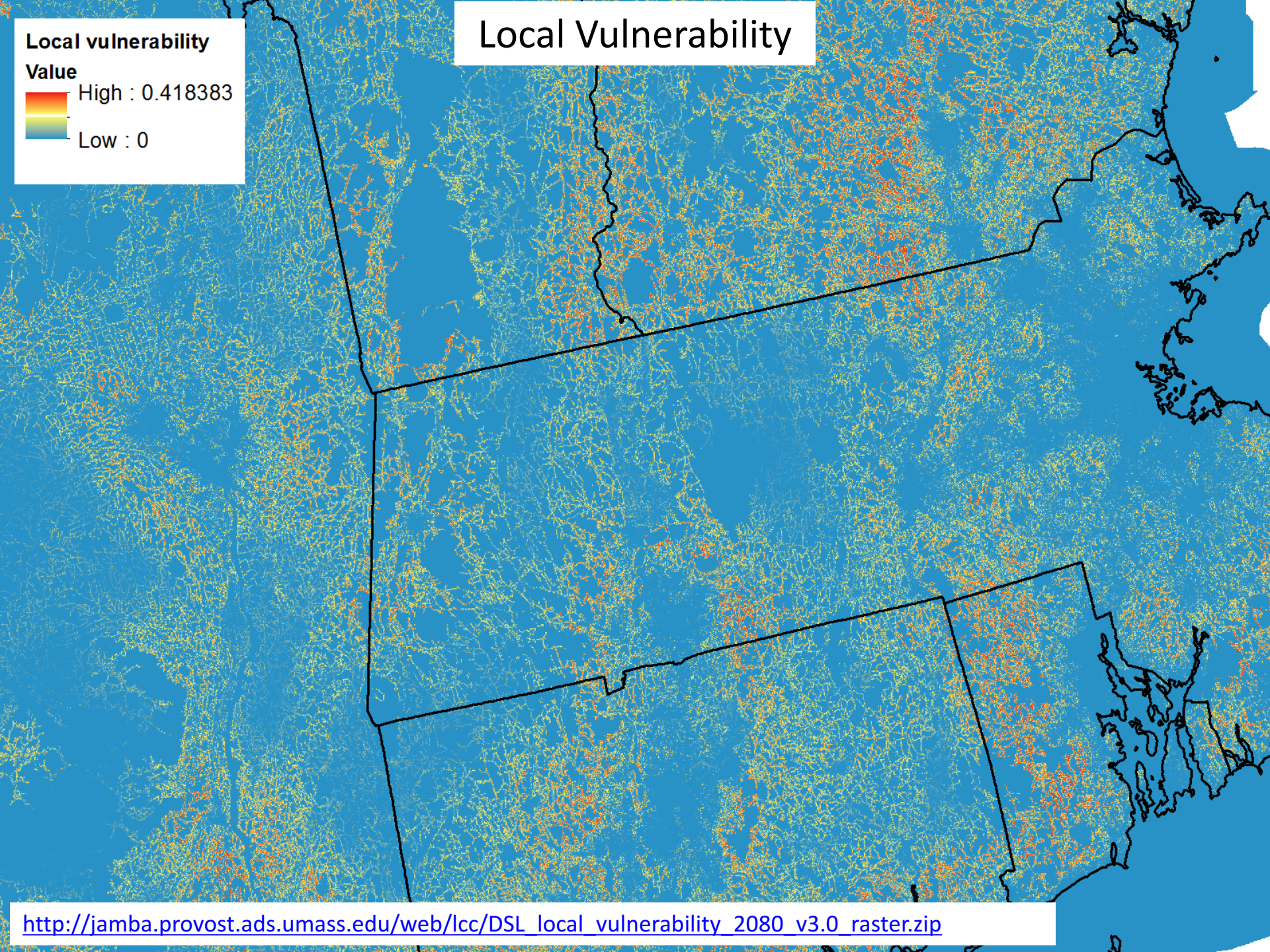
Impact



http://jamba.provost.ads.umass.edu/web/lcc/DSL_development_impact_v3.0.zip

Local Vulnerability



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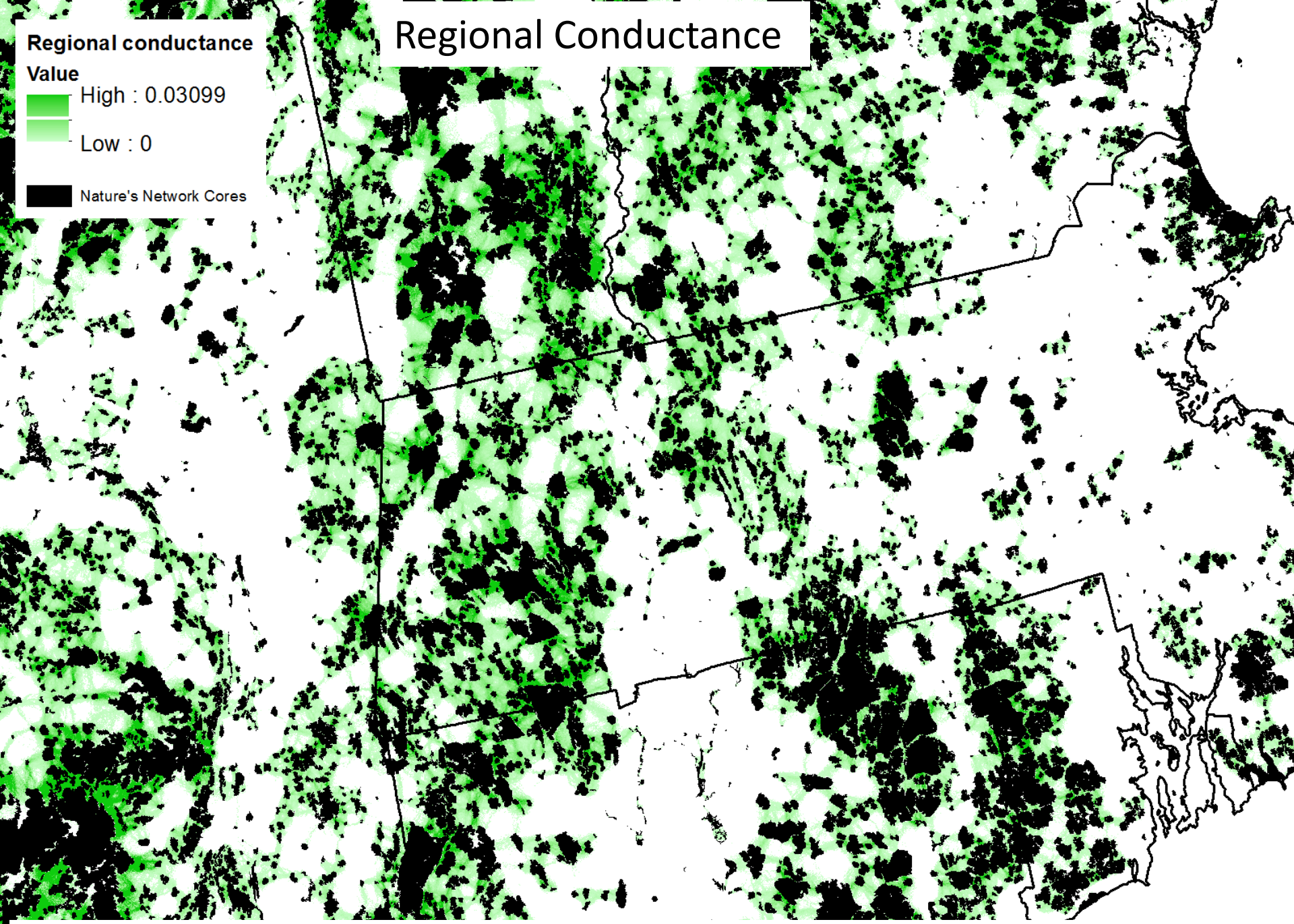
Regional Conductance



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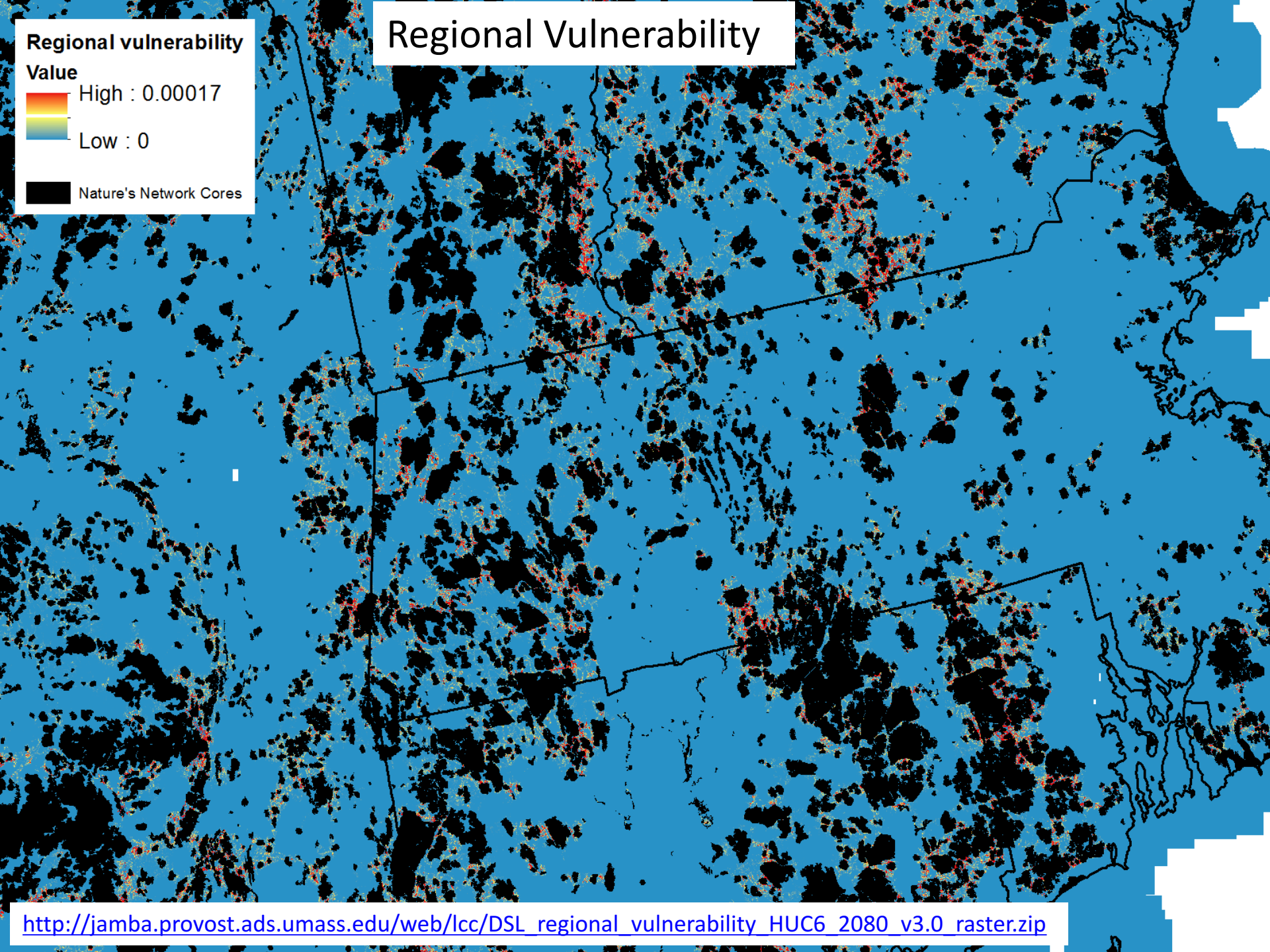
Regional Vulnerability



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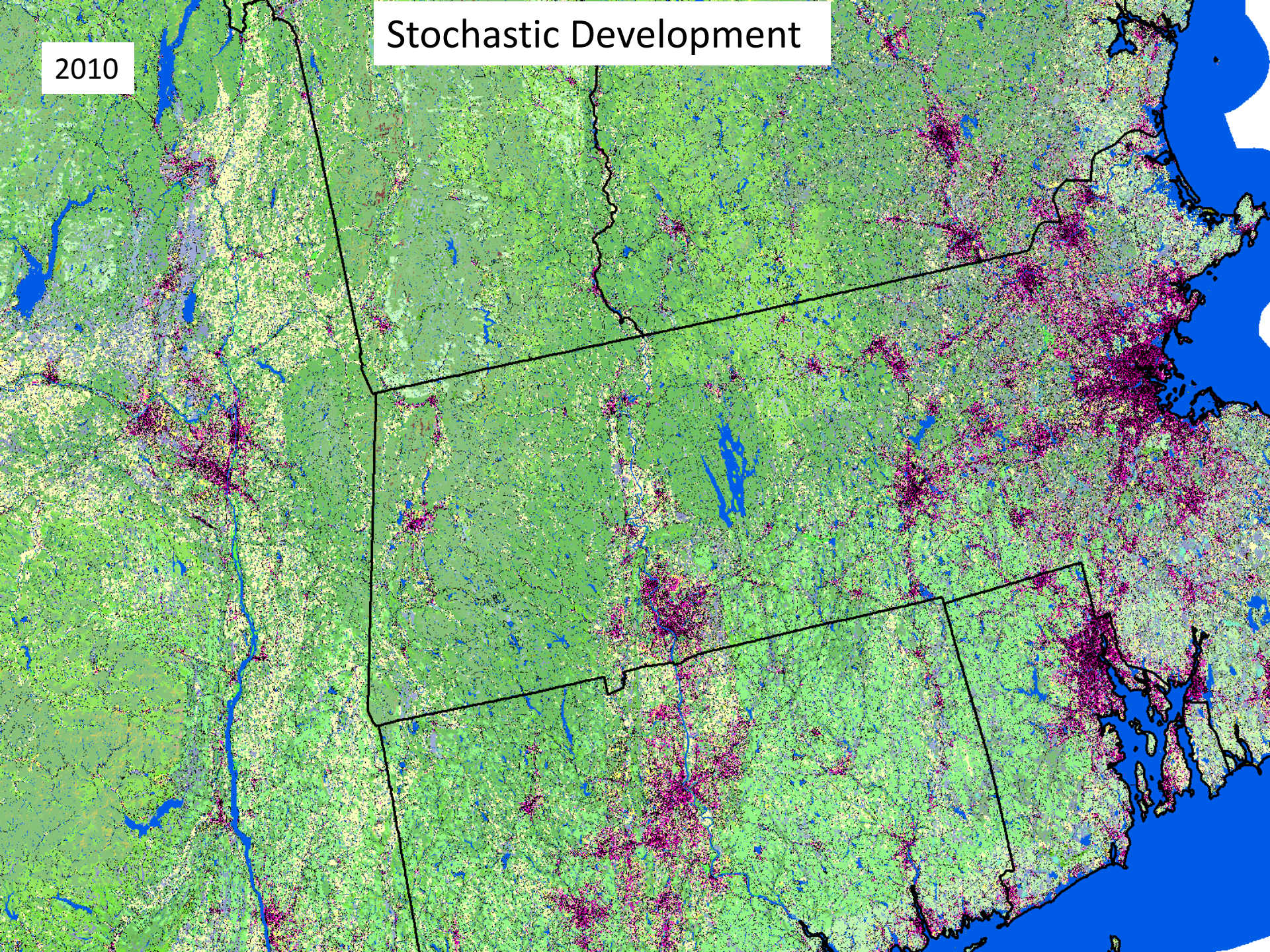
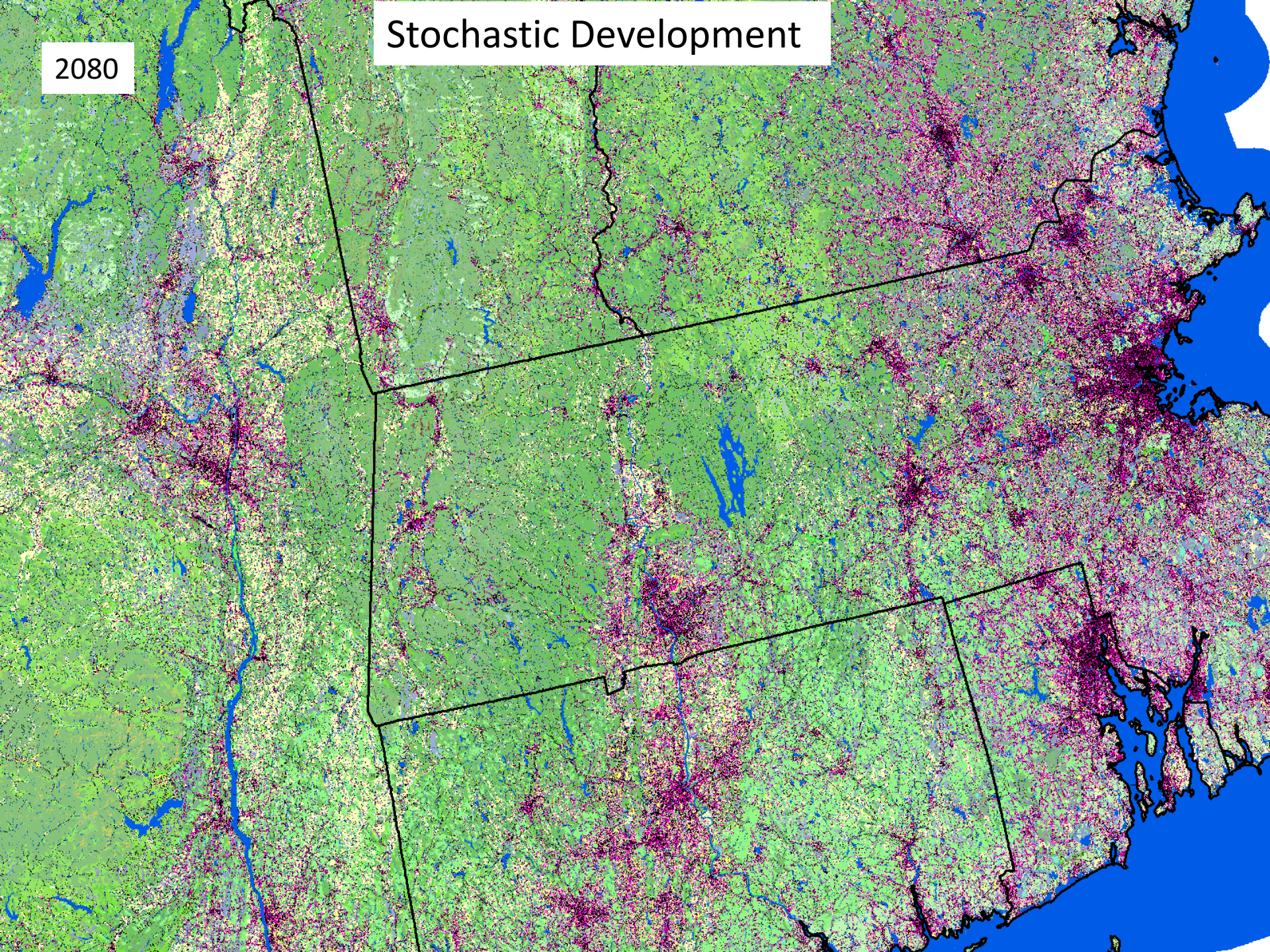
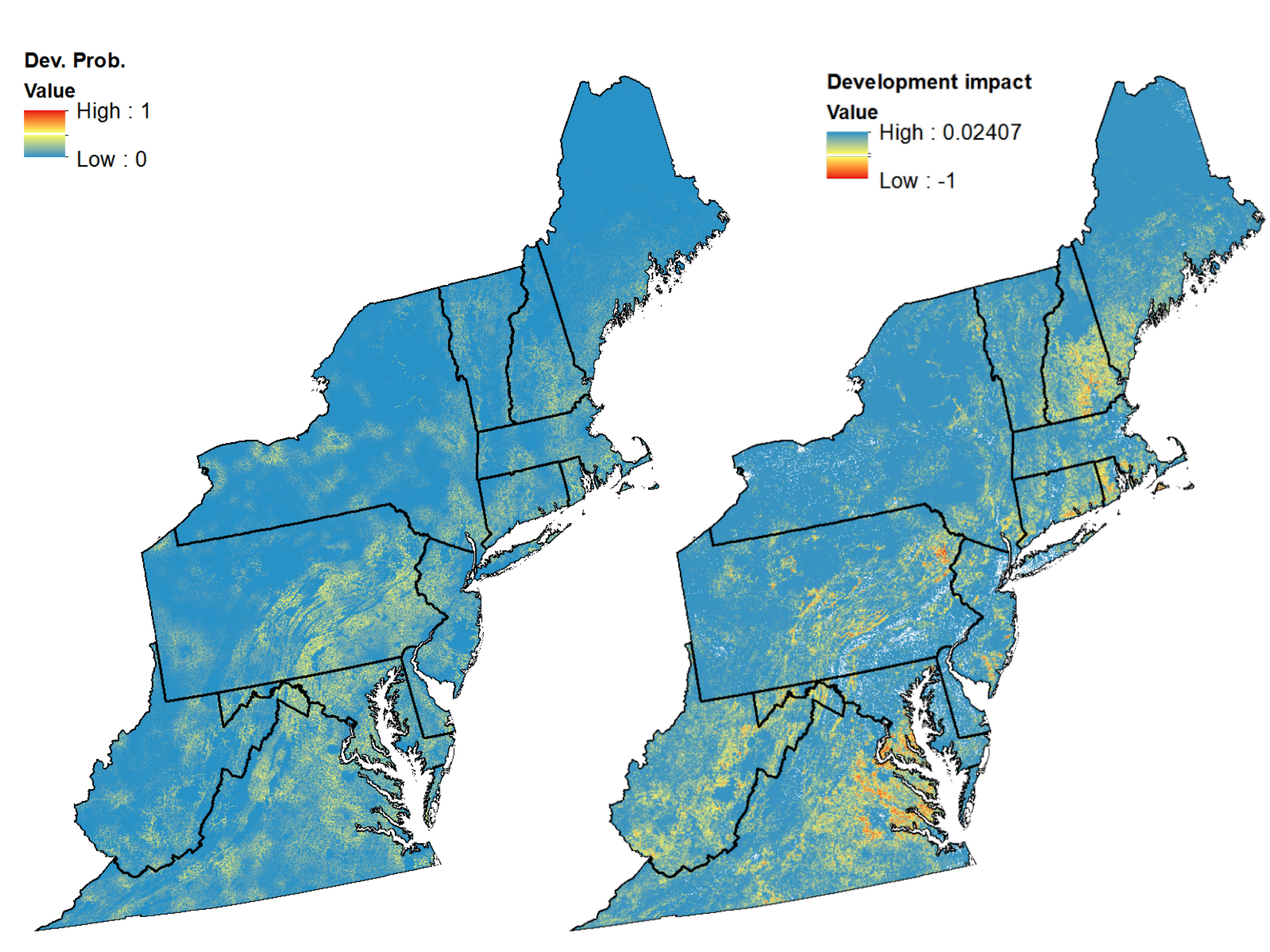
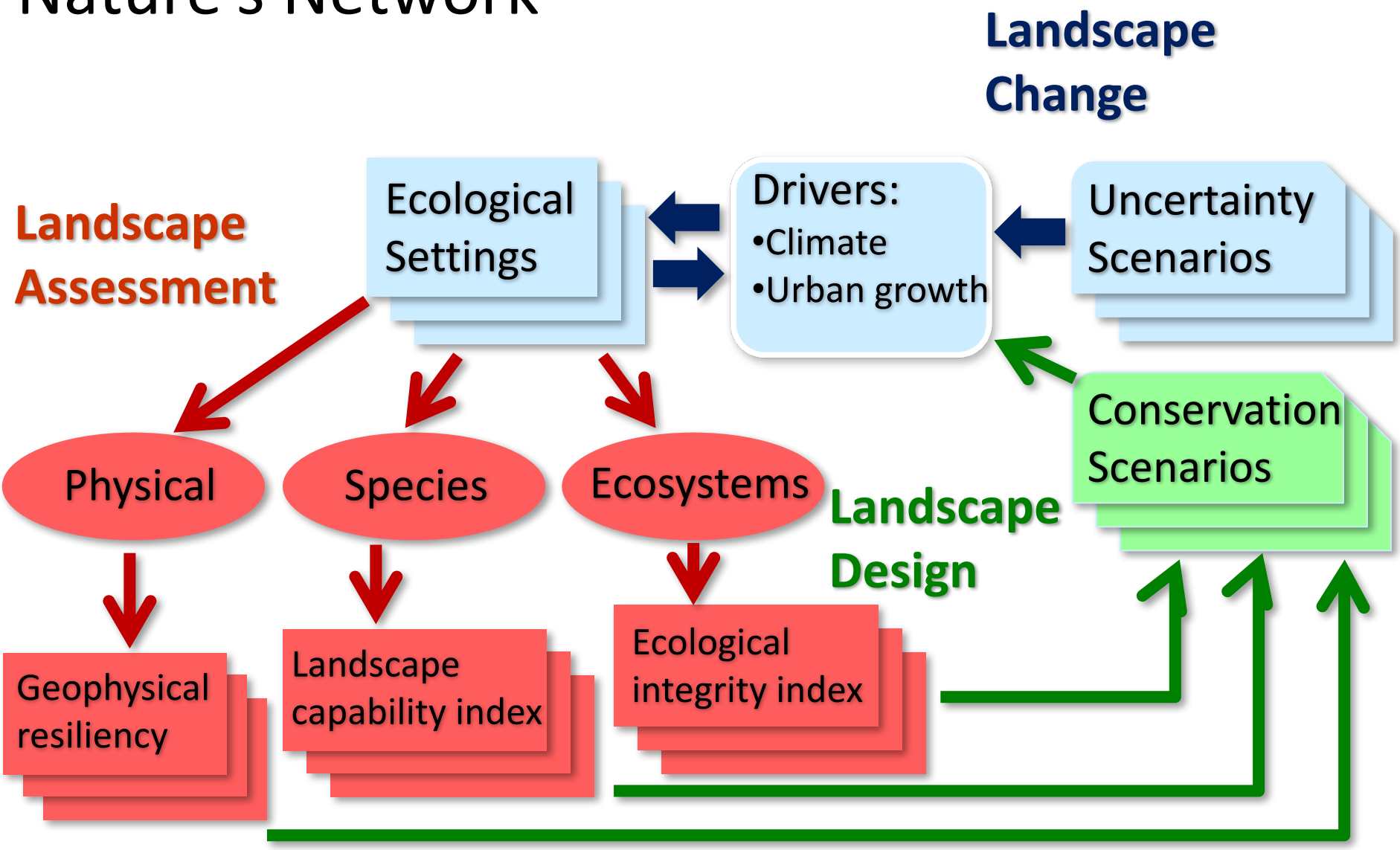
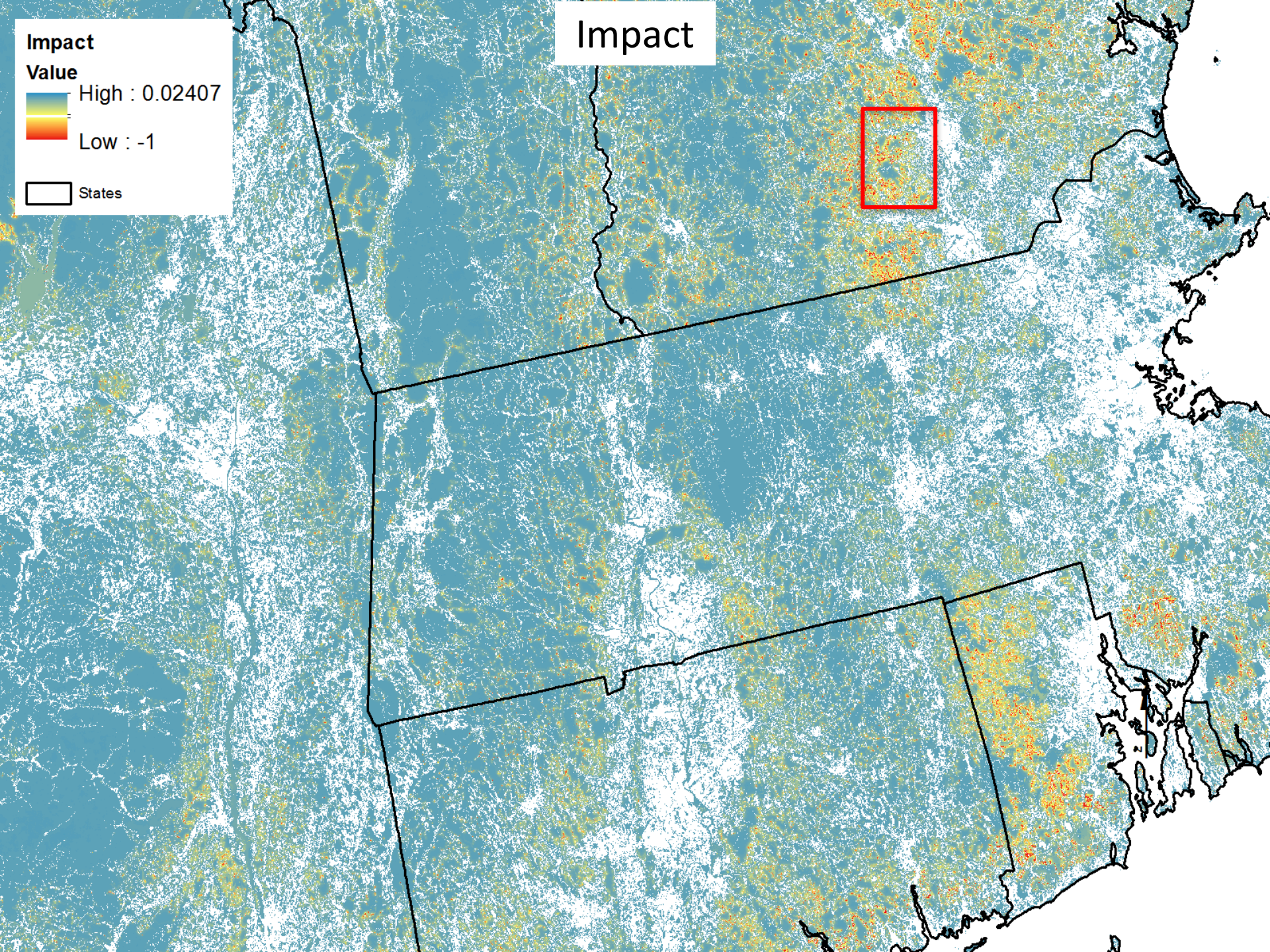

Stochastic Development
2010


Stochastic Development
2080


Dev. Prob.
Value
High : 1
Low : 0
Development impact
Value
High : 0.02407
Low : -1

Designing Sustainable Landscapes
Nature's Network




Impact
Impact
Value
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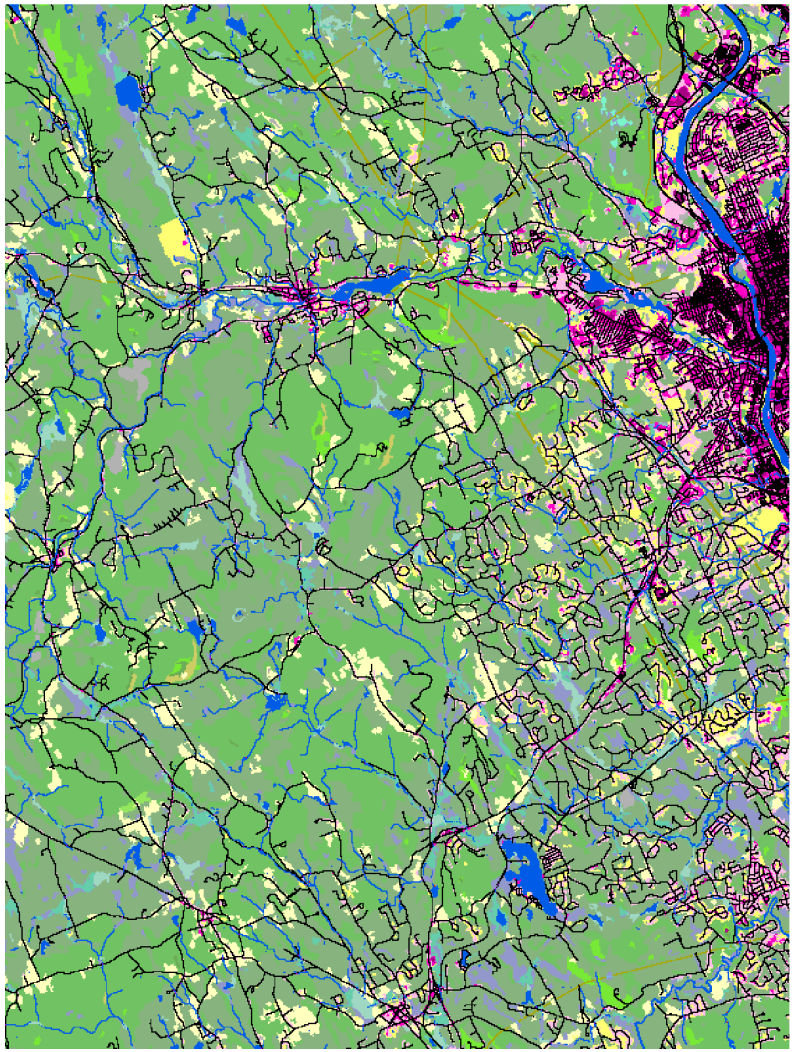
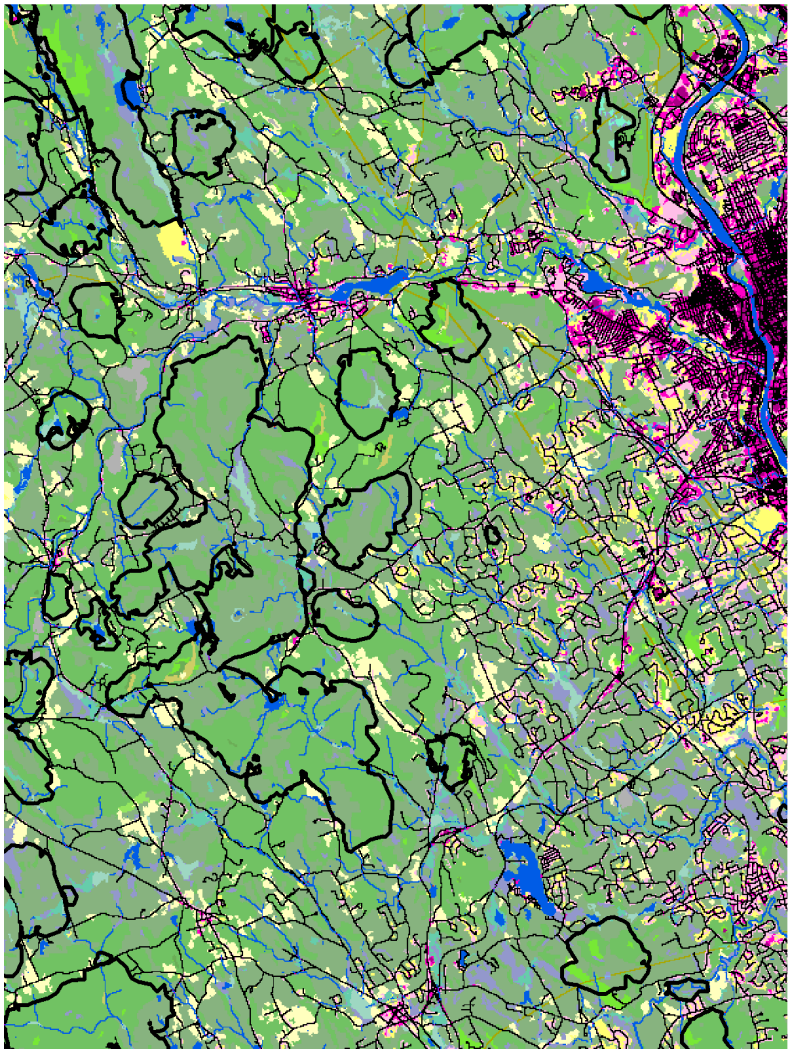
States

Conservation design evaluation

2010 Land cover

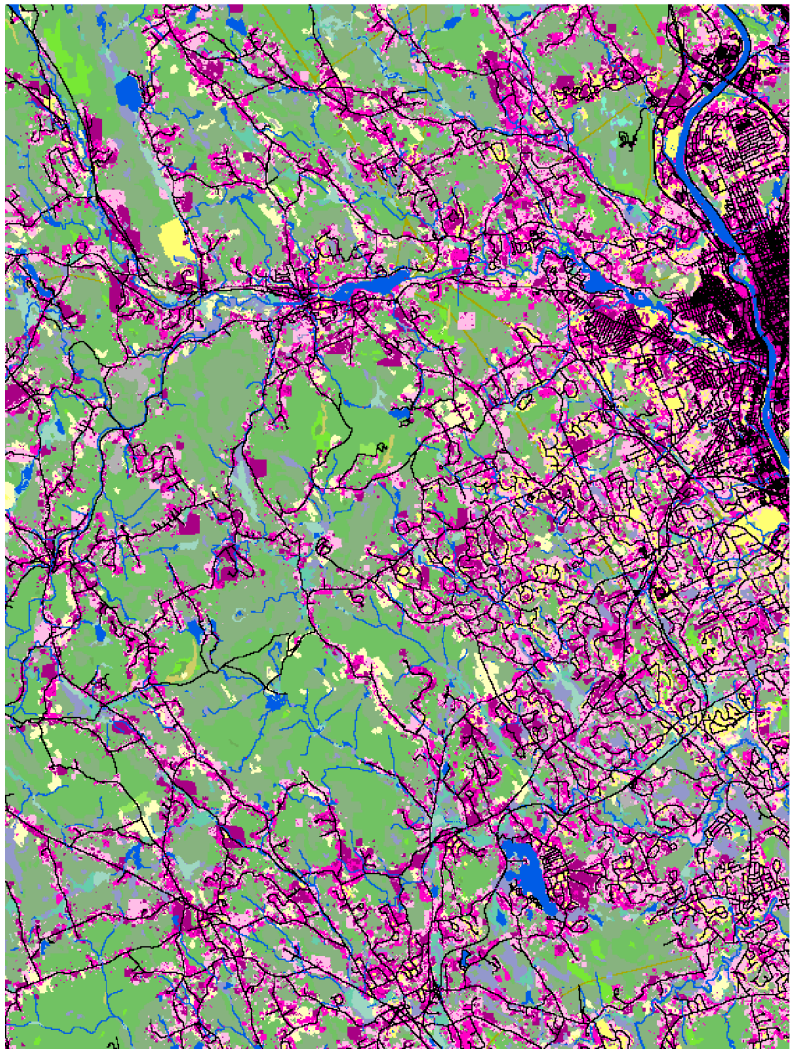


2010 Land cover with cores

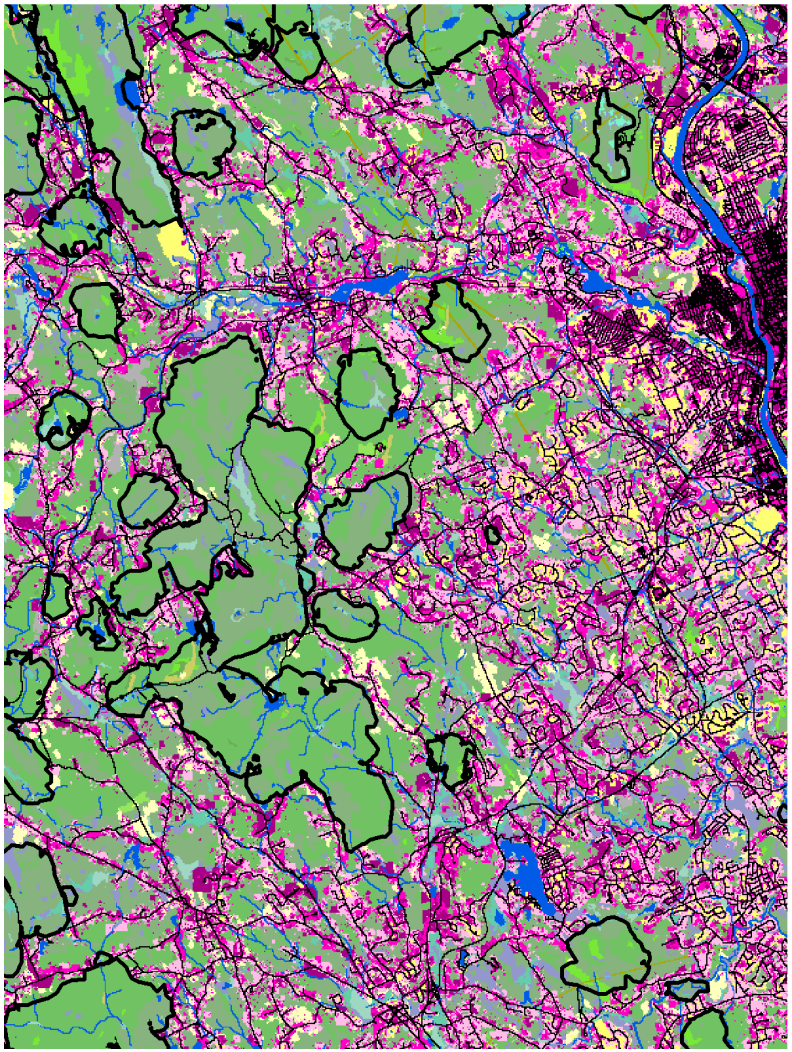


Conservation design evaluation

2080 Land cover

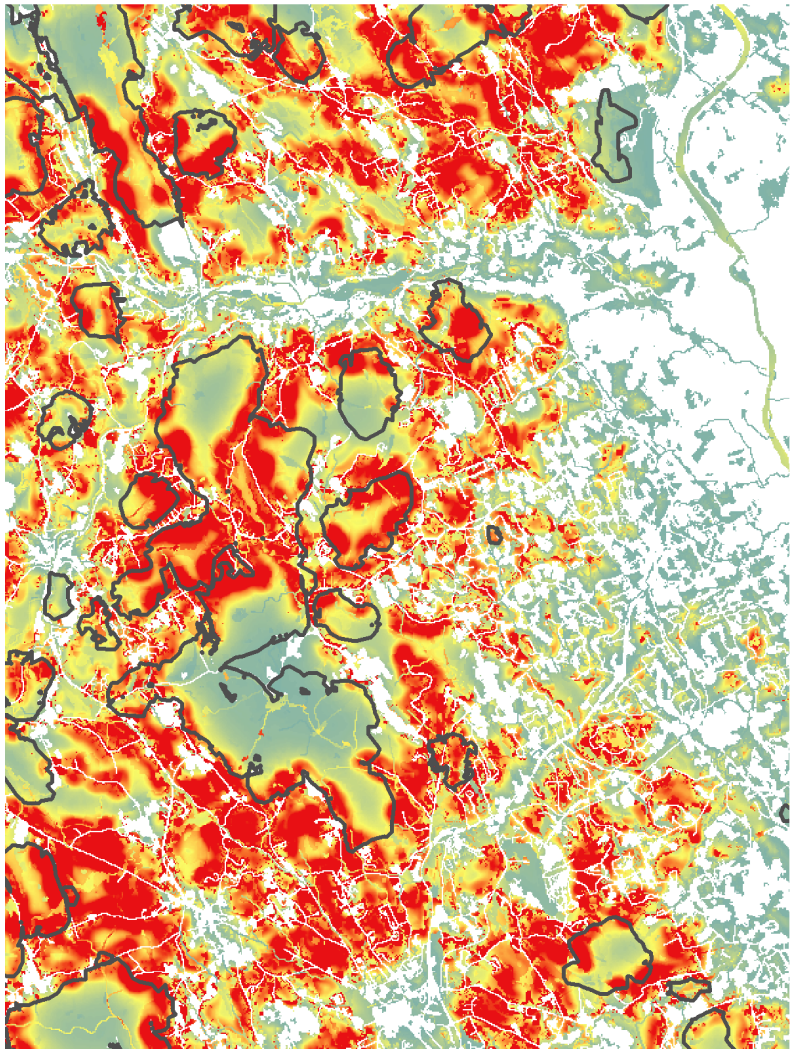


2080 Land cover with cores

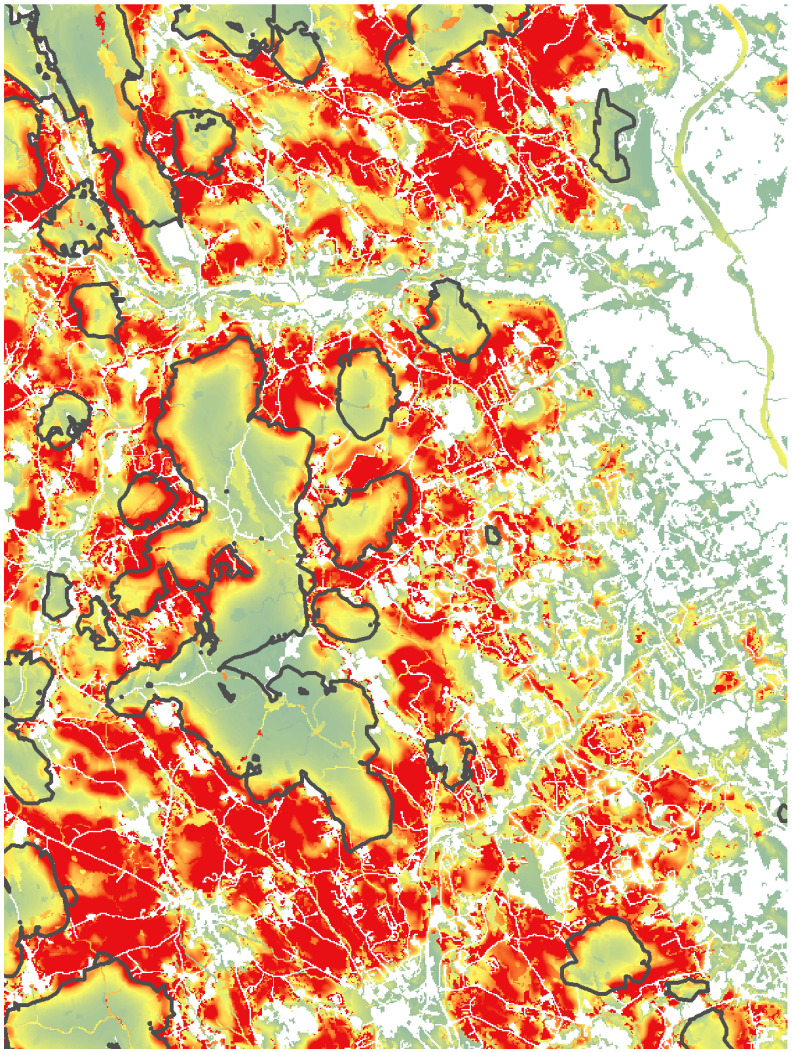


Conservation design evaluation

2080 Impact



2080 Impact with cores



Natures Network design reduces impact on ecological systems

Formation	Percent of baseline impact
Alpine	100.0
Boreal Upland Forest	91.4
Cliff & Rock	78.2
Coastal Scrub-Herb	78.3
Grassland & Shrubland	85.3
Northeastern Upland Forest	80.1
Northeastern Wetland	86.4
Peatland	99.4
Lentic	92.0
Stream	90.0
Estuarine Intertidal	75.6
Marine Intertidal	93.2
Overall	**81.1**

Acknowledgements:

Scott Schwenk
Andrew Milliken
Ken Elowe
Nancy McGarigal
Renee Vieira
Bridget Macdonald

Table 1. SPRAWL model evaluation based on hindcasting, including for each of six development transition types (1-3 represent new development from undeveloped land; 4-6 represent redevelopment) the following statistics: 1) ratio of the average computed probability of development for cells that underwent development in the hindcast dataset (~2000-2010) to that of the corresponding available cells, 2) area under the Receiver Operating Characteristic Curve Area (AUC), 3) coefficient of concordance (CC), and 4) weighted skewness statistic.

Transition type	Use/availability ratio	AUC	CC	Weighted skewness
1 (undeveloped to low-intensity developed)	11.14	0.93	0.70	-0.73
2 (undeveloped to medium-intensity developed)	11.70	0.94	0.77	-0.71
3 (undeveloped to high-intensity developed)	9.86	0.93	0.80	-0.61
4 (low- to medium-intensity developed)	1.08	0.53	0.93	0.05
5 (low- to high-intensity developed)	1.25	0.60	0.98	-0.31
6 (medium- to high-intensity developed)	1.26	0.57	0.77	-0.17