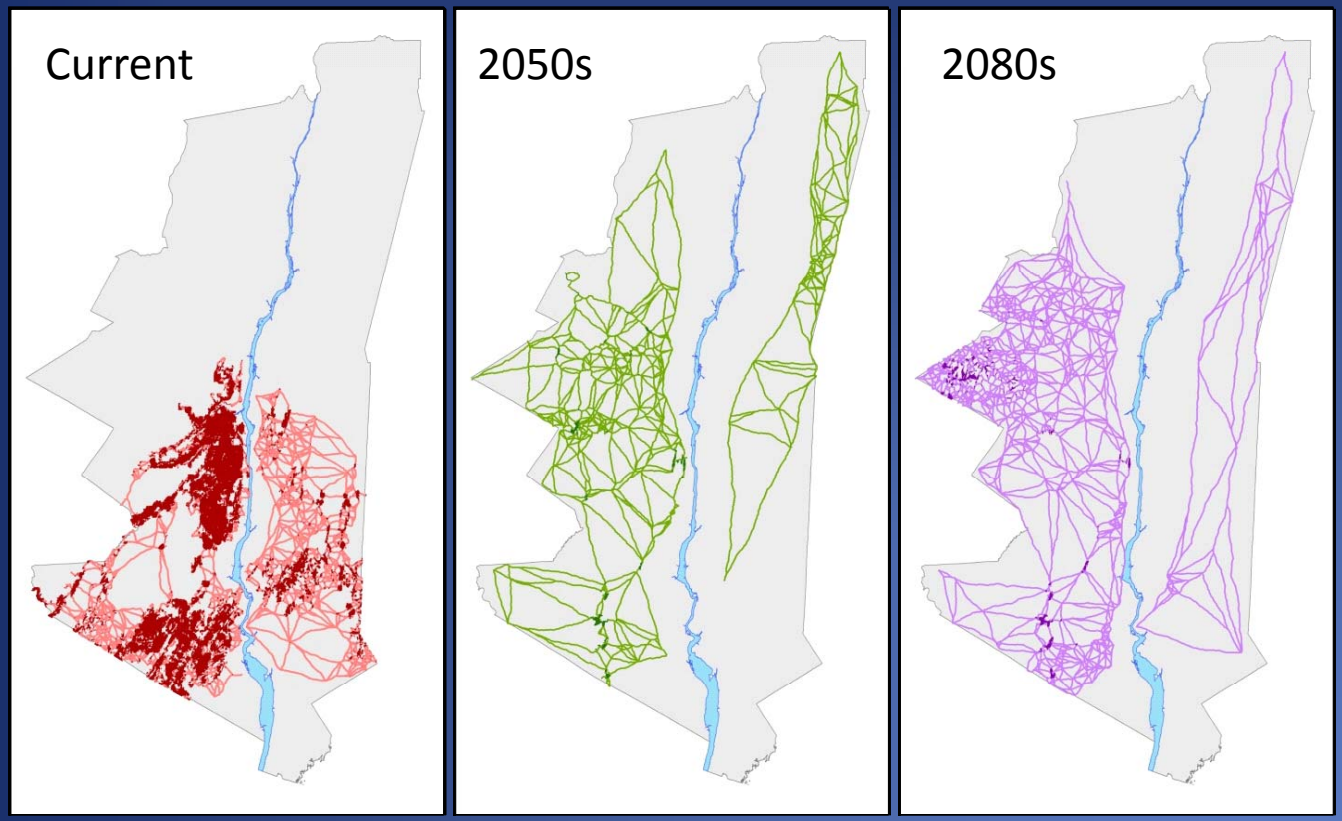
The Catskills connection: Using species distribution modeling to inform regional connectivity assessments under current-day and future climate



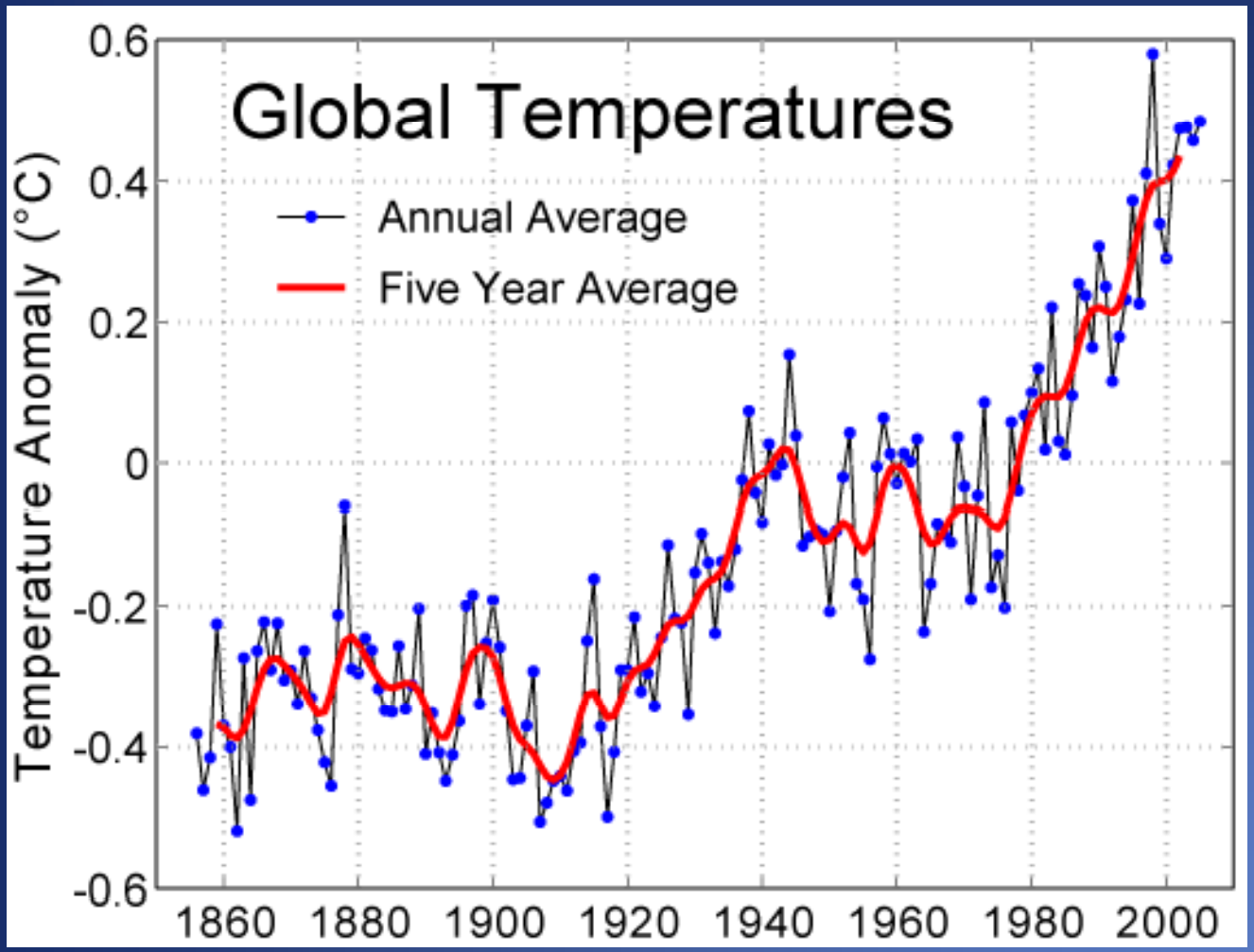
Timothy G. Howard
Matthew D. Schlesinger

October 25, 2012

New York
Natural Heritage
Program

Why does connectivity matter?

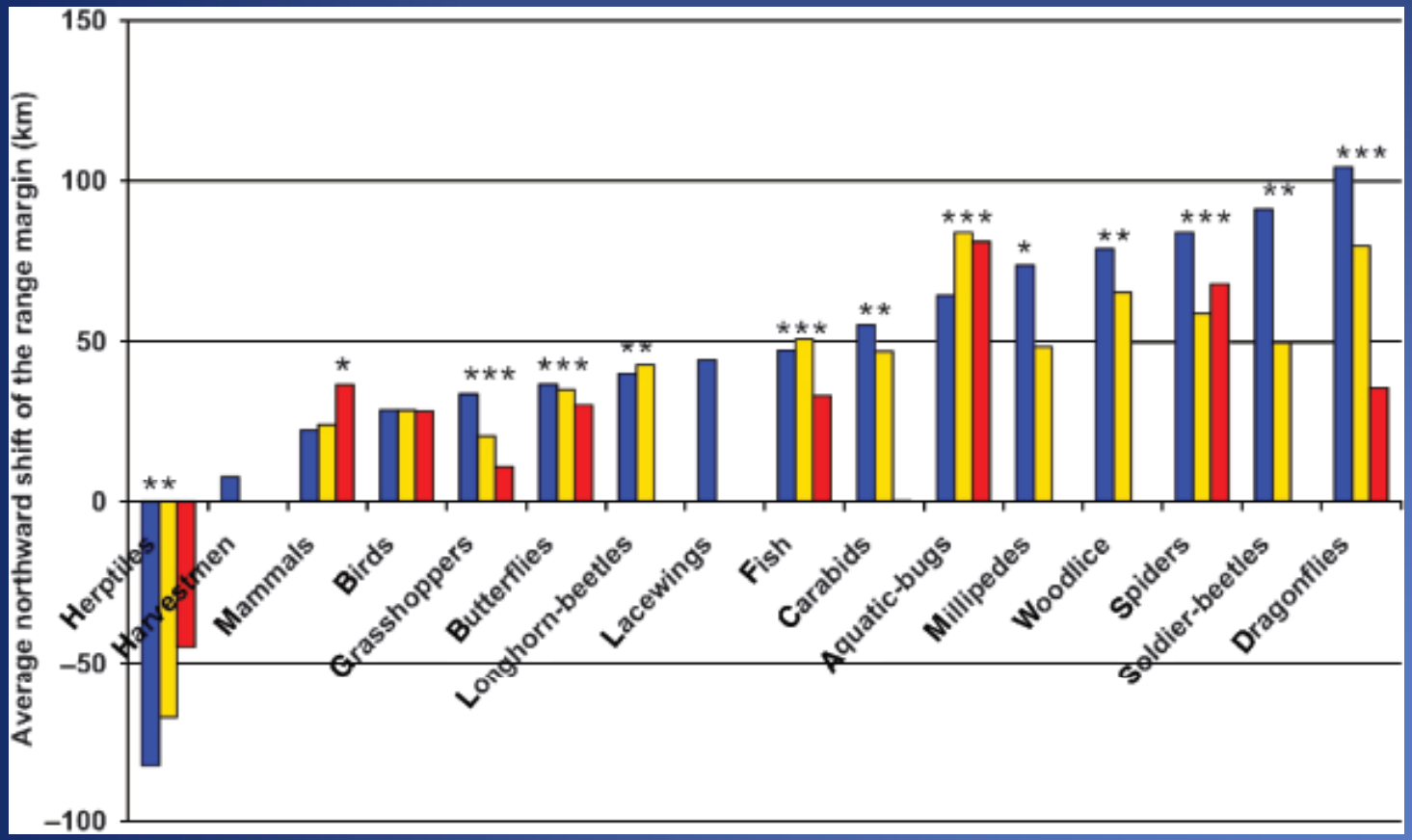
You know about this.



Global Change Biology (2006) **12**, 450–455, doi: 10.1111/j.1365-2486.2006.01116.x

The distributions of a wide range of taxonomic groups are expanding polewards

RACHAEL HICKLING*†, DAVID B. ROY*, JANE K. HILL†, RICHARD FOX‡ and CHRIS D. THOMAS†



Why does connectivity matter even more now?

"Connectivity conservation is particularly important in the face of climate change. Well-connected landscapes promote dispersal and gene flow, processes that will maximize species' abilities to respond to the stress of climate change. Furthermore, highly permeable landscapes will be important as species shift their ranges to track changes in climate and vegetation patterns."

- Washington Wildlife Habitat Connectivity Working Group

PATHWAYS project: Key questions

- How will species' distributions likely change in the Hudson Valley?
- Where are the likely connections?
- Where are connection consistencies between current day, the 2050s and the 2080s?
- What are priority locations (patches and paths) for maintaining or restoring connectivity?

Steps along our path

- Build species distribution models
  - assemble known locations
  - habitat patches
  - resistance-to-travel landscape
- Assess connectivity and prioritize patches
- Change the climate
- Re-run distribution models
- Assess future connectivity
- Scale up to ownership parcels

Focal species (1)

Forest

- Black rat snake
- Eastern box turtle
- Northern black racer
- Black-throated blue warbler
- Kentucky warbler
- Scarlet tanager
- Wood thrush
- Worm-eating warbler

Forest (open rocky ridges)

- Timber rattlesnake
- Common five-lined skink
- Northern copperhead

Forest (riparian)

- Wood turtle
- Longtail salamander
- Cerulean warbler

Focal species (2)

Forest (seeps)

- Arrowhead spiketail
- Gray petaltail
- Tiger spiketail

Forest (vernal pool)

- Blue-spotted/Jefferson salamander complex
- Four-toed salamander
- Marbled salamander

Wetland

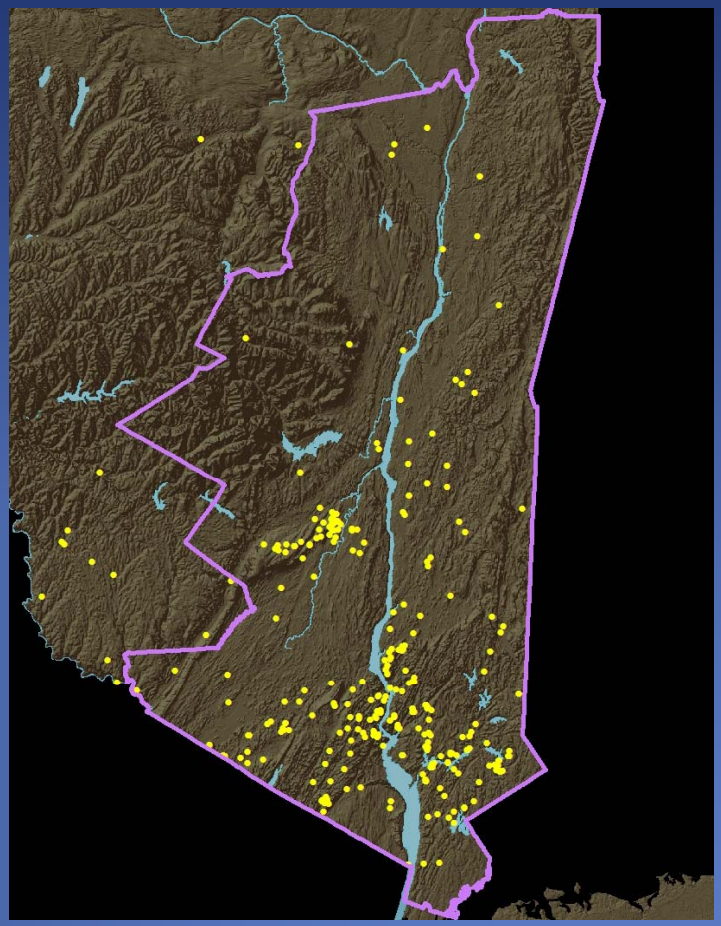
- Blanding's turtle
- Bog turtle
- Eastern ribbon snake
- Spotted turtle
- Northern cricket frog

Shrubland

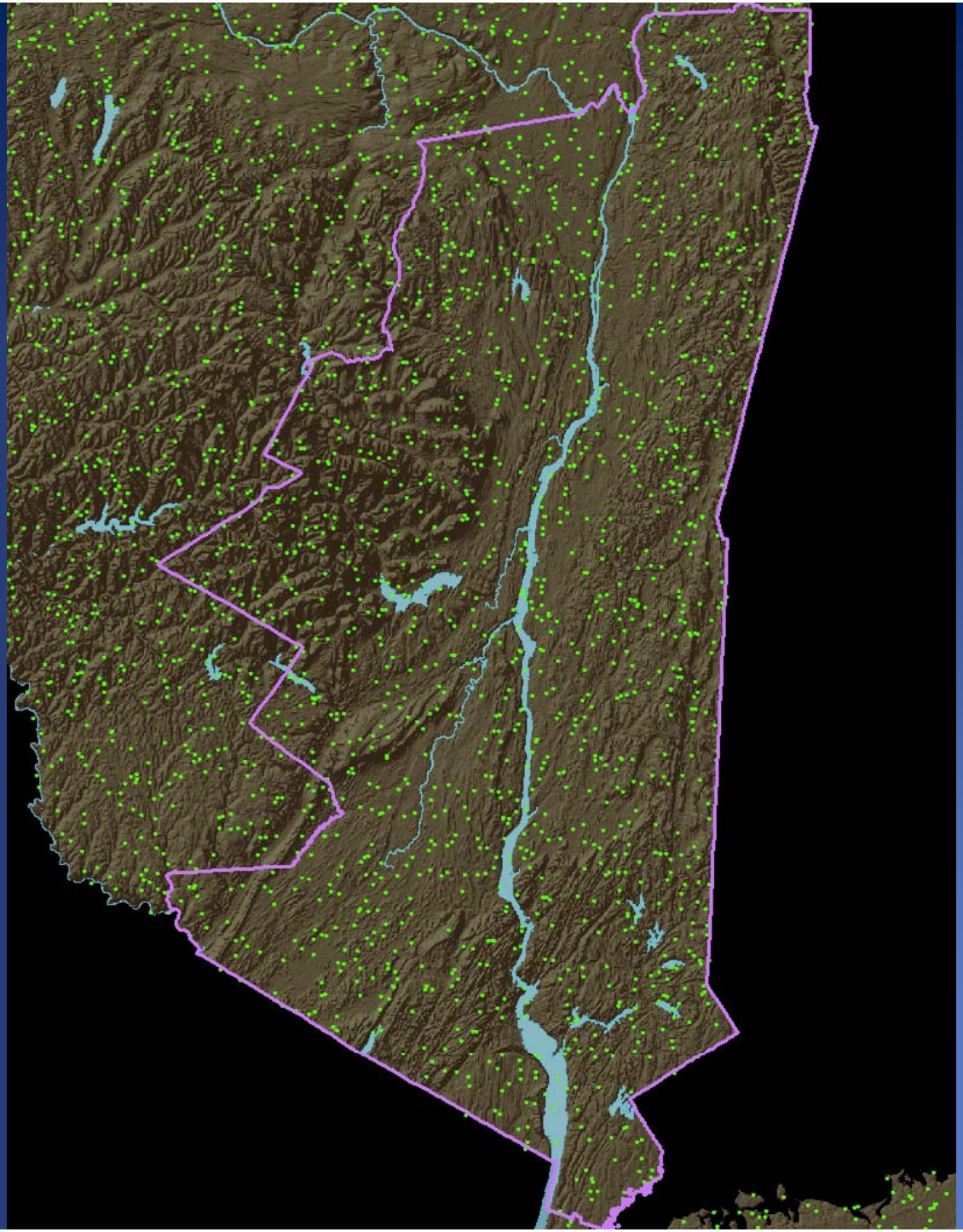
- New England cottontail

6,000 species locations

- Natural Heritage element occurrences
- NYSDEC Herp Atlas
- Breeding Bird Survey
- Metropolitan Conservation Alliance
- NY Dragonfly and Damselfly Survey
- Others



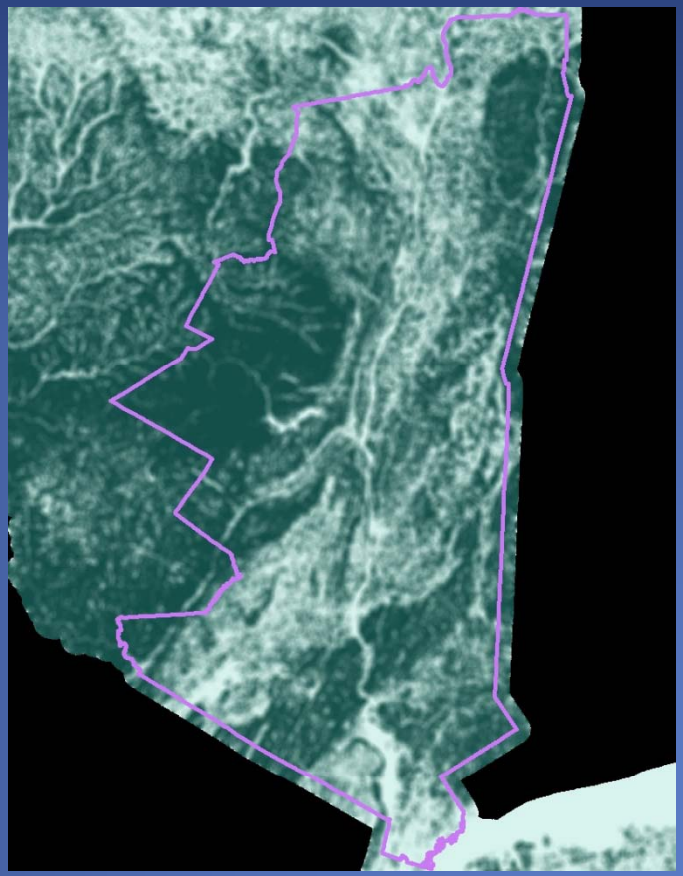
10,000 background points



44 environmental variables in 30-m grids

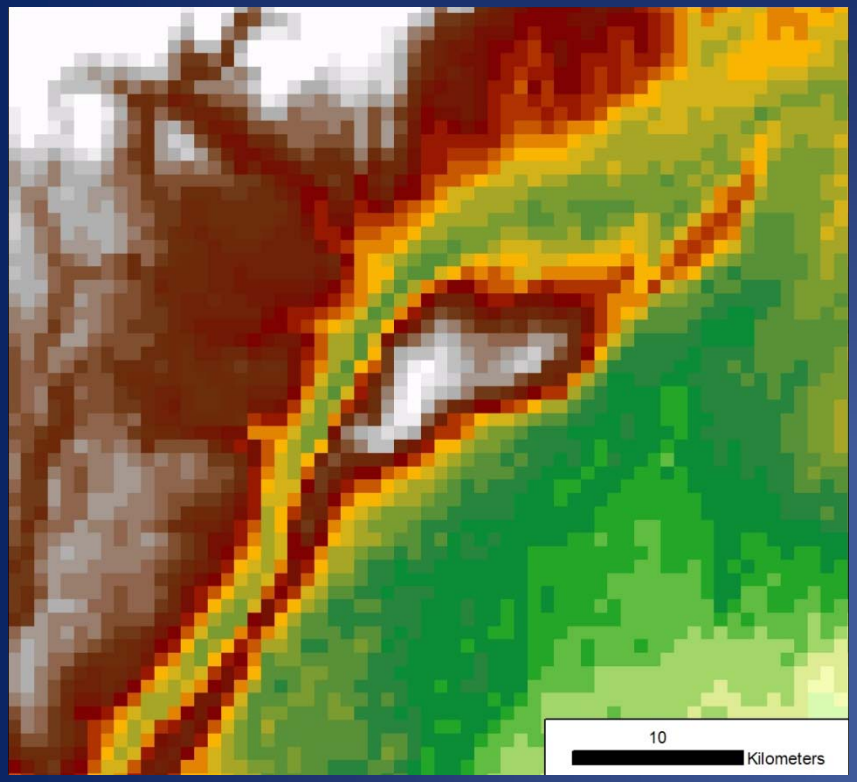
- Climate (9)
- Elevation and topography (8)
- Geology and soils (9)
- Land cover (18)

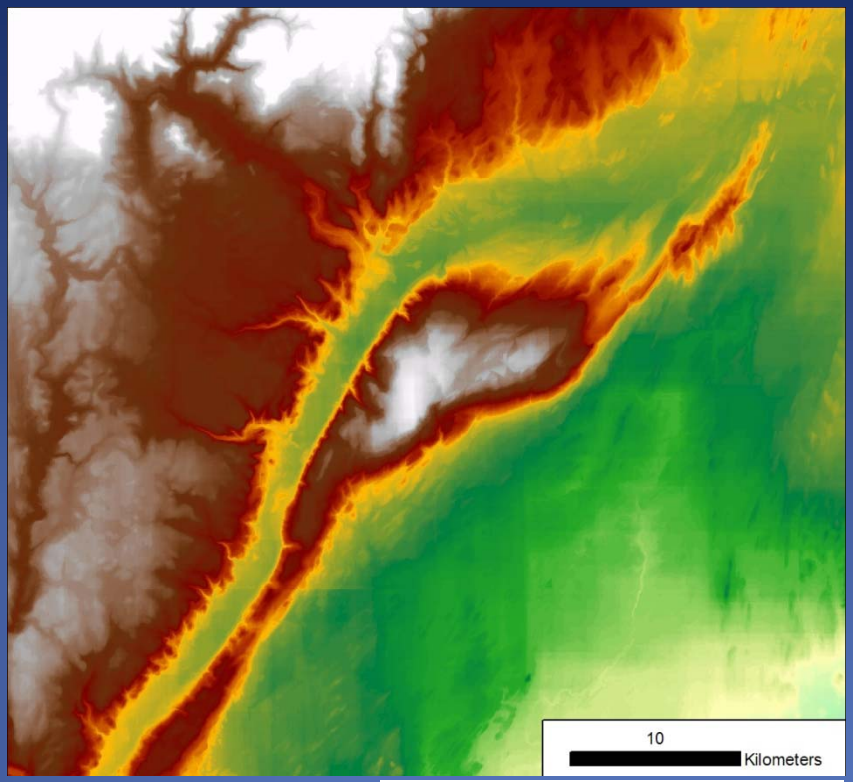
Land cover category



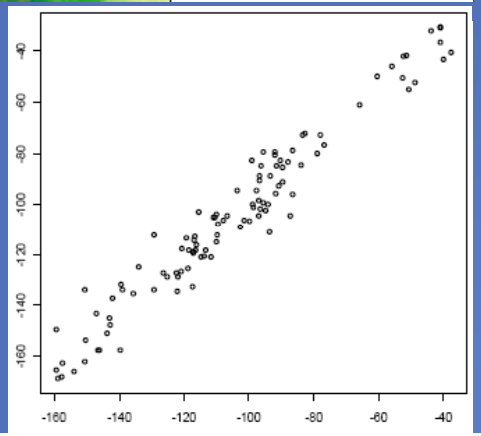
Forest within 1 km

Climate downscaling





Current-day downscaling validated with newly available higher resolution weather station data.



$R^2 = 0.949$

Statistical approach: Random Forests

- Data mining method for nonparametric analyses
- Creates classification tree ensemble

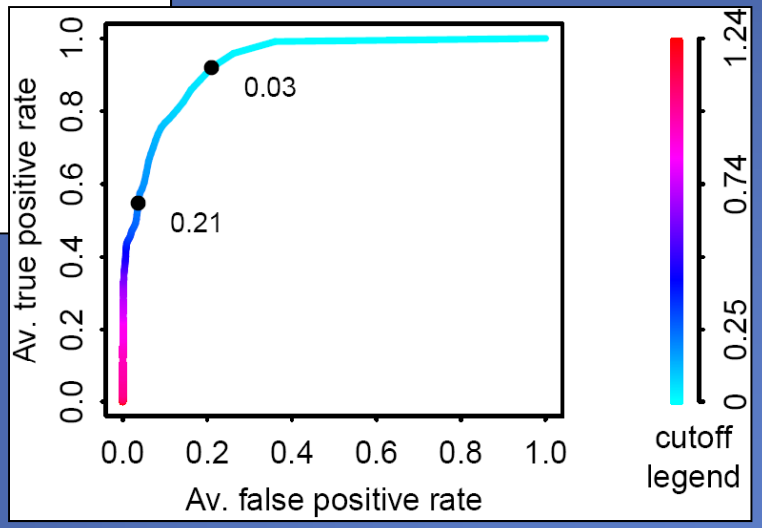
Benefits of RF:

- Able to handle collinearity
- Can handle mixed variables and unbalanced data sets
- One of the most accurate learning algorithms available

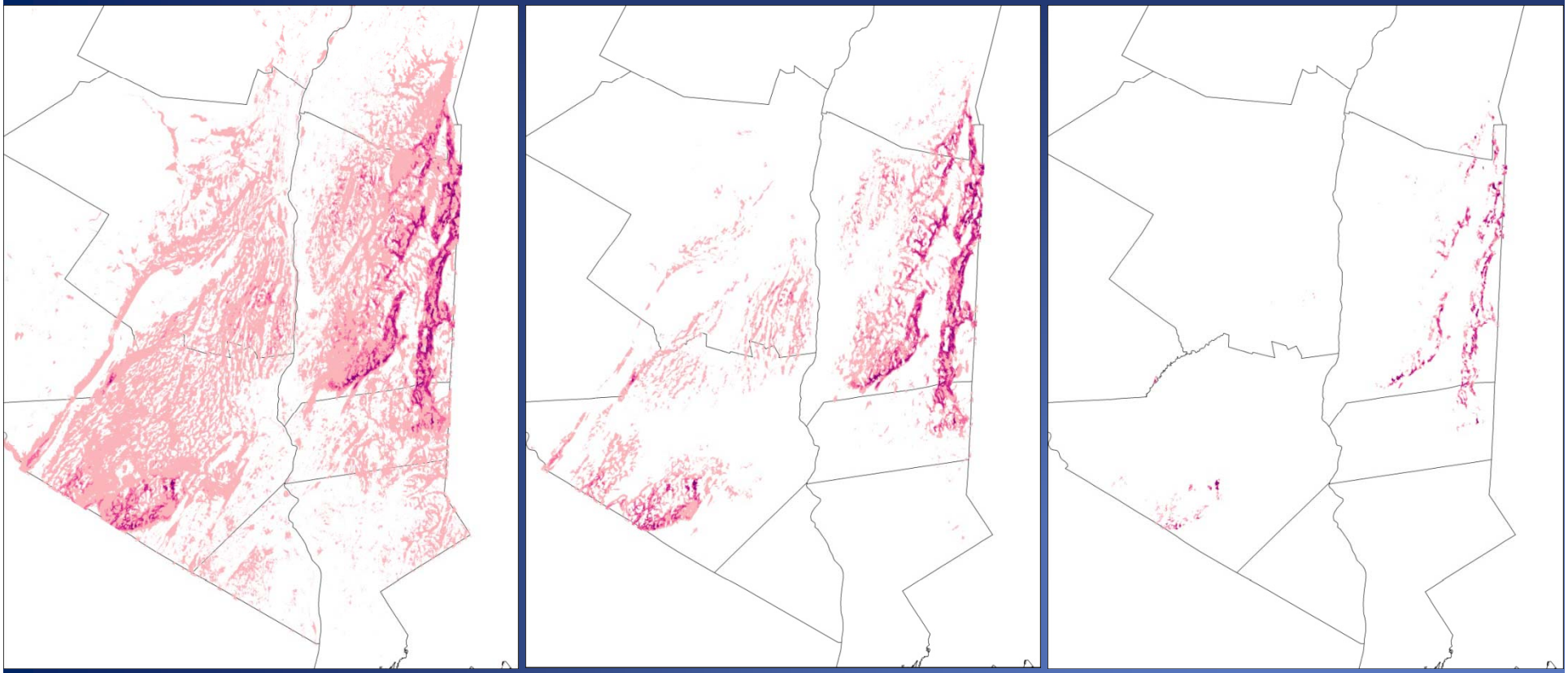
Validation Statistics

Table 2. Validation statistics for jackknife trials. Overall Accuracy = Correct Classification Rate, TSS = True Skill Statistic, AUC = area under the ROC curve; see [8, 9, 6].

Name	Mean	SD	SEM
Overall Accuracy	0.93	0.13	0.02
Specificity	0.95	0.04	0.01
Sensitivity	0.91	0.26	0.05
TSS	0.86	0.26	0.05
Kappa	0.86	0.26	0.05
AUC	0.98	0.04	0.01



Which model representation?

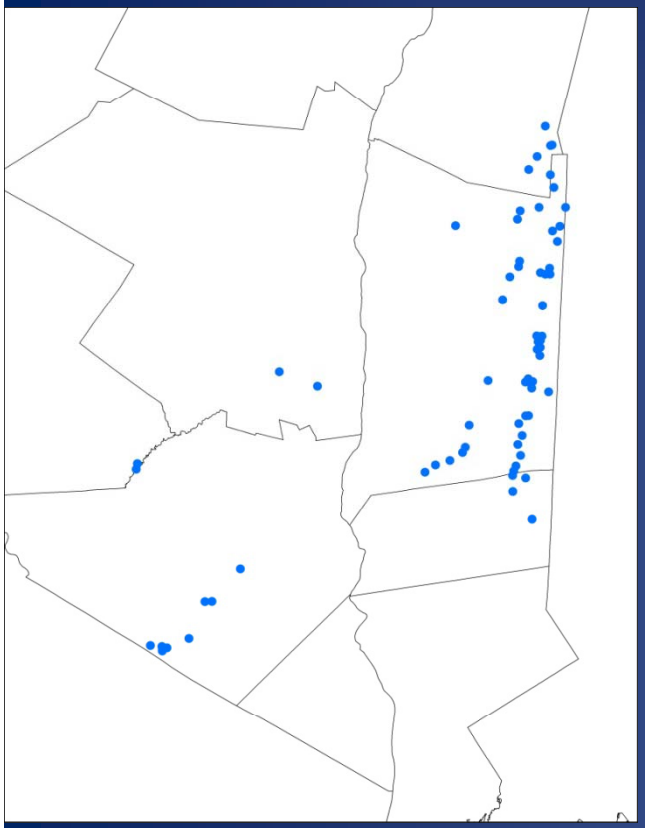


5% and greater

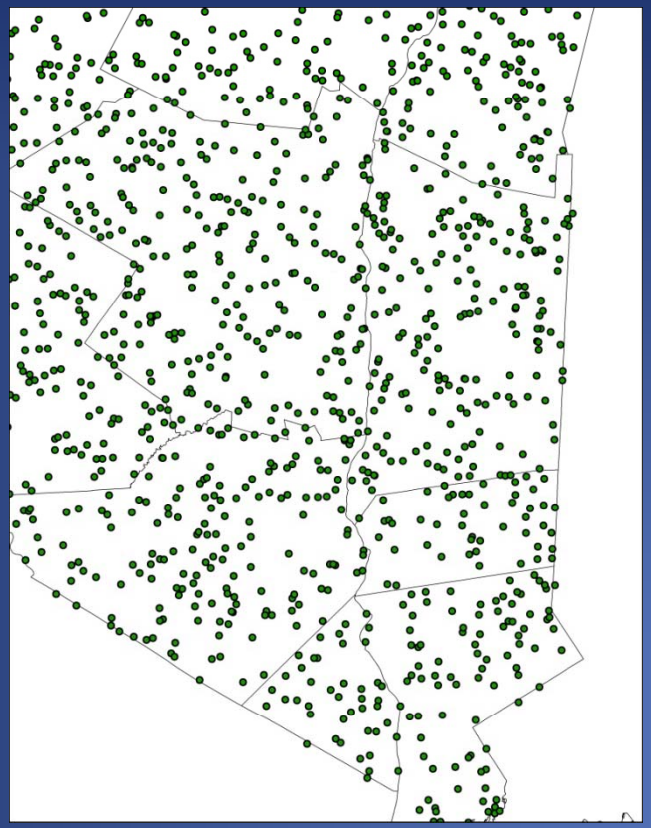
20.5% and greater

75% and greater

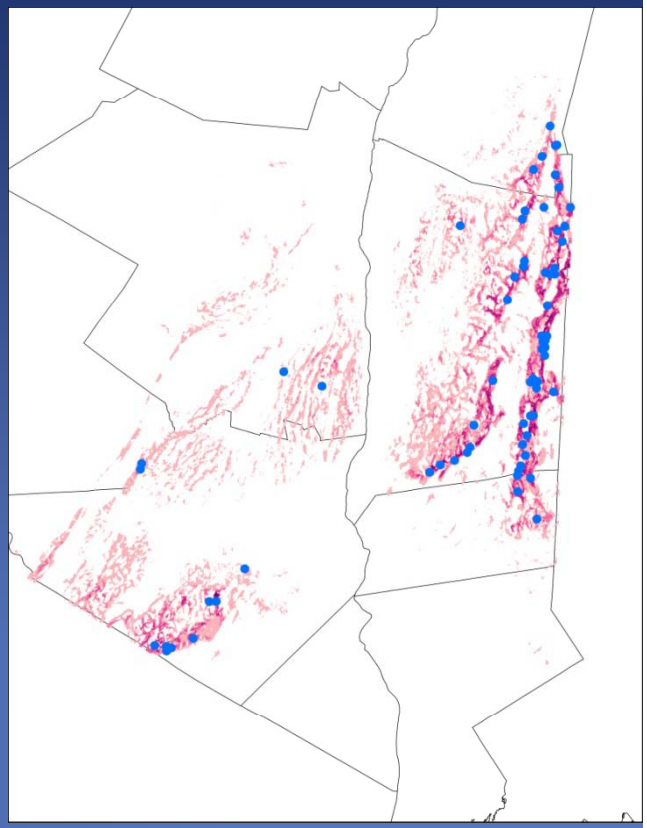
Balance known locations and background



Known Bog Turtle locations



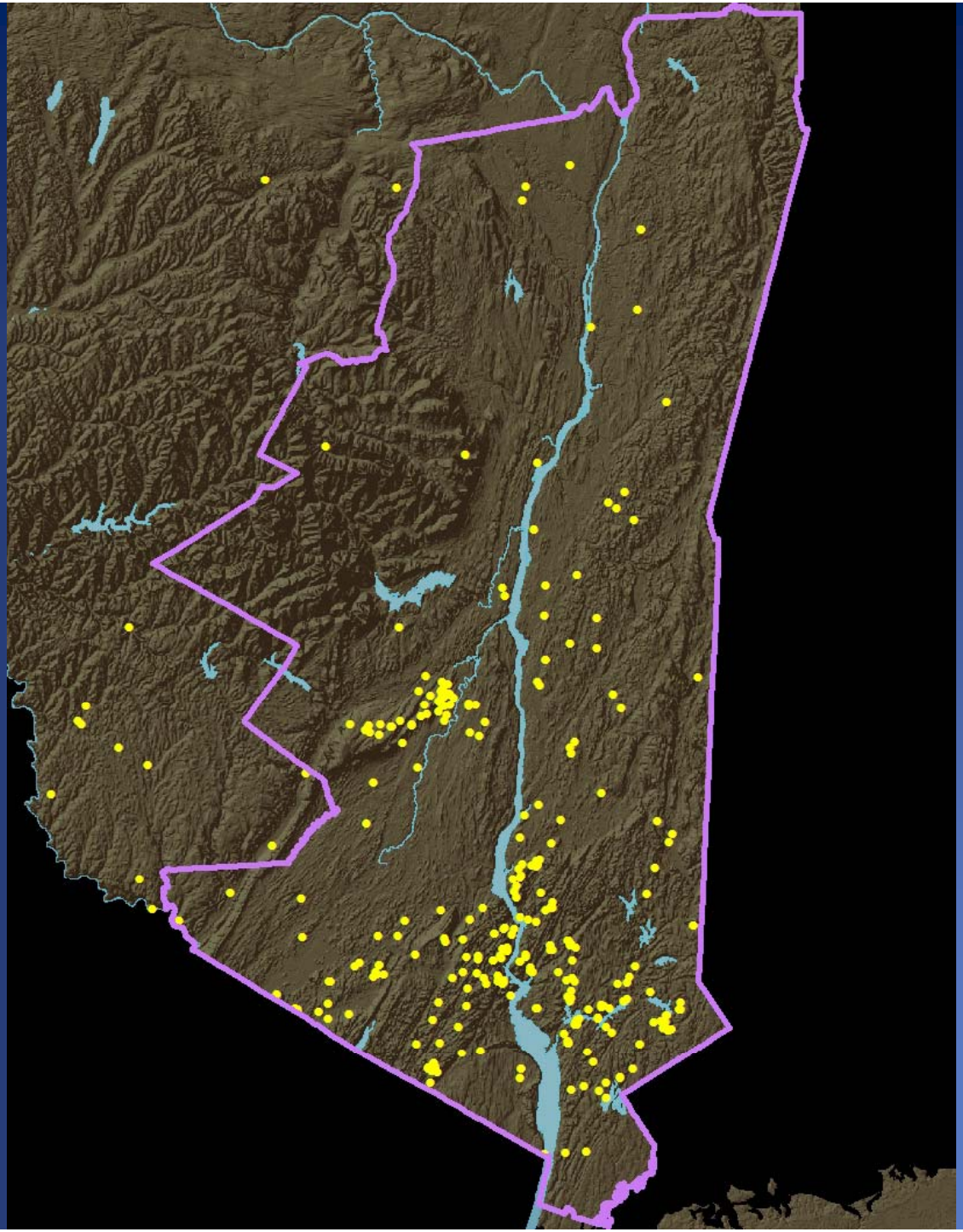
Background points



Balance between two

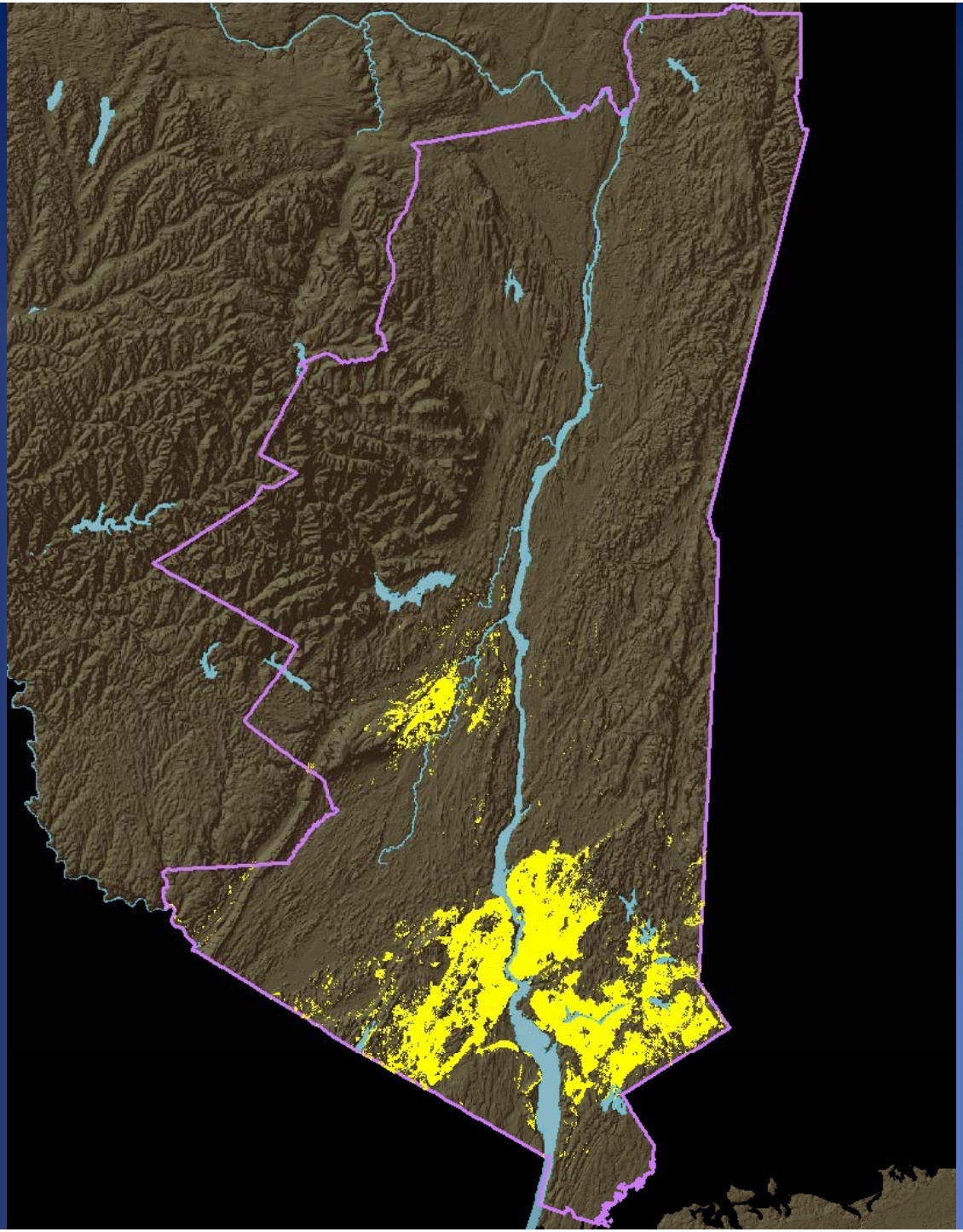
Eastern box turtle

Input points



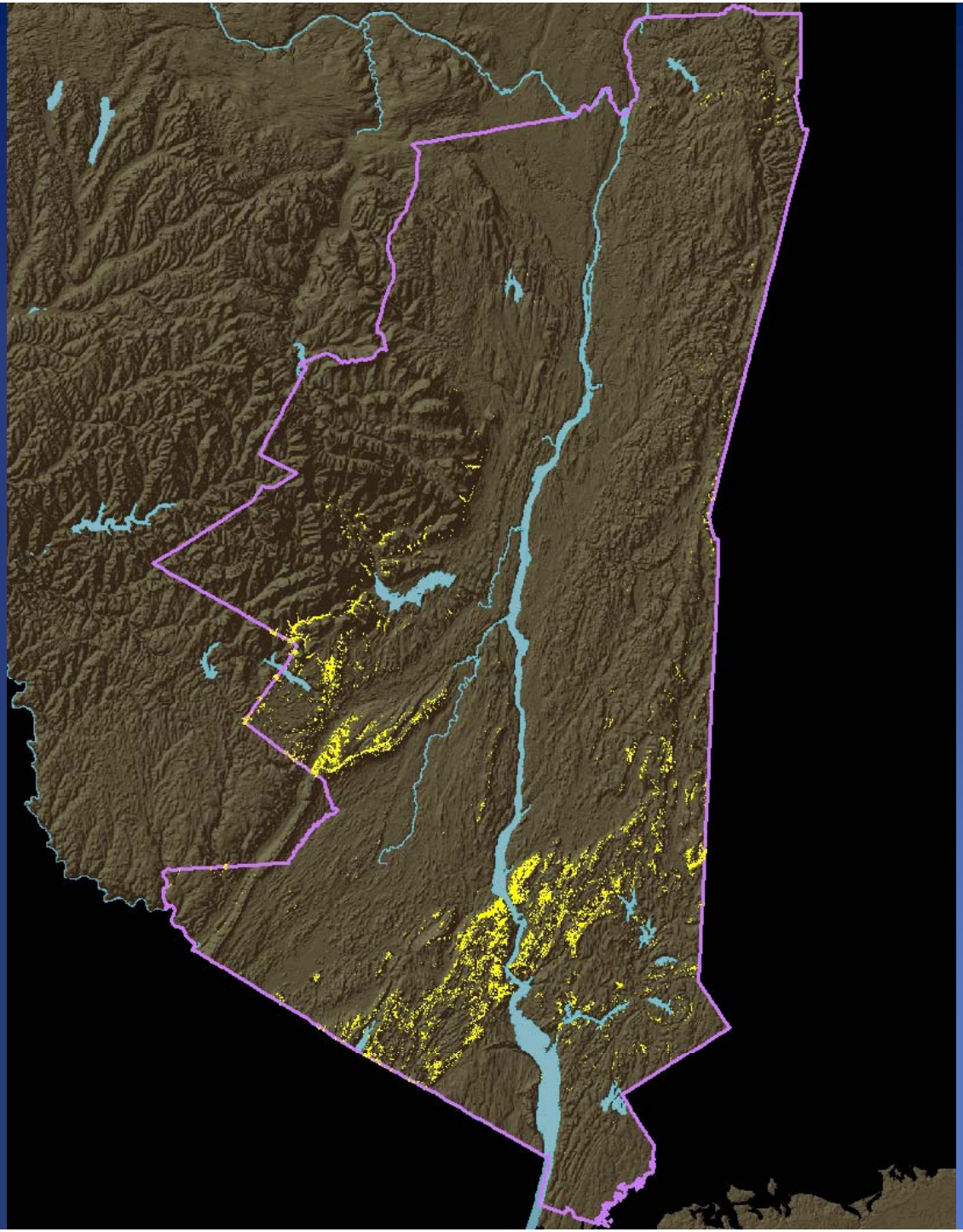
Eastern box turtle

Current



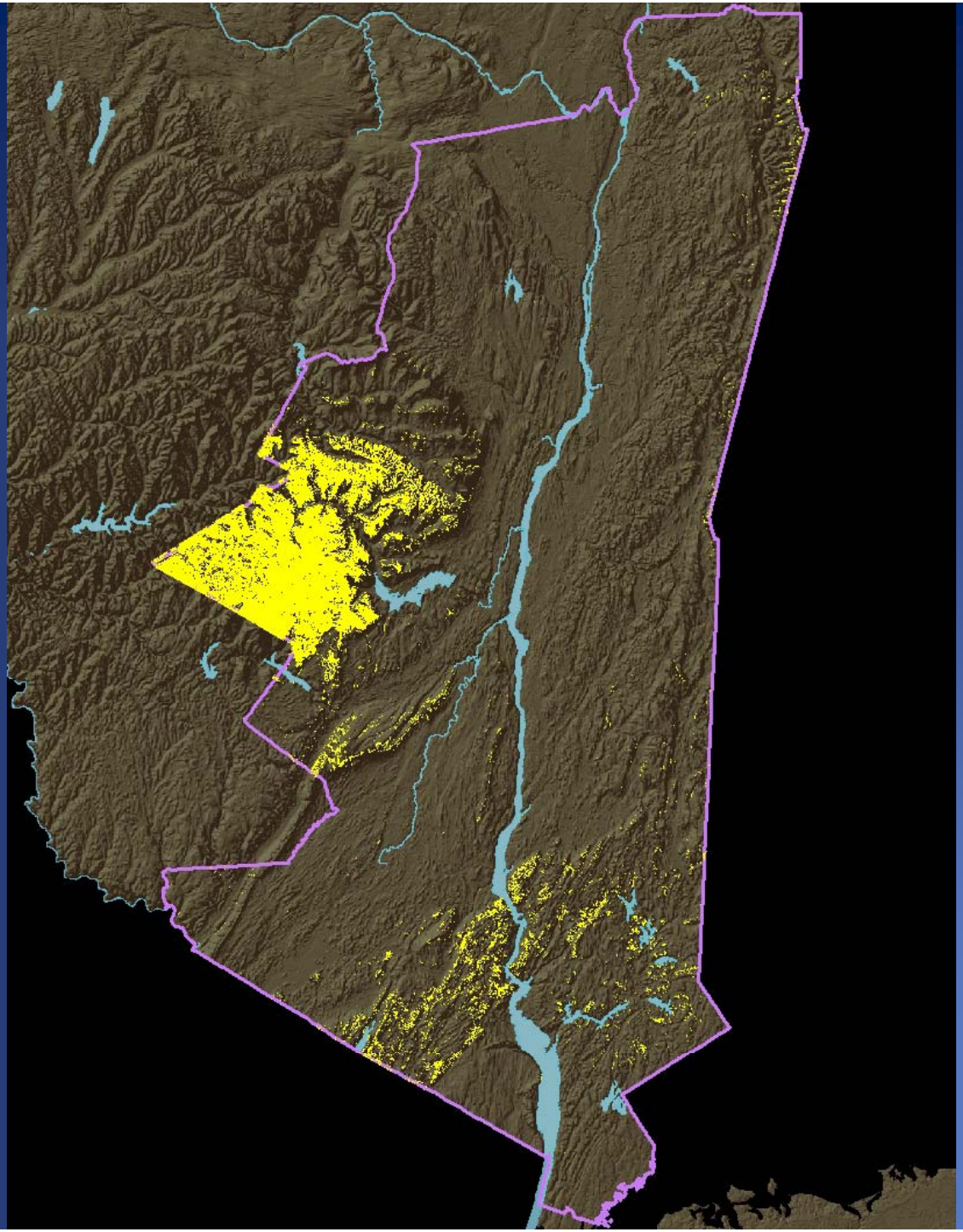
Eastern box turtle

2050s



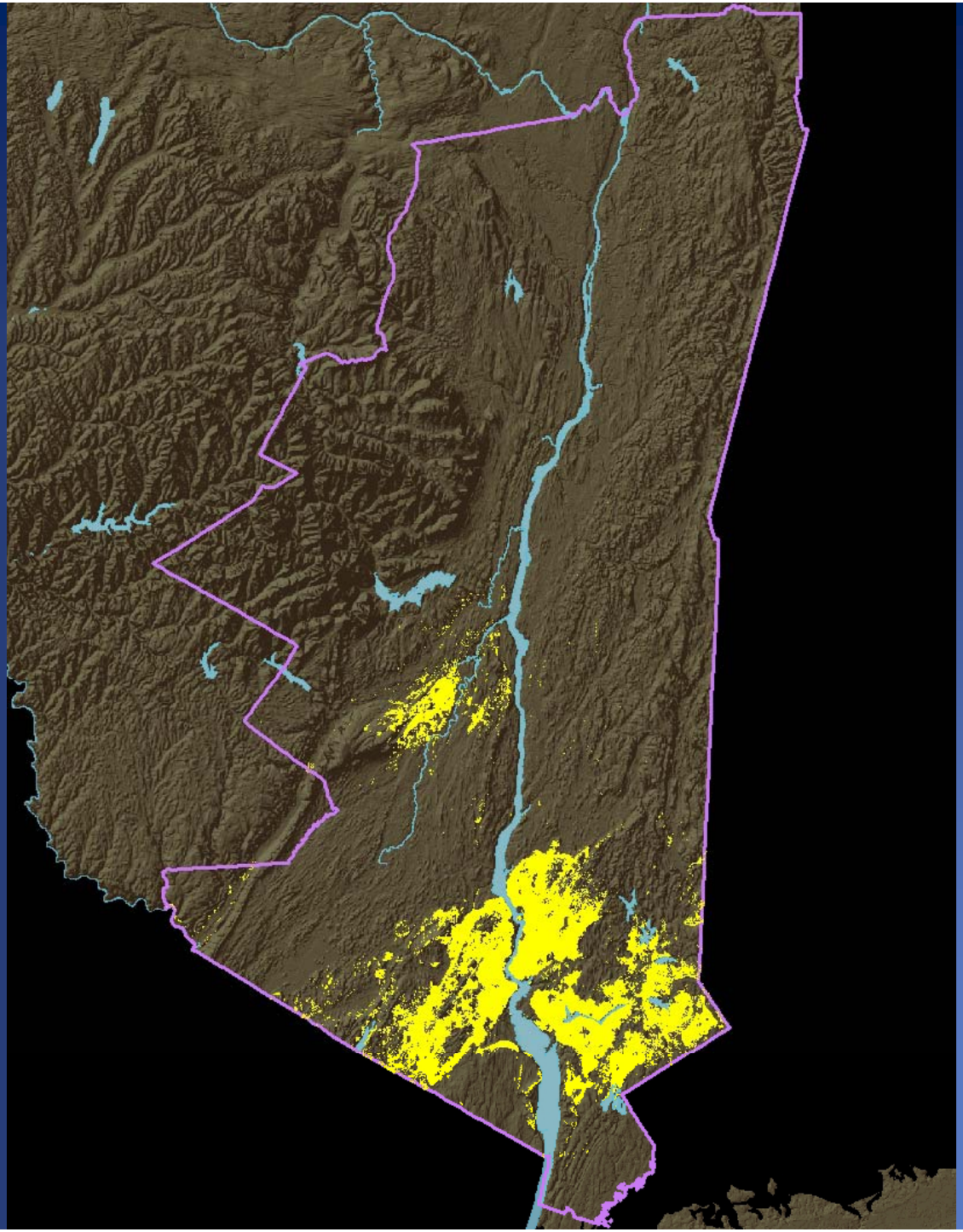
Eastern box turtle

2080s



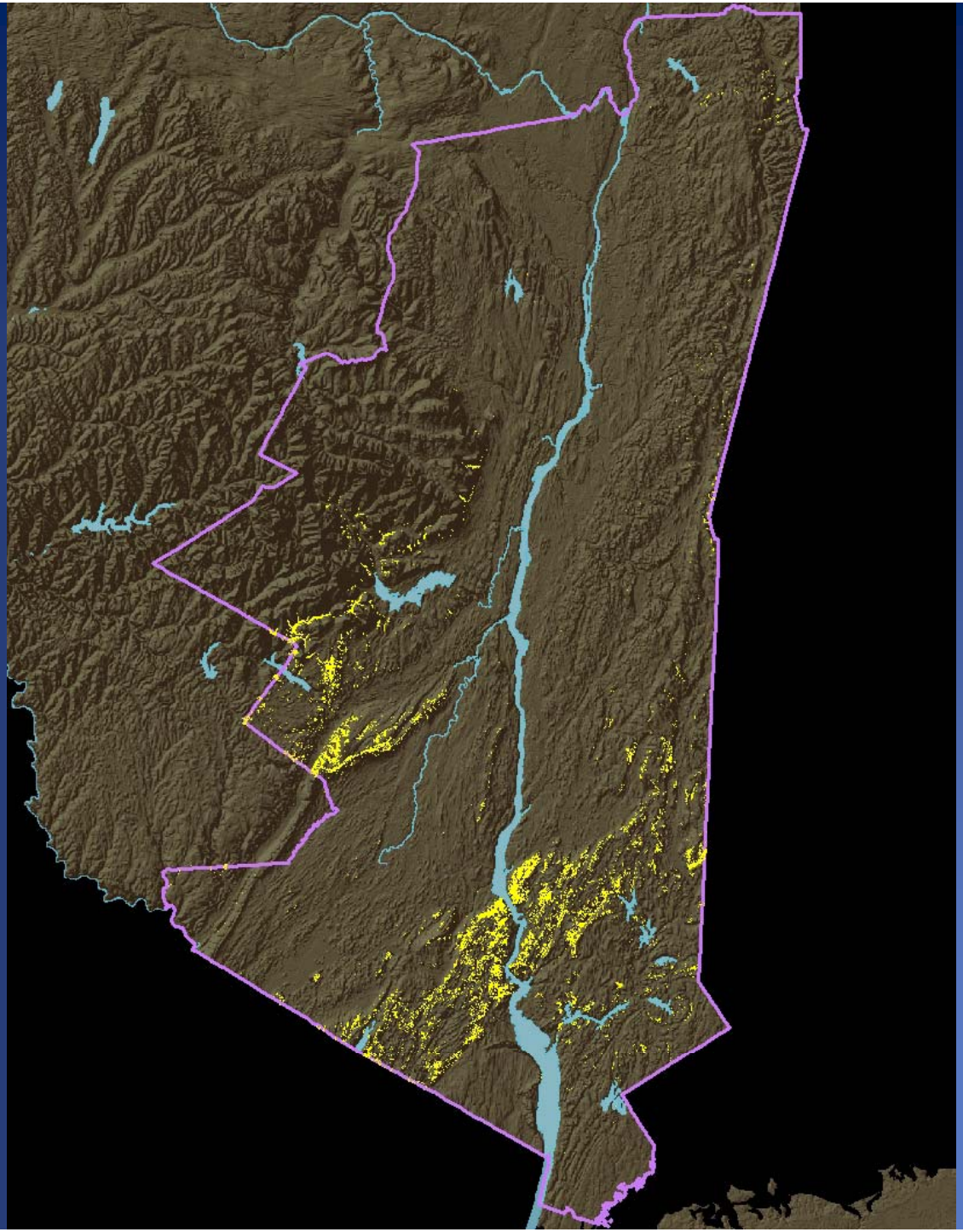
Eastern box turtle

Current



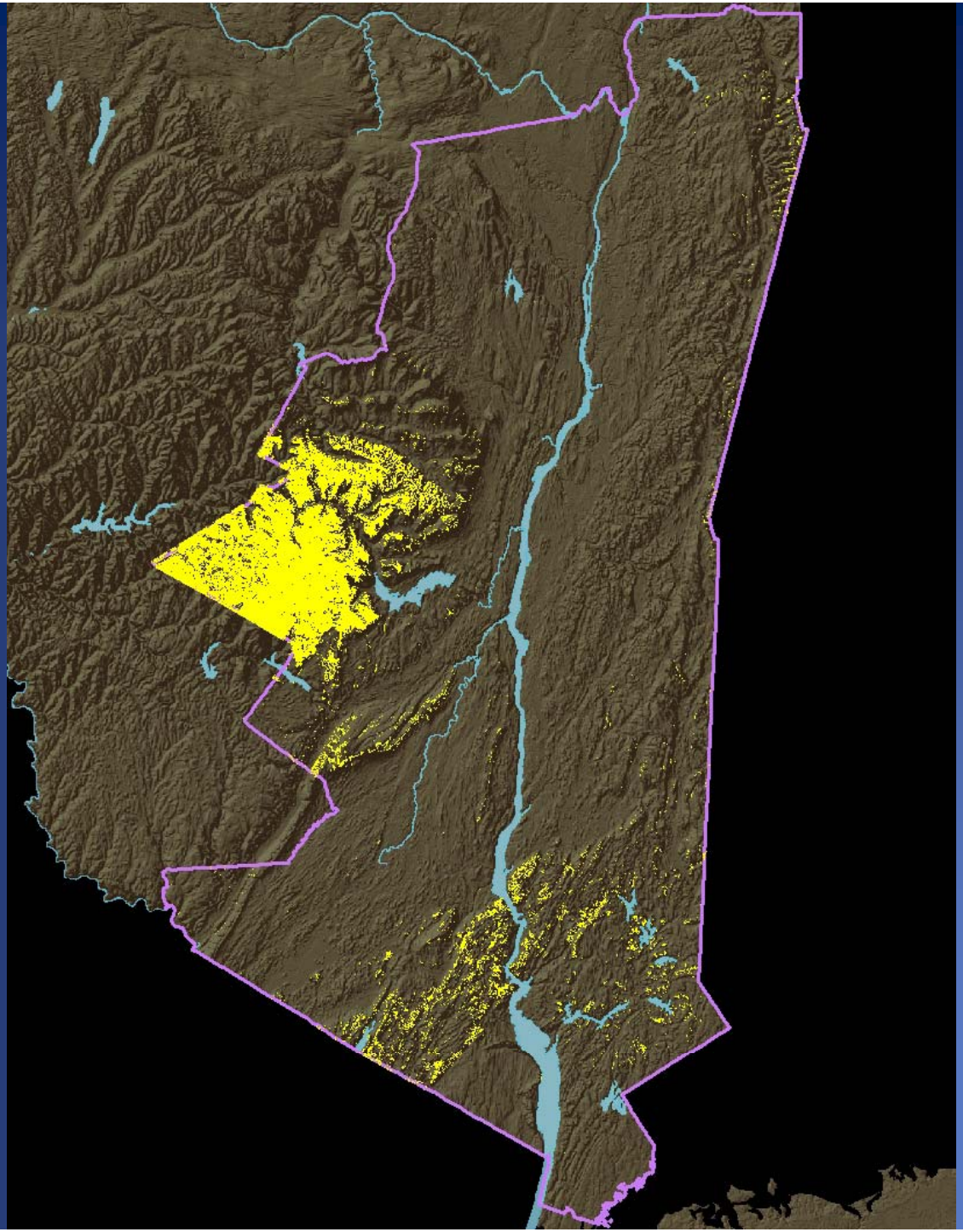
Eastern box turtle

2050s



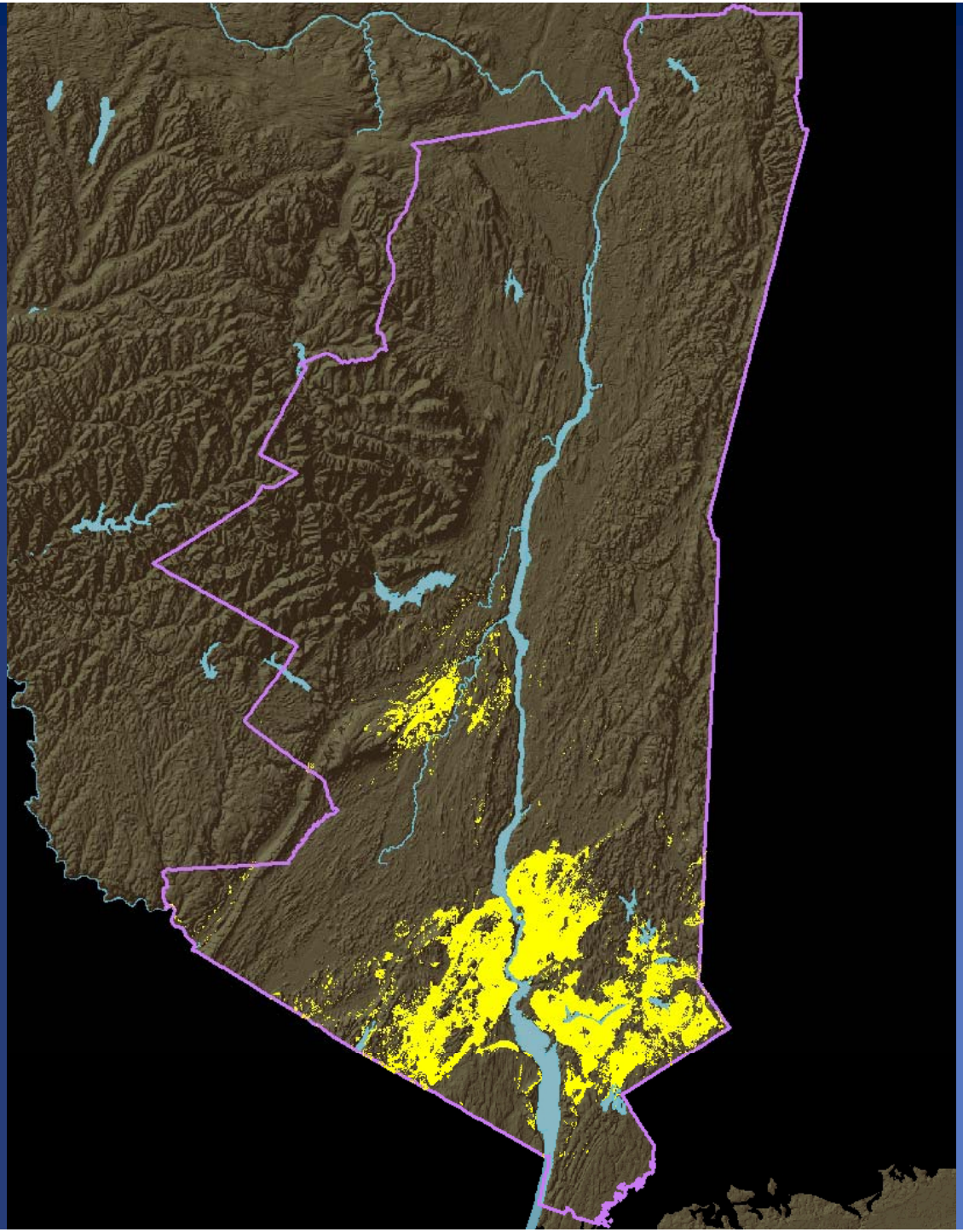
Eastern box turtle

2080s



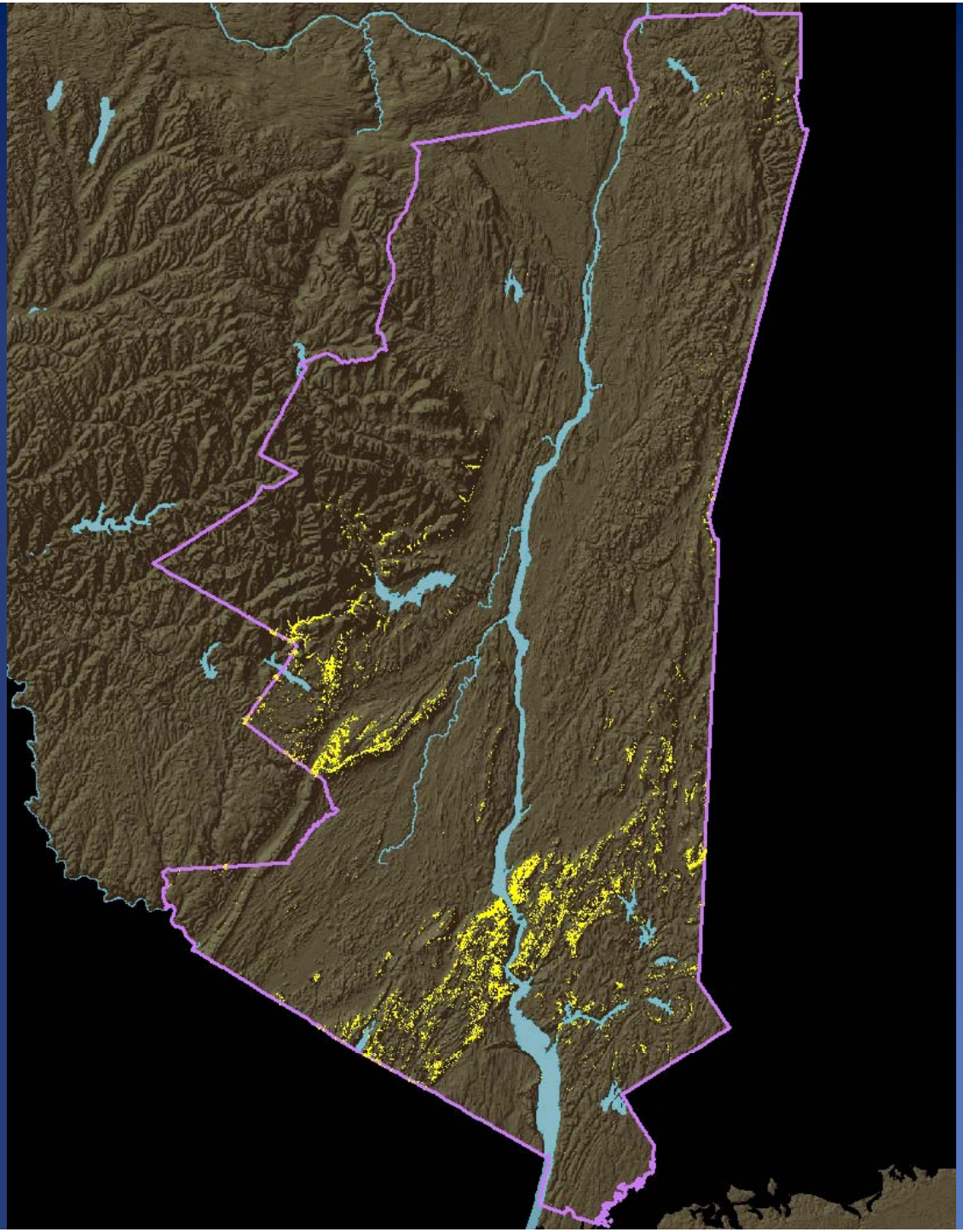
Eastern box turtle

Current



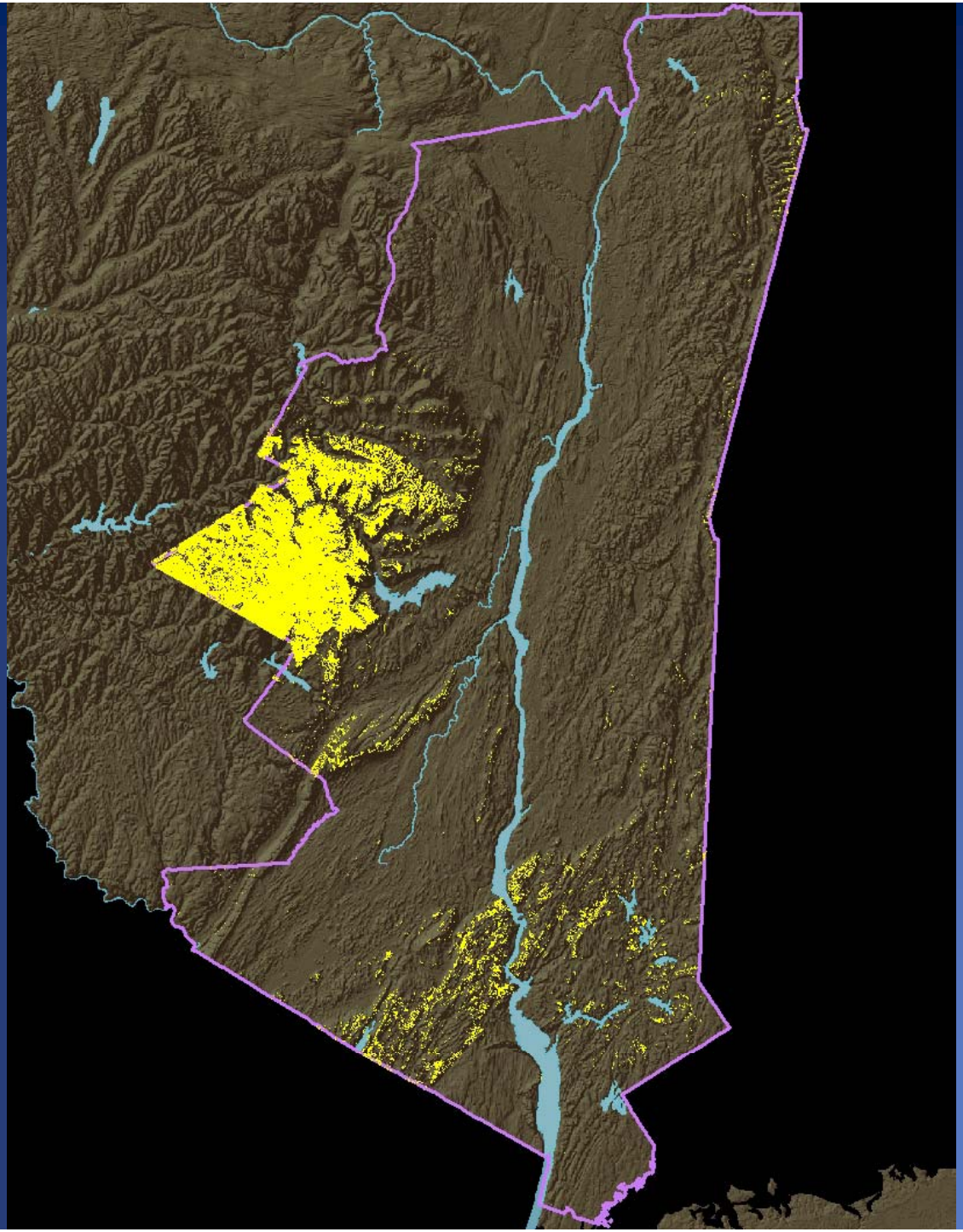
Eastern box turtle

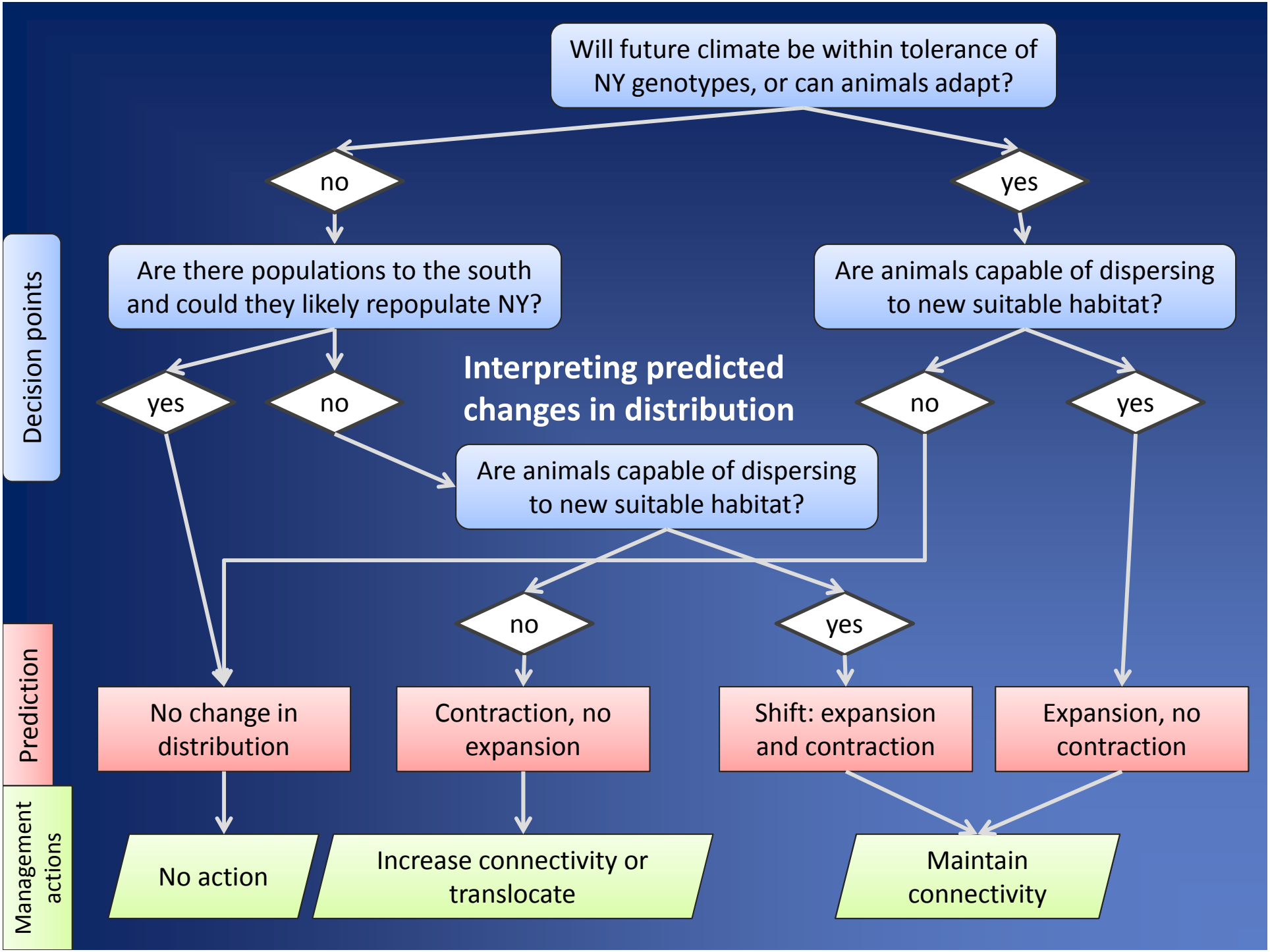
2050s



Eastern box turtle

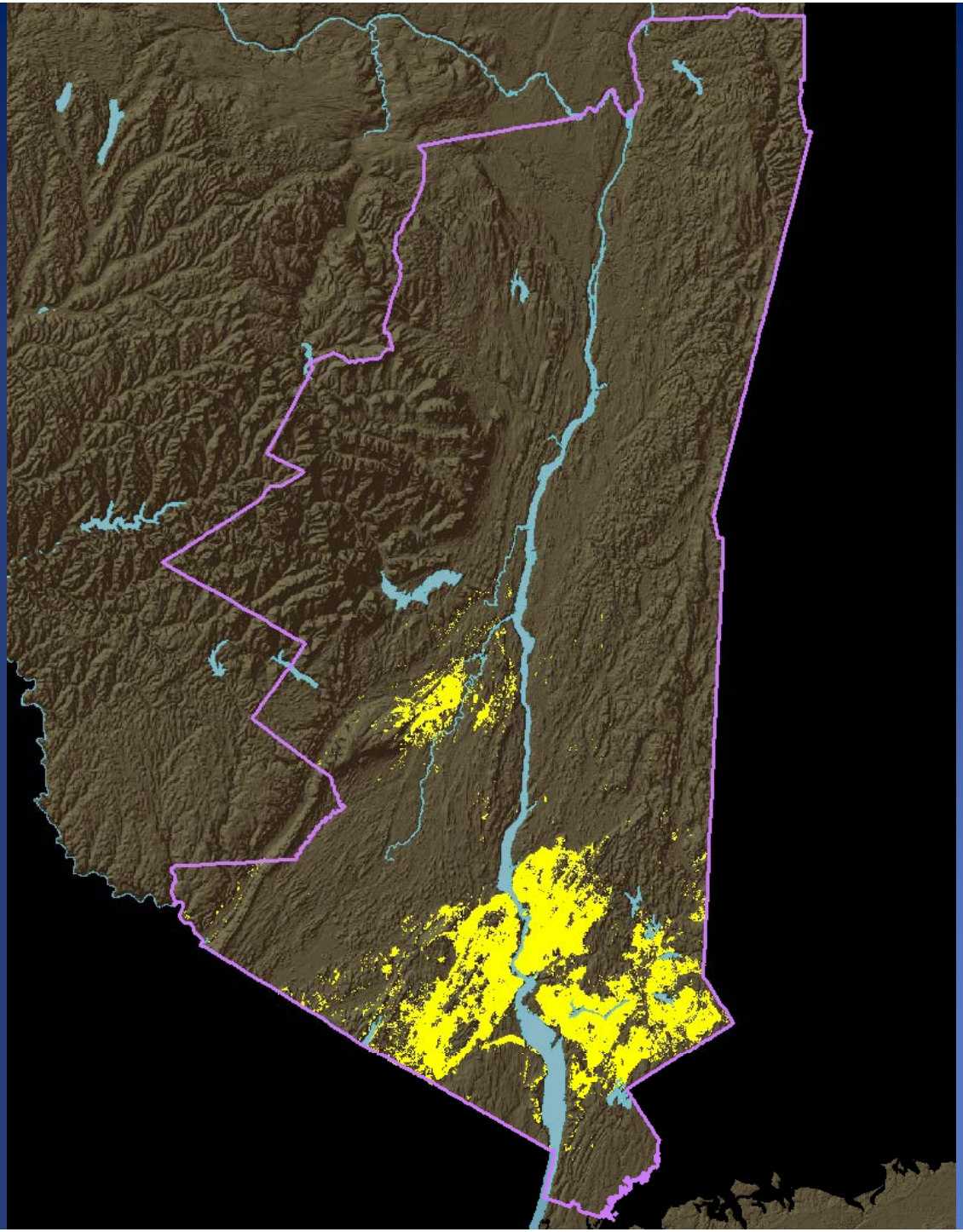
2080s




Will future climate be within tolerance of NY genotypes, or can animals adapt?
no
yes
Are there populations to the south and could they likely repopulate NY?
Are animals capable of dispersing to new suitable habitat?
Interpreting predicted changes in distribution
yes
no
no
yes
Are animals capable of dispersing to new suitable habitat?
no
yes
Decision points
Prediction
Management actions
No change in distribution
Contraction, no expansion
Shift: expansion and contraction
Expansion, no contraction
No action
Increase connectivity or translocate
Maintain connectivity

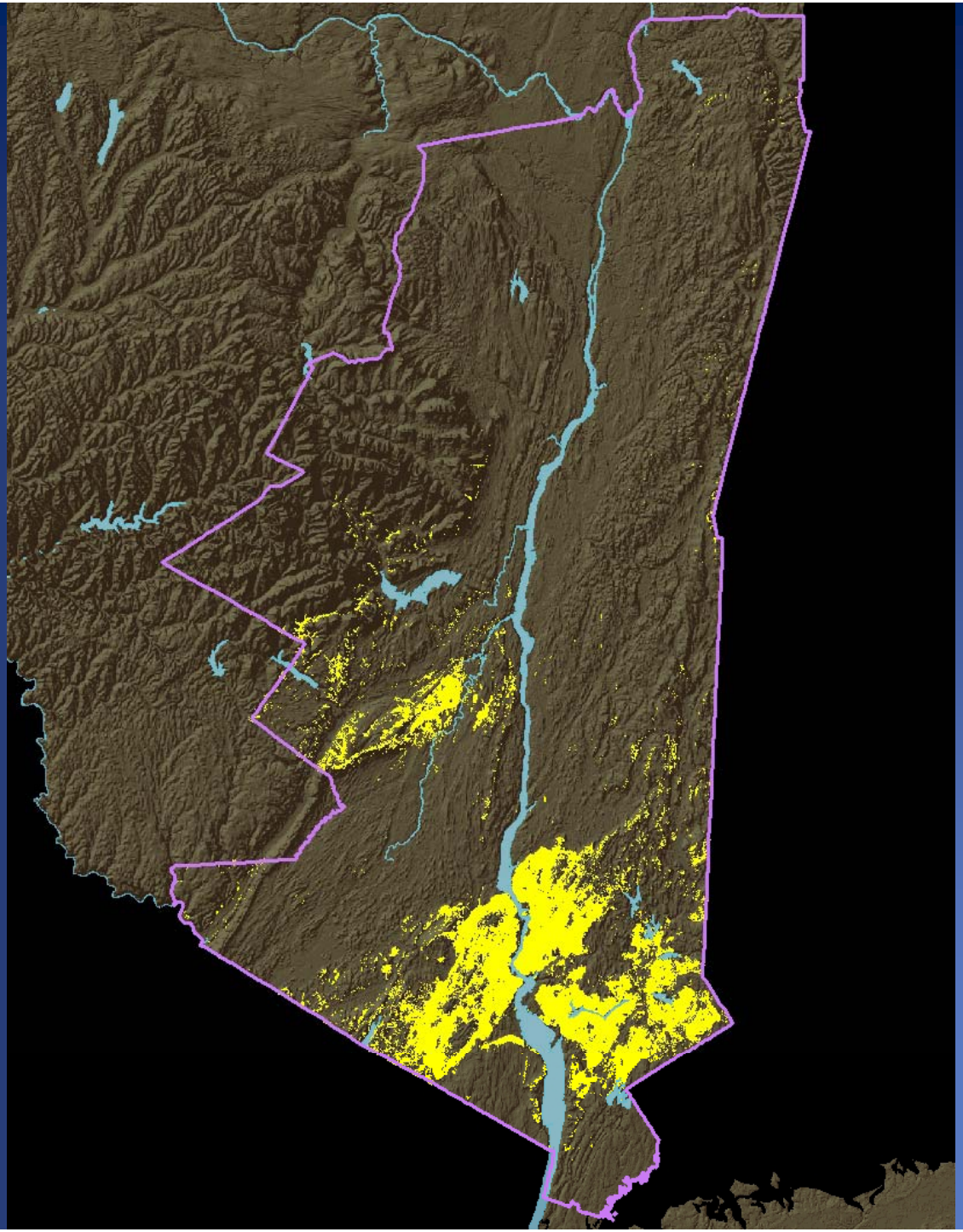
Eastern box turtle

Current



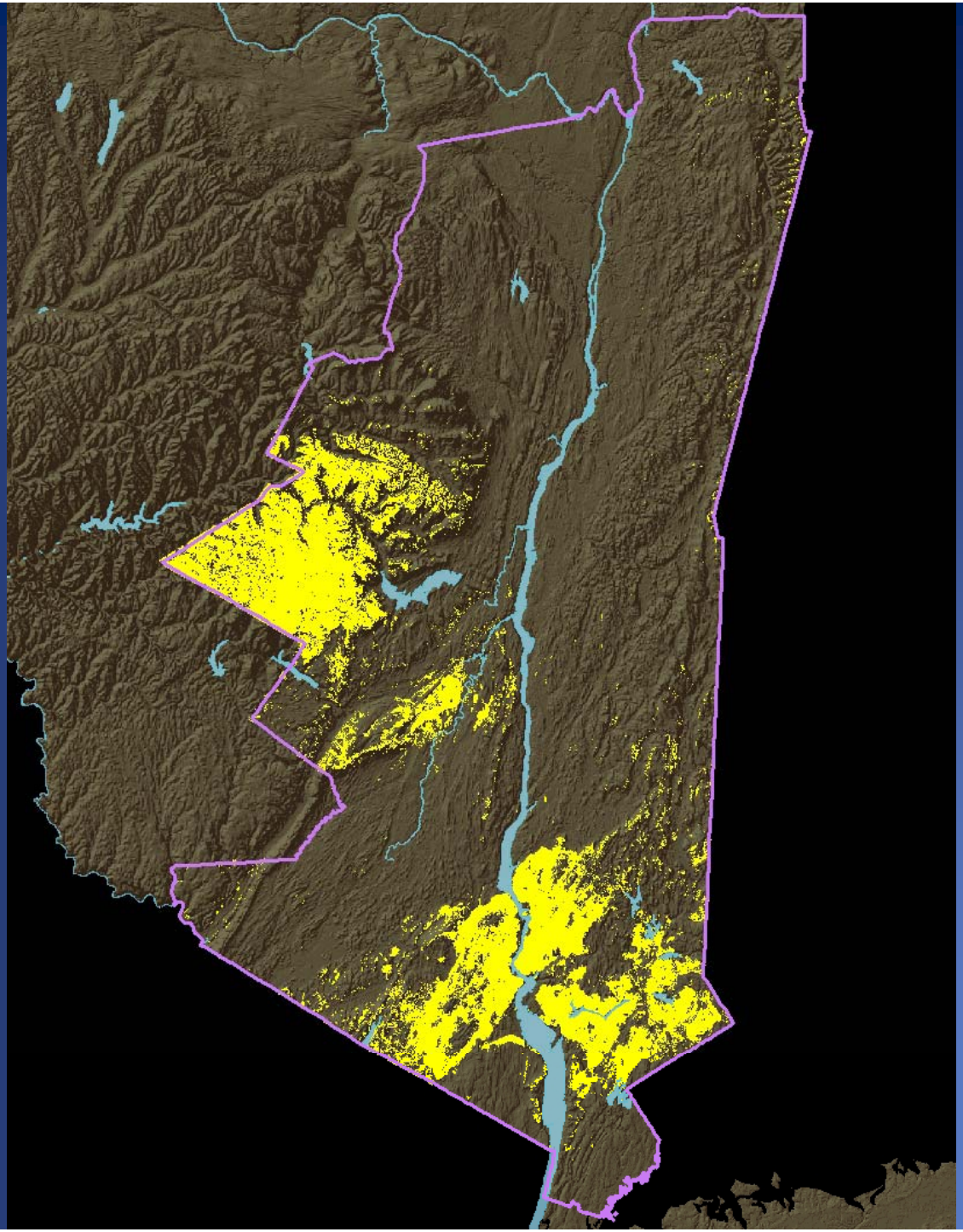
Eastern box turtle

2050s



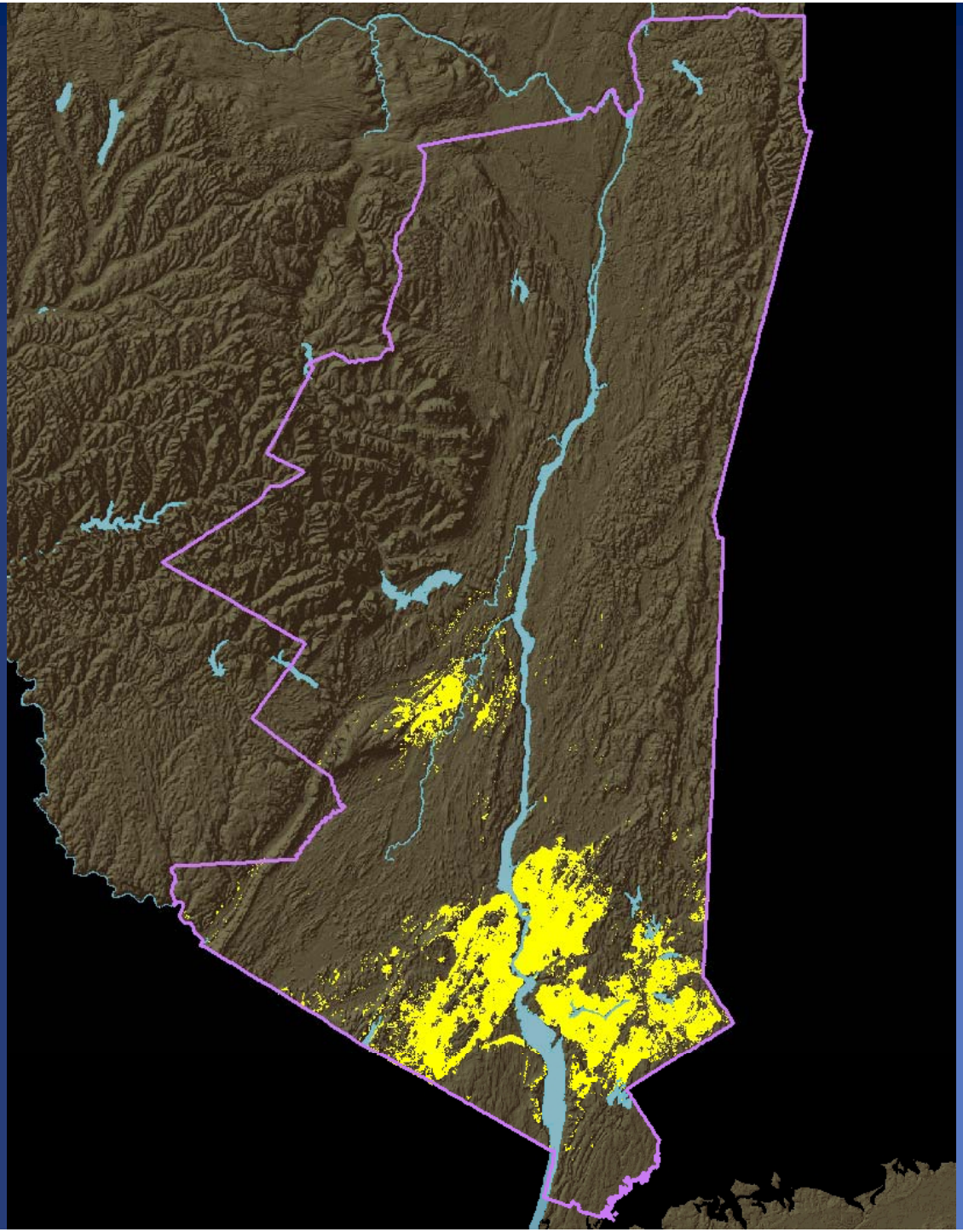
Eastern box turtle

2080s



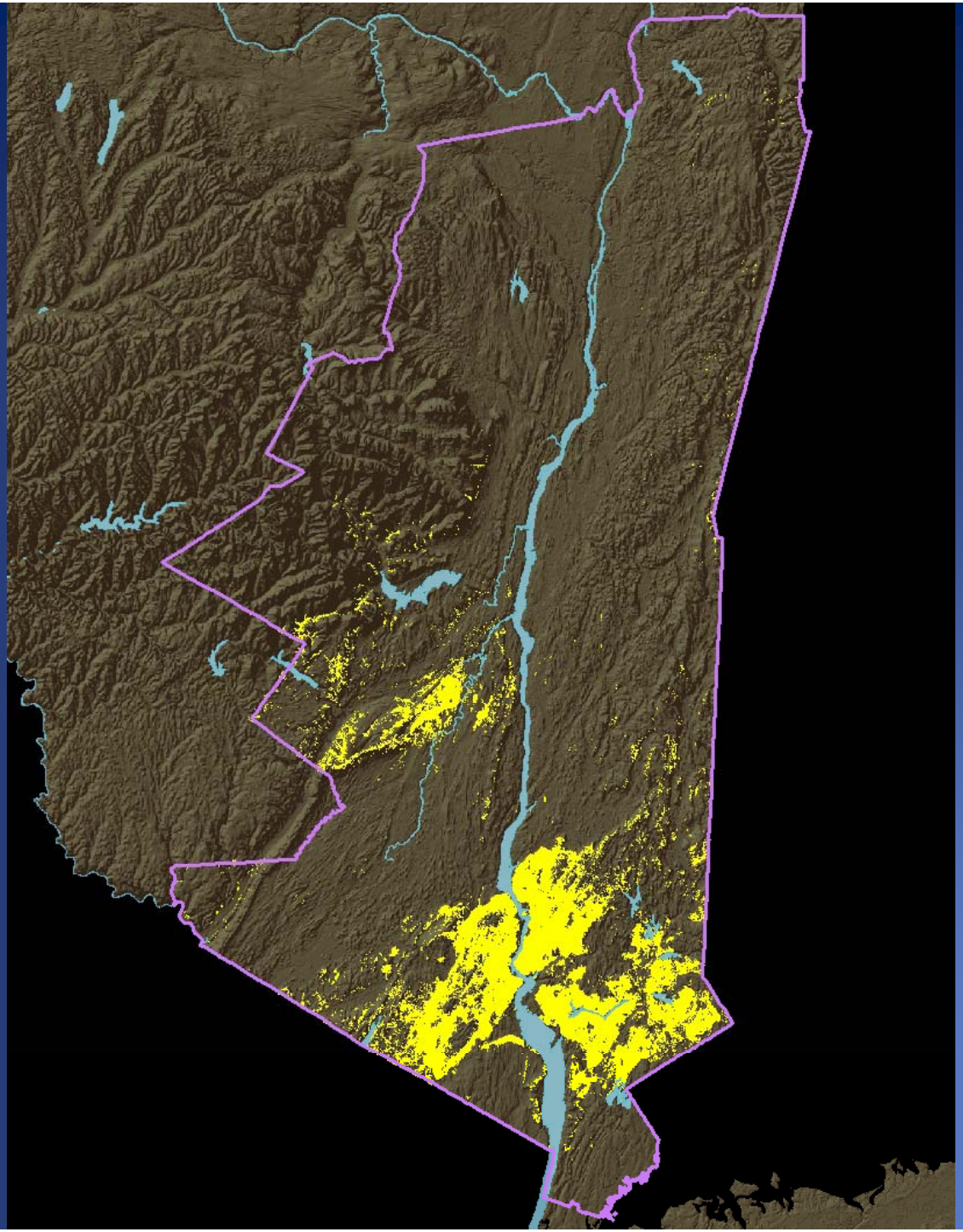
Eastern box turtle

Current



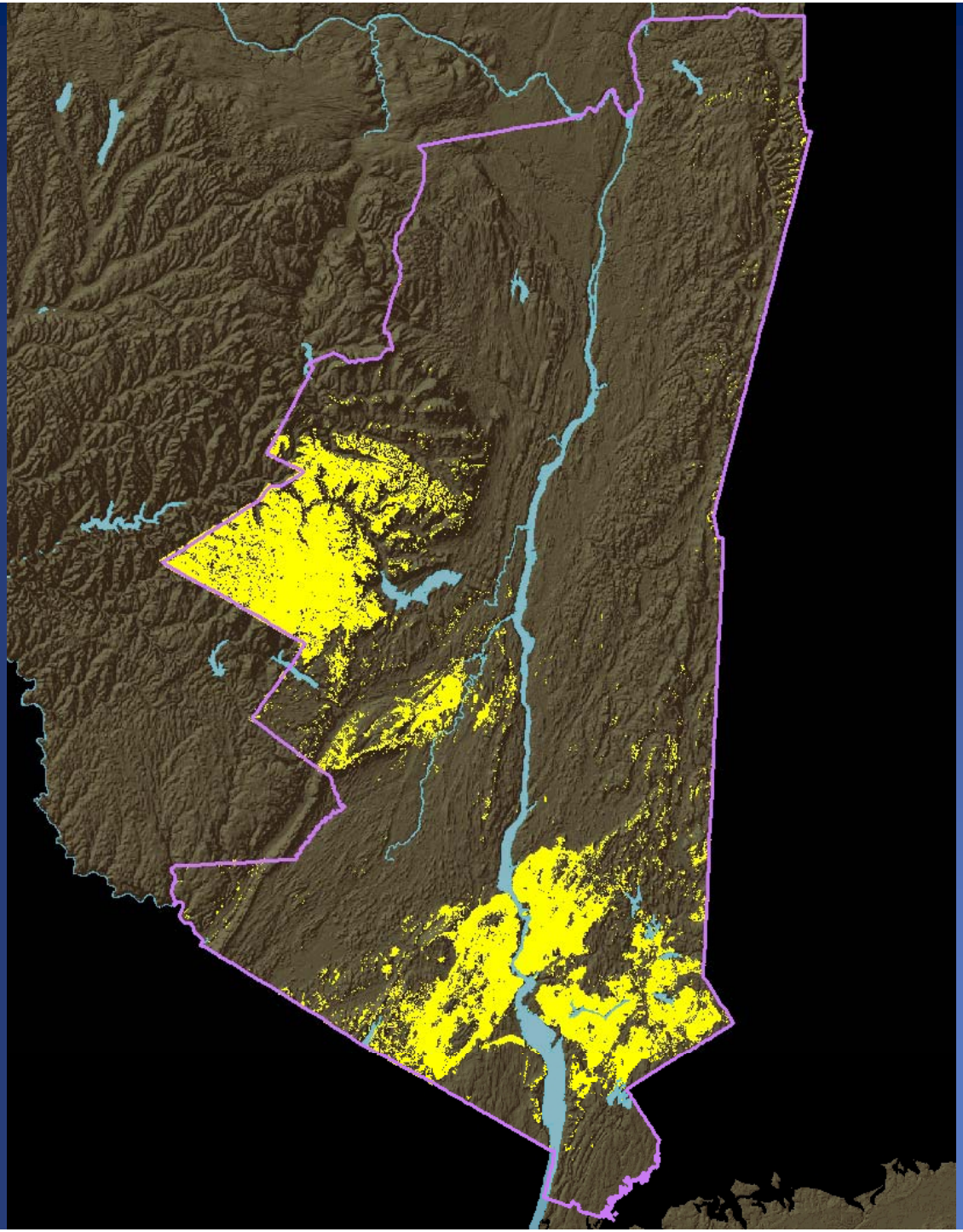
Eastern box turtle

2050s



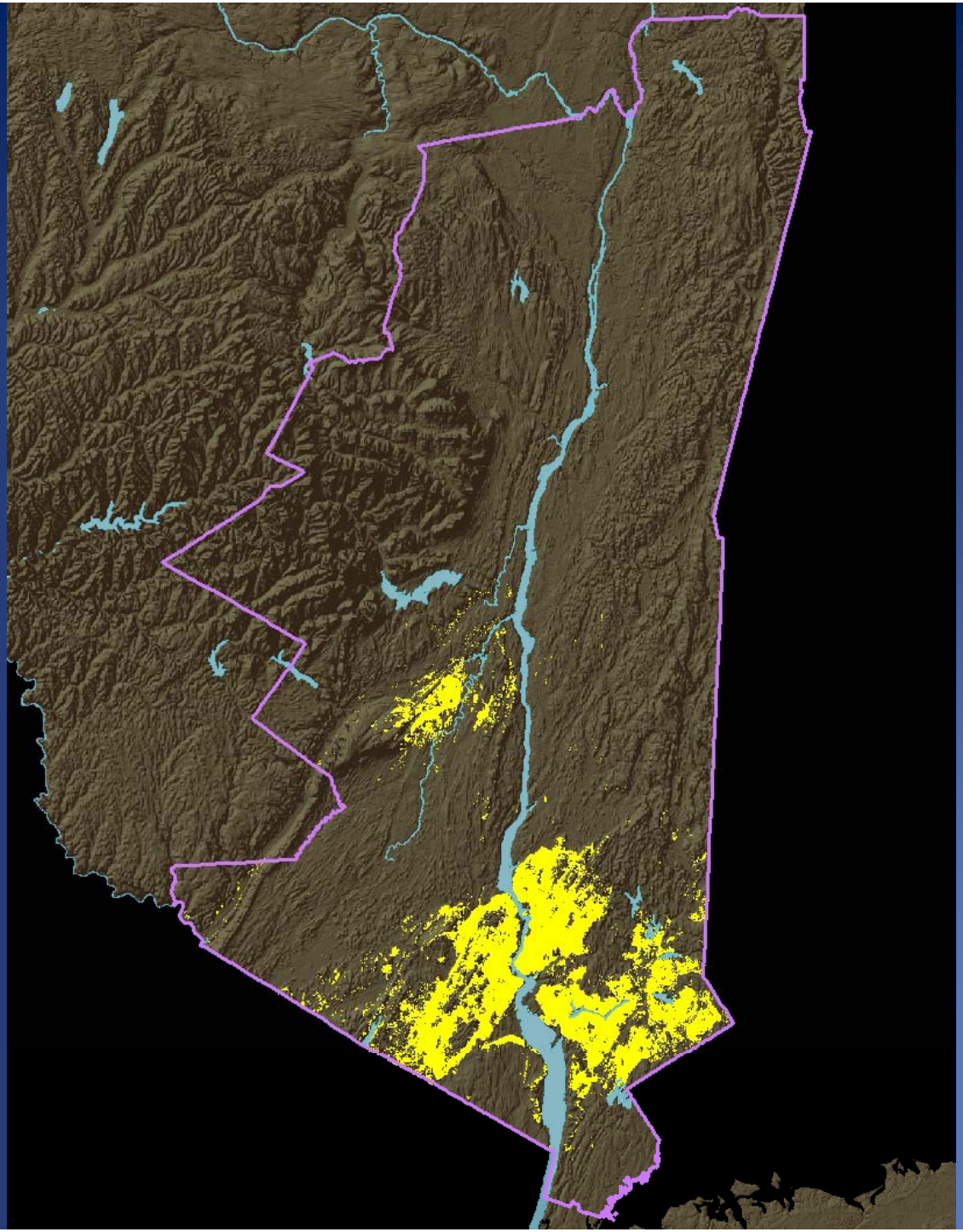
Eastern box turtle

2080s



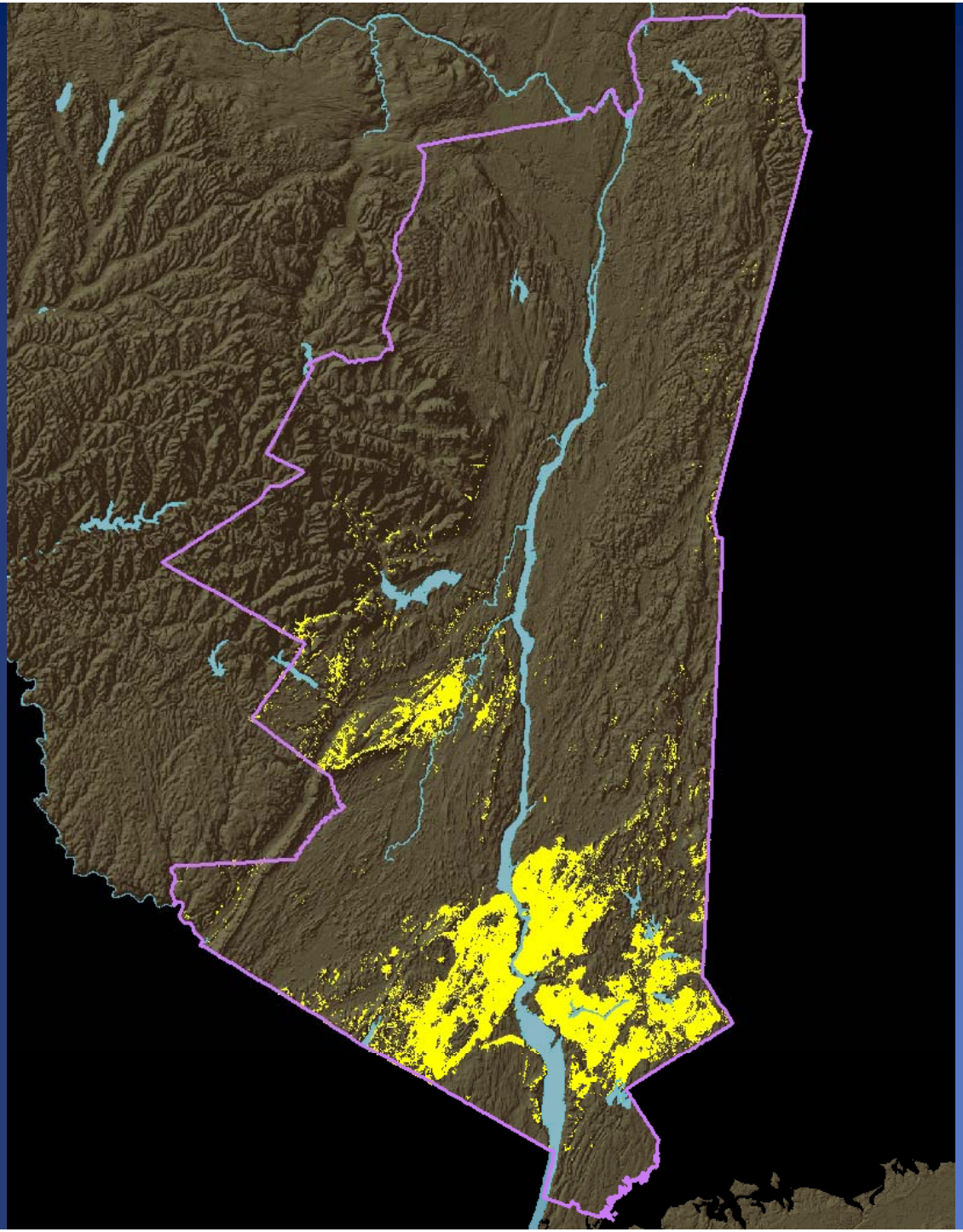
Eastern box turtle

Current



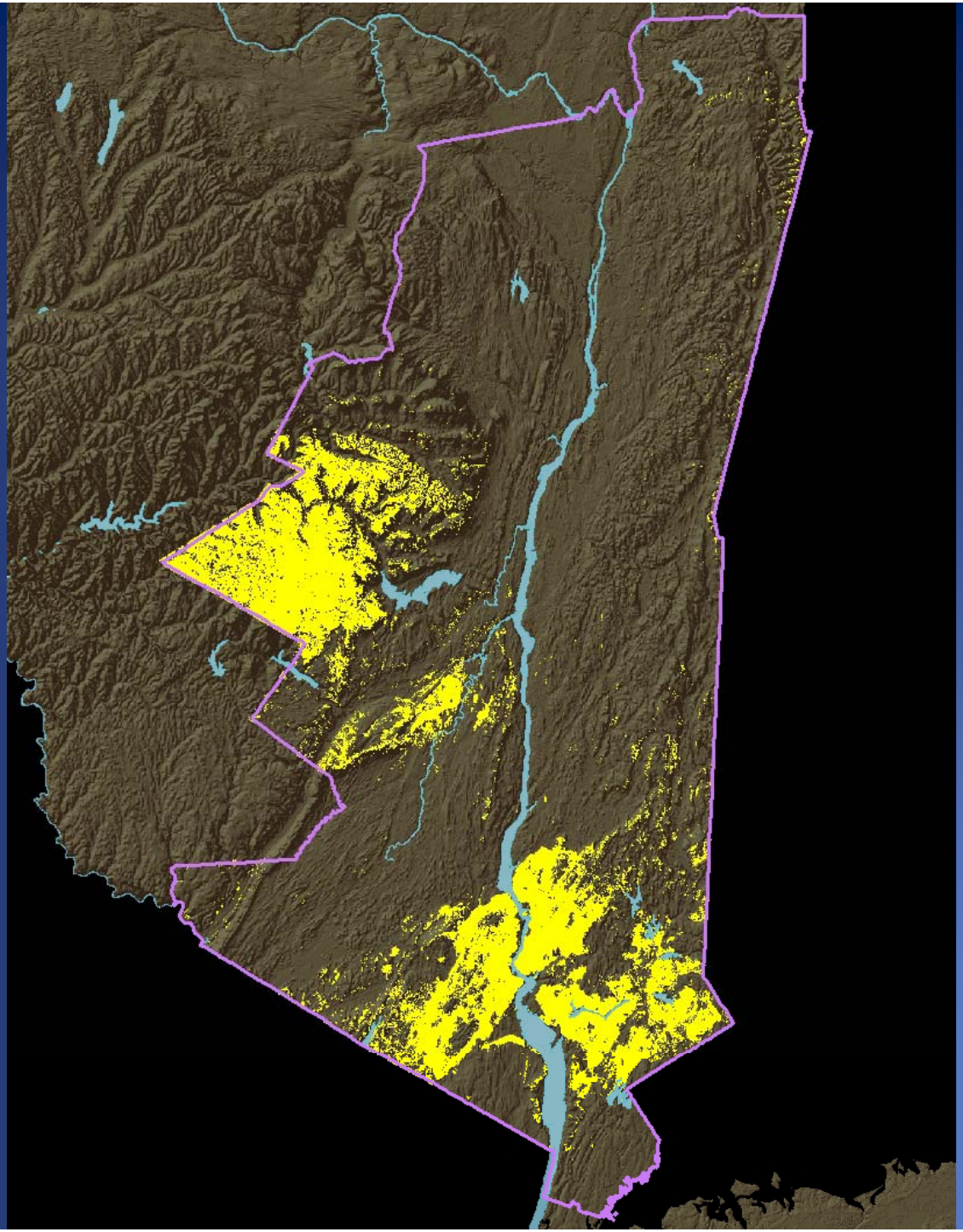
Eastern box turtle

2050s

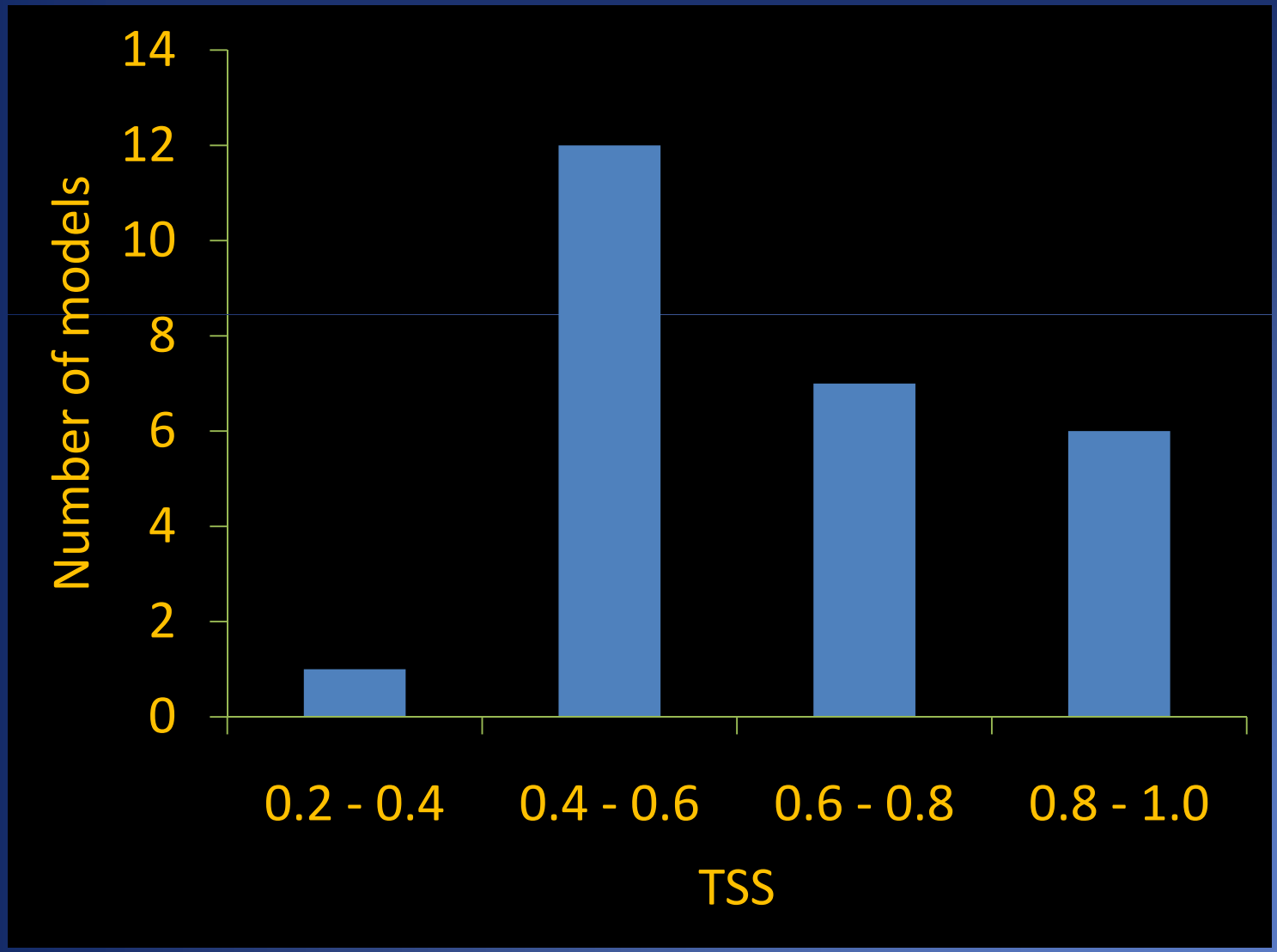


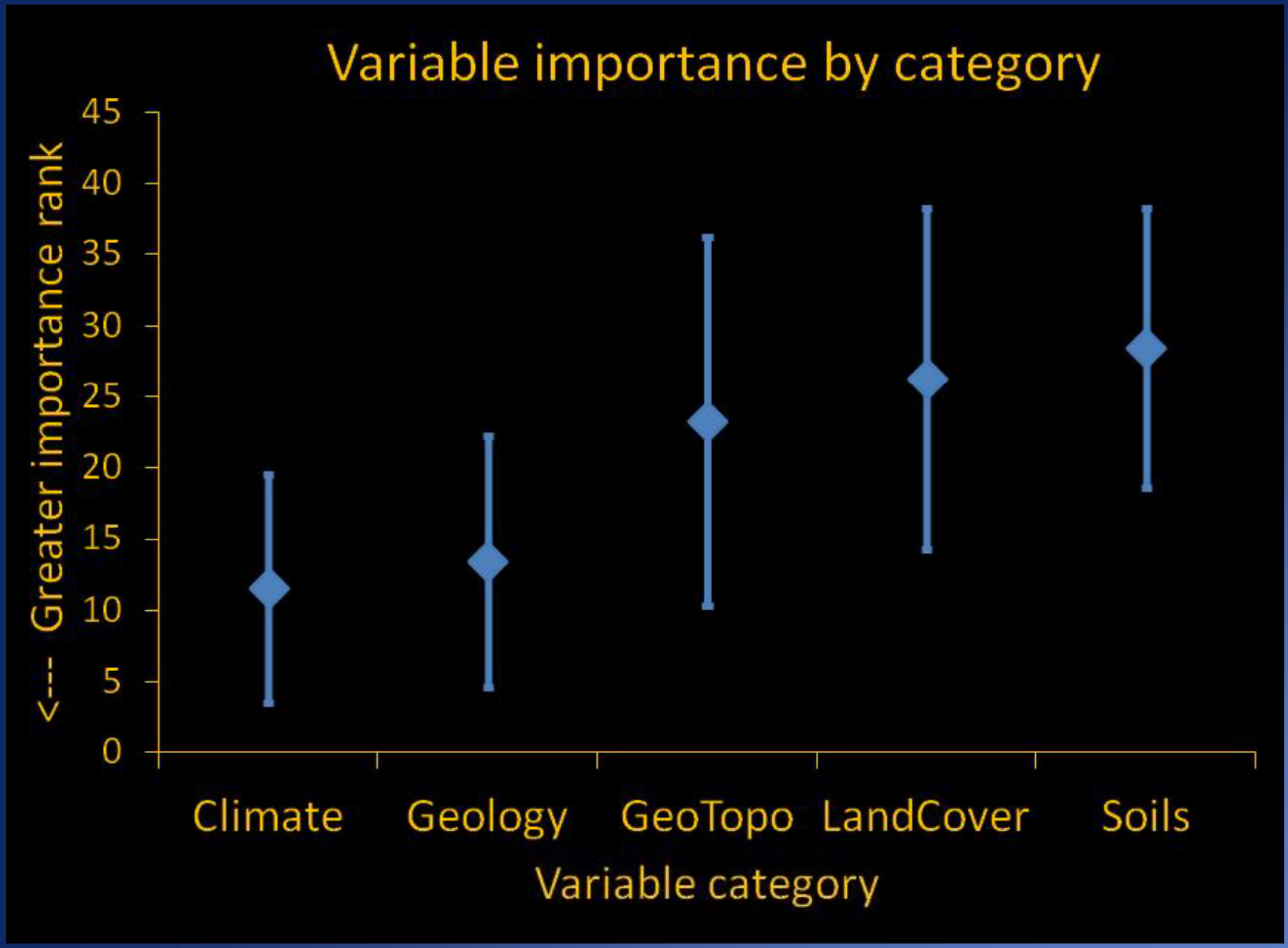
Eastern box turtle

2080s



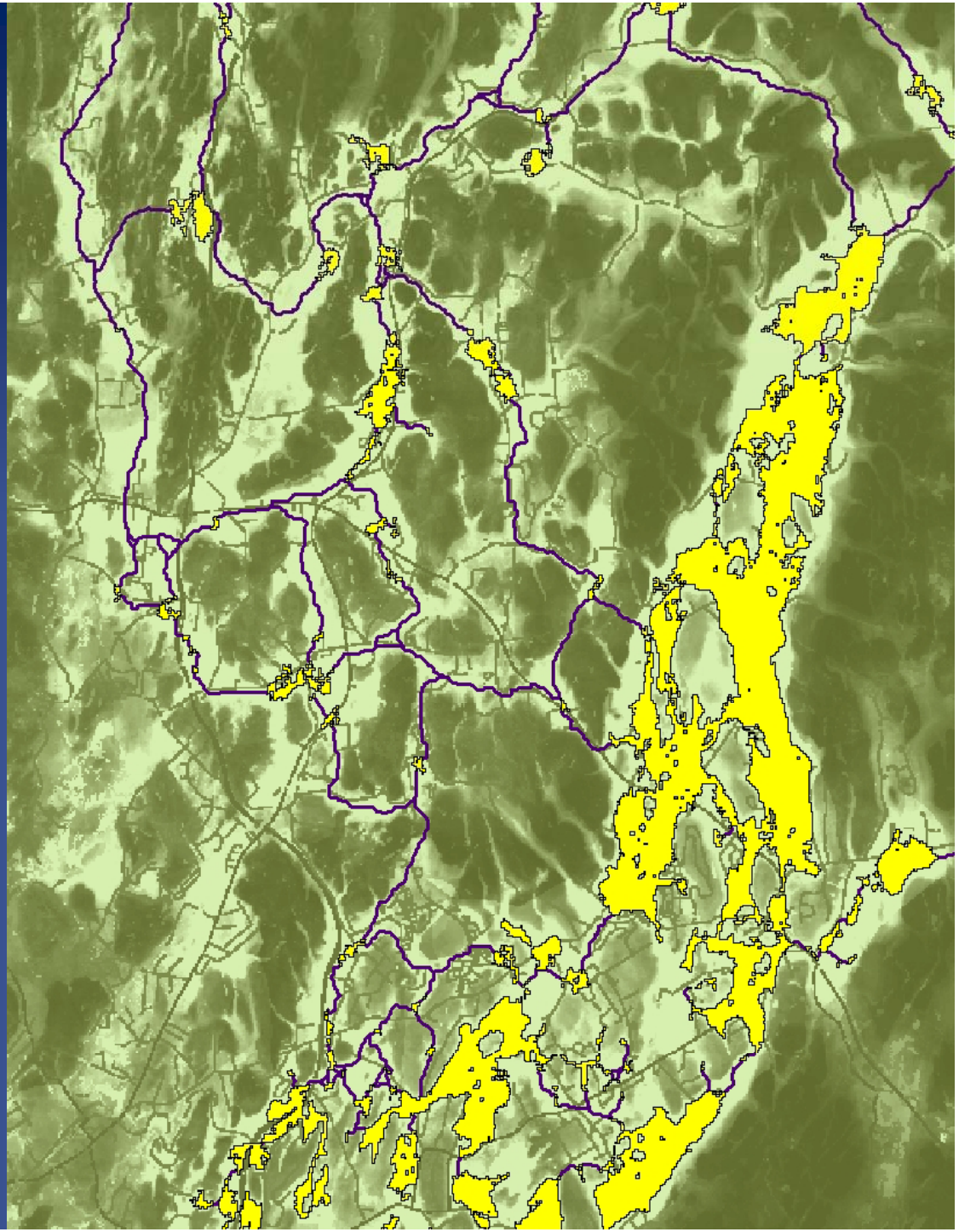
Evaluation



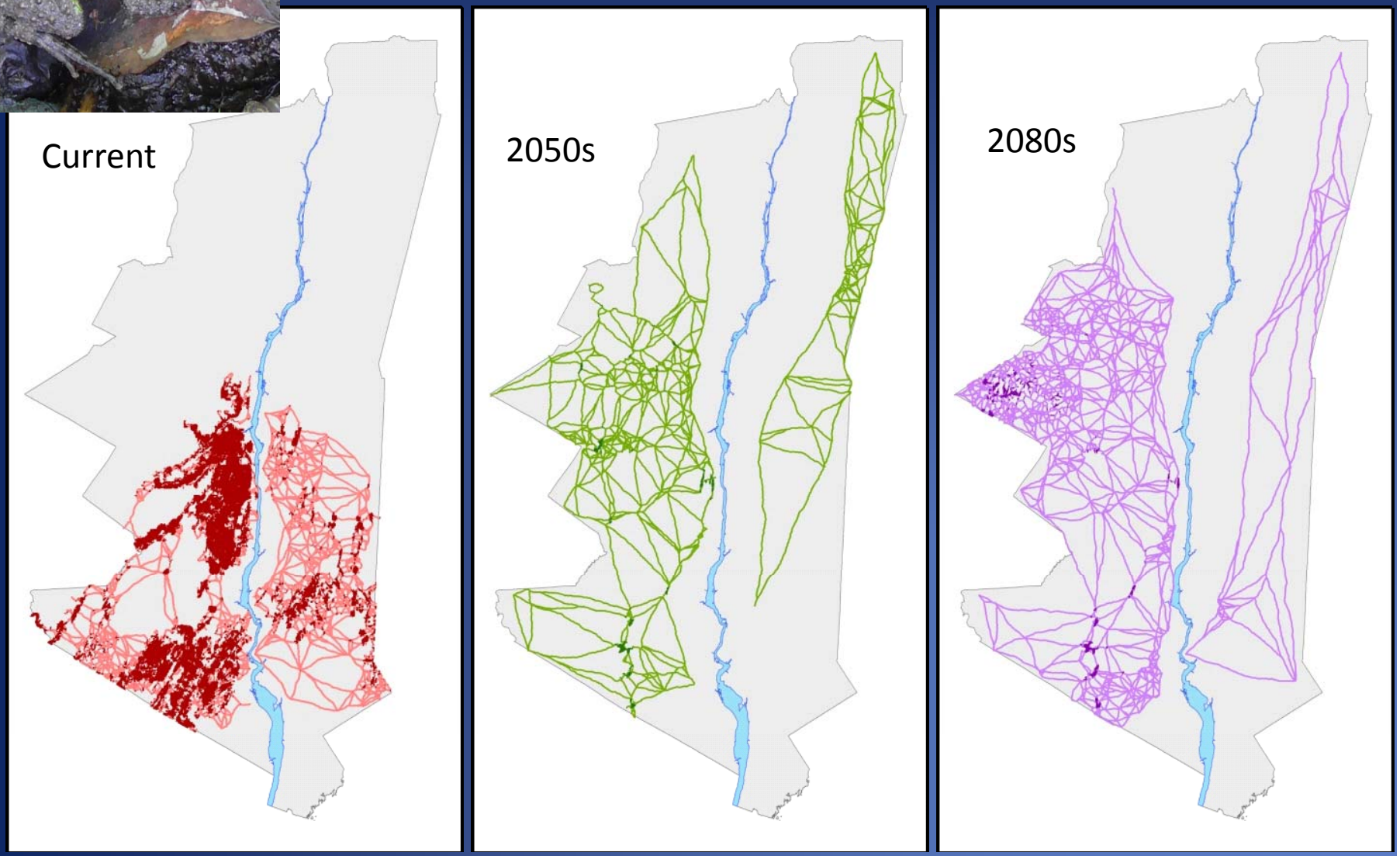

Variable importance by category
<--- Greater importance rank
45
40
35
30
25
20
15
10
5
0
Climate
Geology
GeoTopo
LandCover
Soils
Variable category

Assessing connectivity for habitats

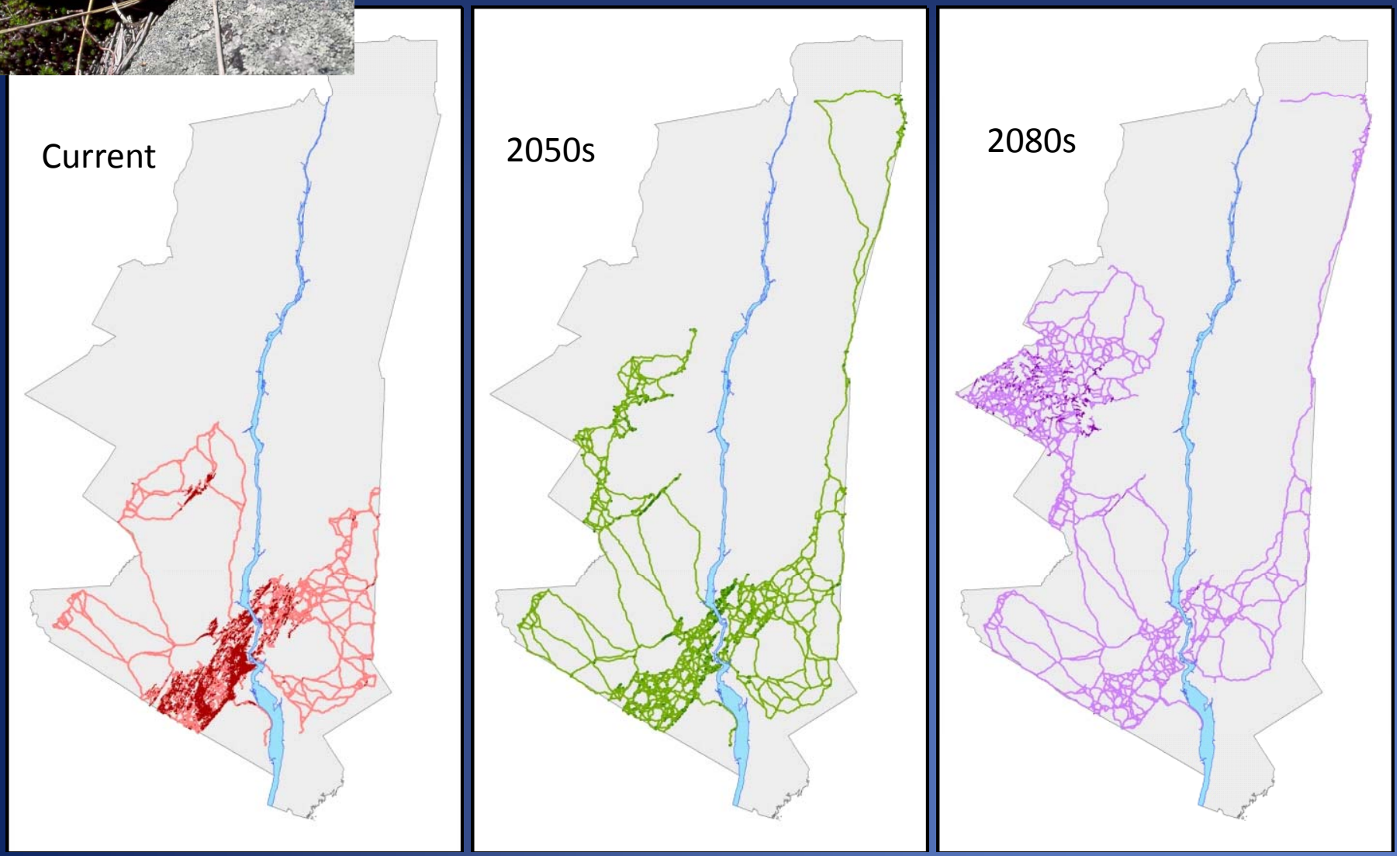
- Start with modeled hbitat patches
- Inverse of habitat suitability proportional to resistance
- Roads are added to resistance, with value depending on size
- Model both
  - least cost between patches
  - patch importance using network metrics



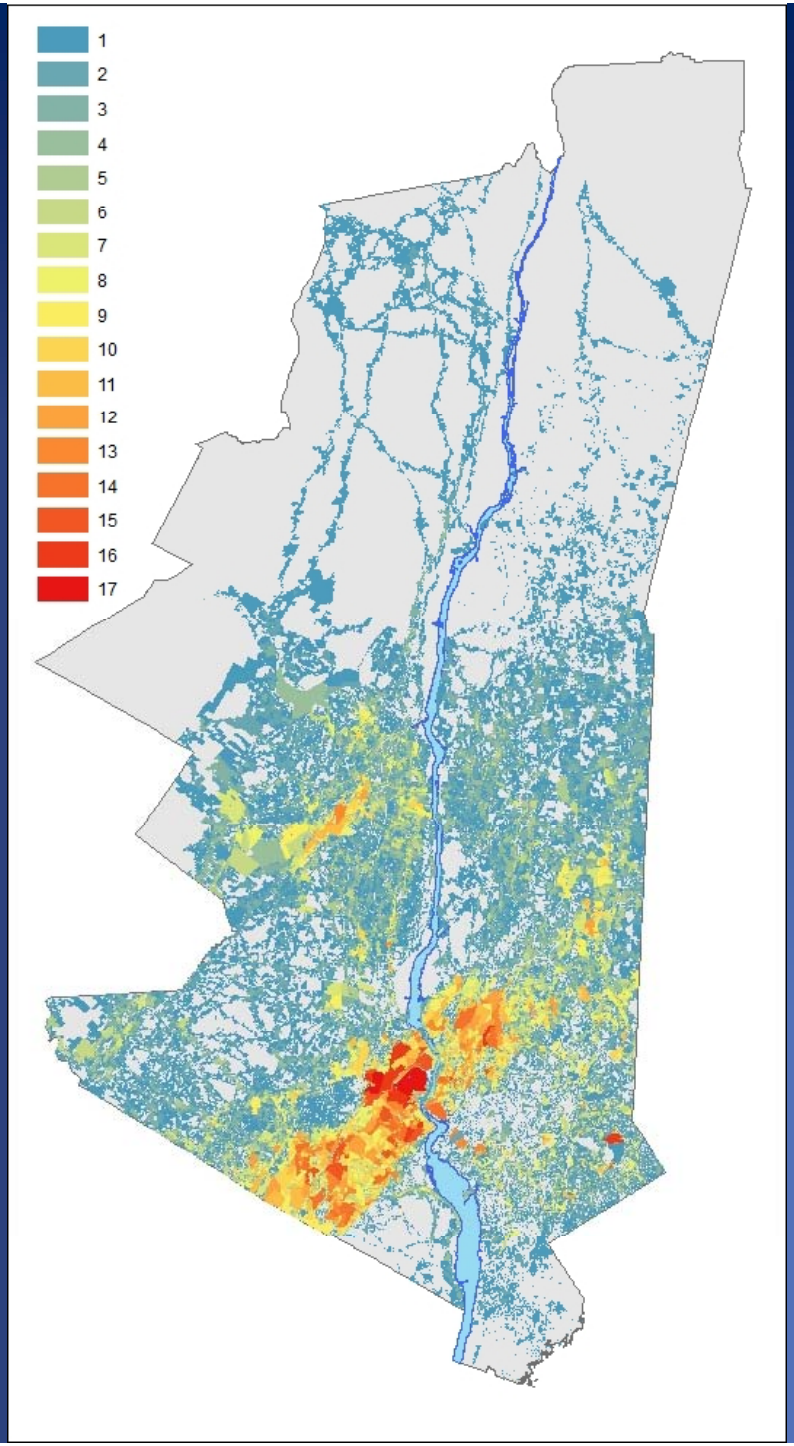
Patches and paths



Patches and paths

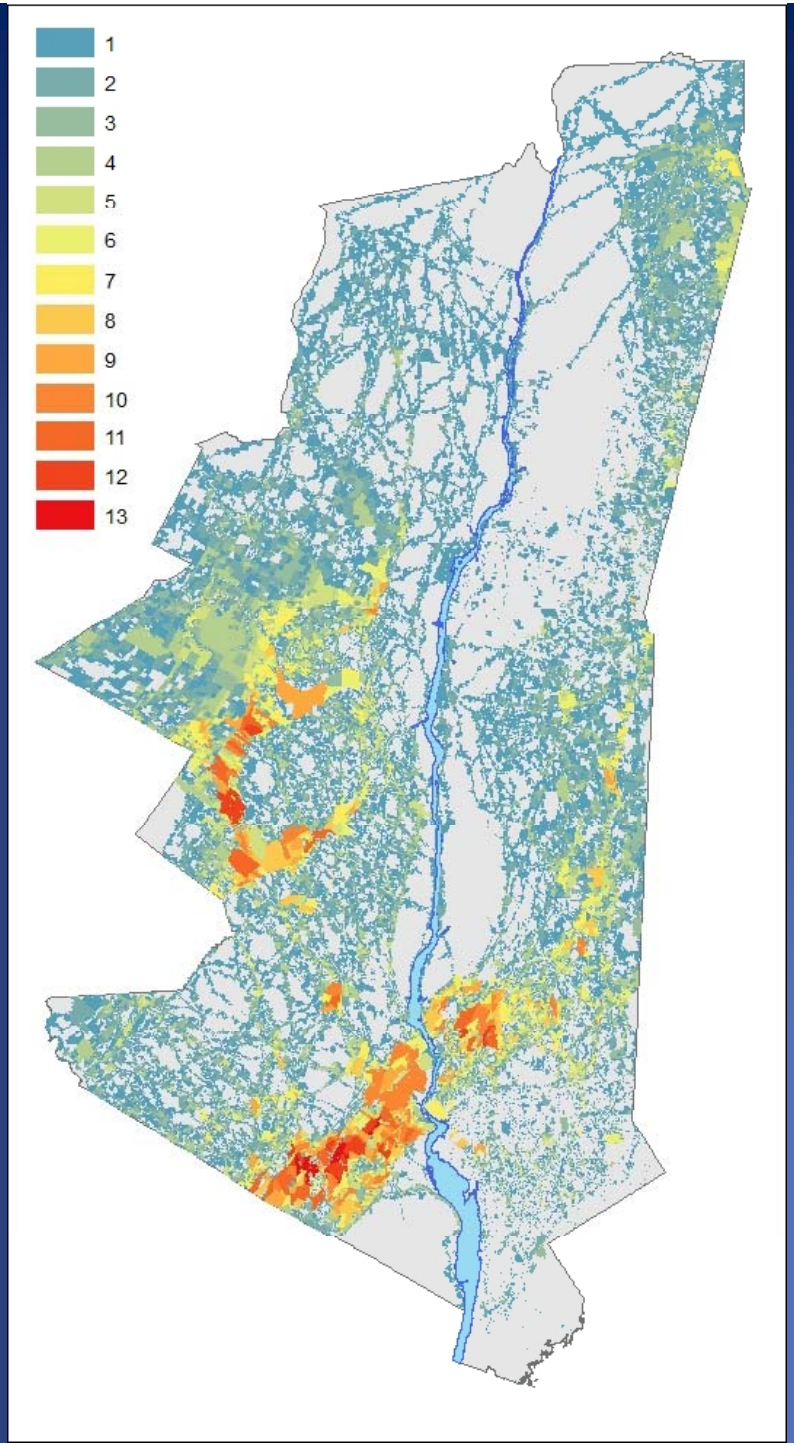


Multispecies metrics and scaling up

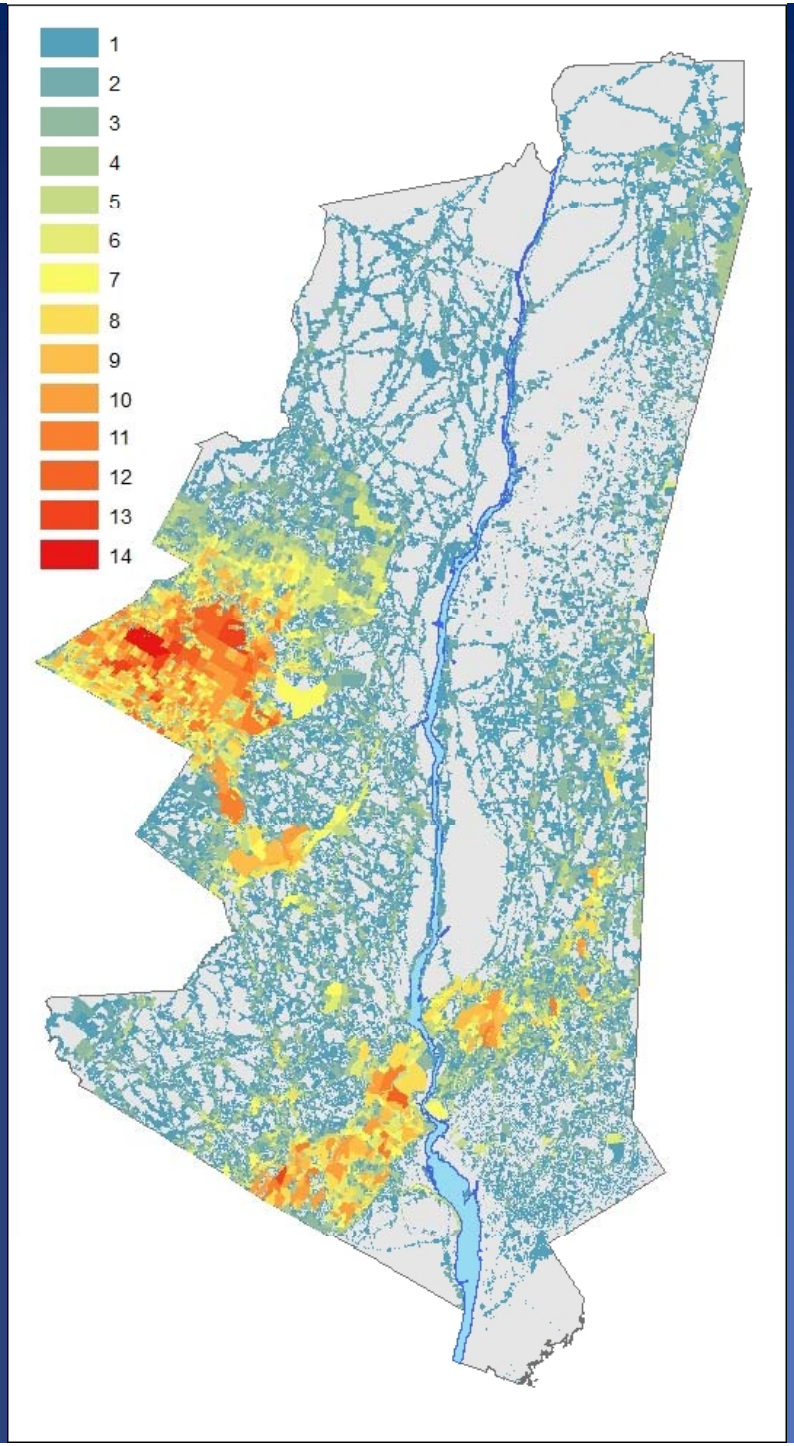


Ownership parcels: Current day

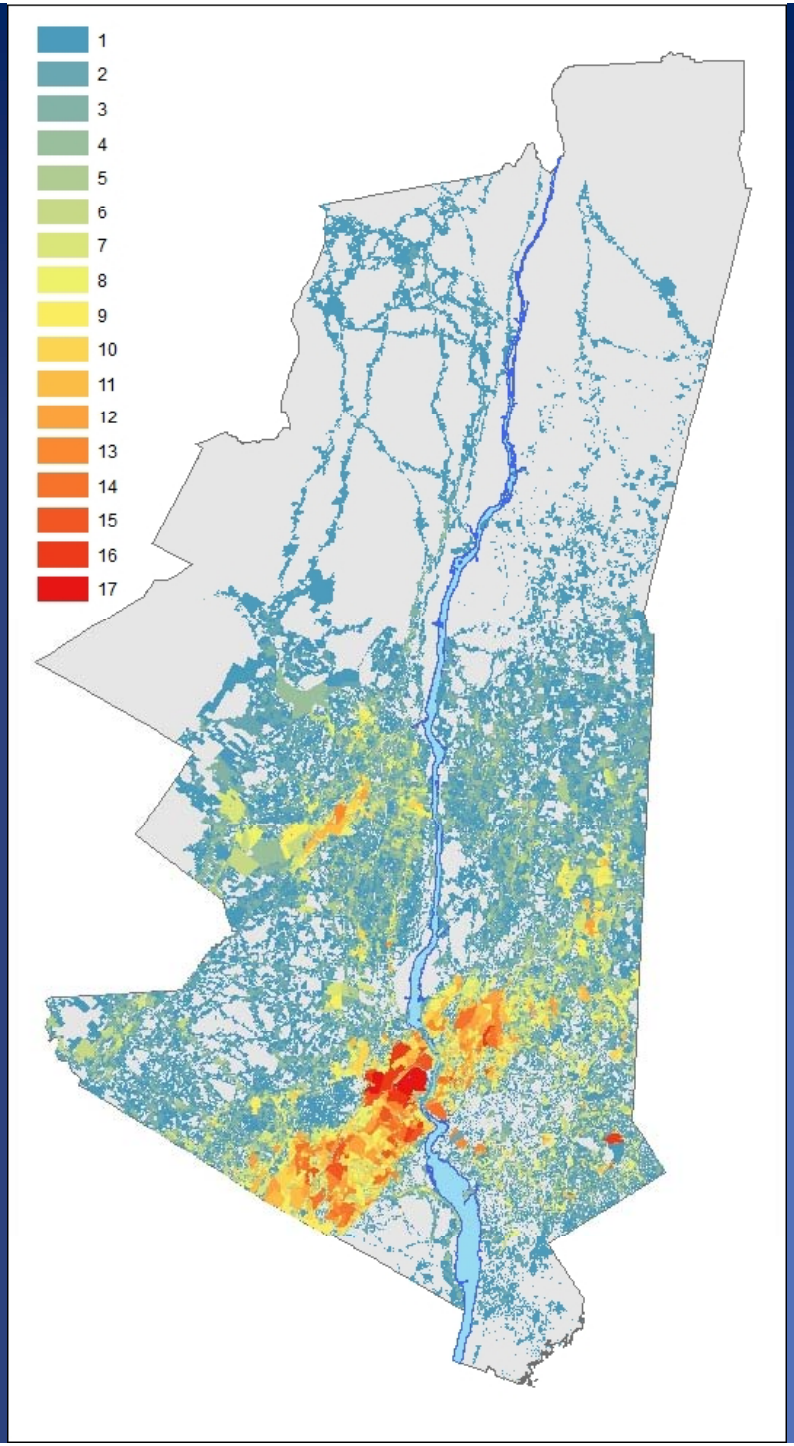
Ownership parcels: 2050



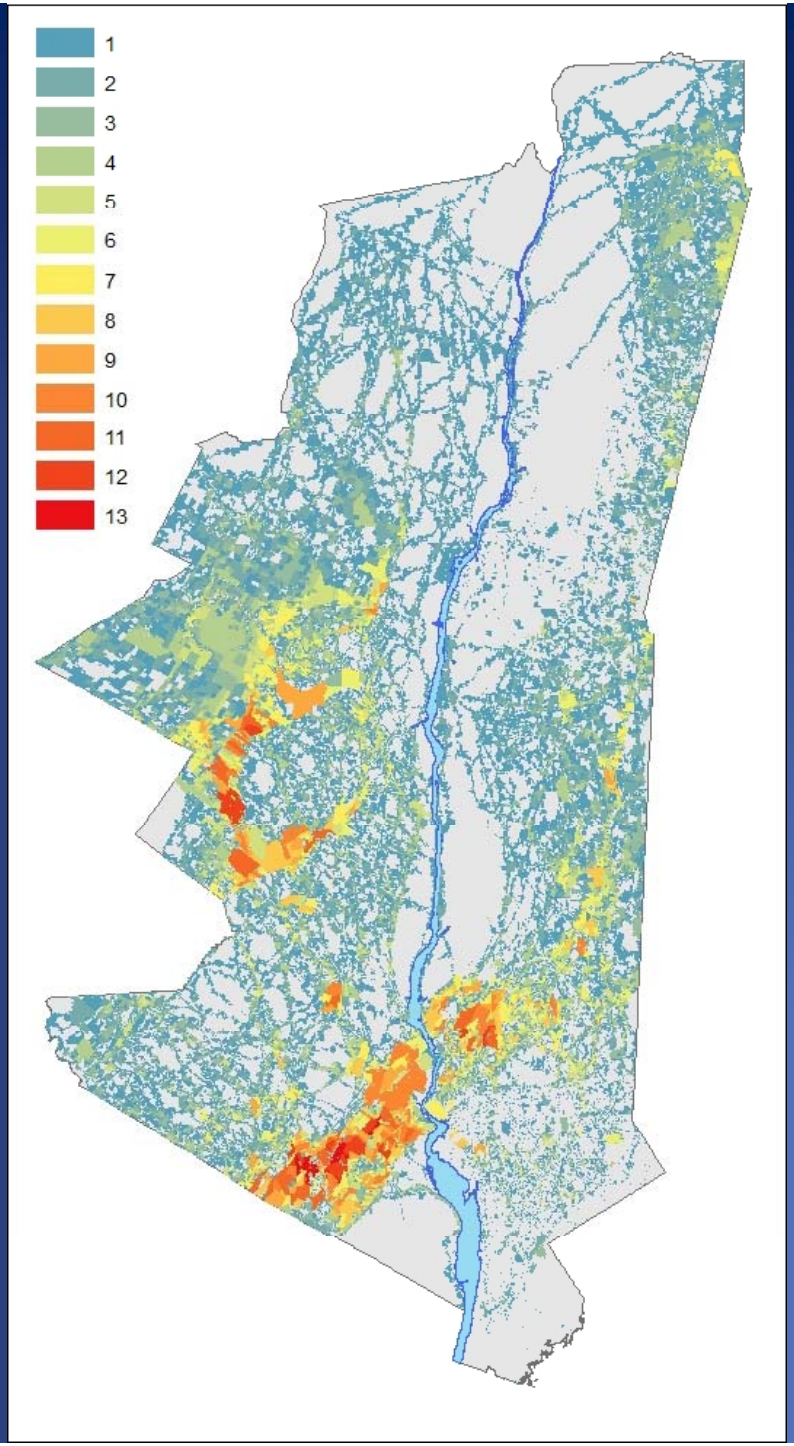
Ownership parcels: 2080



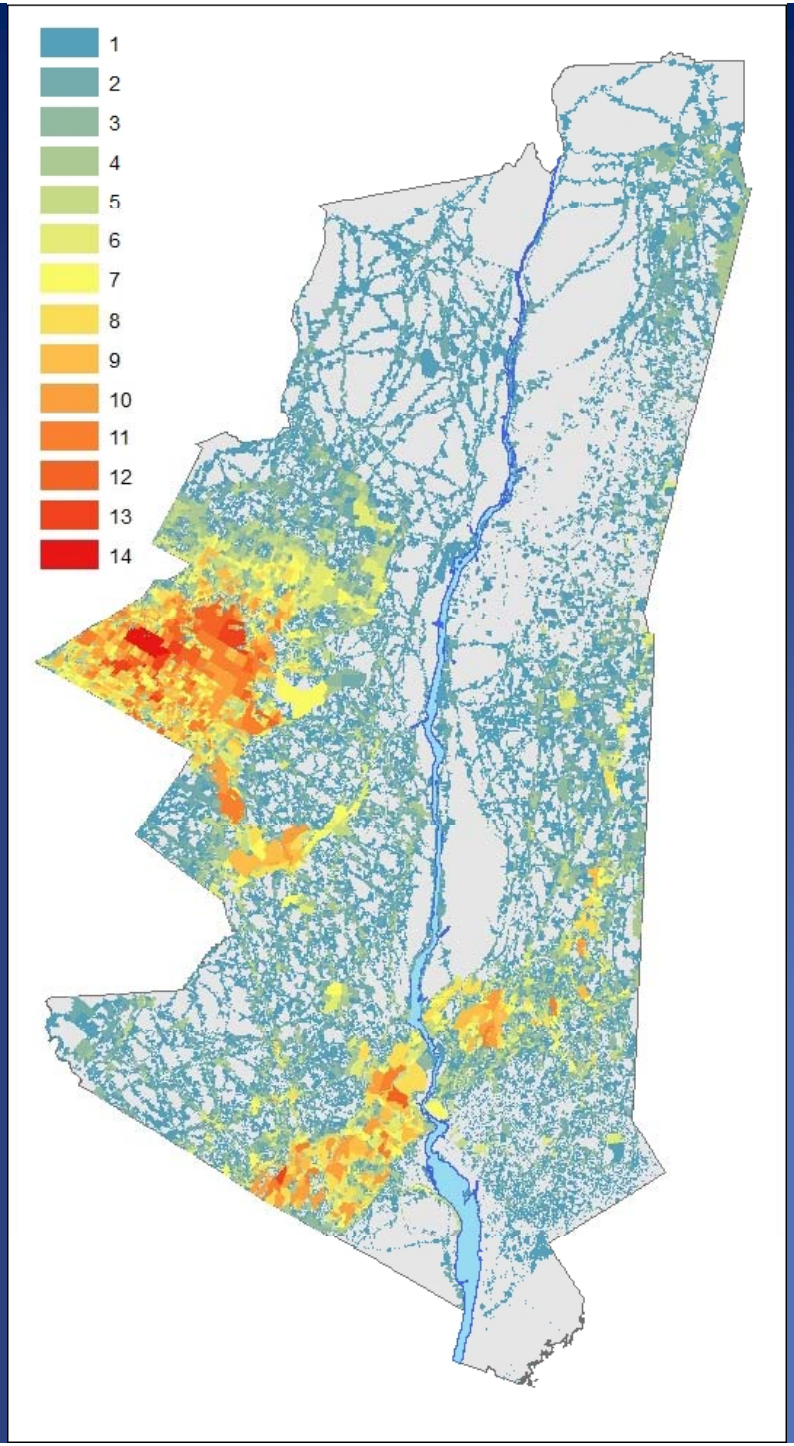
Ownership parcels: Current day



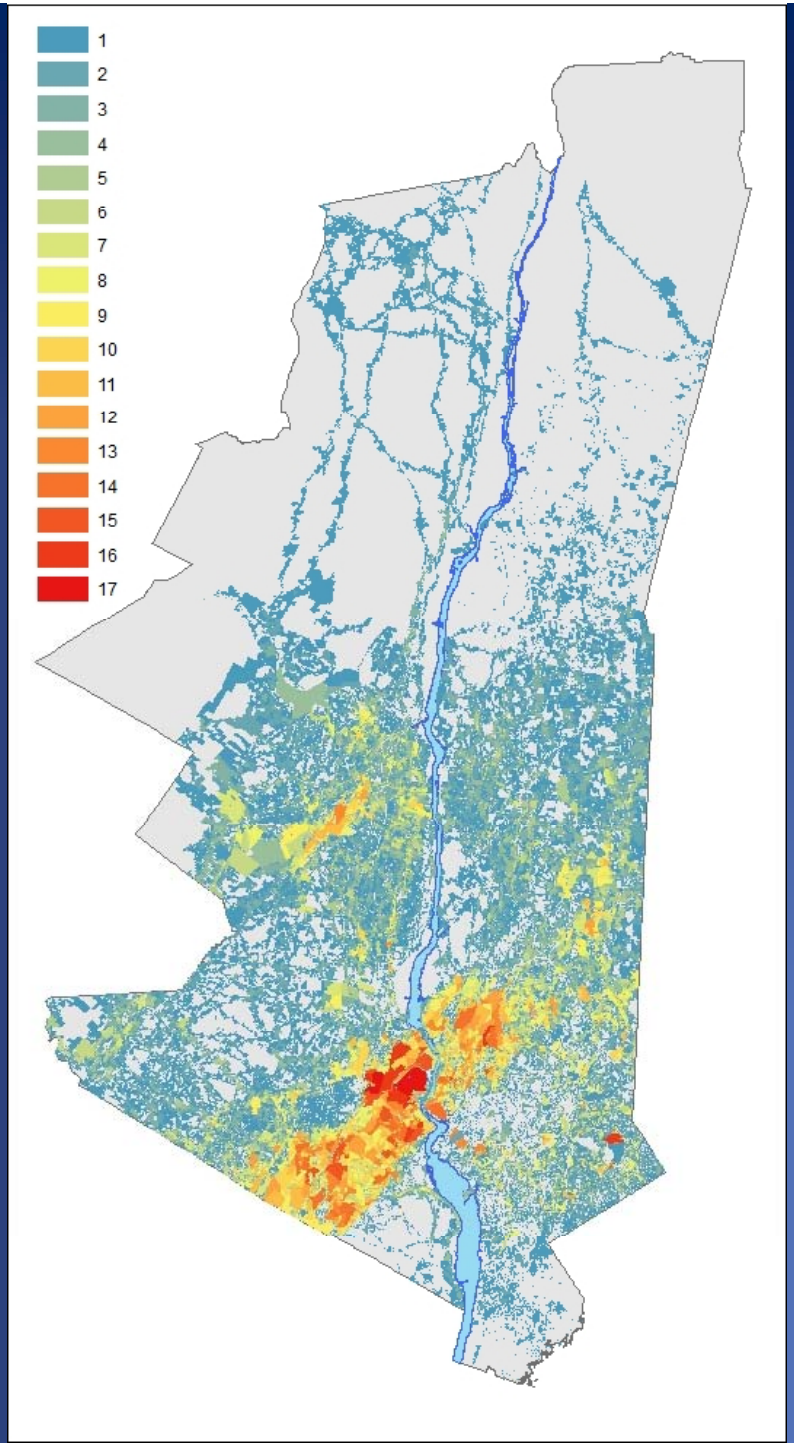
Ownership parcels: 2050



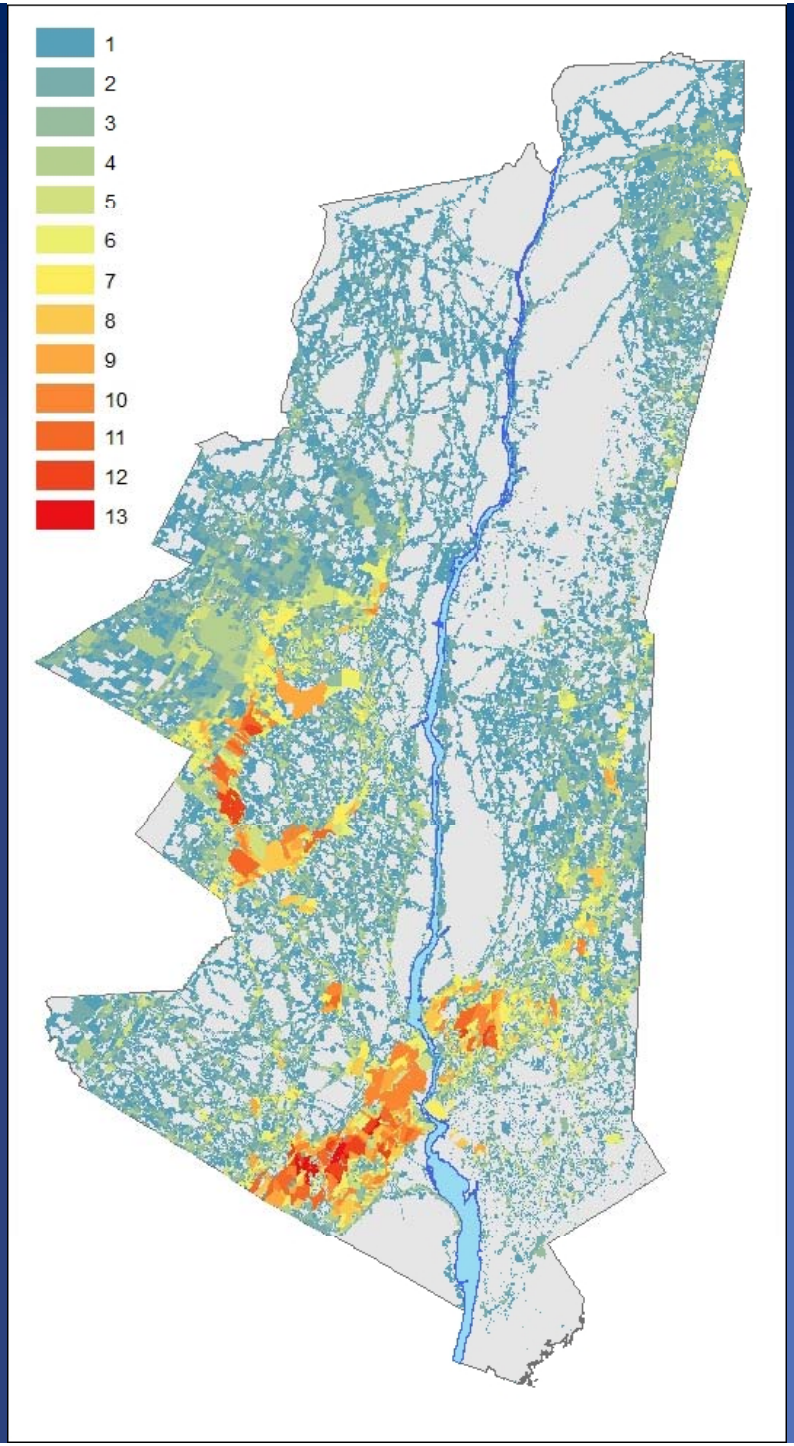
Ownership parcels: 2080



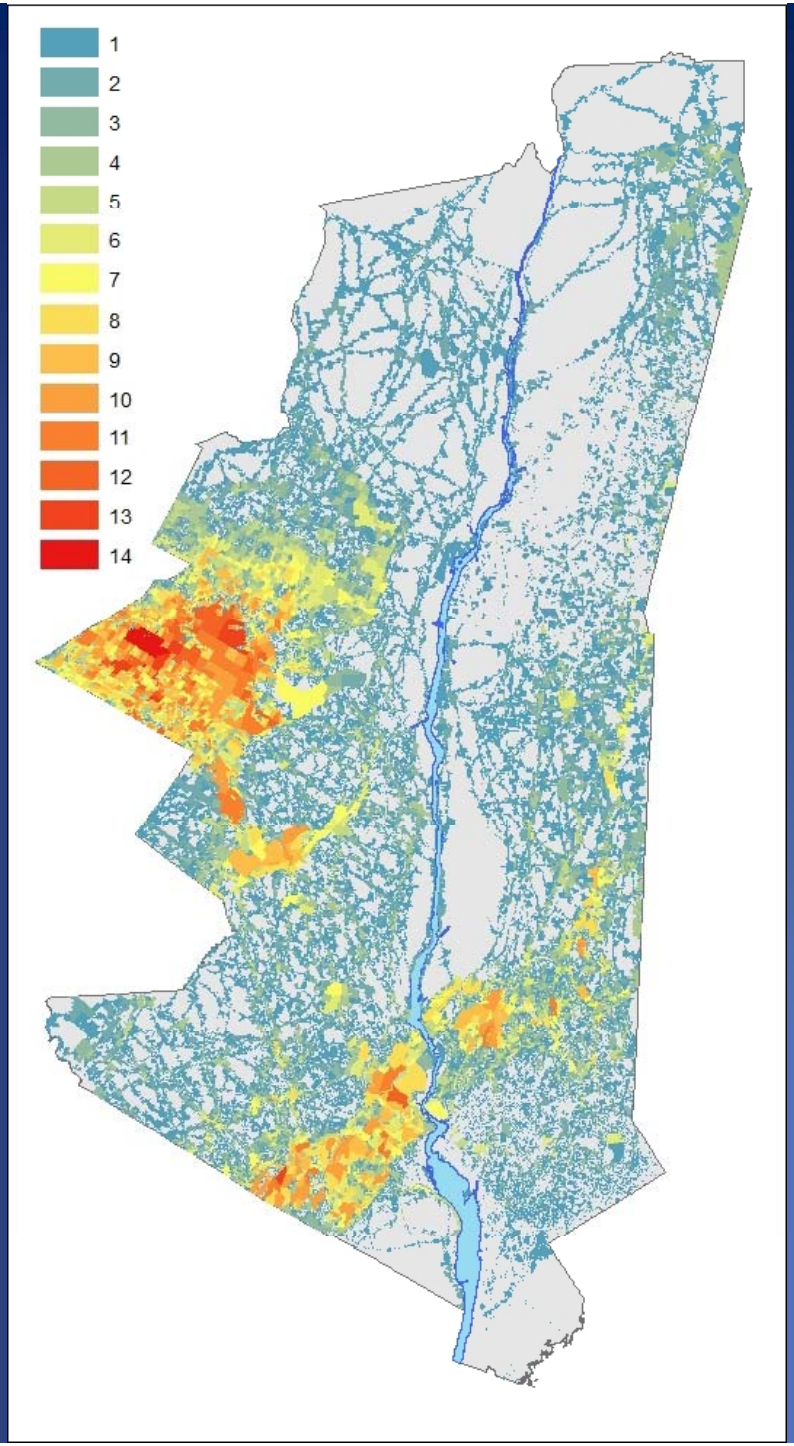
Ownership parcels: Current day



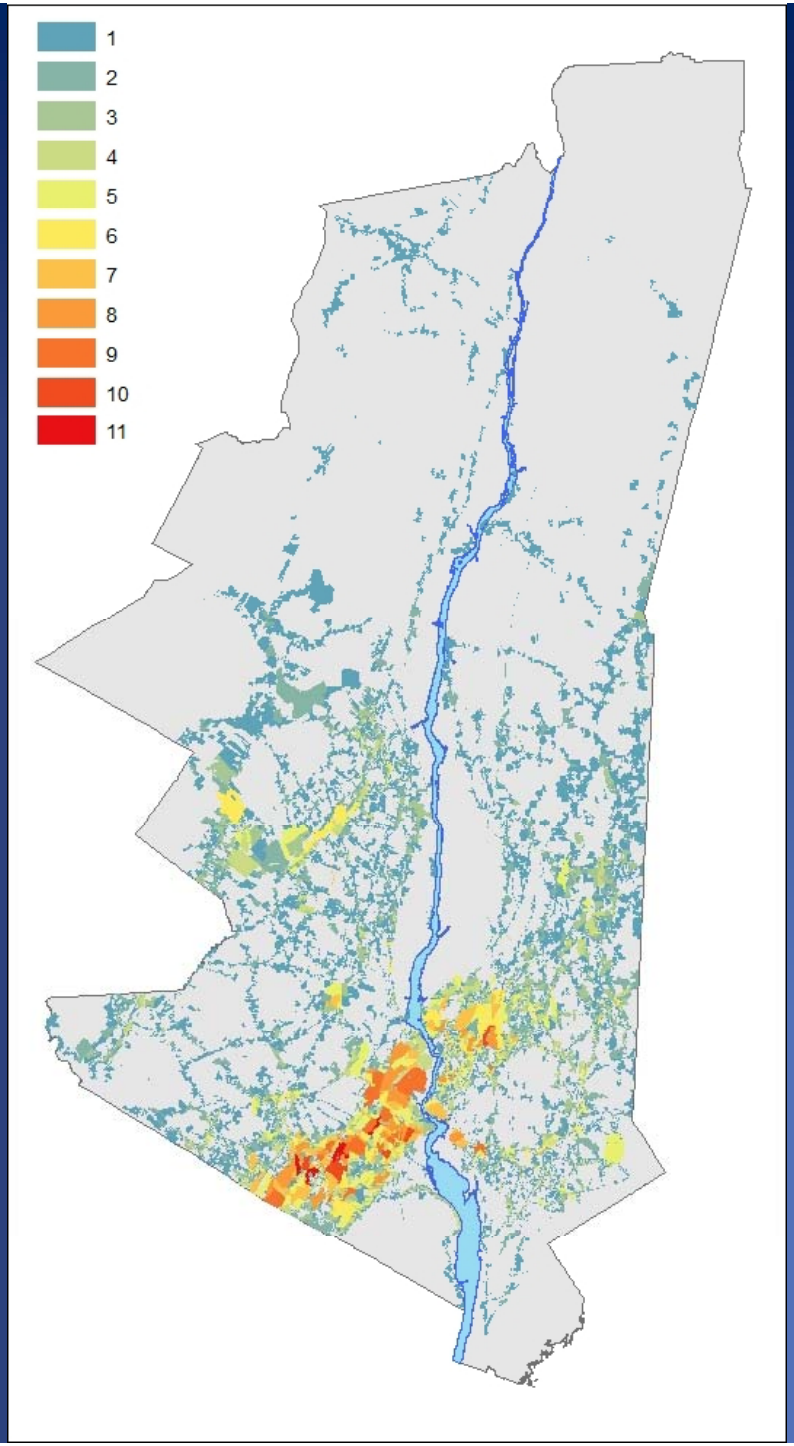
Ownership parcels: 2050



Ownership parcels: 2080



Consistency: Number of species per parcel in 2 or 3 time periods



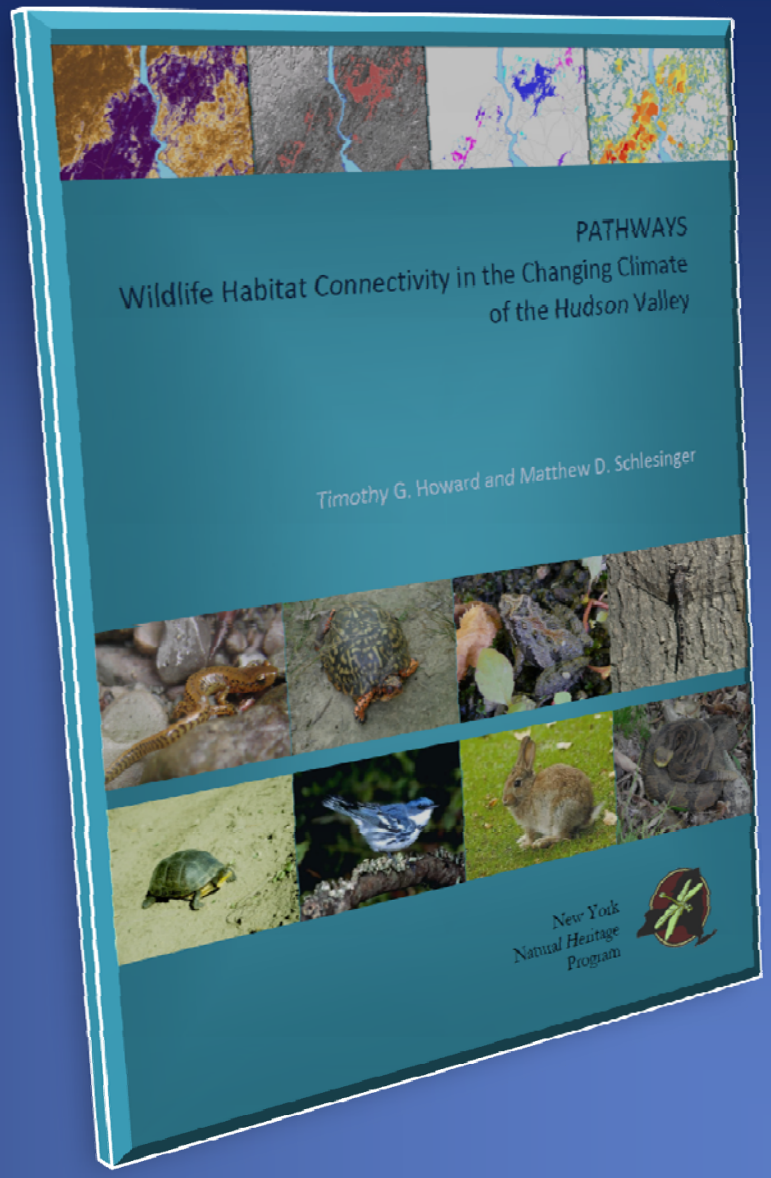
Interpreting connectivity models

- Consider dispersal distances
  - Within generations
  - Between generations → Stepping stones
- Move beyond the line
- For species occurring in metapopulations, consider whole network of patches and paths
- Validate on the ground

Summary of key predictions

- The Catskills will have suitable climate for many at-risk species
- The Hudson Highlands will likely remain important for many species
- Vital connections:
  - Hudson Highlands → Shawangunk Ridge → Catskills
  - Lower Hudson → Harlem Valley
  - Catskills → Adirondacks?

Download our report at
www.nynhp.org/howard



Acknowledgments

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