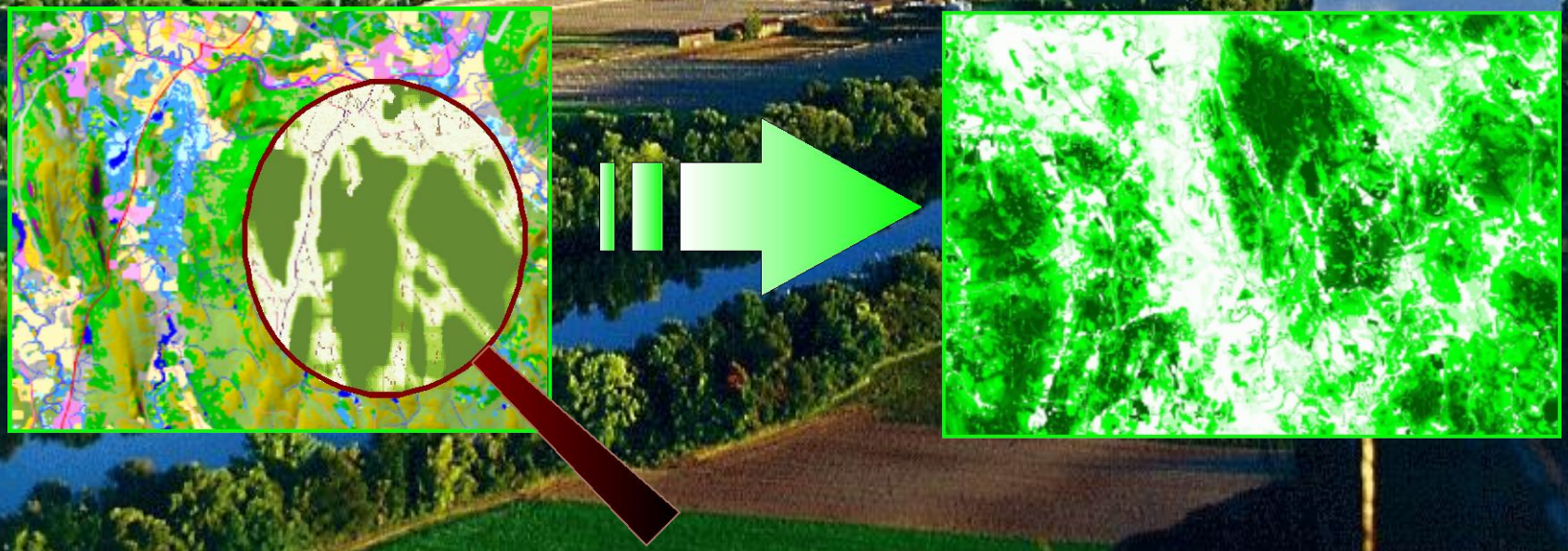
Designing Sustainable Landscapes in the Northeast

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

Landscape Conservation Design

December 19, 2014

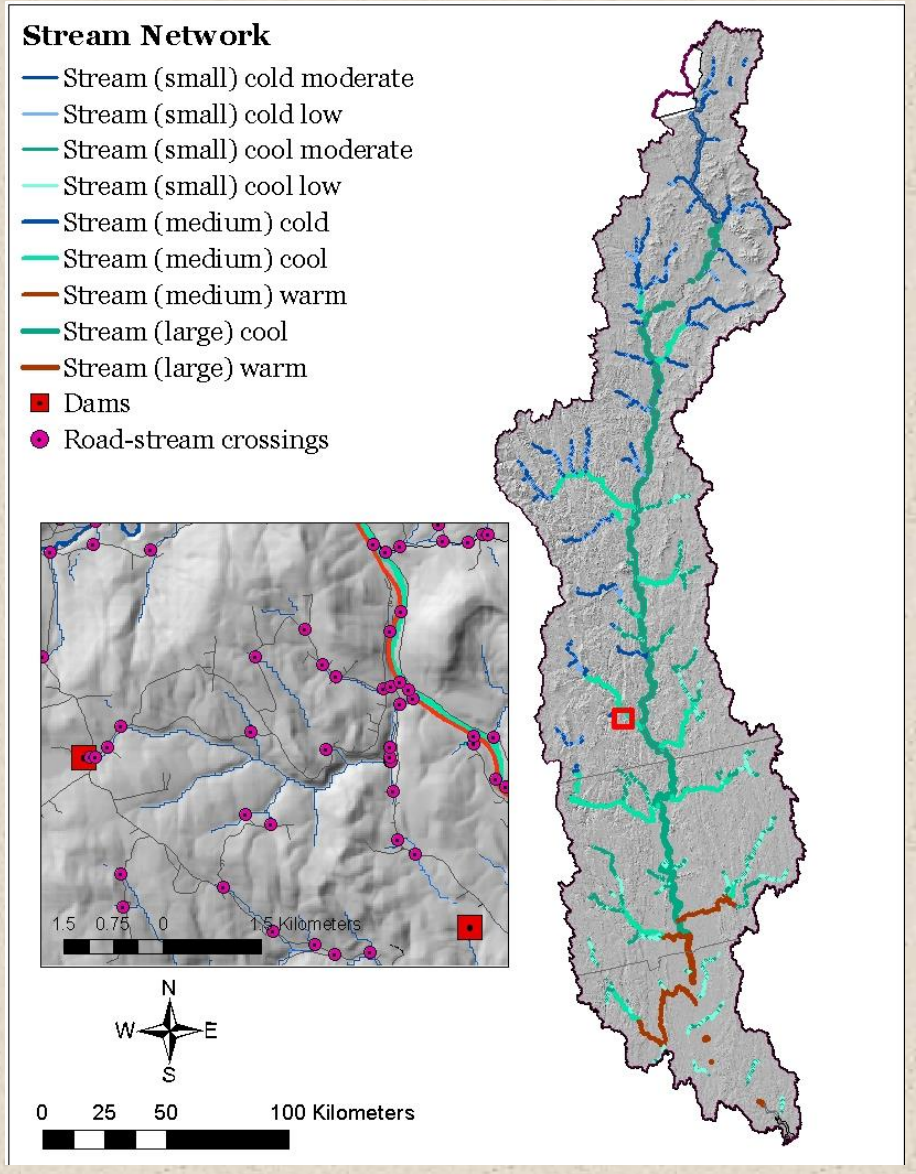


Topics for today

1. Clarify how aquatic connectivity is being addressed
2. Review of incorporation of future landscape conditions into design
3. Scenario comparison
4. Derivation of connectors
5. Concept of core area buffers
6. Tiers/priorities for watershed
7. How do restoration opportunities fit into design
8. Terrestrial and aquatic core area overlap
9. Model validation options

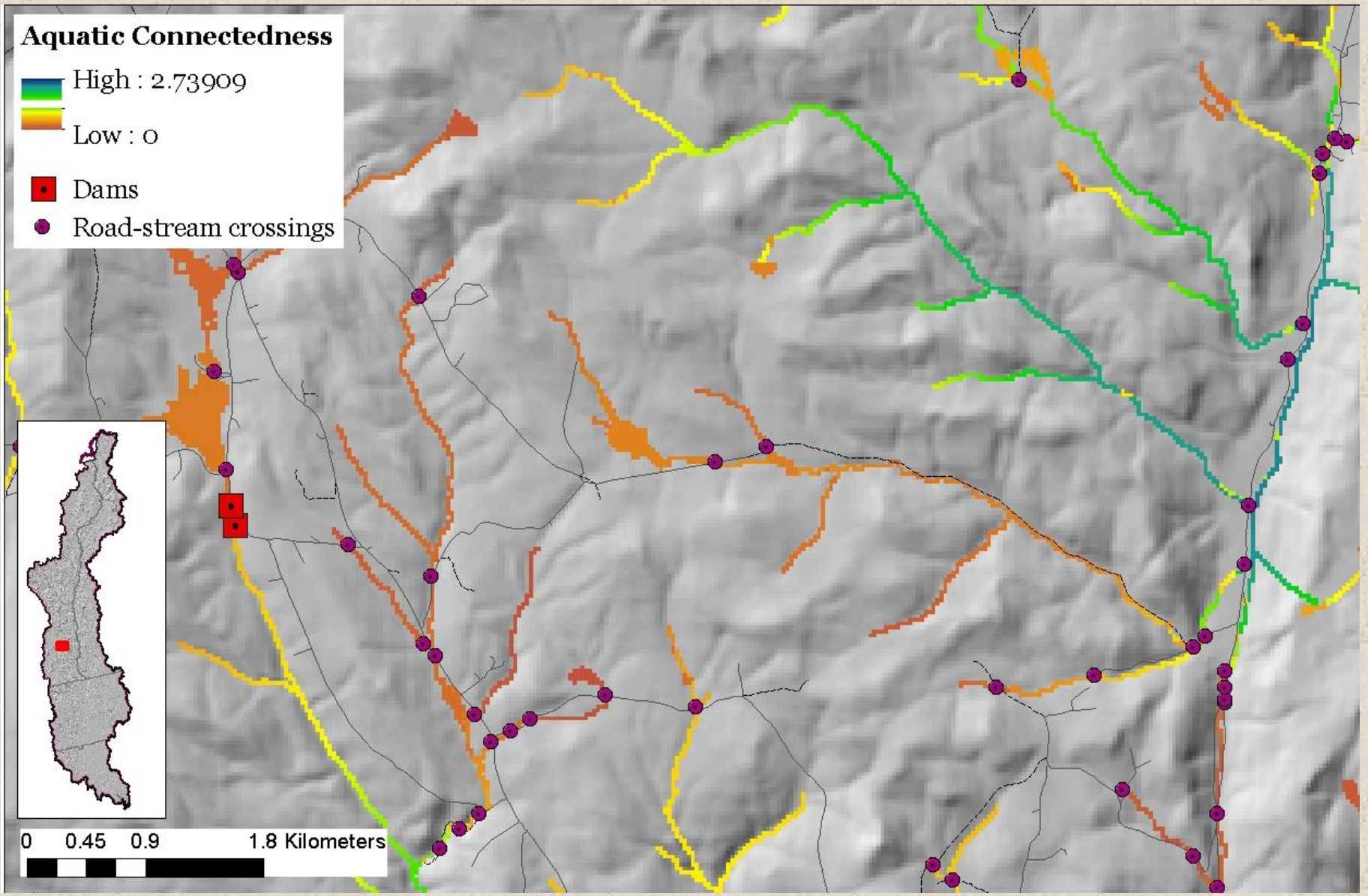
Aquatic Connectivity

- Aquatic connectedness metric (local connectivity; 5-8 km) incorporated into IEI (15-22% of IEI for aquatic systems) and thus into the aquatic core area selection index
- Note, regional connectivity for anadromous species (i.e., ocean to stream) is currently <u>not</u> addressed



Aquatic Connectivity

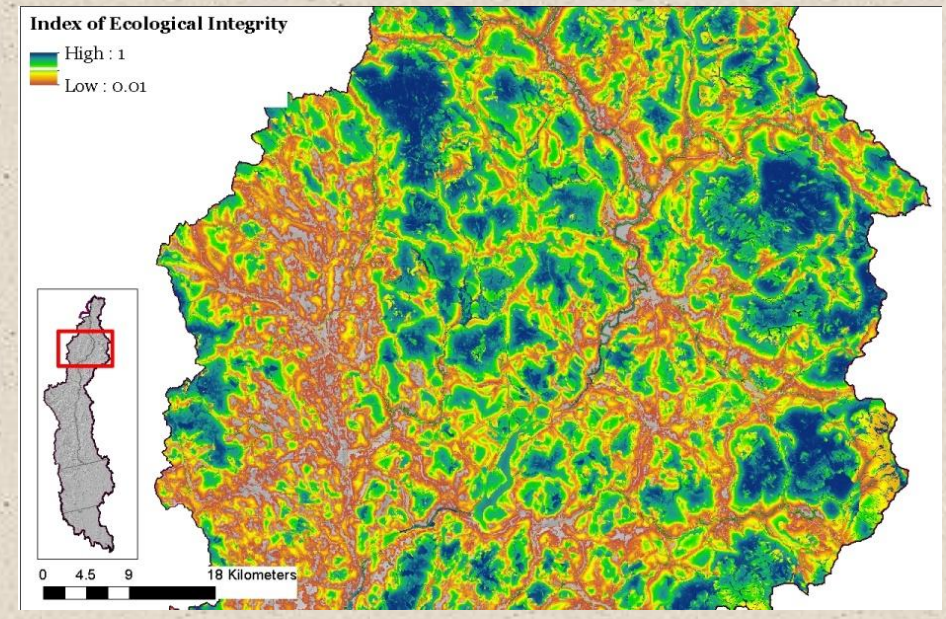
- Aquatic connectedness metric



Incorporating Future Conditions

Ecosystem: IEI-climate

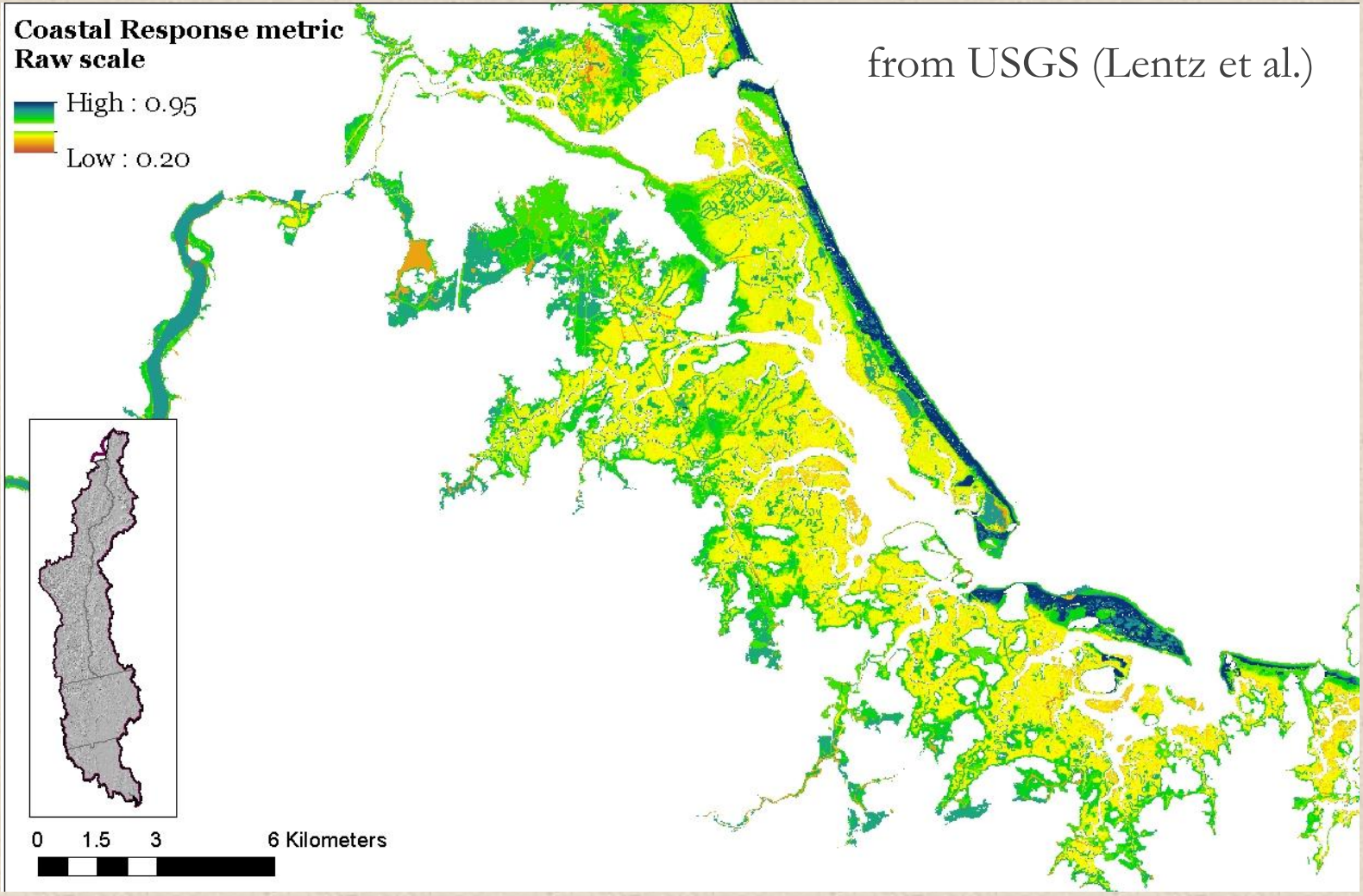
- Add *sea level rise* metric
- Add *climate stressor* metric
- Compute resiliency metrics (*similarity, connectedness, aquatic connectedness*) with future climate settings (*gdd, tmin, heat35, wet, volume*)
- Compute *IEI-climate*



Incorporating Future Conditions

Ecosystem: IEI-climate

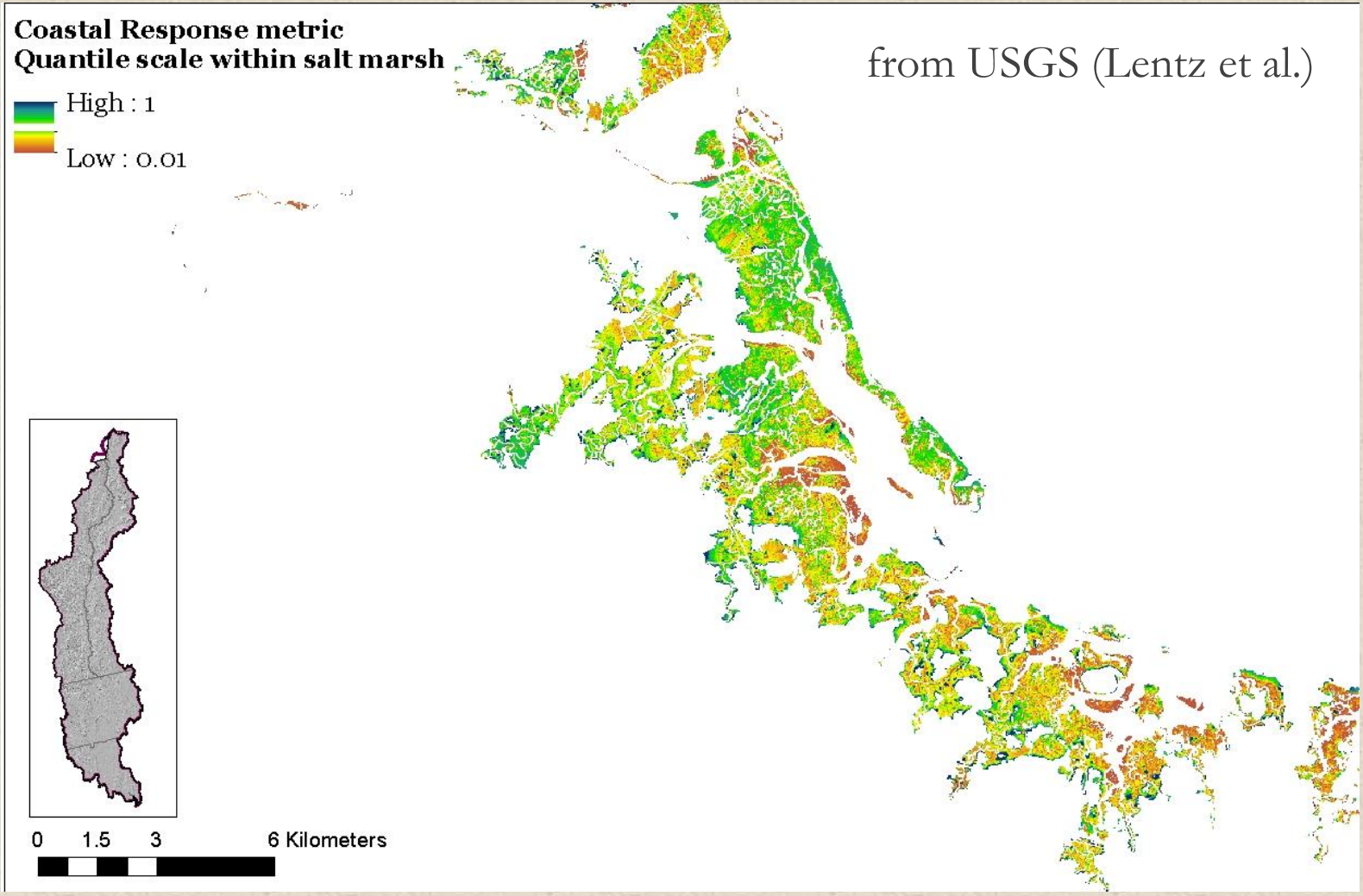
- Add sea level rise inundation metric to IEI



Incorporating Future Conditions

Ecosystem: IEI-climate

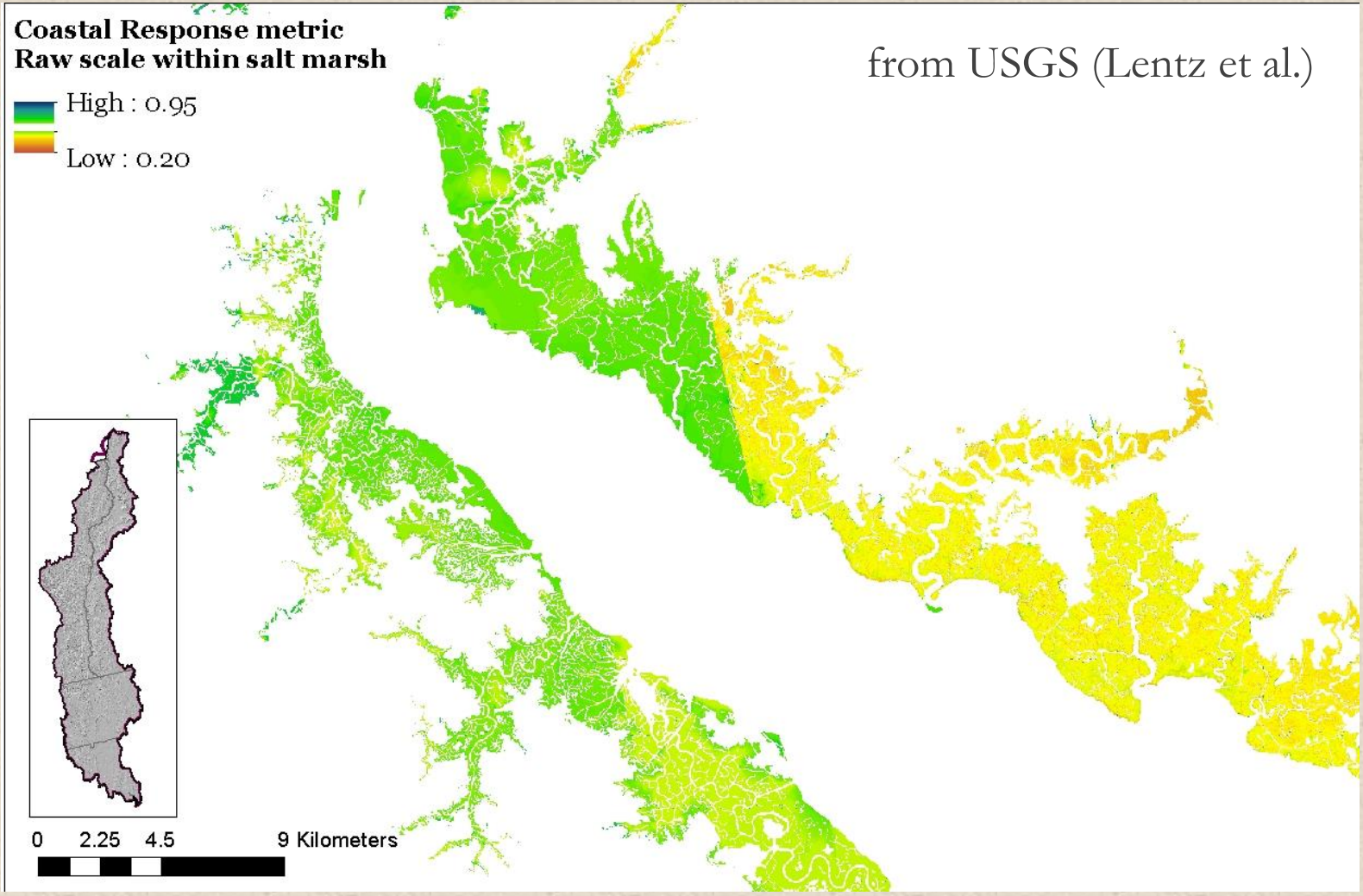
- Add sea level rise inundation metric to IEI



Incorporating Future Conditions

Ecosystem: IEI-climate

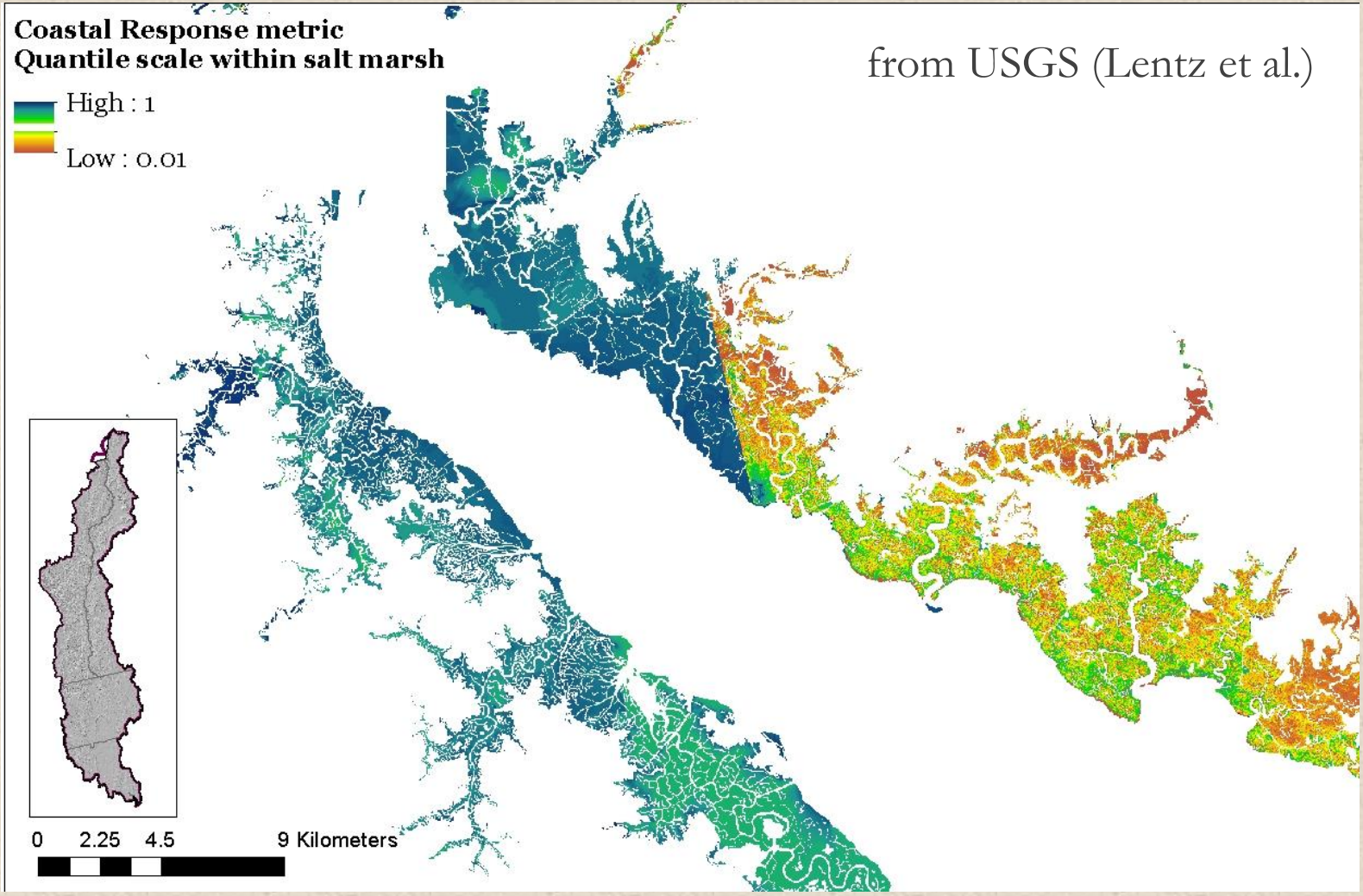
- Add sea level rise inundation metric to IEI



Incorporating Future Conditions

Ecosystem: IEI-climate

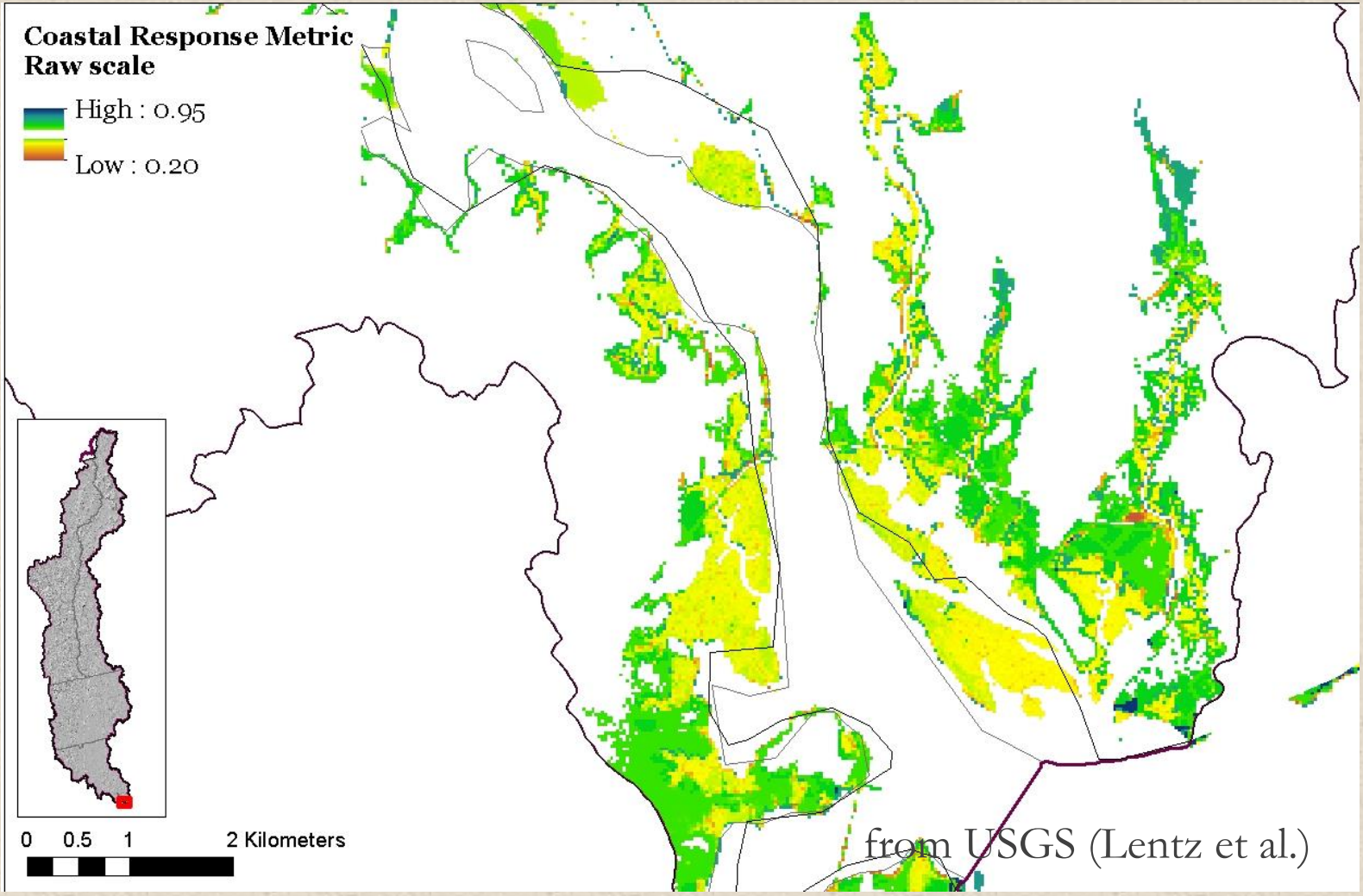
- Add sea level rise inundation metric to IEI



Incorporating Future Conditions

Ecosystem: IEI-climate

- Add sea level rise inundation metric to IEI

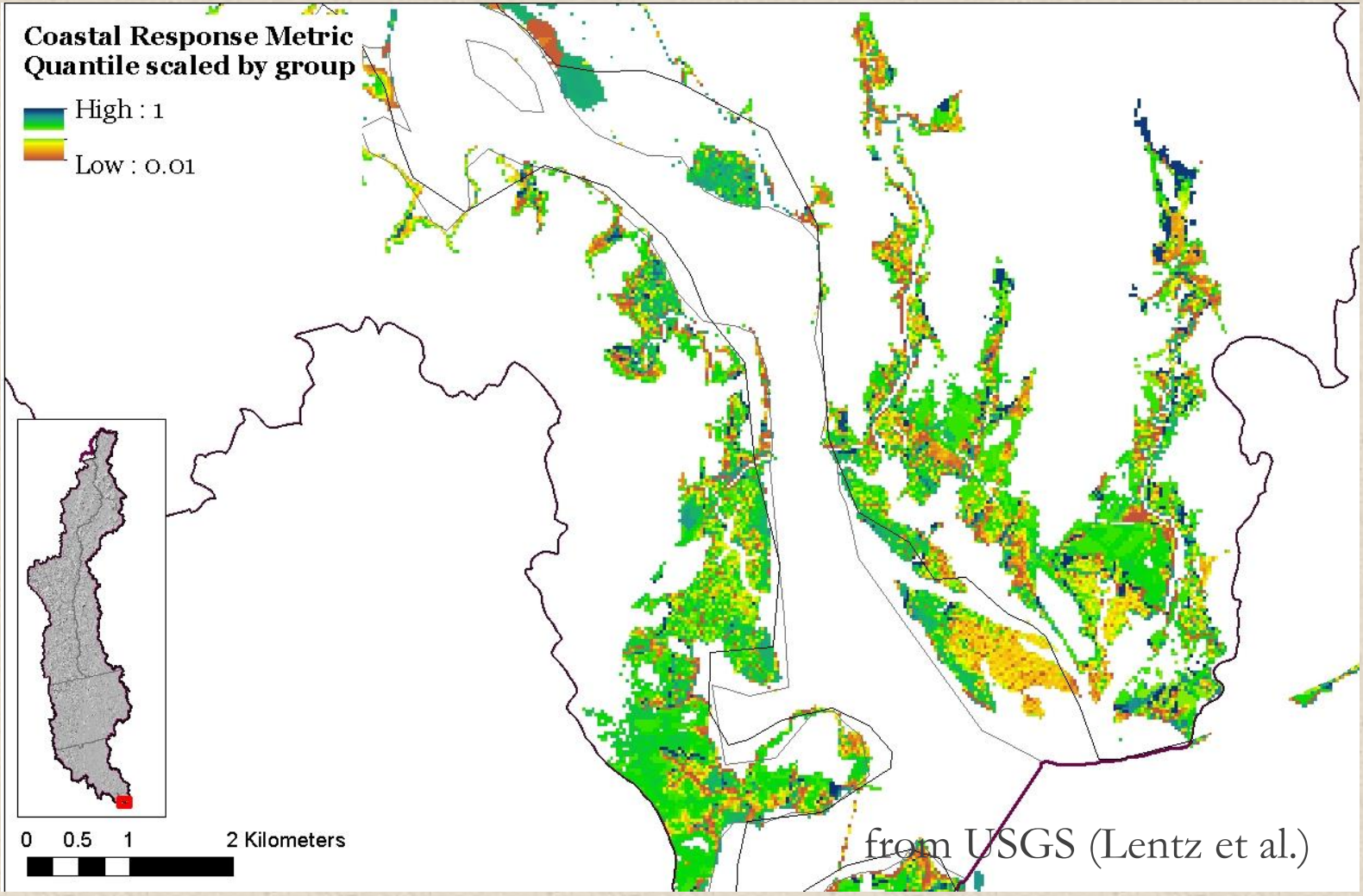


from USGS (Lentz et al.)

Incorporating Future Conditions

Ecosystem: IEI-climate

- Add sea level rise inundation metric to IEI

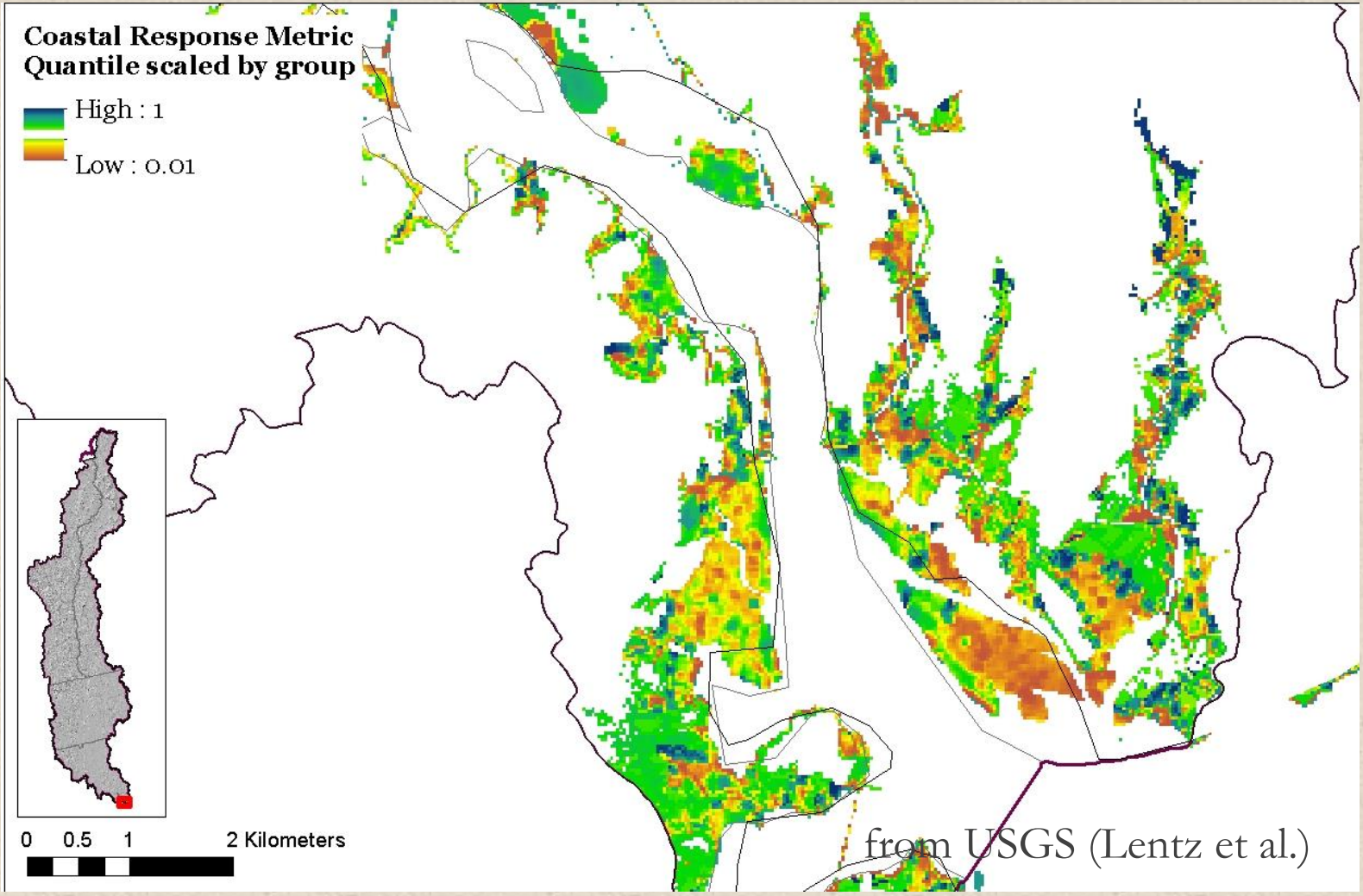


from USGS (Lentz et al.)

Incorporating Future Conditions

Ecosystem: IEI-climate

- Add sea level rise inundation metric to IEI

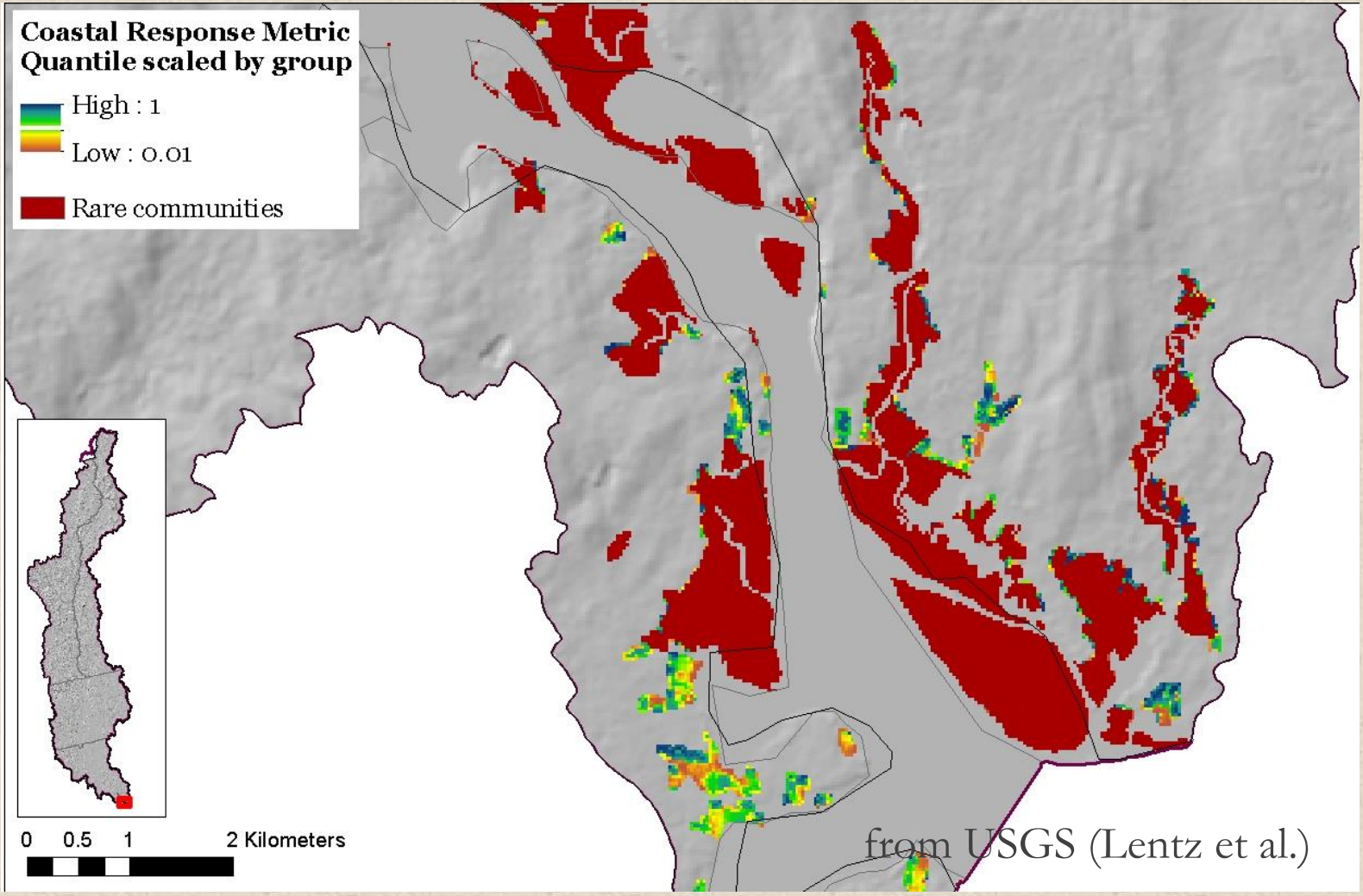


from USGS (Lentz et al.)

Incorporating Future Conditions

Ecosystem: IEI-climate

- Add sea level rise inundation metric to IEI

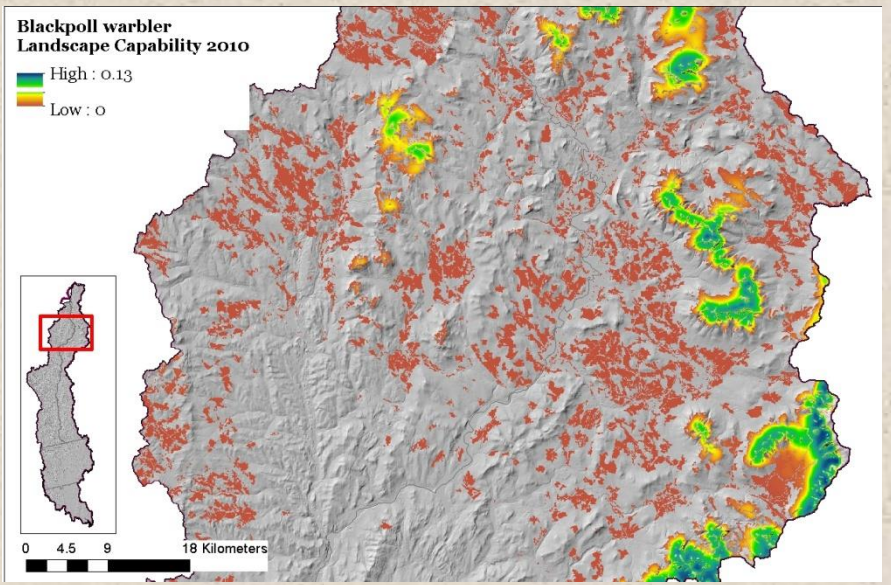


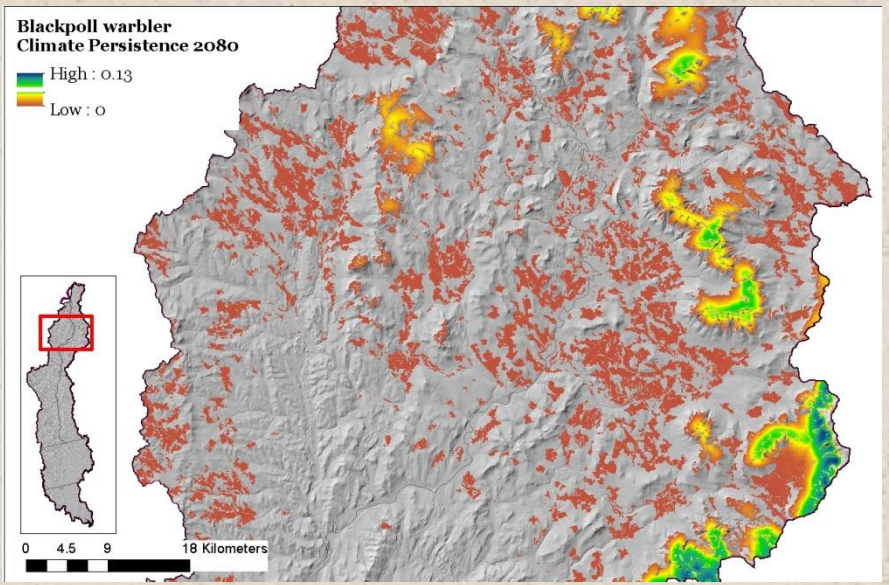
from USGS (Lentz et al.)

Incorporating Future Conditions

Species: Climate persistence

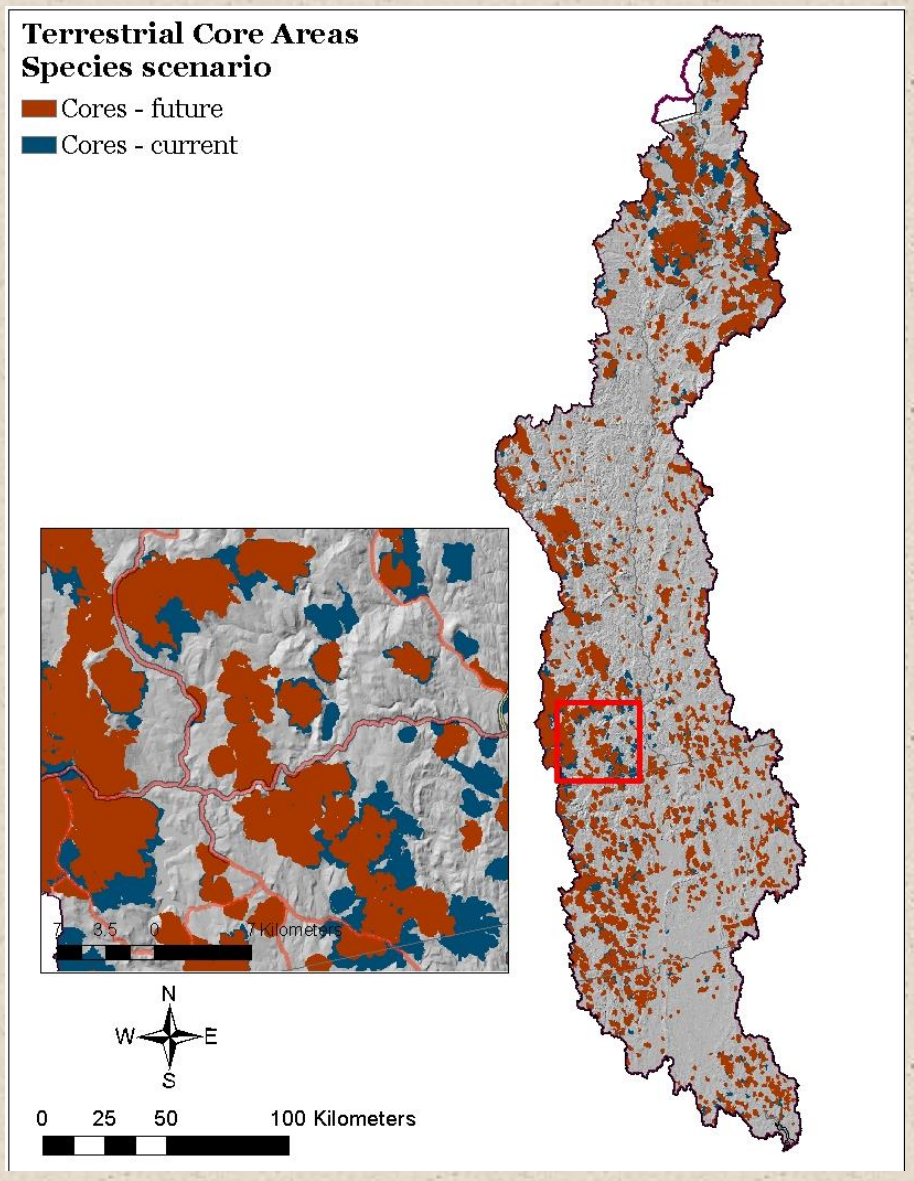
- Use climate persistence metric (average of current LC and future LC-climate)
- Use brook trout equivalent (average of current and future prob(occur))

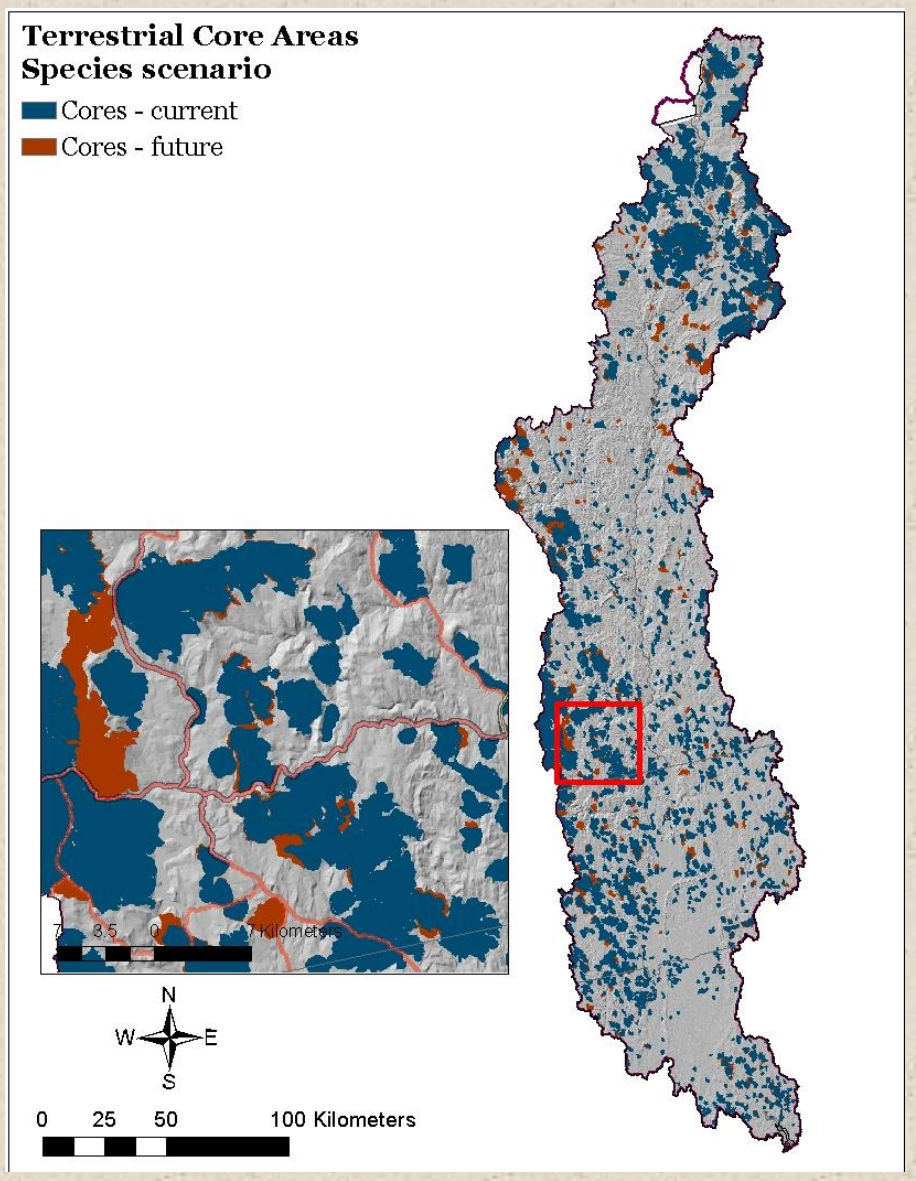




Incorporating Future Conditions

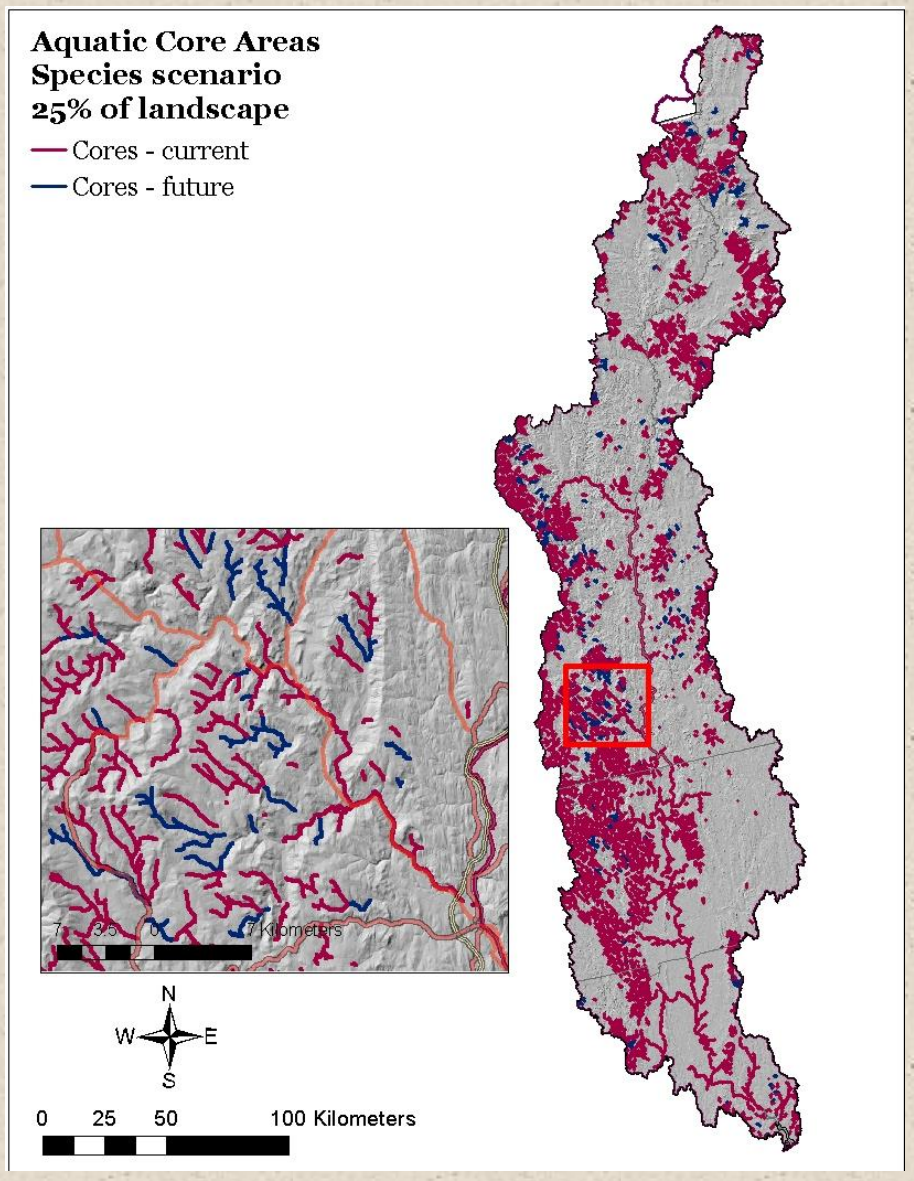
Species: Climate persistence

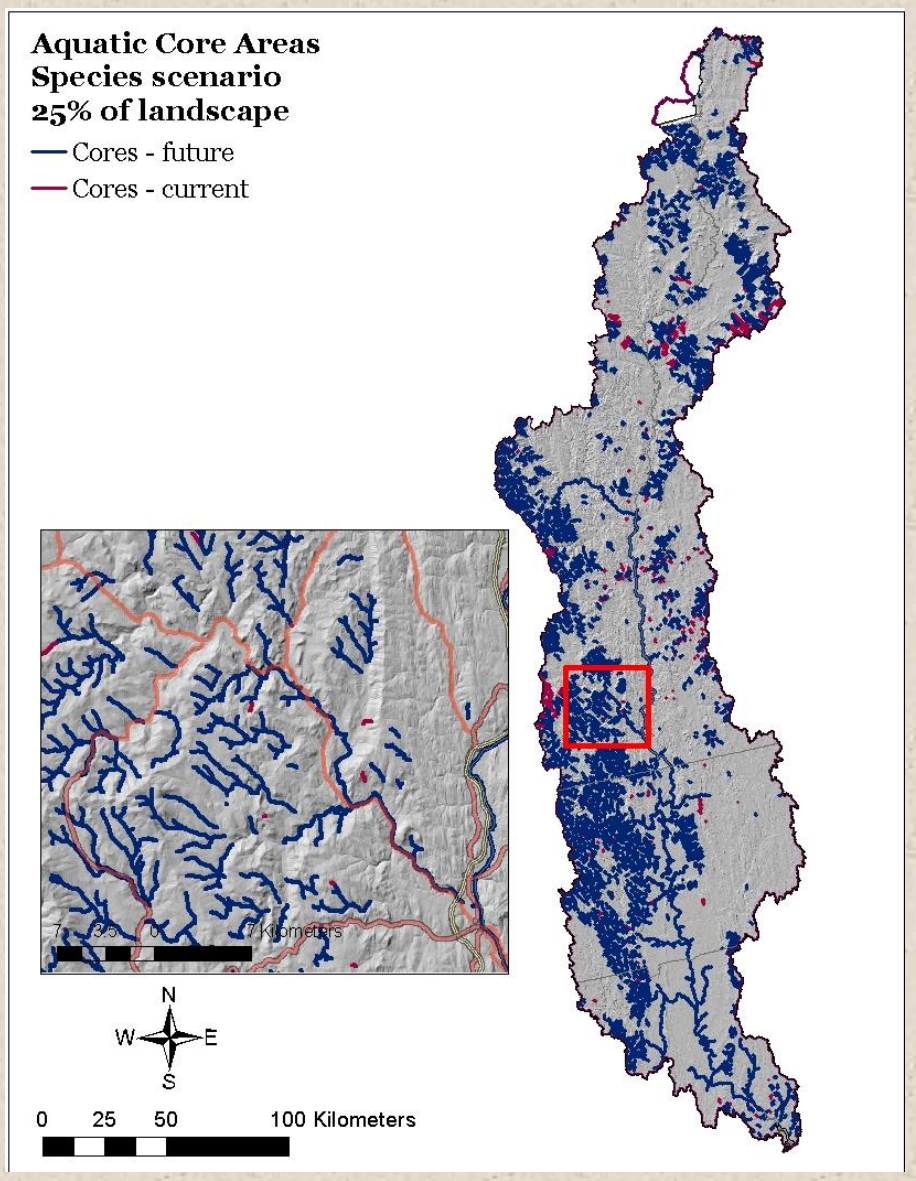




Incorporating Future Conditions

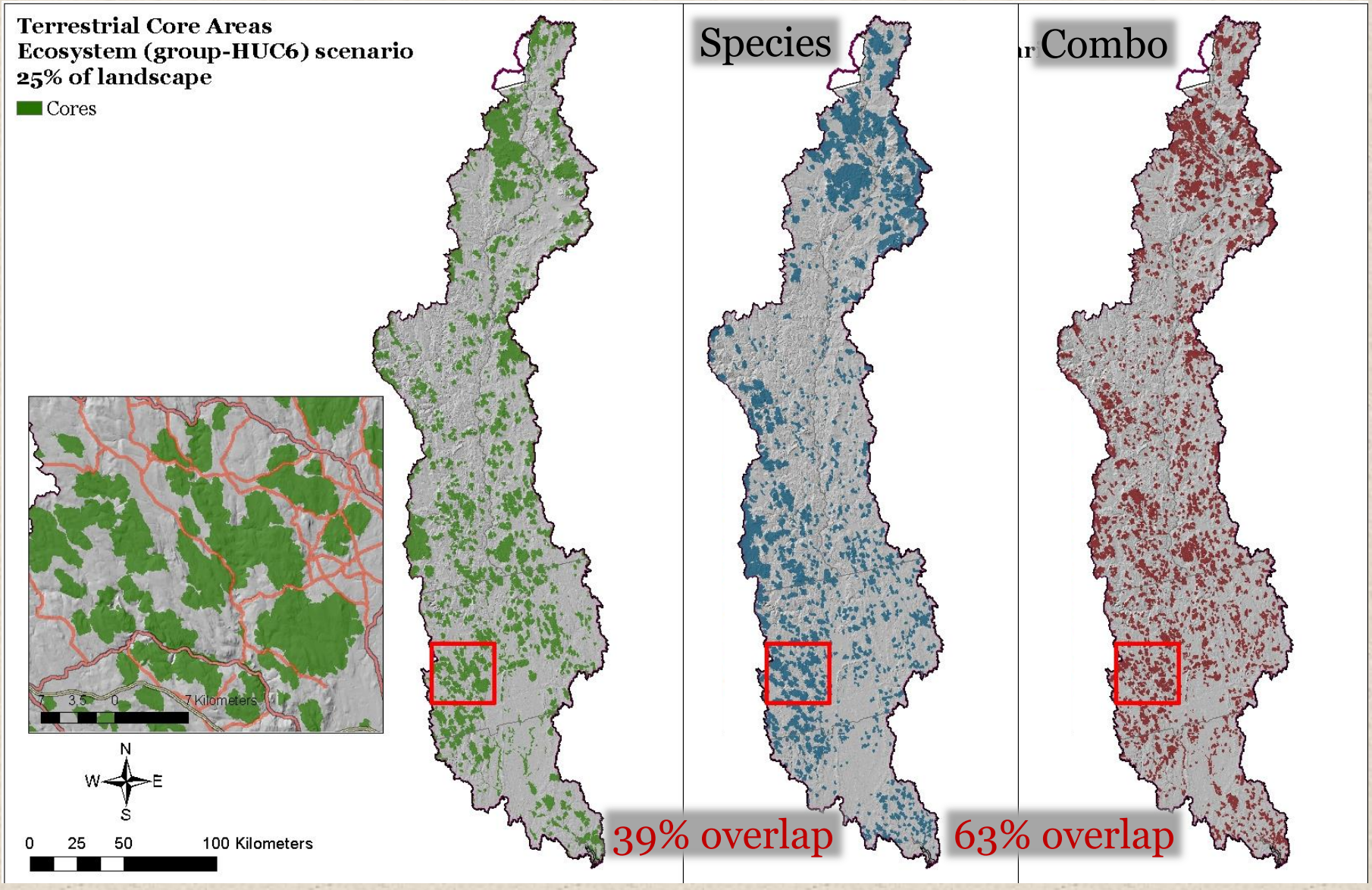
Species: Climate persistence





Scenario Comparison

Current options



Scenario Comparison

The issues

Goals:

- Fewer/larger cores
- Efficient capture of total LC units across species
- Capture most (if not all) of the best places for each ecosystem and species

Tradeoffs:

Creating larger cores necessitates growing through lower valued places -- that still accumulate LC units (albeit slowly) that help meet species targets

Scenario Comparison

The issues

Goals:

- Fewer/larger cores
- Efficient capture of total LC units across species
- Capture most (if not all) of the best places for each ecosystem and species

Tradeoffs:

← Areas of overlapping LC units across species is efficient in meeting LC targets, but doesn't guarantee that the best LC units for any species are being captured (and may even work against it)

Scenario Comparison

The issues

Goals:

- Fewer/larger cores
- Efficient capture of total LC units across species
- Capture most (if not all) of the best places for each species

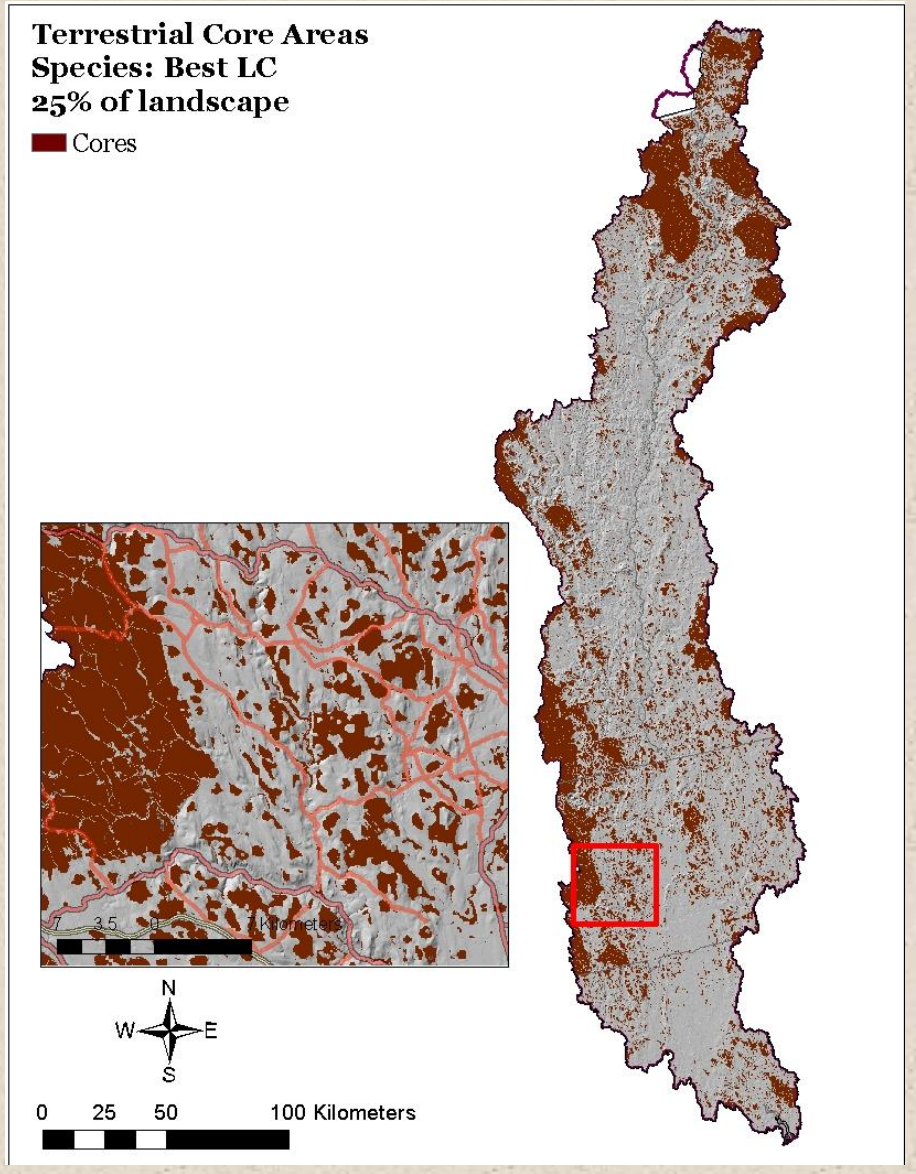
Tradeoffs:

← Capturing the best for each ecosystem/species achieves no efficiency and results in more/smaller cores that target just the very best places

Scenario Comparison

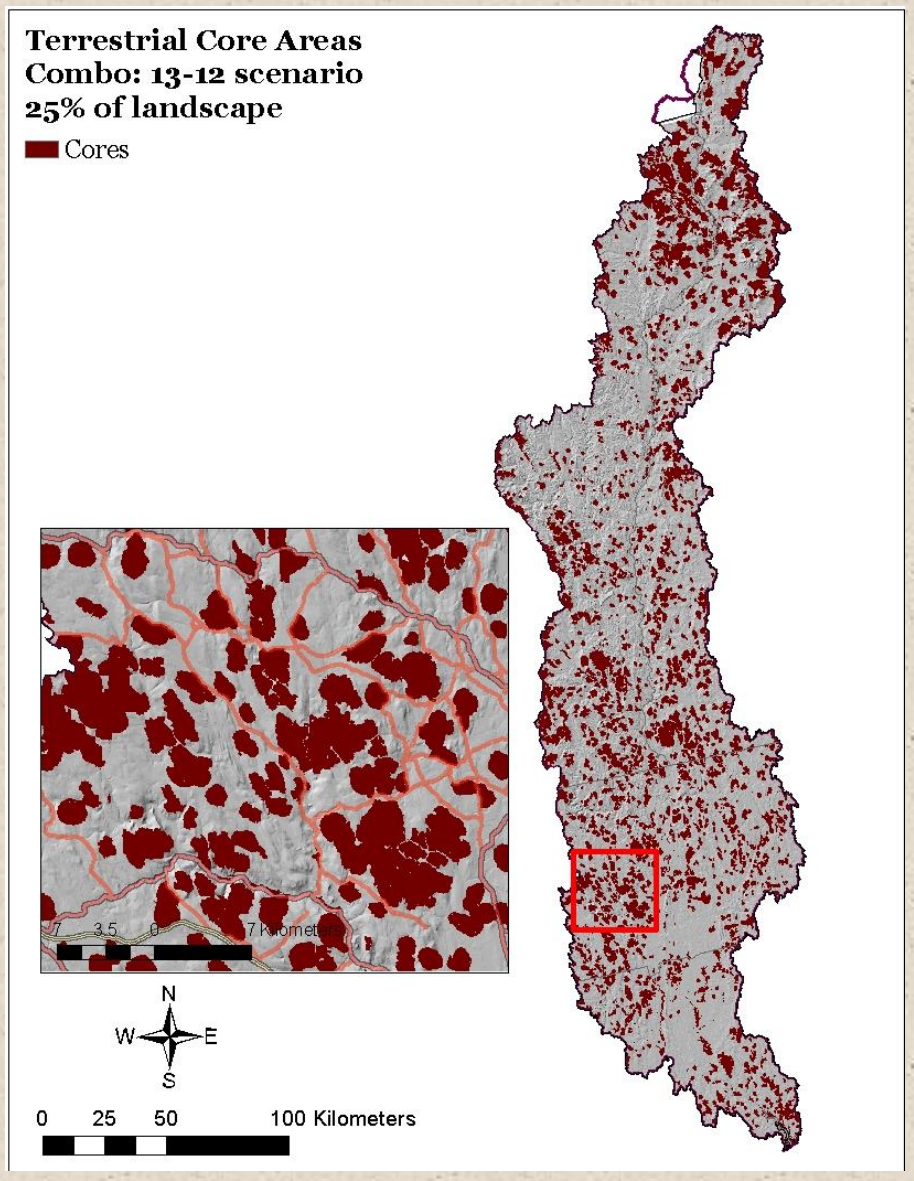
Alternative species approach

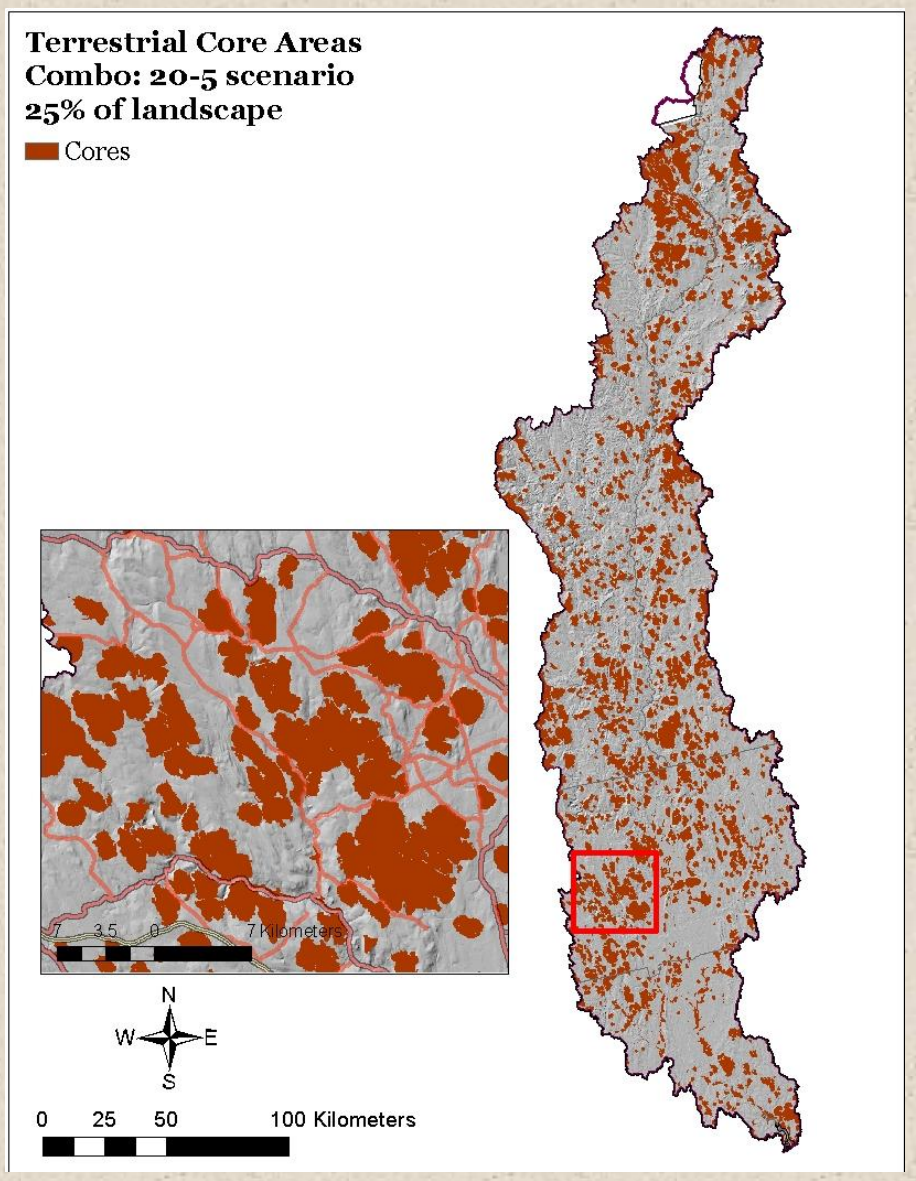
- Union of top x% of LC for each species independently (i.e., no consideration of overlap among species)
- Top x% varies among species depending on species' weights
- No constraint on core area size



Scenario Comparison

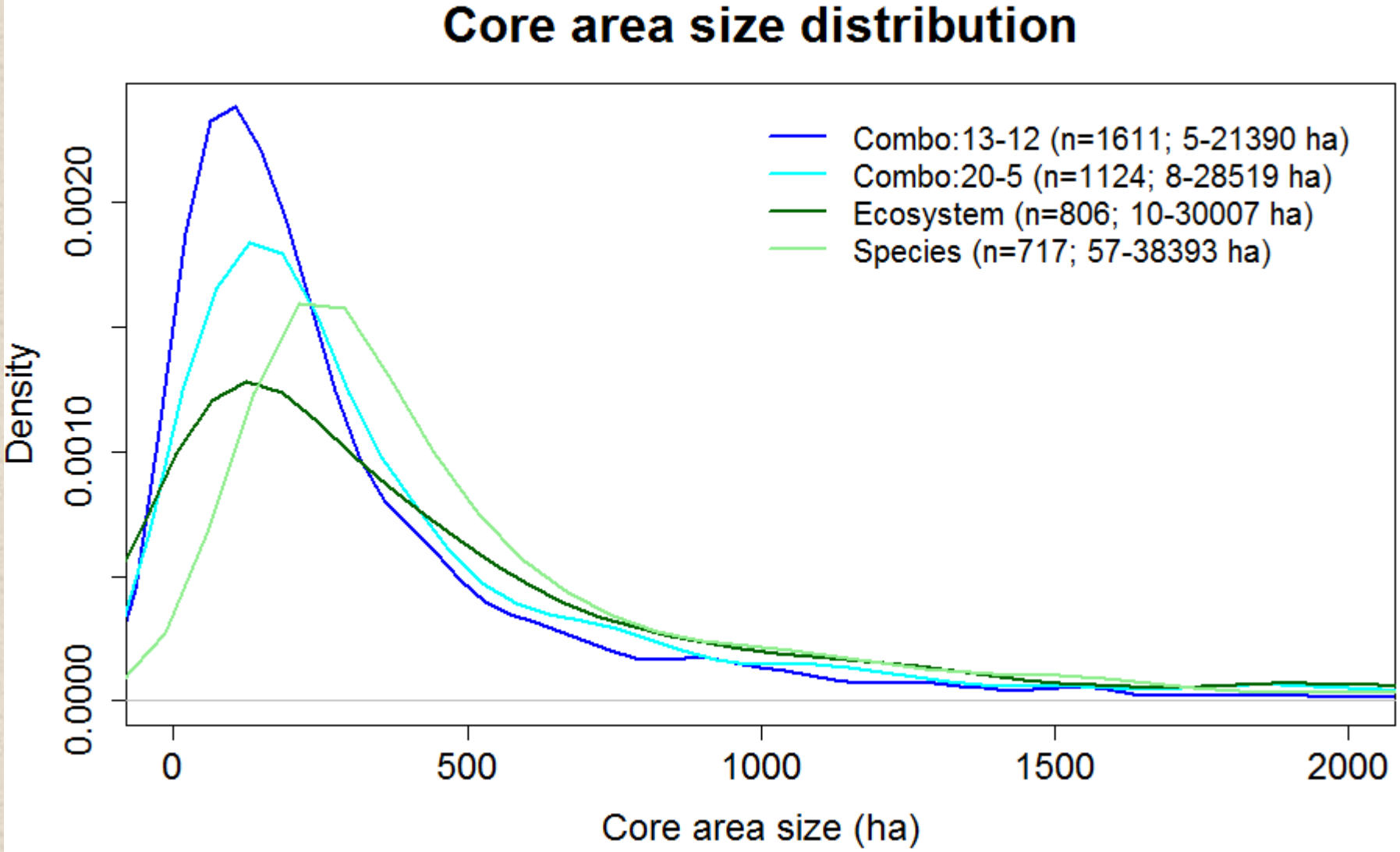
20-5 split?





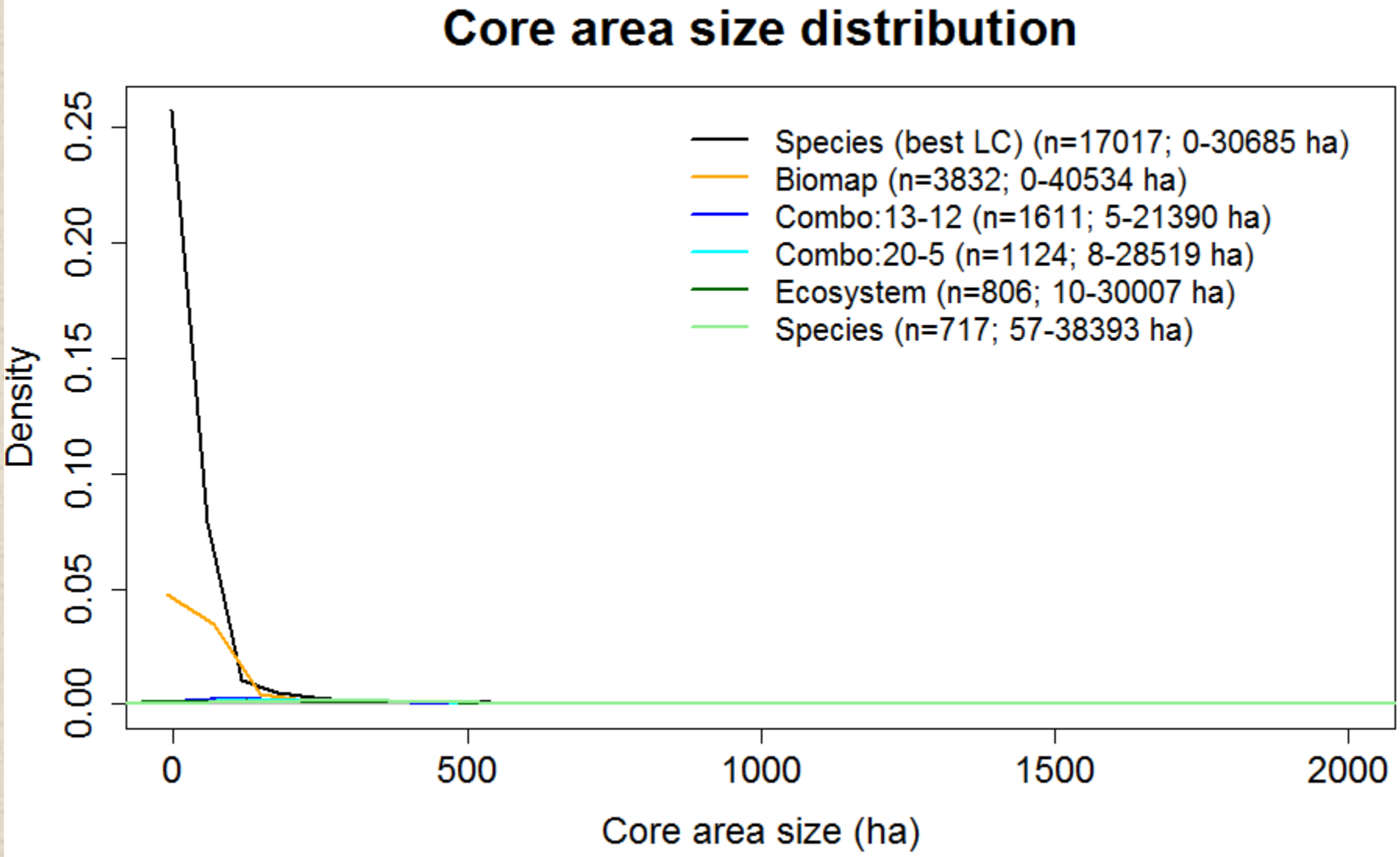
Scenario Comparison

Patch size distribution



Scenario Comparison

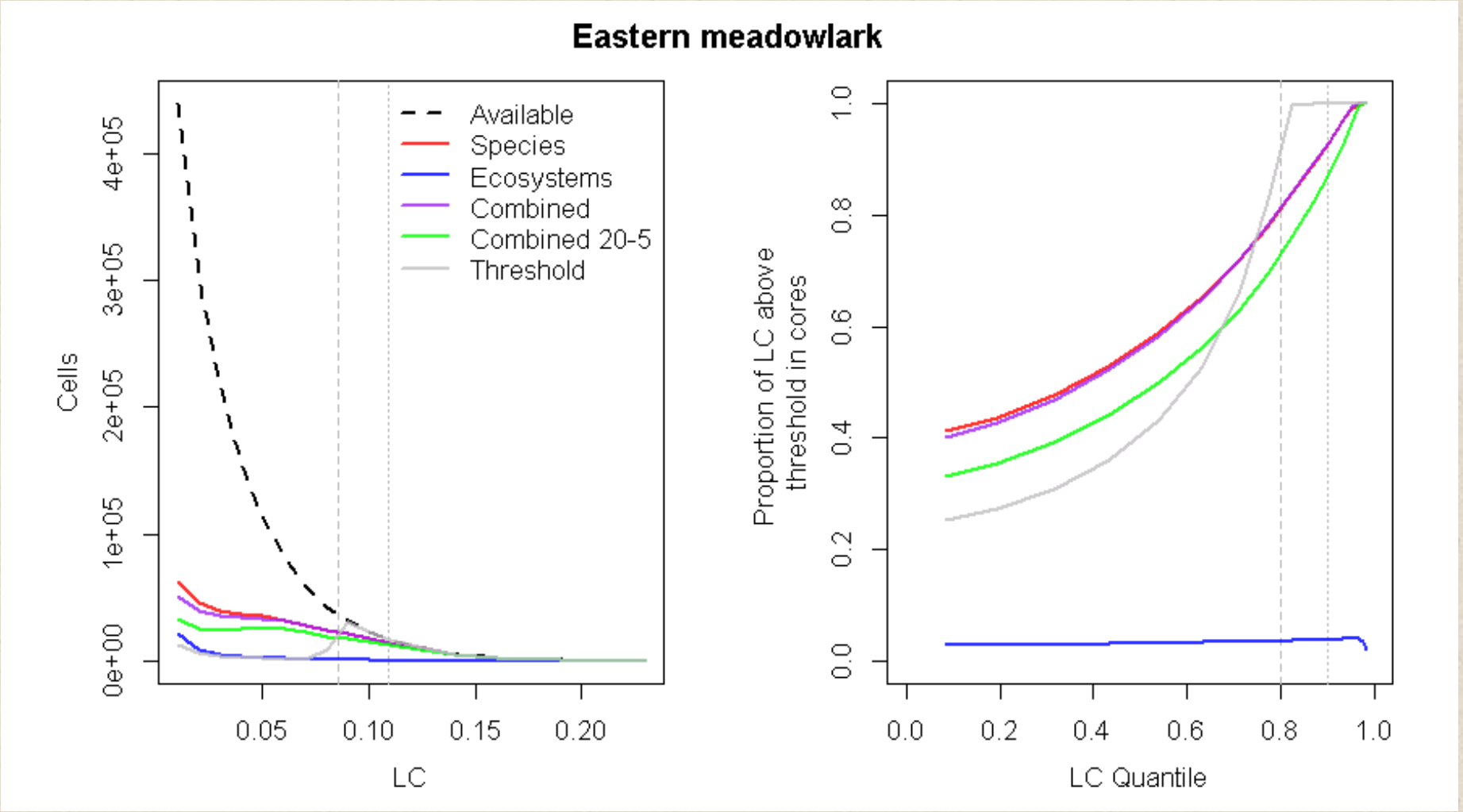
Patch size distribution



Scenario Comparison

Achieving species goals

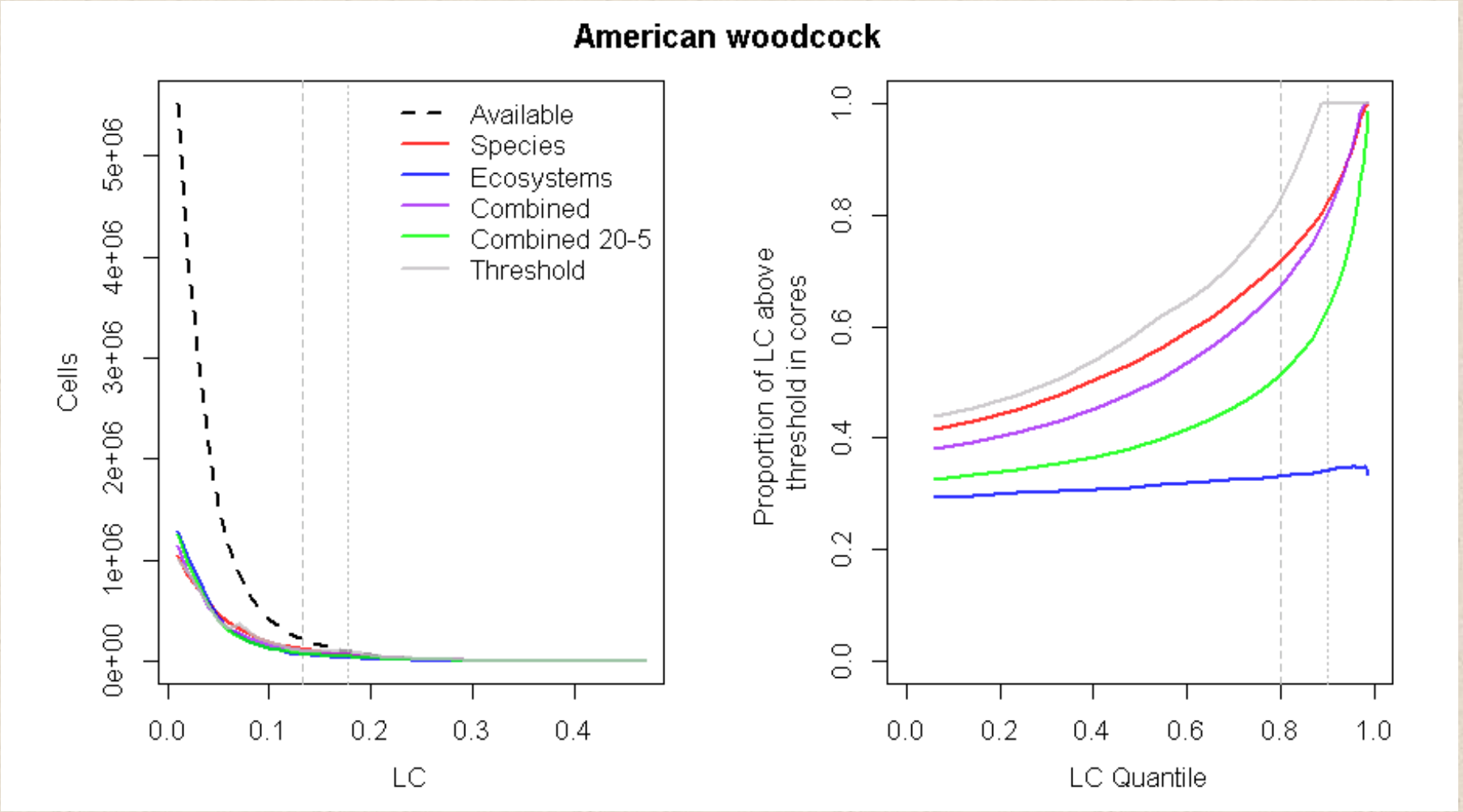
Ecosystem scenario considerably worse:



Scenario Comparison

Achieving species goals

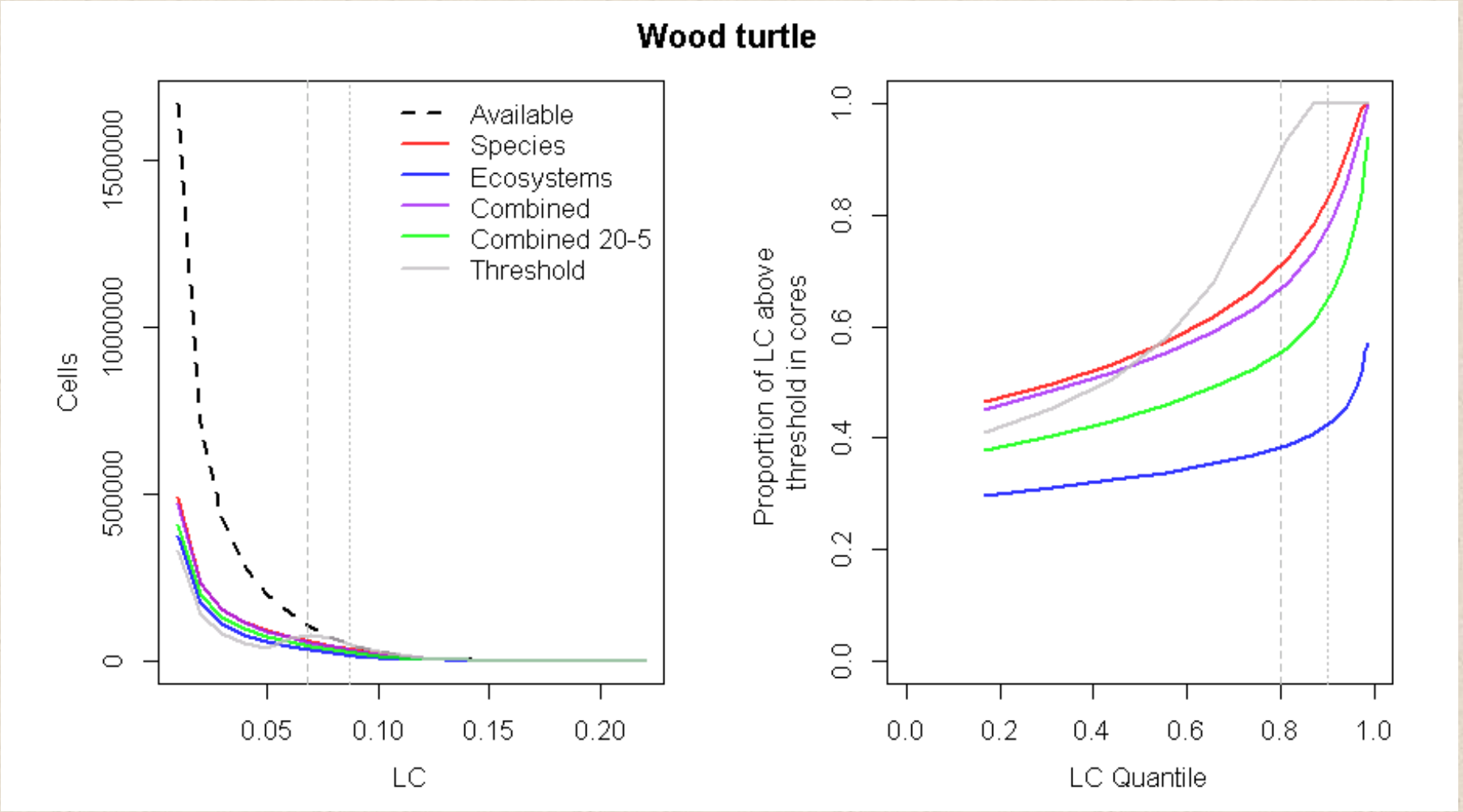
Ecosystem scenario considerably worse:



Scenario Comparison

Achieving species goals

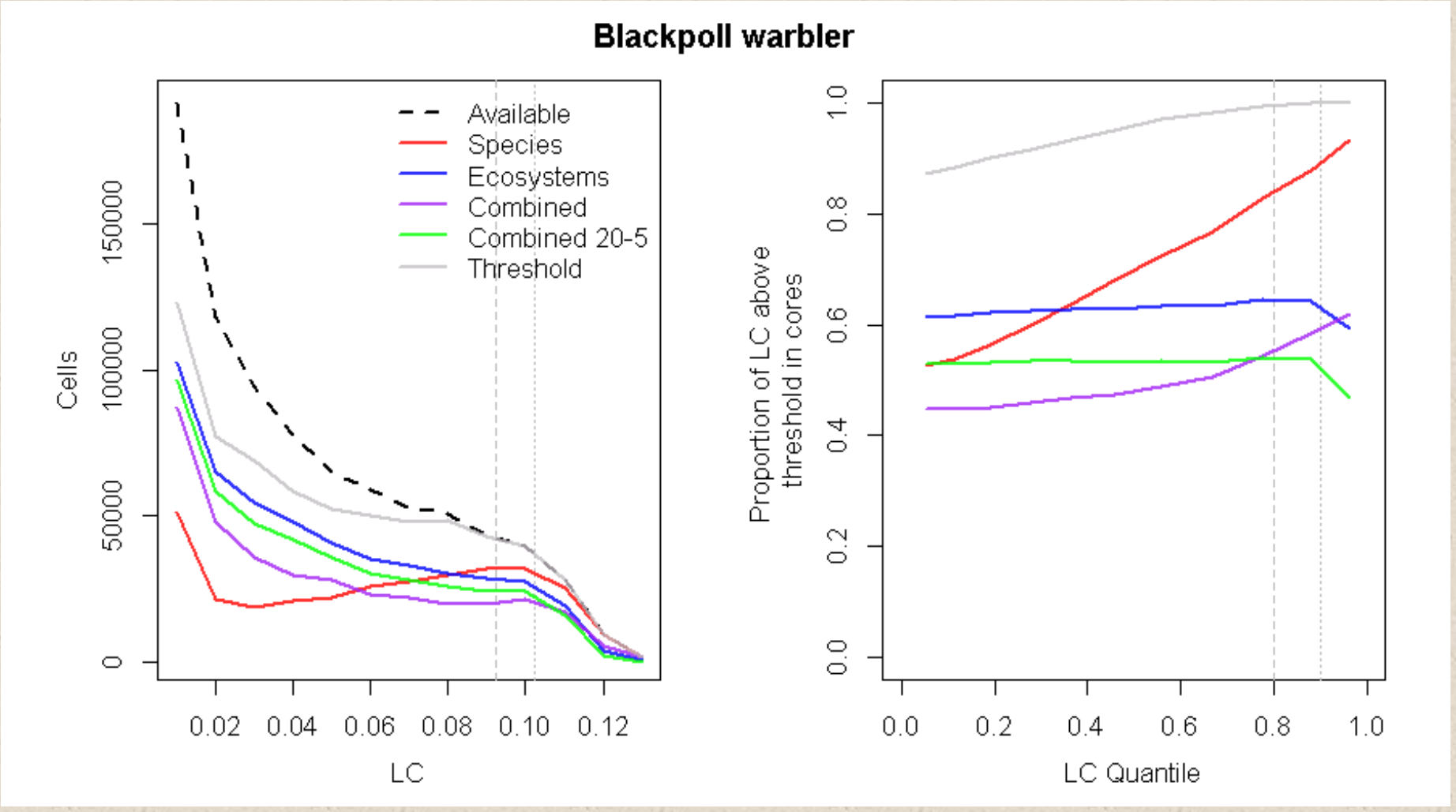
Ecosystem scenario considerably worse:



Scenario Comparison

Achieving species goals

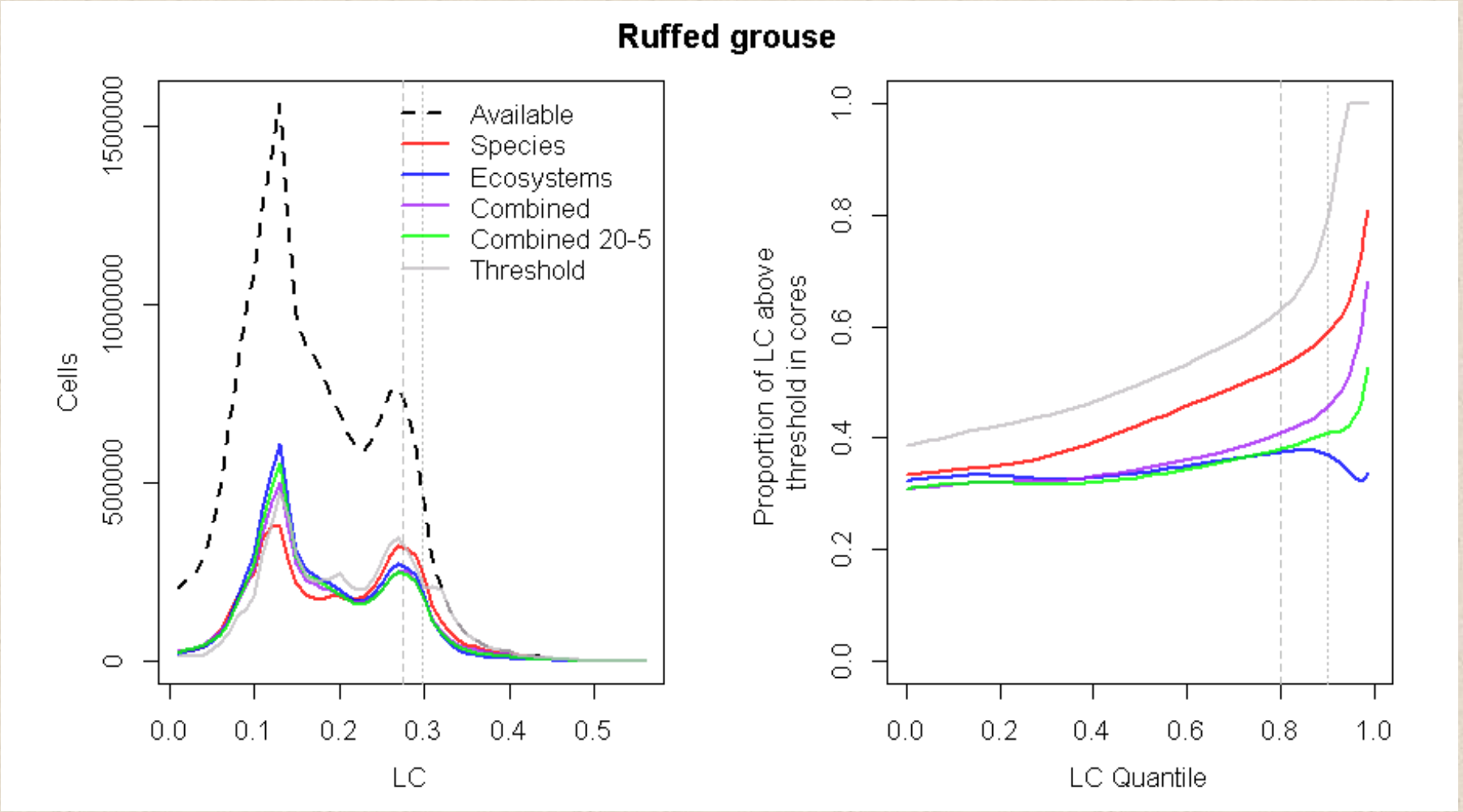
Species scenario considerably better:



Scenario Comparison

Achieving species goals

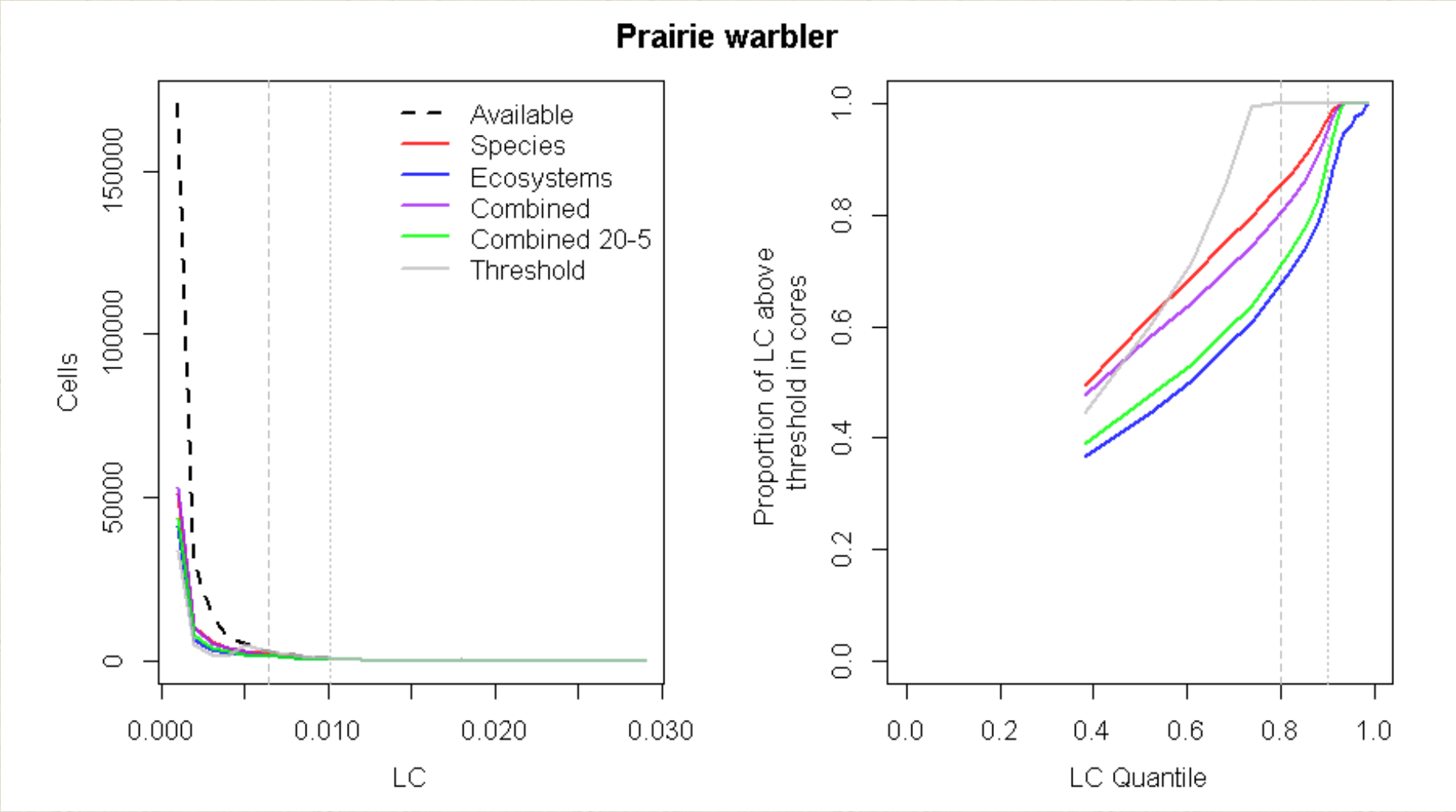
Species scenario considerably better:



Scenario Comparison

Achieving species goals

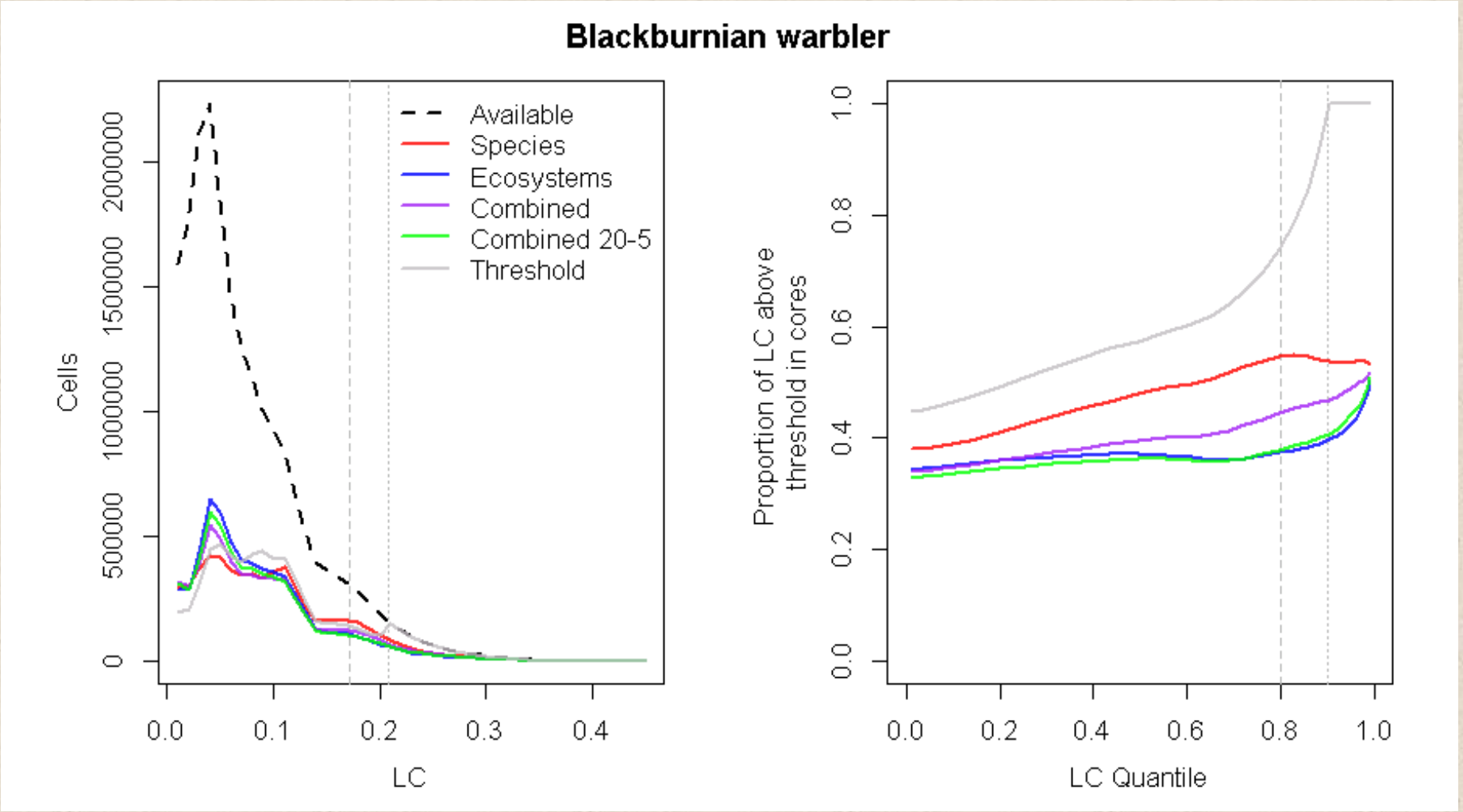
Species scenario slightly better:



Scenario Comparison

Achieving species goals

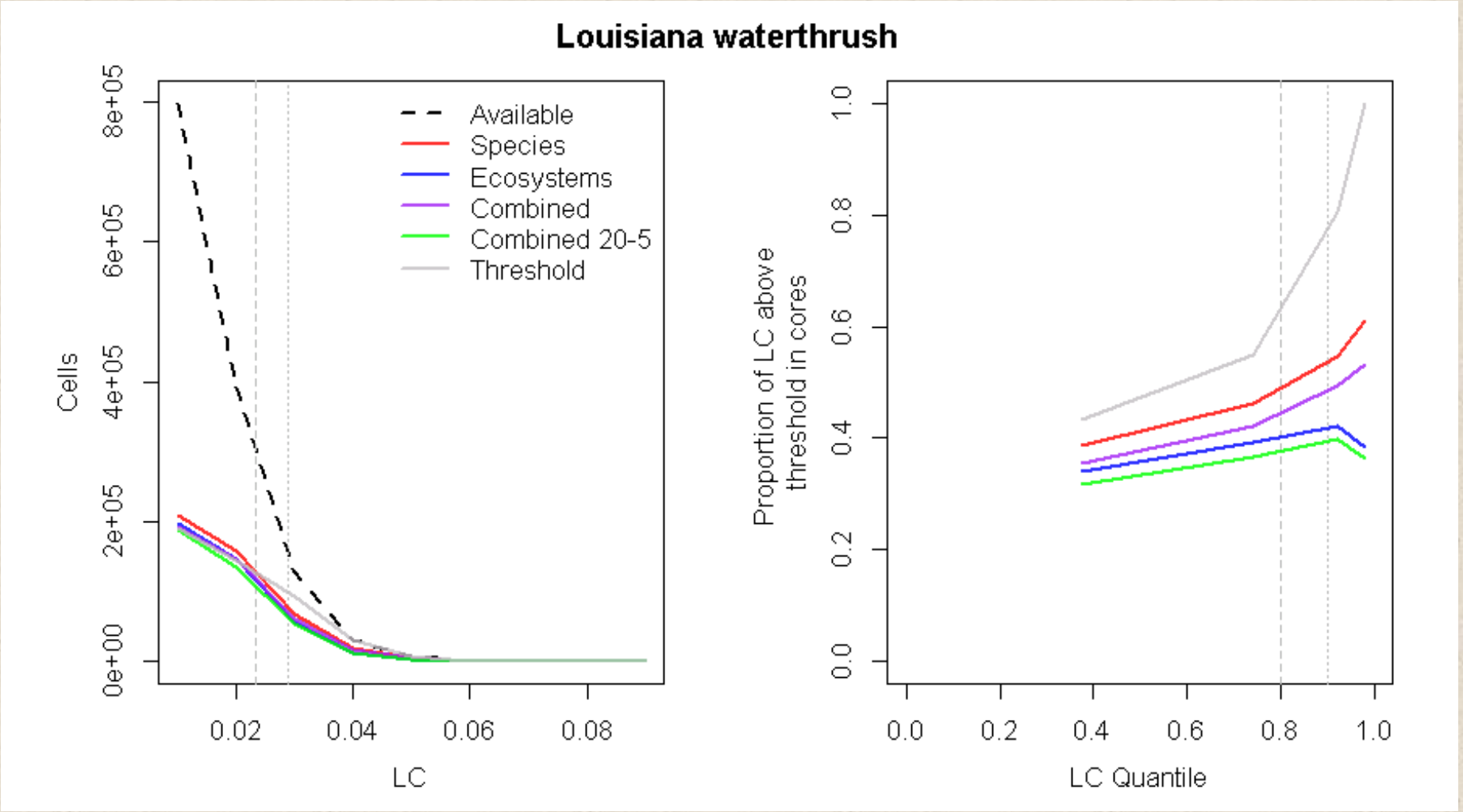
Species scenario slightly better:



Scenario Comparison

Achieving species goals

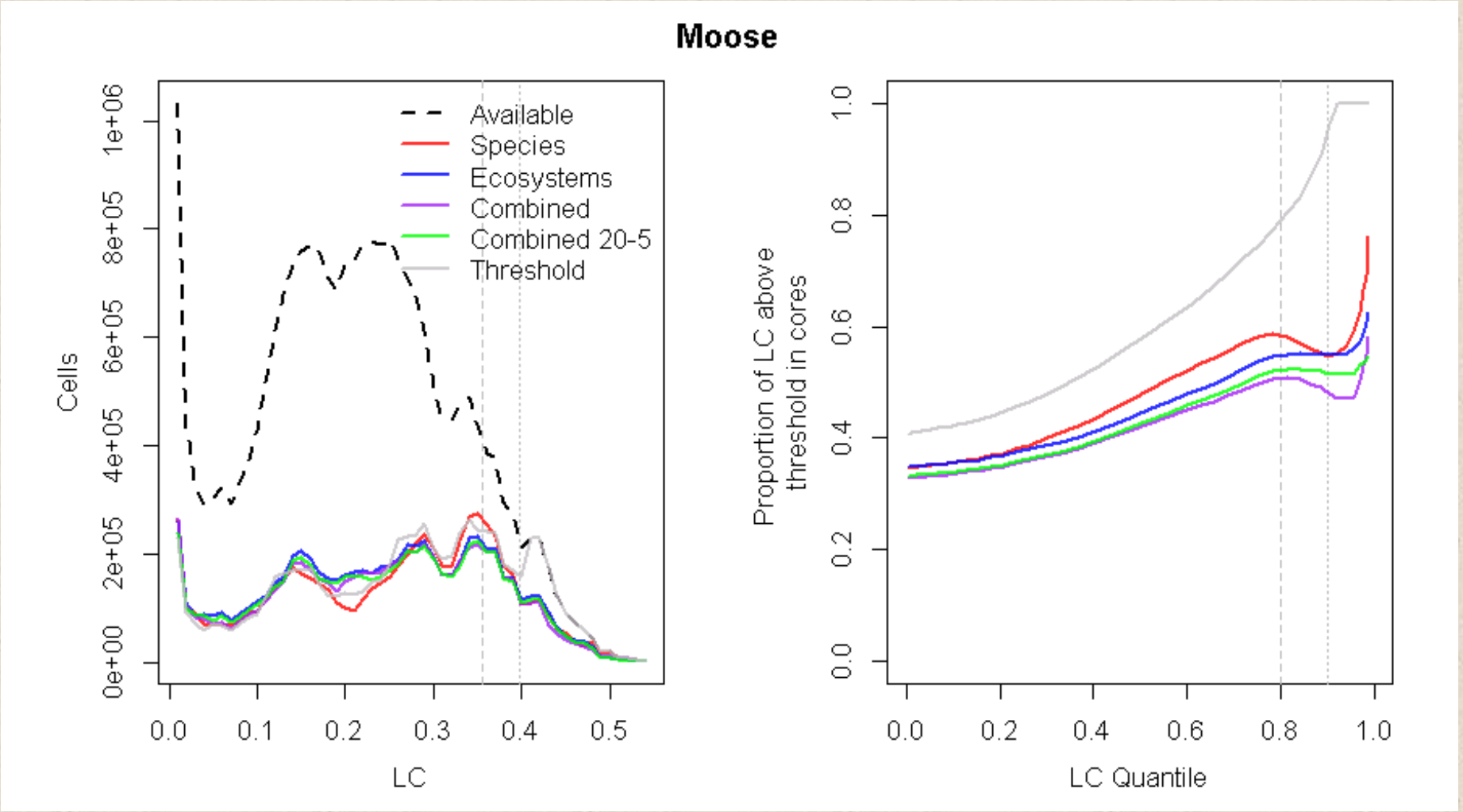
Species scenario slightly better:



Scenario Comparison

Achieving species goals

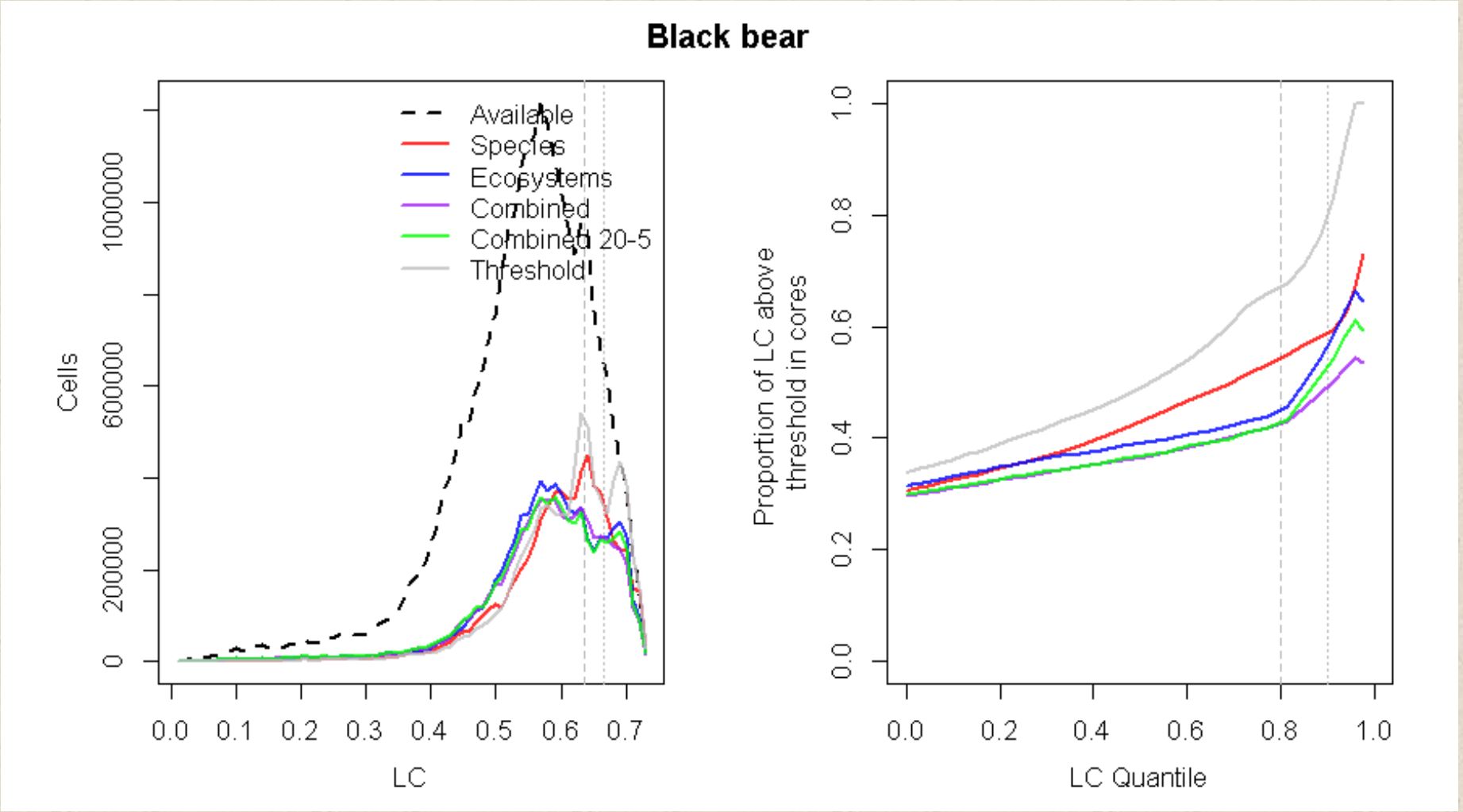
Species scenario slightly better:



Scenario Comparison

Achieving species goals

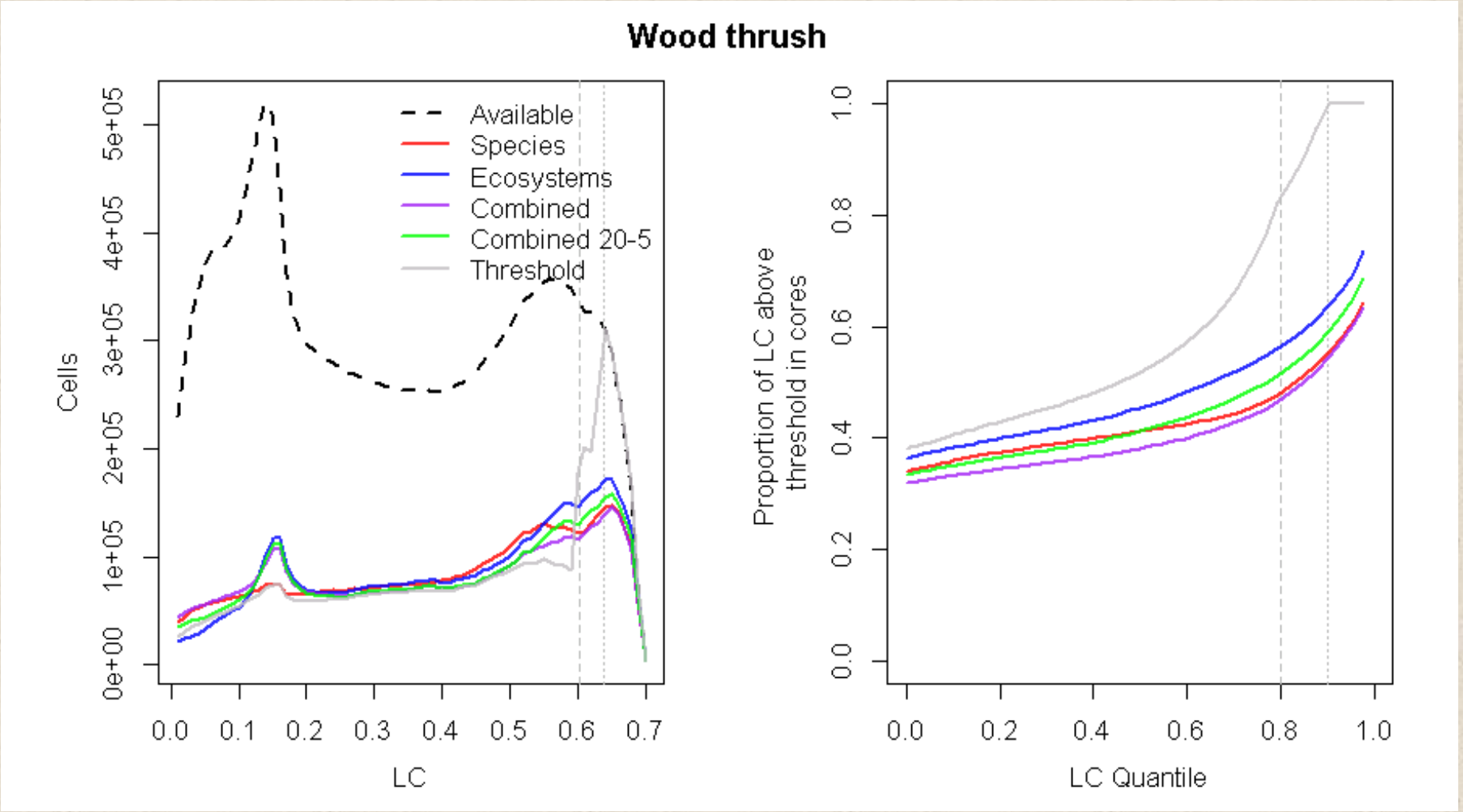
Species scenario slightly better:



Scenario Comparison

Achieving species goals

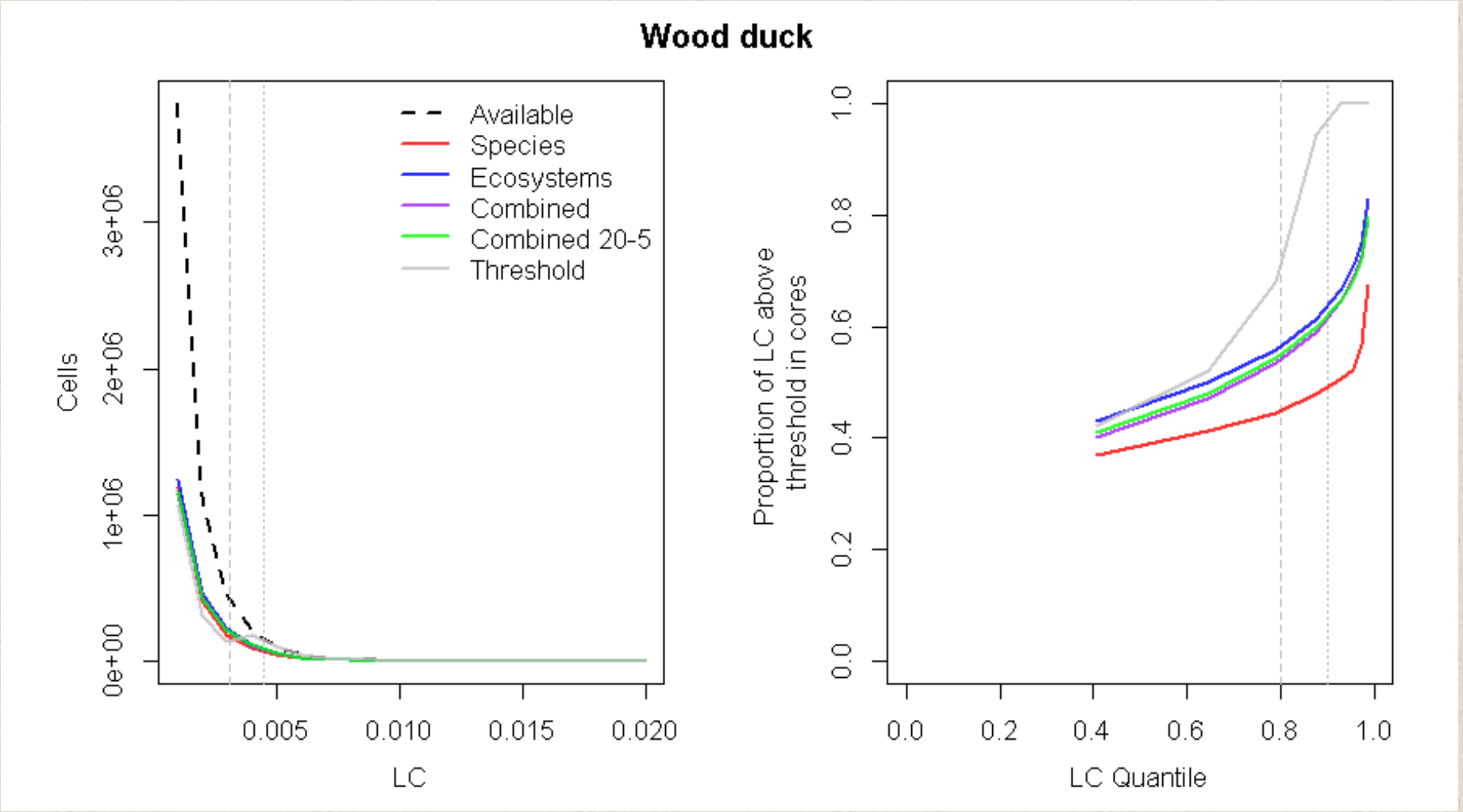
Ecosystem scenario slightly better:



Scenario Comparison

Achieving species goals

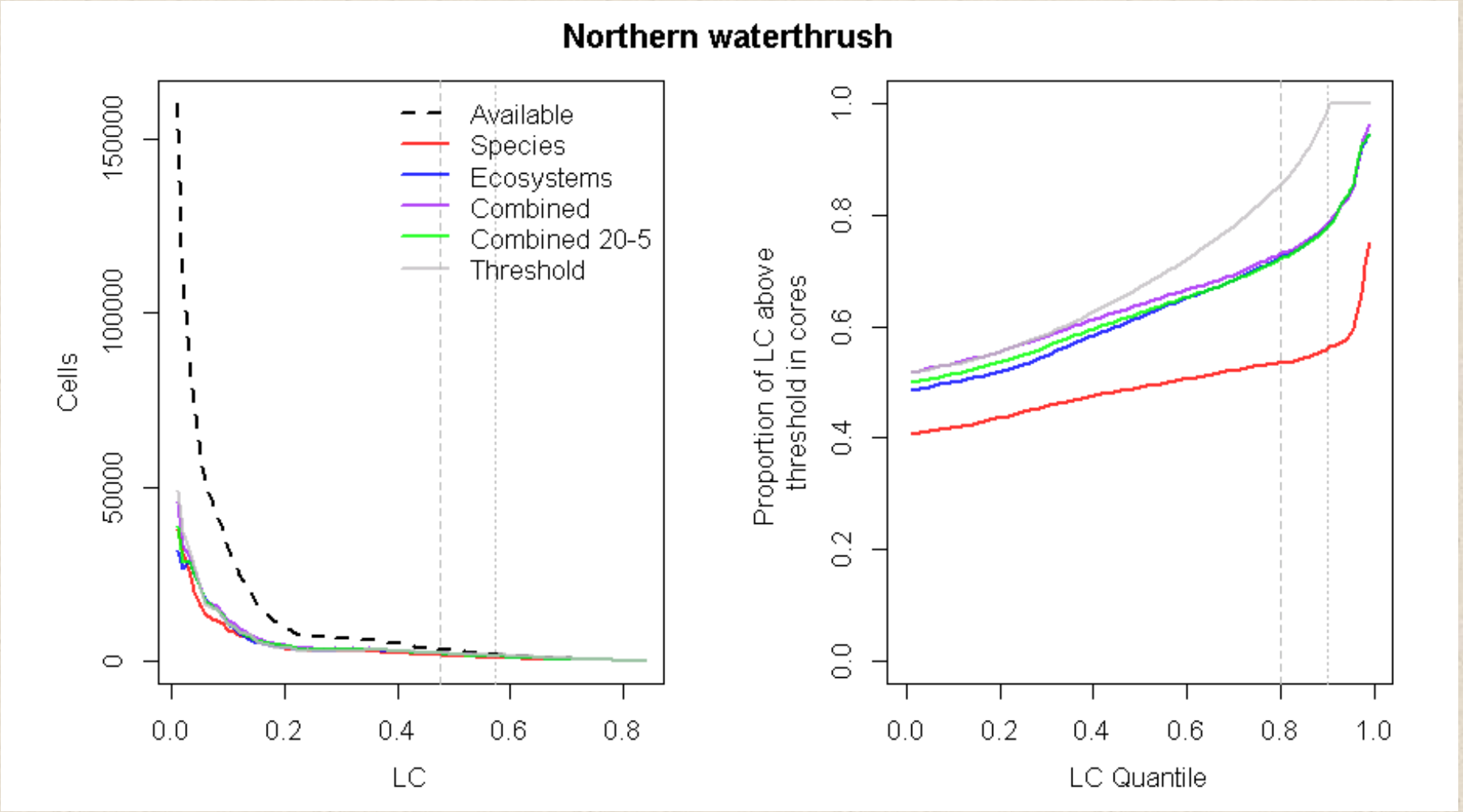
Species scenario considerably worse:



Scenario Comparison

Achieving species goals

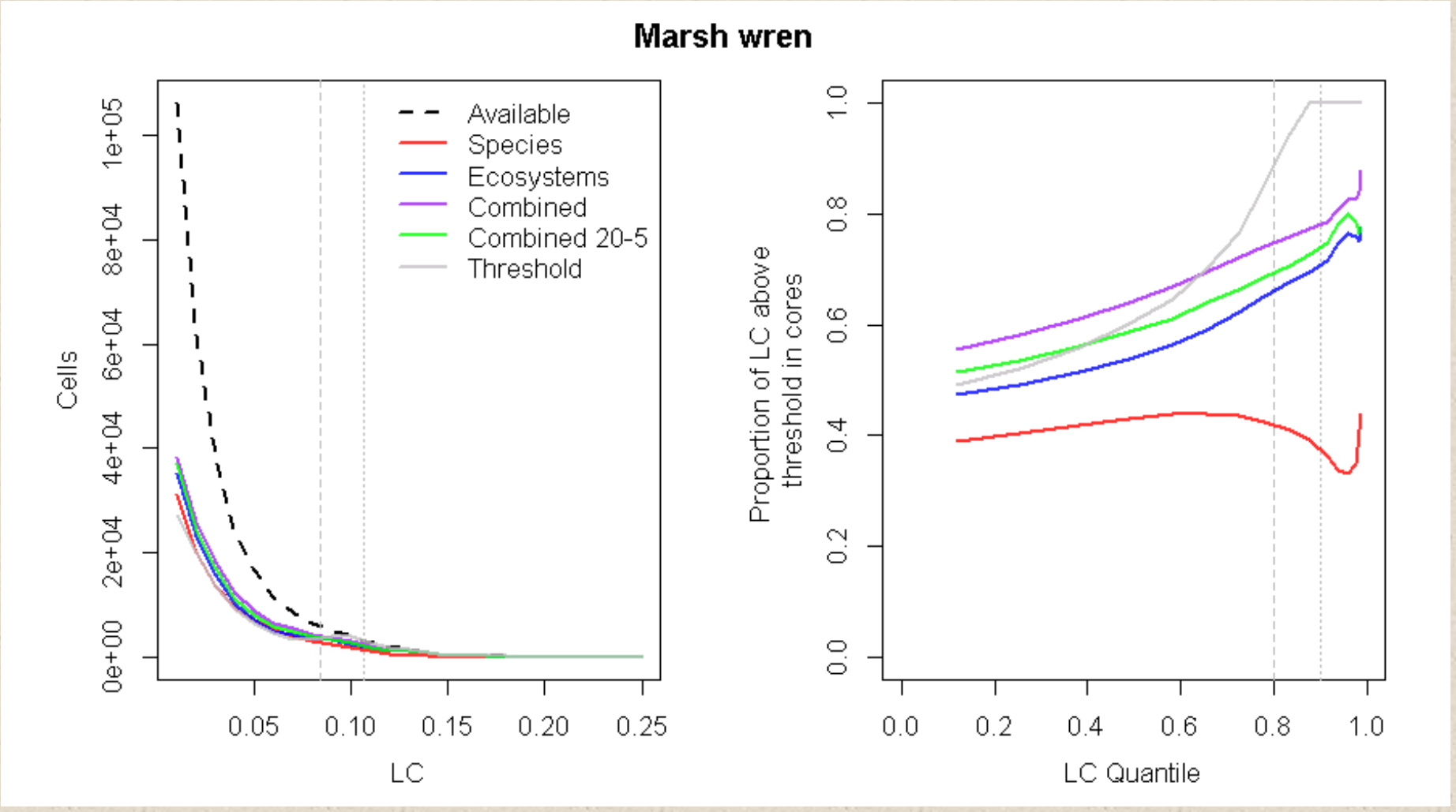
Species scenario considerably worse:



Scenario Comparison

Achieving species goals

Species scenario considerably worse:



Scenario Comparison

Achieving species goals

Scott's summary:

Cores	Best – substantially	Best – Marginally	Worst – Marginally	Worst - Substantially
Species	2 Blackpoll Warbler Ruffed Grouse	8	0	3 Marsh Wren No. Waterthrush Wood Duck
Combo (13-23)	0	2	3	0
Combo (20-5)	0	0	2	0
Ecosystem	0	2	3	3 American Woodcock E. Meadowlark Wood Turtle

Scenario Comparison

Species tradeoffs

Terrestrial Core Areas

Species	Realized %LC[1]				
	Eco-g	Species	Species (best LC)[2]	Combo (13-12)[3]	Combo (20-5)[4]
Blackpoll Warbler	61%	52%	**87%**	45%	53%
Wood Turtle	29%	**46%**	40%	44%	37%
American Woodcock	29%	42%	**44%**	38%	33%
Eastern Meadowlark	3%	**41%**	25%	40%	33%
Blackburnian Warbler	34%	38%	**45%**	34%	33%
Louisiana Waterthrush	33%	38%	**43%**	35%	31%
Marsh Wren	47%	39%	49%	**55%**	52%
Moose	35%	35%	**41%**	33%	33%
Northern Waterthrush	48%	41%	**52%**	**52%**	50%
Wood Thrush	36%	34%	**38%**	32%	33%
Prairie Warbler	32%	**43%**	38%	42%	34%
Wood Duck	**41%**	36%	**41%**	39%	39%
Ruffed Grouse	32%	33%	**39%**	31%	31%
Black Bear	31%	31%	**34%**	30%	30%
Average	**35%**	**39%**	**44%**	**39%**	**37%**

Scenario Comparison

Ecosystem tradeoffs

Terrestrial Core Areas

Group	CTR area (ha)	%CTR selindex in Cores			
		Eco-g	Species[2]	Combo (13-12)	Combo (20-5)
Laurentian-Acadian Northern Hardwood Forest	675,372	45	48	41	42
Appalachian (Hemlock)-Northern Hardwood Forest	585,310	45	28	36	41
Laurentian-Acadian Pine-Hemlock-Hardwood Forest	390,504	29	13	25	28
Northeastern Interior Dry-Mesic Oak Forest	110,964	33	27	29	30
Laurentian-Acadian Red Oak-Northern Hardwood Forest	88,298	26	8	17	23
Lotic	85,992	34	32	33	33
Acadian Low Elevation Spruce-Fir-Hardwood Forest	79,209	34	33	40	36
Acadian-Appalachian Montane Spruce-Fir-Hardwood Forest	72,424	67	39	50	60
North Atlantic Coastal Plain Basin Peat Swamp	78	100	0	100	100
Boreal-Laurentian Bog	62	100	2	100	100
Laurentian-Acadian Alkaline Fen	37	37	15	37	37
North Atlantic Coastal Plain Maritime Forest	36	40	0	30	31
Estuarine Intertidal Rocky Shore	26	89	0	69	81
North Atlantic Coastal Plain Heathland and Grassland	13	1	0	1	1
Atlantic Coastal Plain Beach and Dune	9	84	0	44	81
Total	**2,376,091**	**41**	**31**	**36**	**39**

Scenario Comparison

Ecosystem tradeoffs

Scott's summary:

Mean IEI (weighted HUC6 scaled)

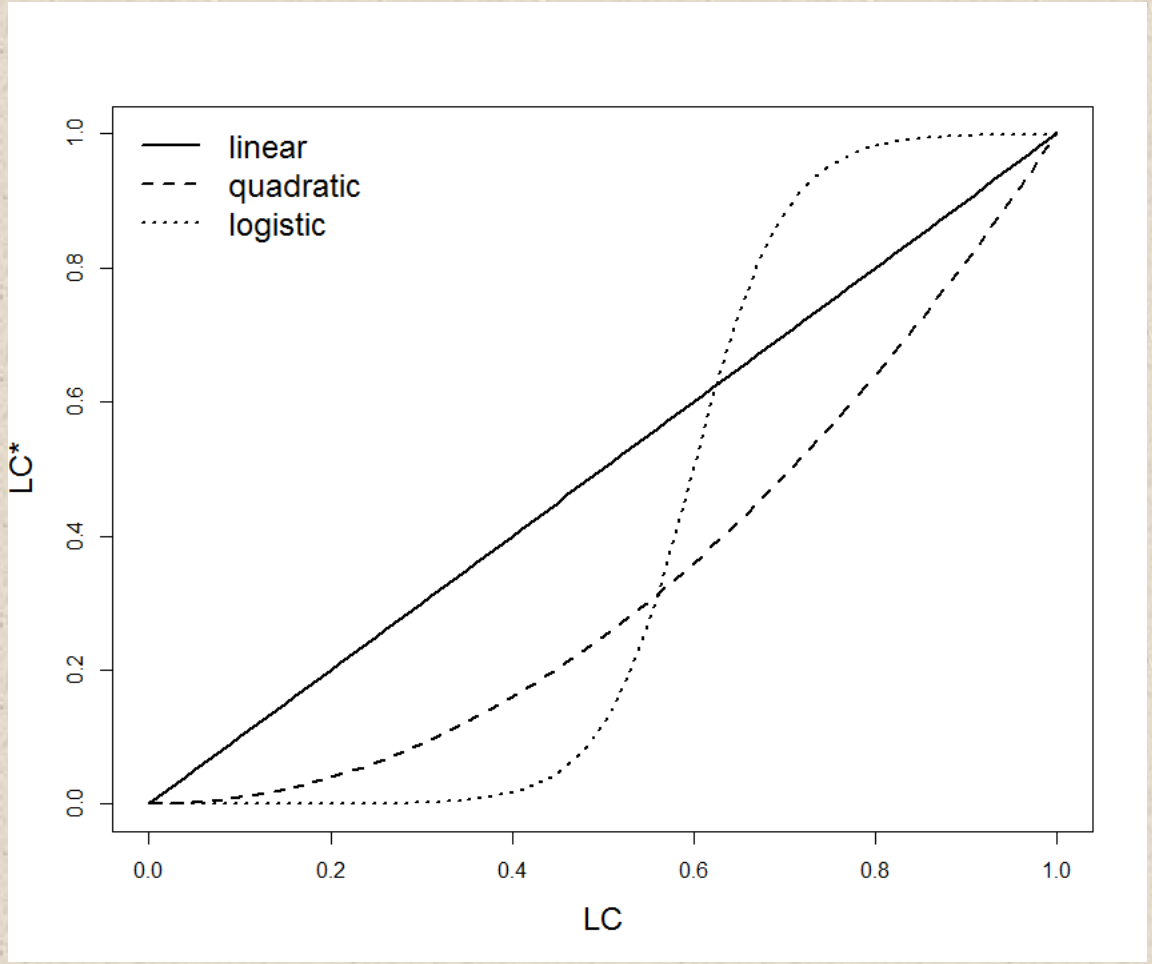
Conn. River Watershed as a whole	Species Cores	Combo Cores (13-12)	Combo Cores (20-5)	Ecosystem Cores
0.49	0.61	0.68	0.73	0.76

Scenario Comparison

Other scenario options

- Weight higher LC values more and conduct standard species optimization (or combo on weighted species LC)

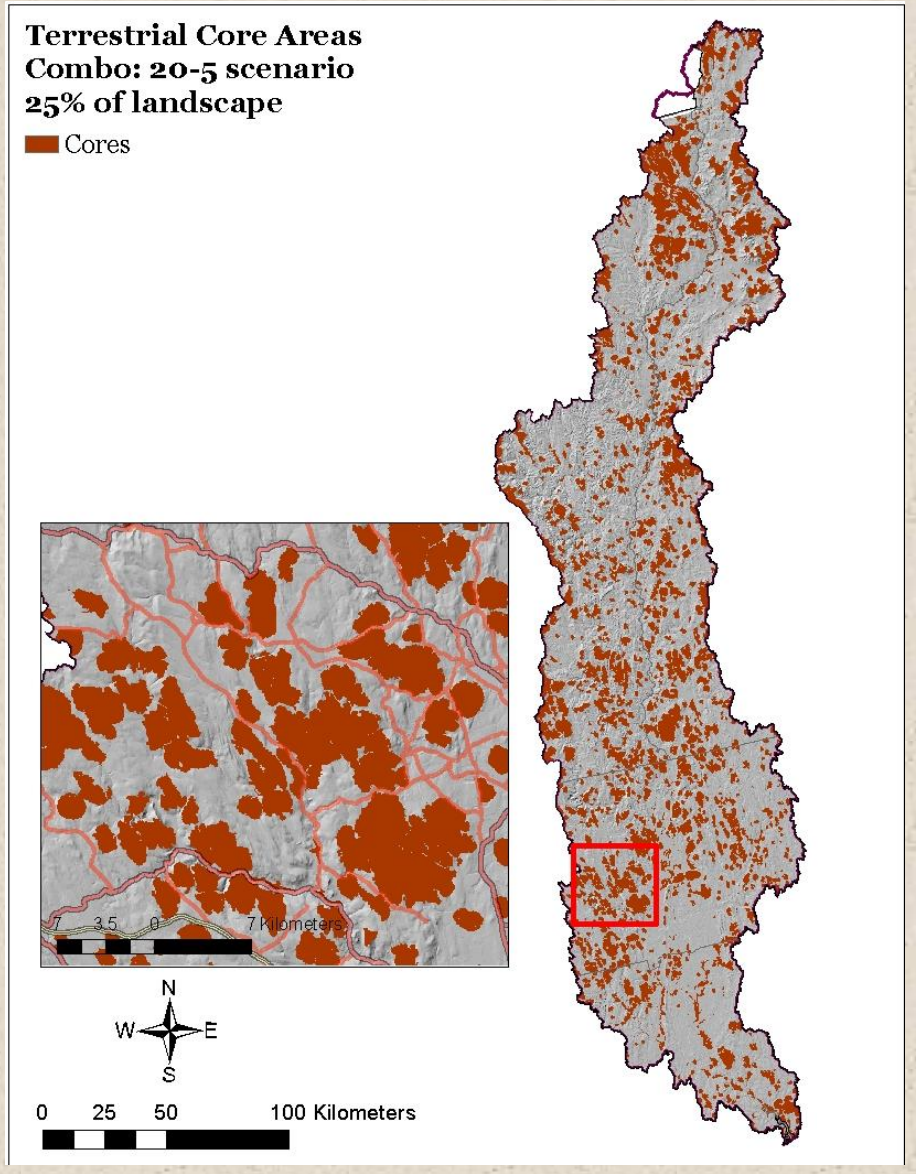
Note, this will come at the cost of more smaller cores!



Derivation of Connectors

Conductance

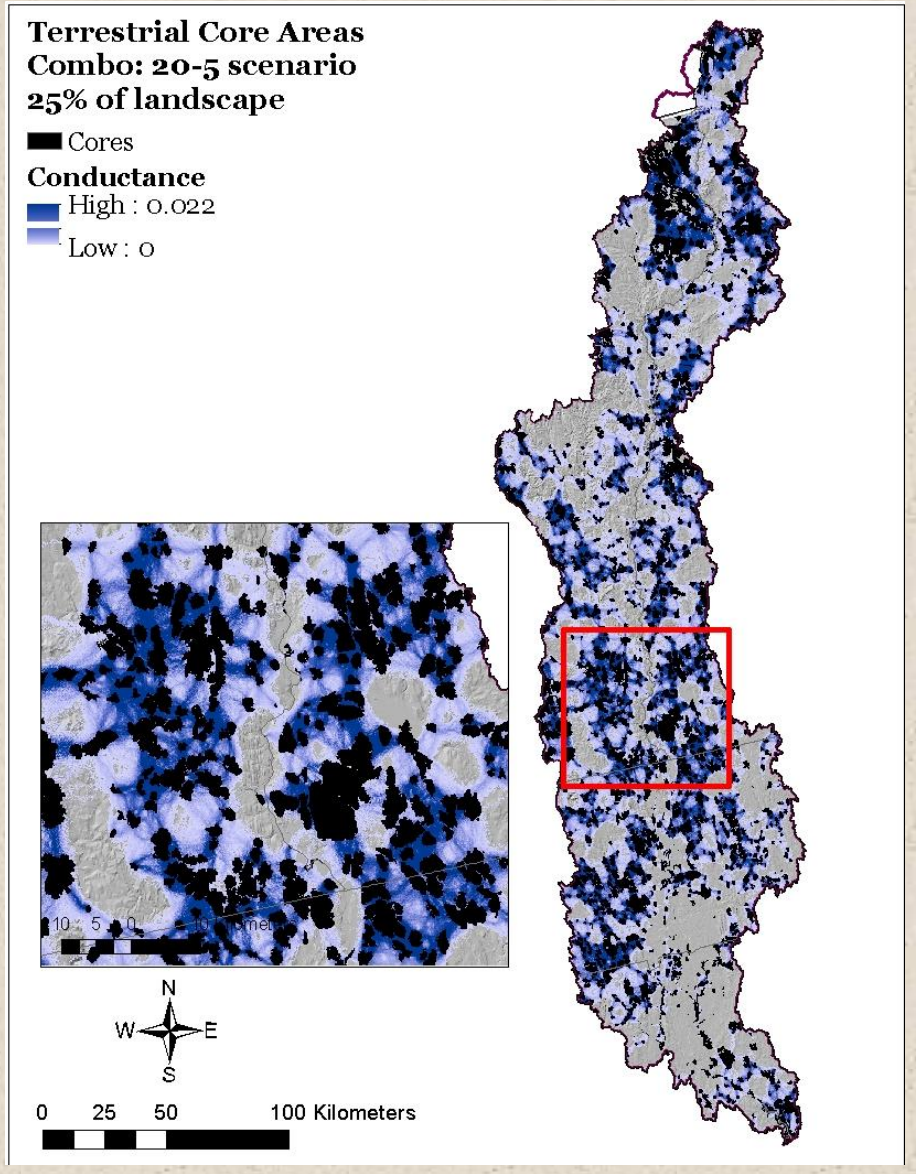
1. Start with core areas
2. Build random low-cost paths
3. Threshold max path conductance
4. Buffer paths by 250 m and cores by 500 m



Derivation of Connectors

Conductance

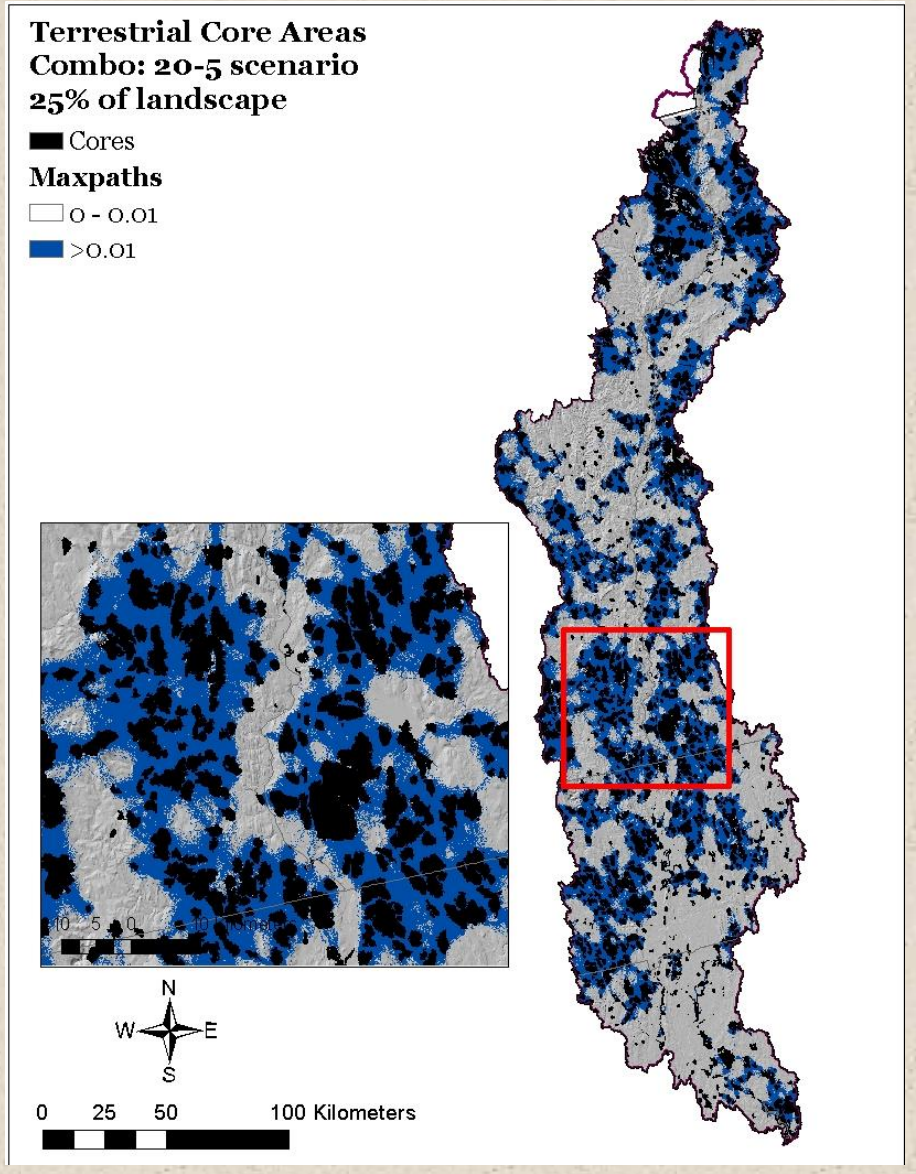
1. Start with core areas
2. Build random low-cost paths
3. Threshold max path conductance
4. Buffer paths by 250 m and cores by 500 m



Derivation of Connectors

Conductance

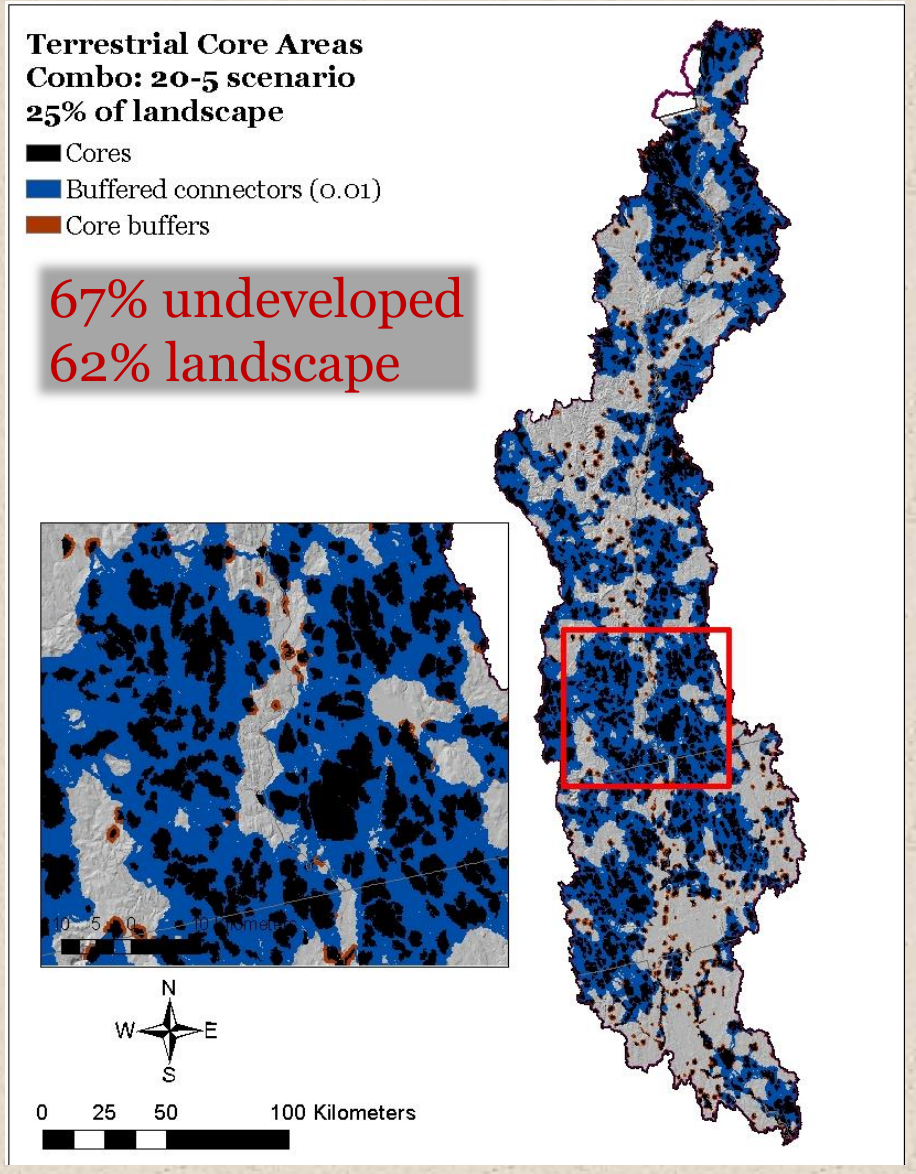
1. Start with core areas
2. Build random low-cost paths
3. Threshold max path conductance
4. Buffer paths by 250 m and cores by 500 m



Derivation of Connectors

Conductance

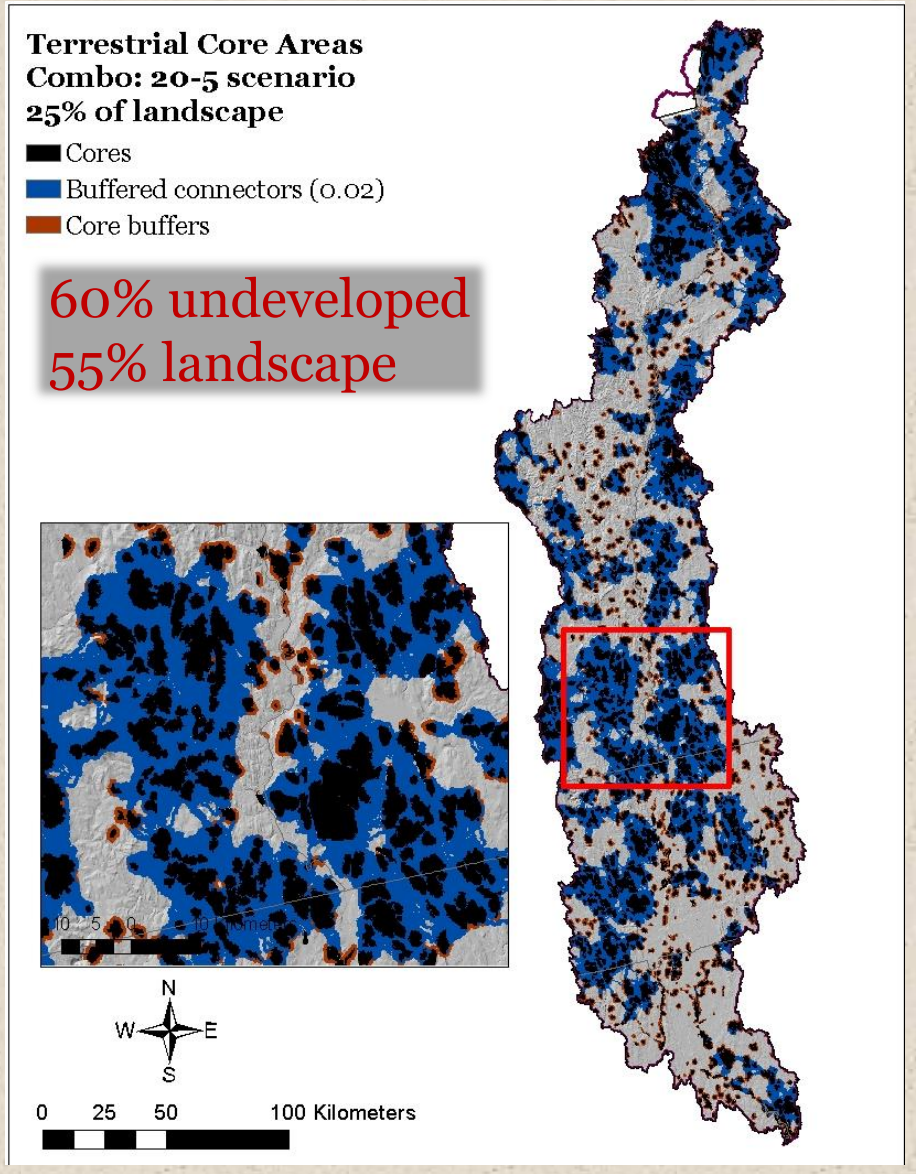
1. Start with core areas
2. Build random low-cost paths
3. Threshold max path conductance
4. Buffer paths by 250 m and cores by 500 m



Derivation of Connectors

Conductance

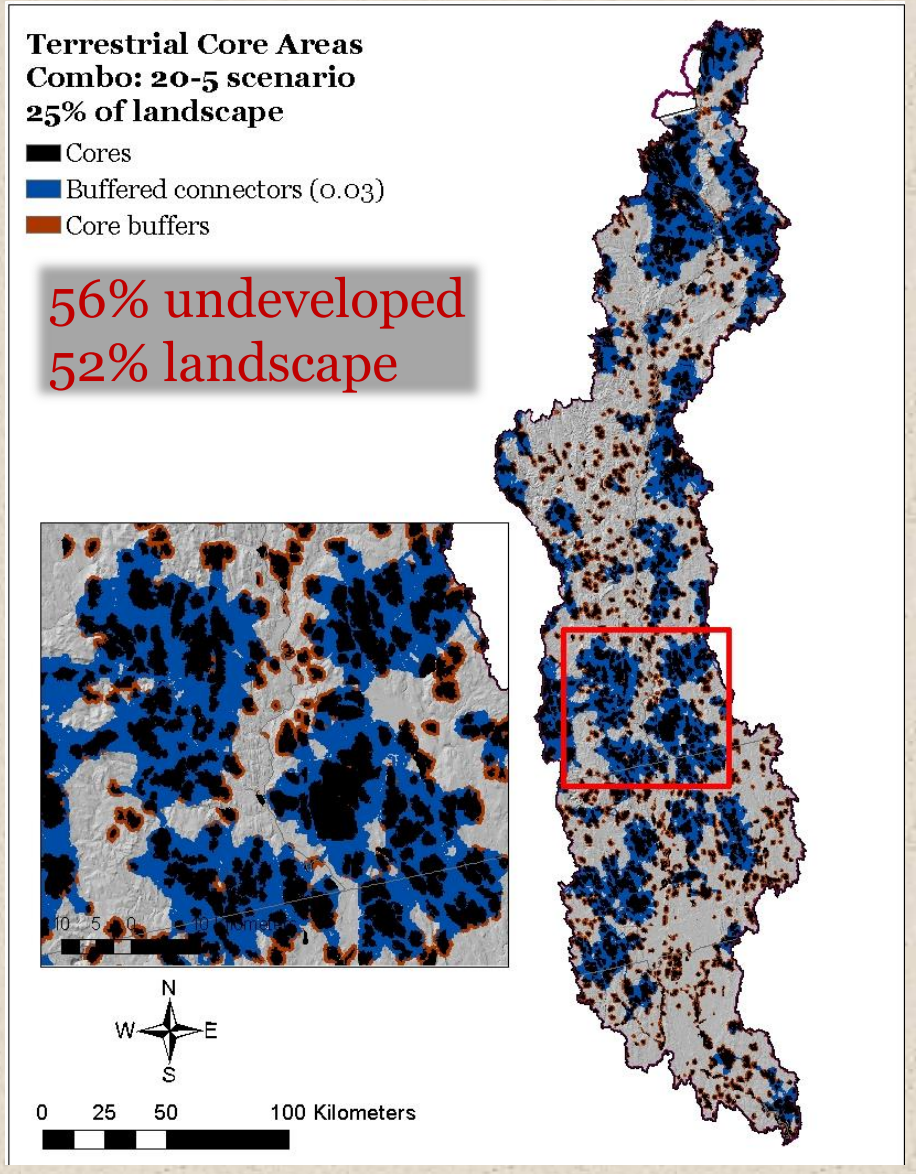
1. Start with core areas
2. Build random low-cost paths
3. Threshold max path conductance
4. Buffer paths by 250 m and cores by 500 m



Derivation of Connectors

Conductance

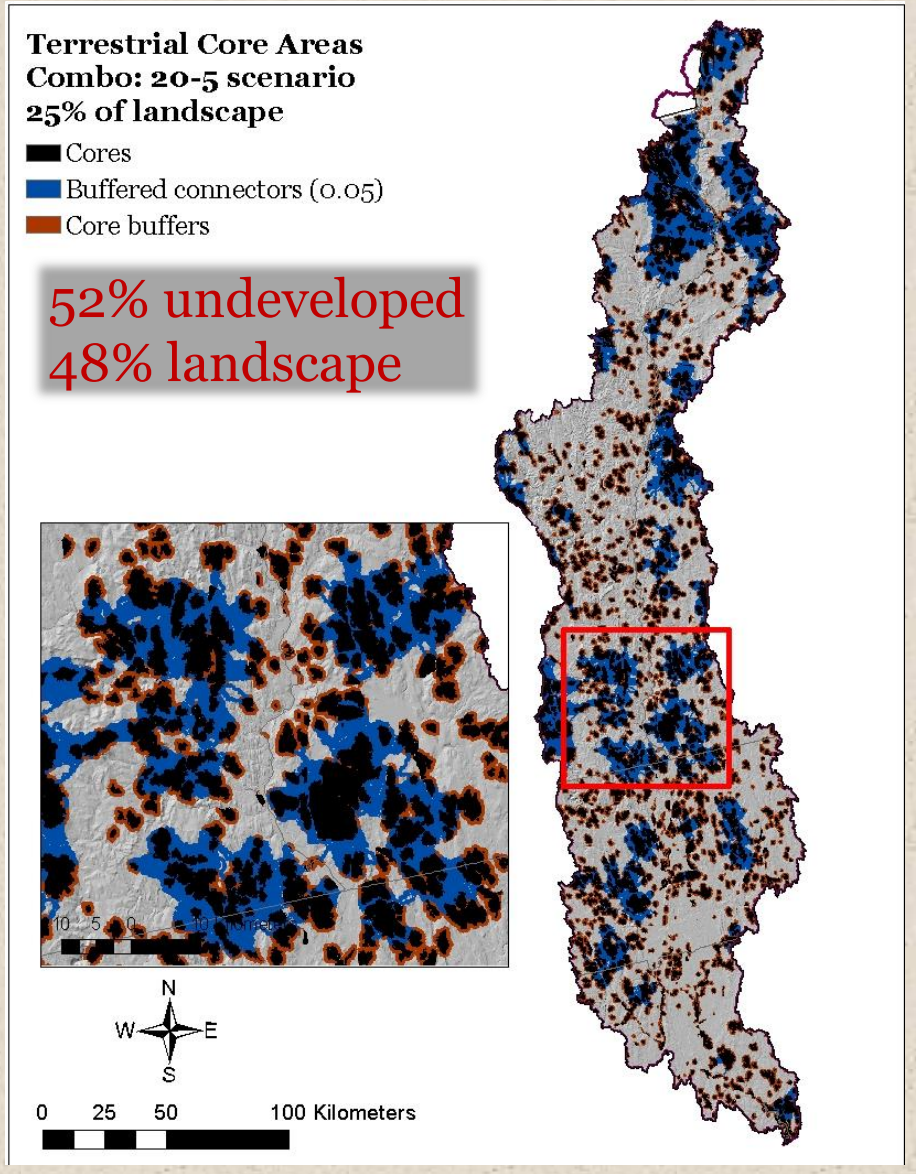
1. Start with core areas
2. Build random low-cost paths
3. Threshold max path conductance
4. Buffer paths by 250 m and cores by 500 m



Derivation of Connectors

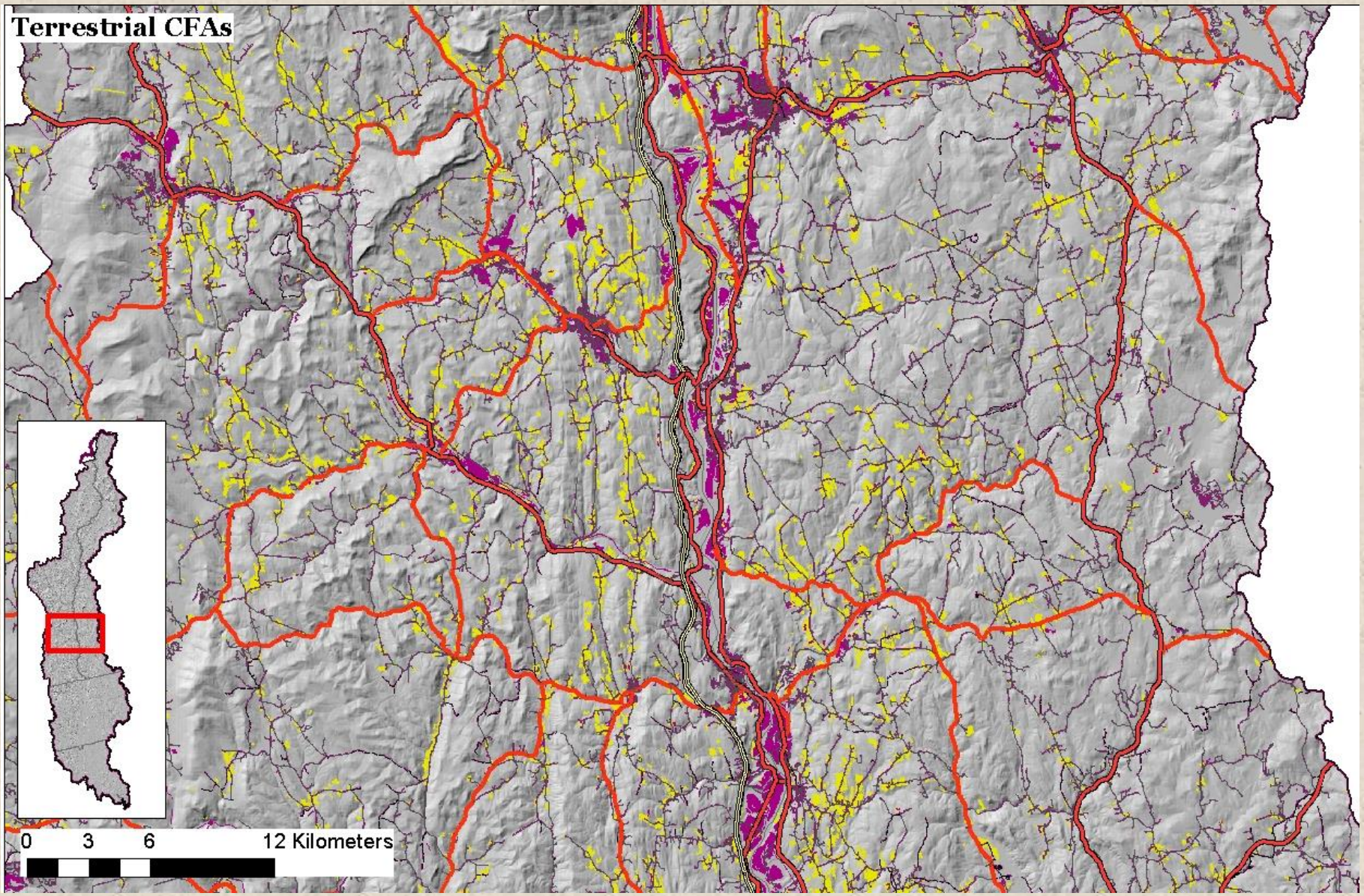
Conductance

1. Start with core areas
2. Build random low-cost paths
3. Threshold max path conductance
4. Buffer paths by 250 m and cores by 500 m



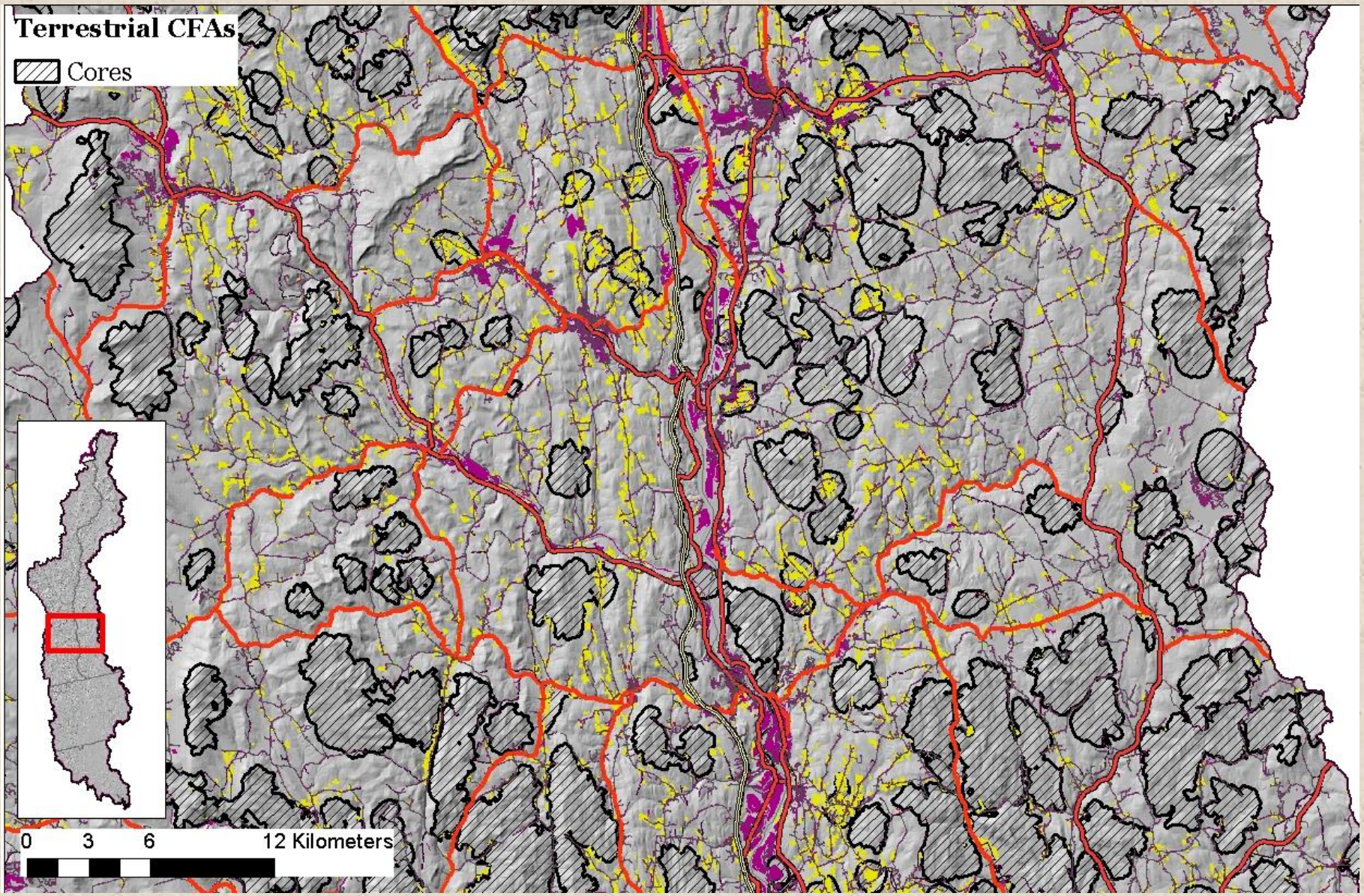
Derivation of Connectors

Conductance



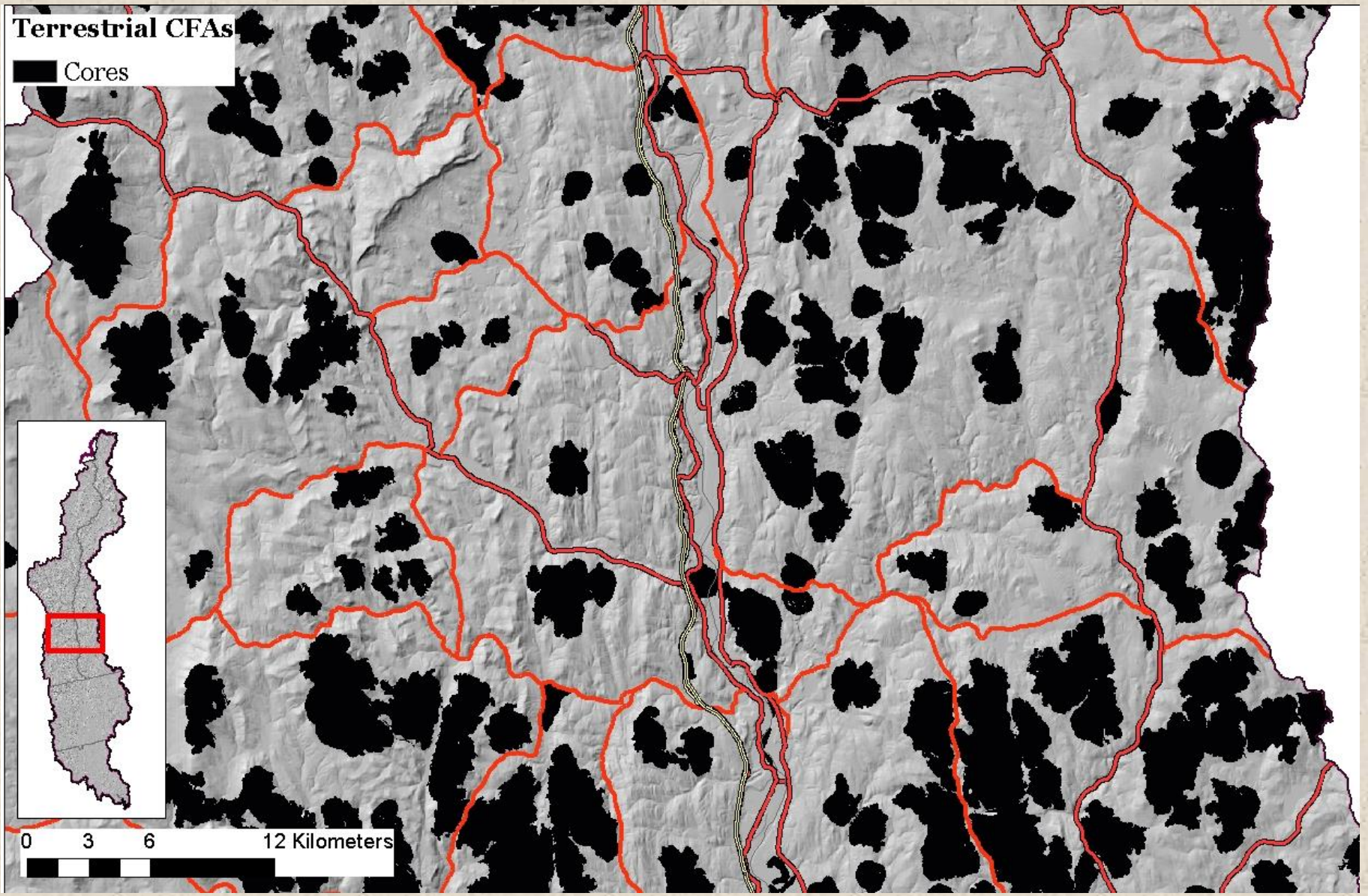
Derivation of Connectors

Conductance



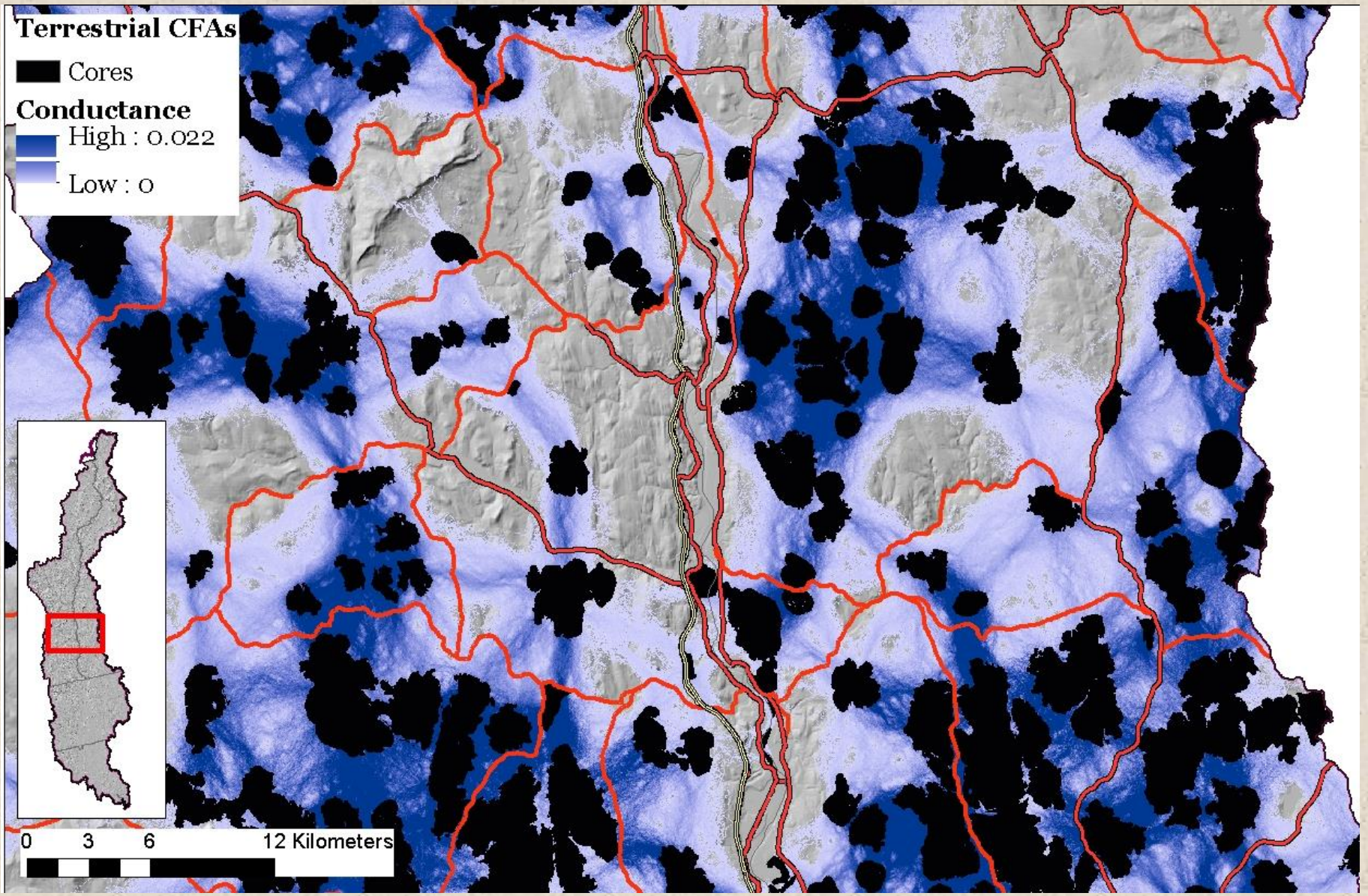
Derivation of Connectors

Conductance



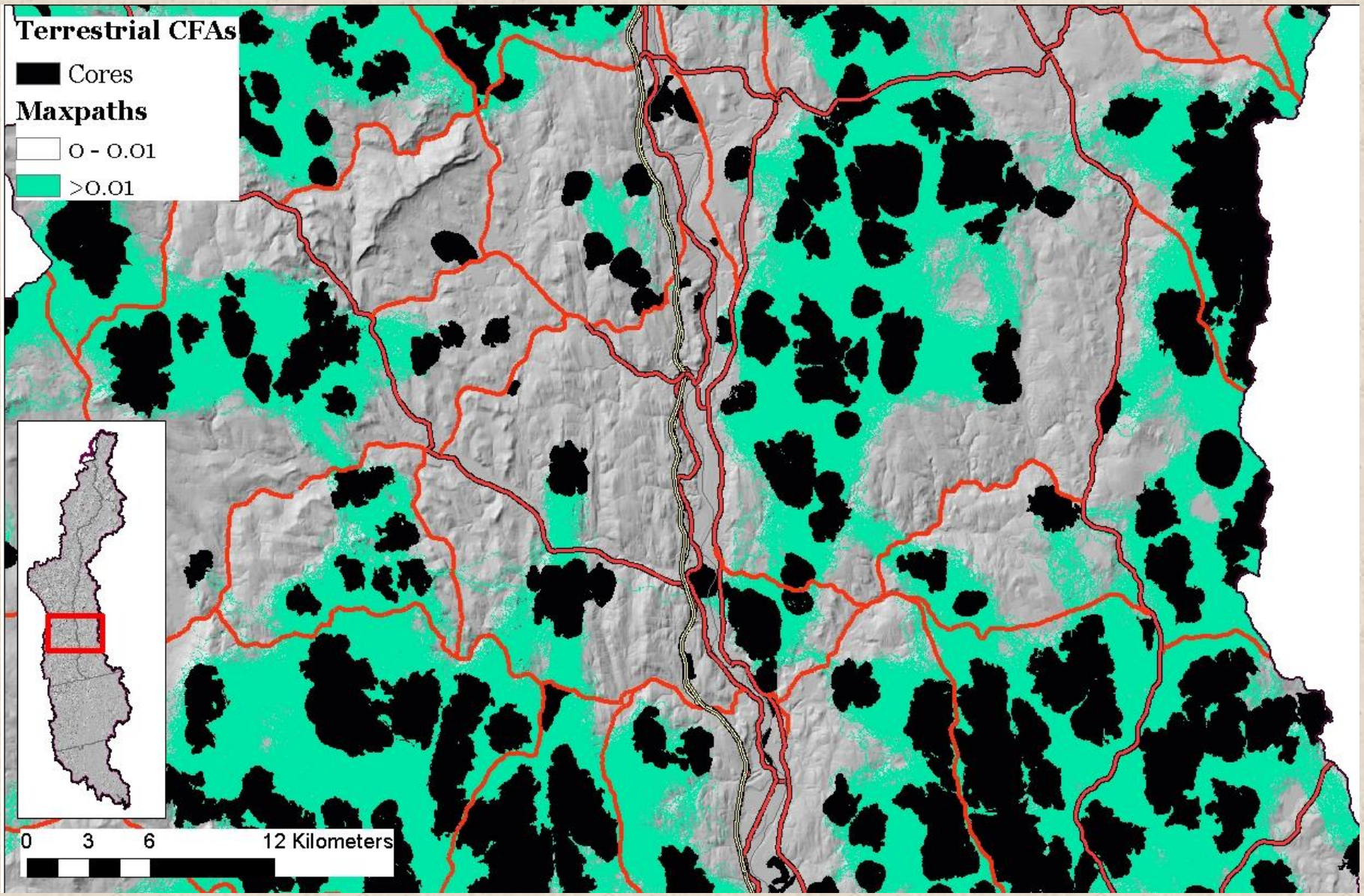
Derivation of Connectors

Conductance



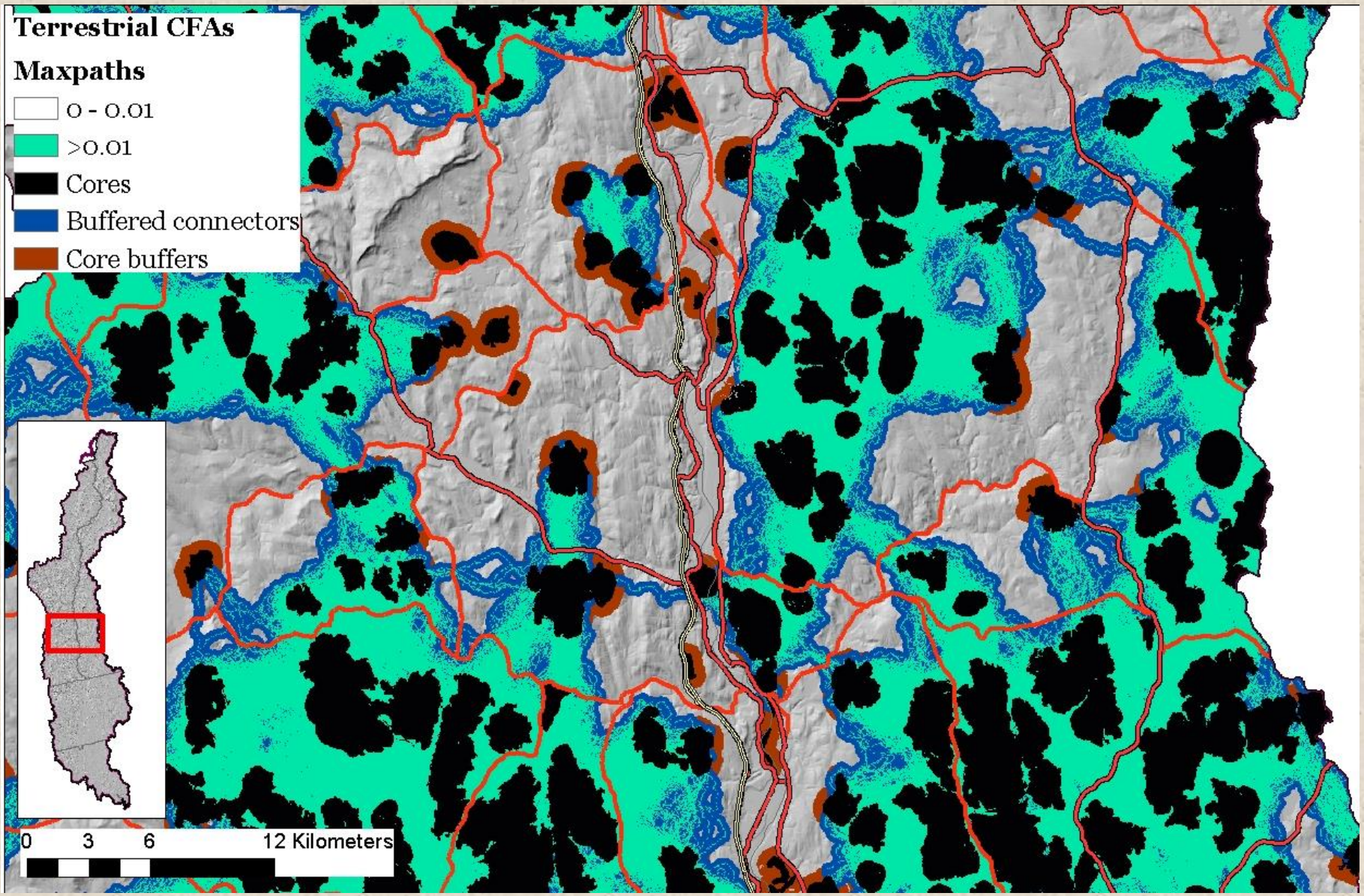
Derivation of Connectors

Conductance



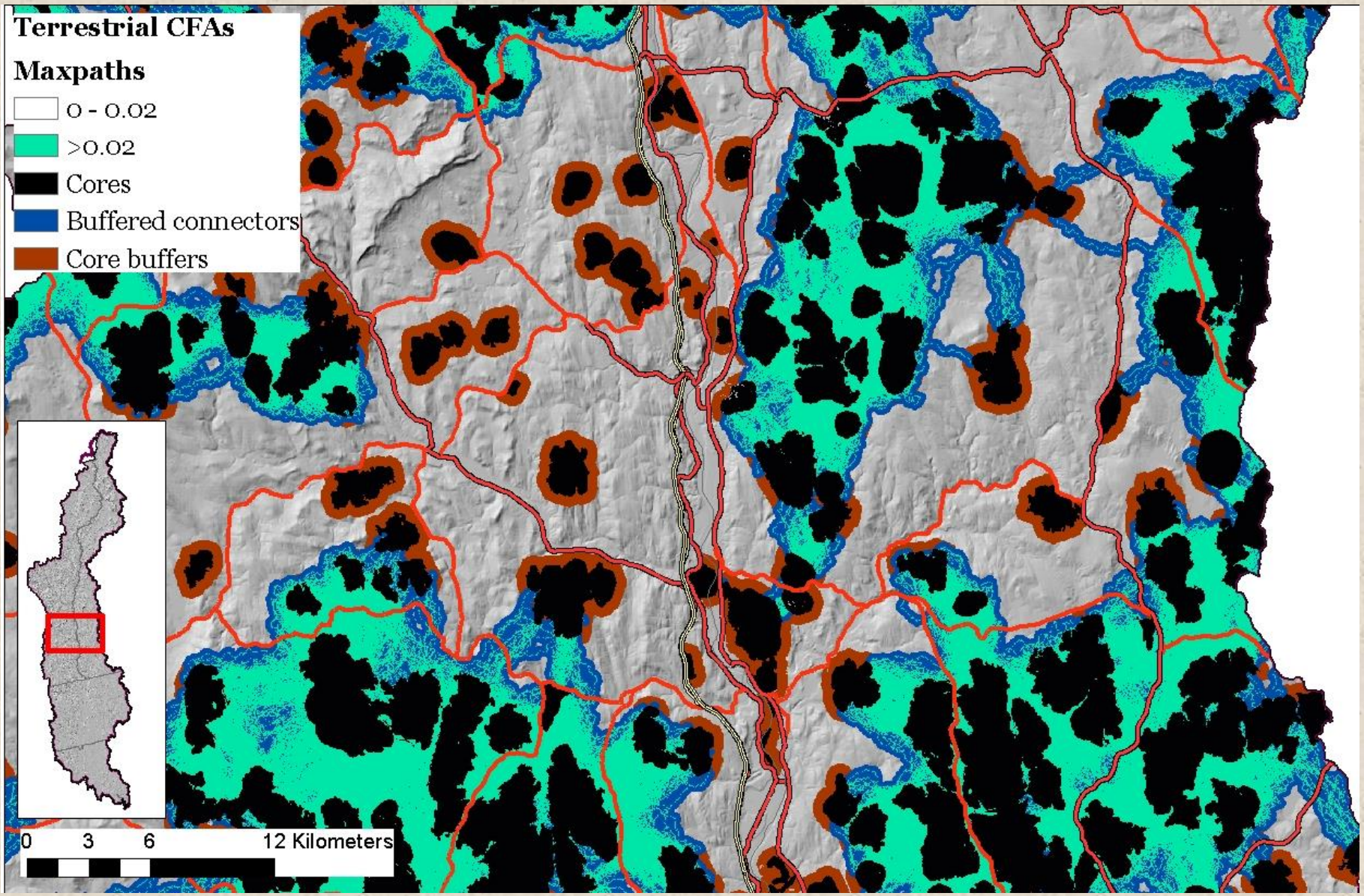
Derivation of Connectors

Conductance



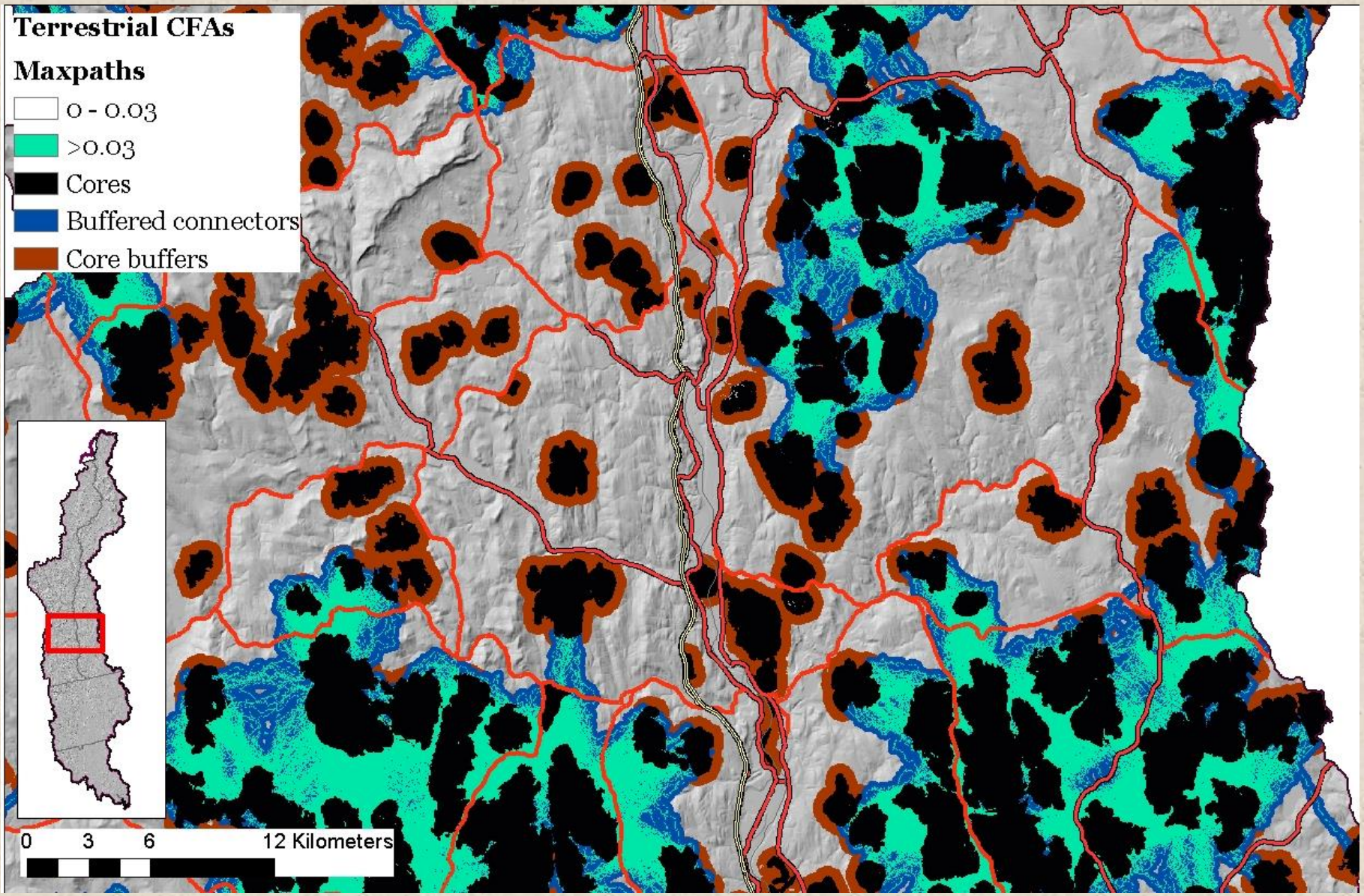
Derivation of Connectors

Conductance



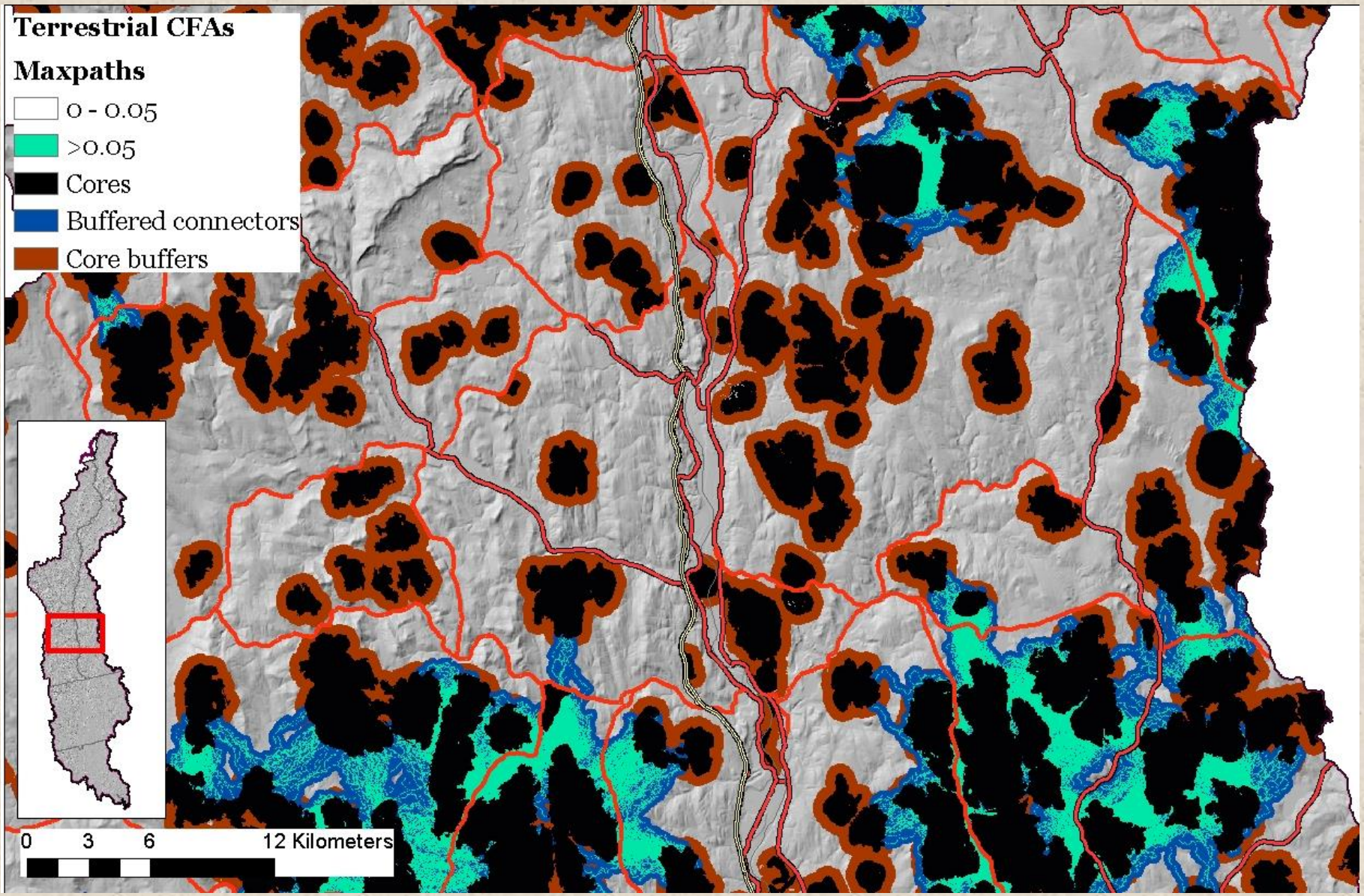
Derivation of Connectors

Conductance



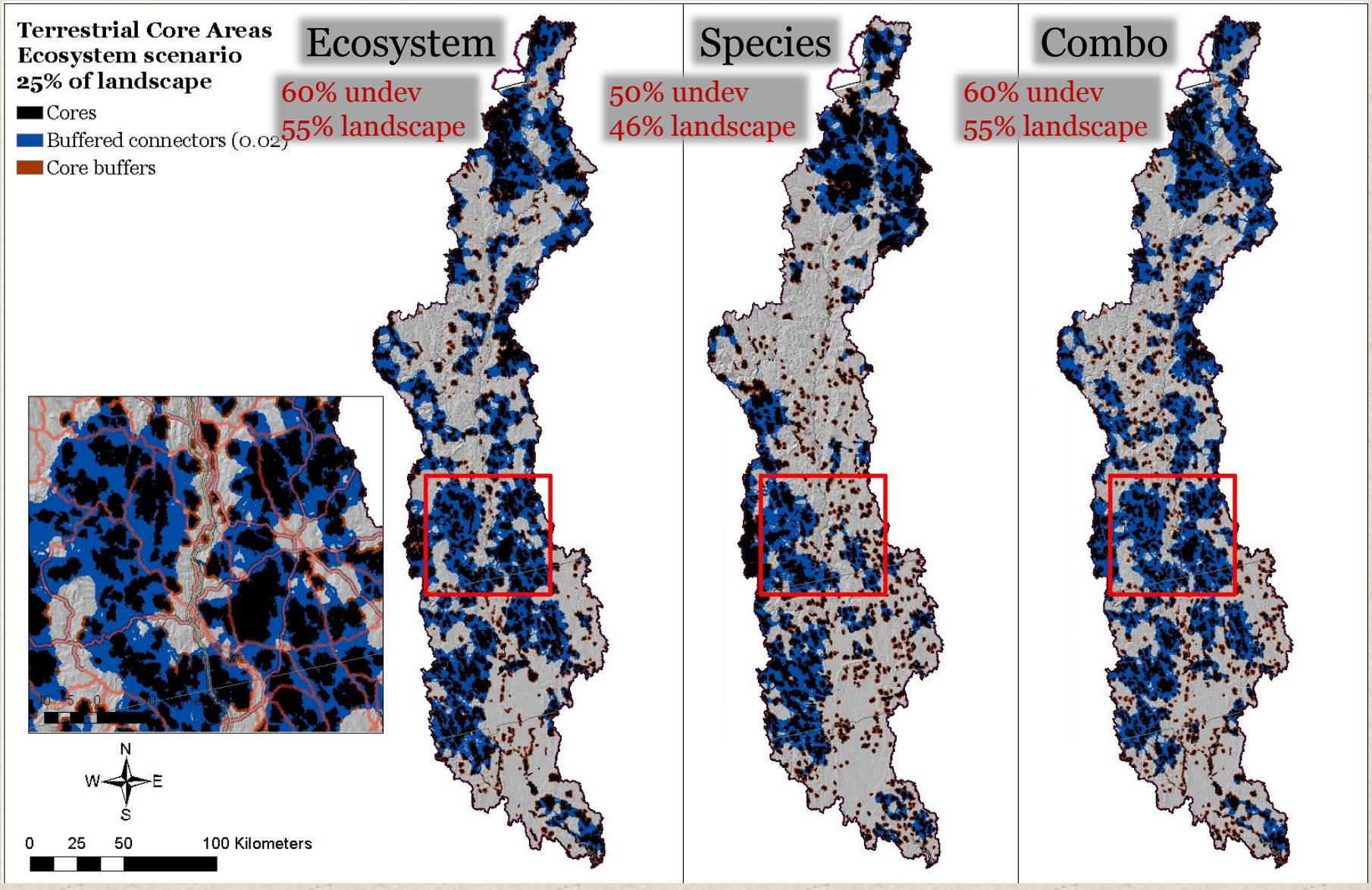
Derivation of Connectors

Conductance



Scenario Comparison

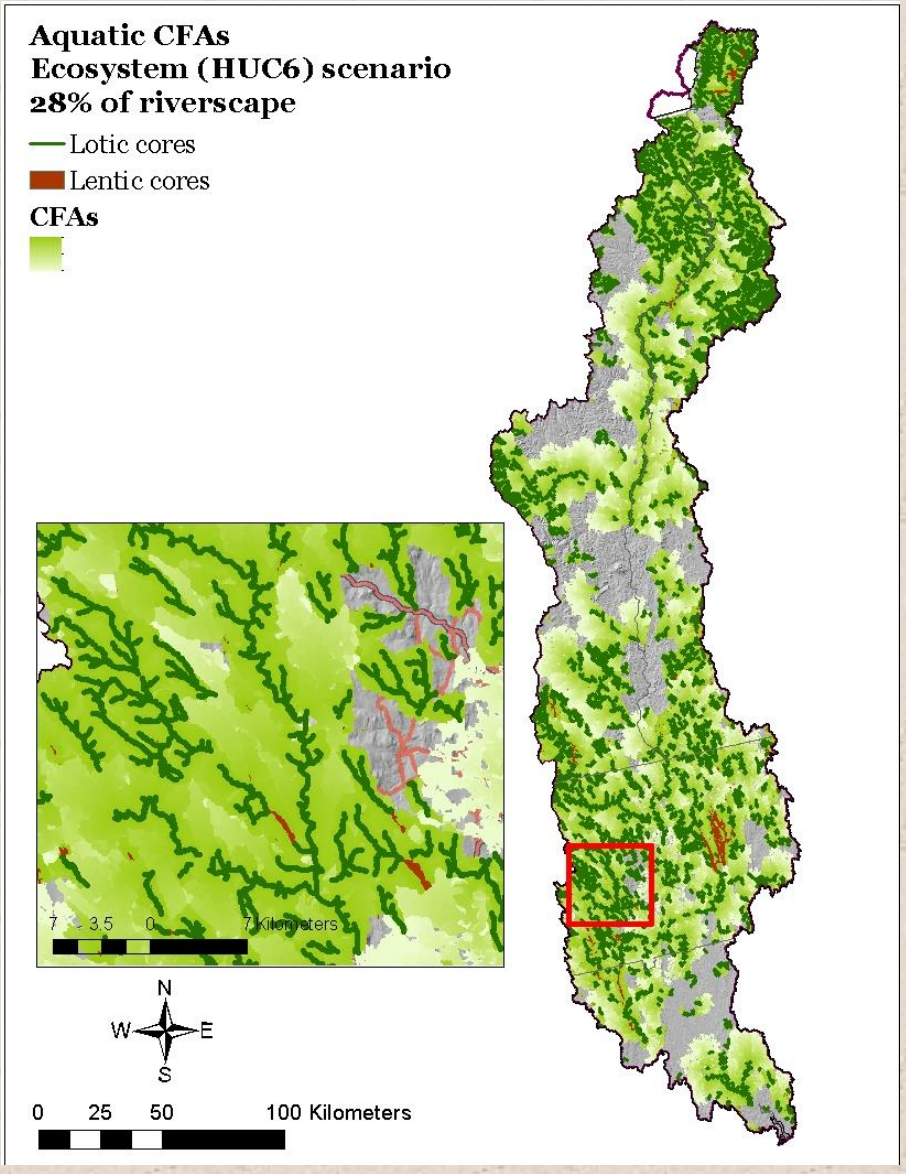
Conservation focus areas



Core Area Buffers

The buffer concept

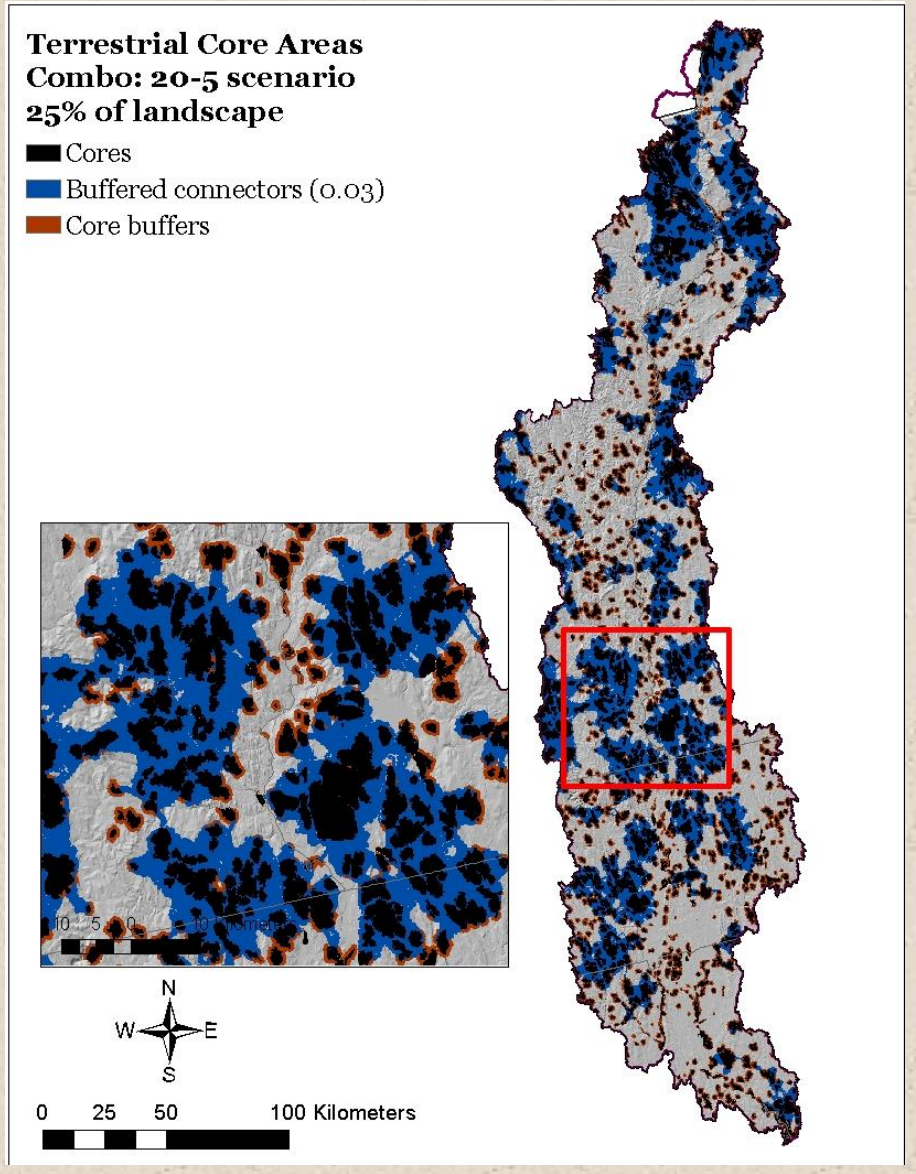
- **Aquatic buffers…**
  constrained watershed area with influence on integrity of aquatic cores



Core Area Buffers

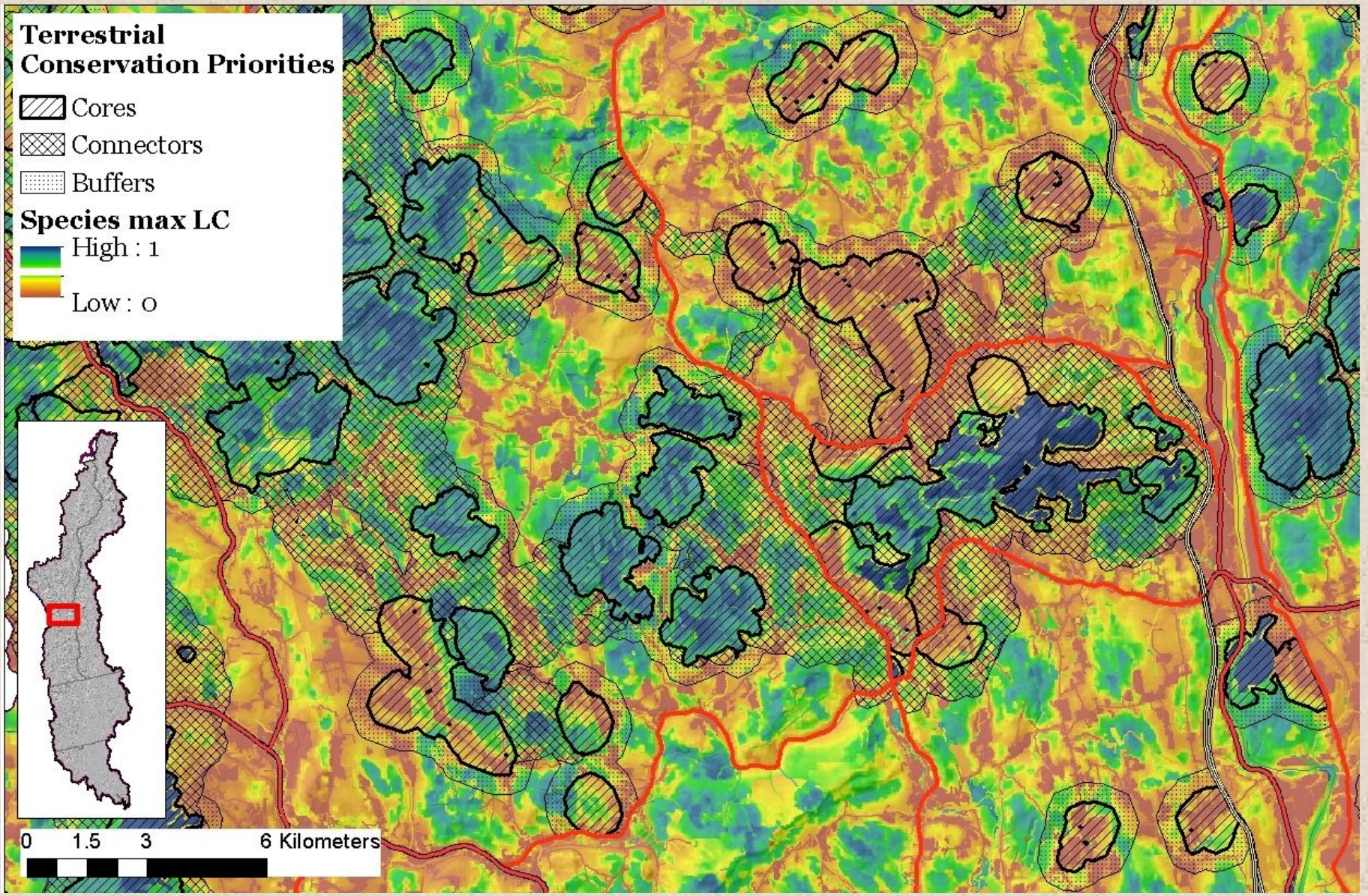
The buffer concept

- **Terrestrial buffers…** constrained (by major development) 500 m (?) wide buffer around core areas representing an "area of influence" on integrity of terrestrial cores



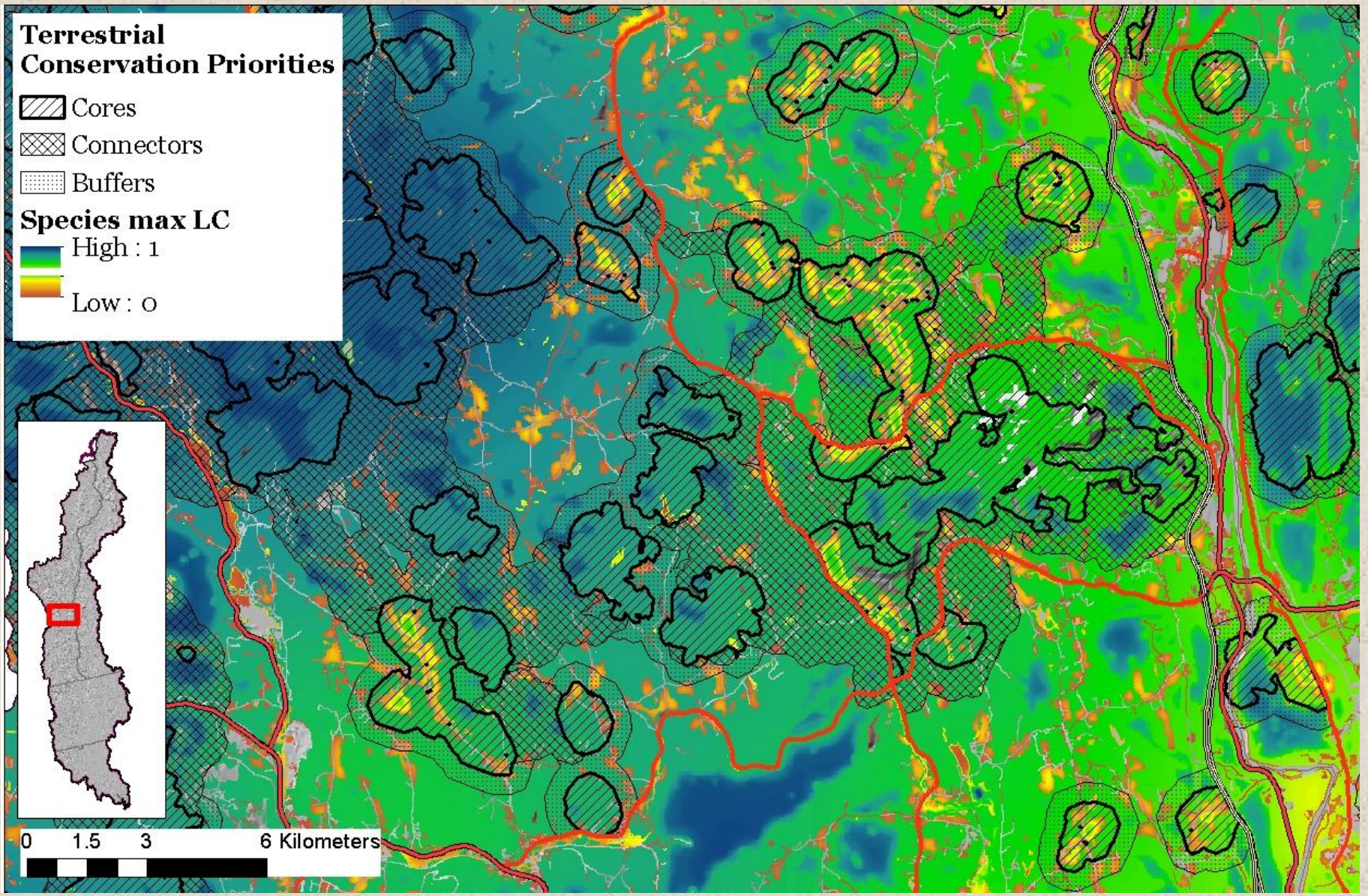
Conservation Tiers/Priorities

Ecosystem value



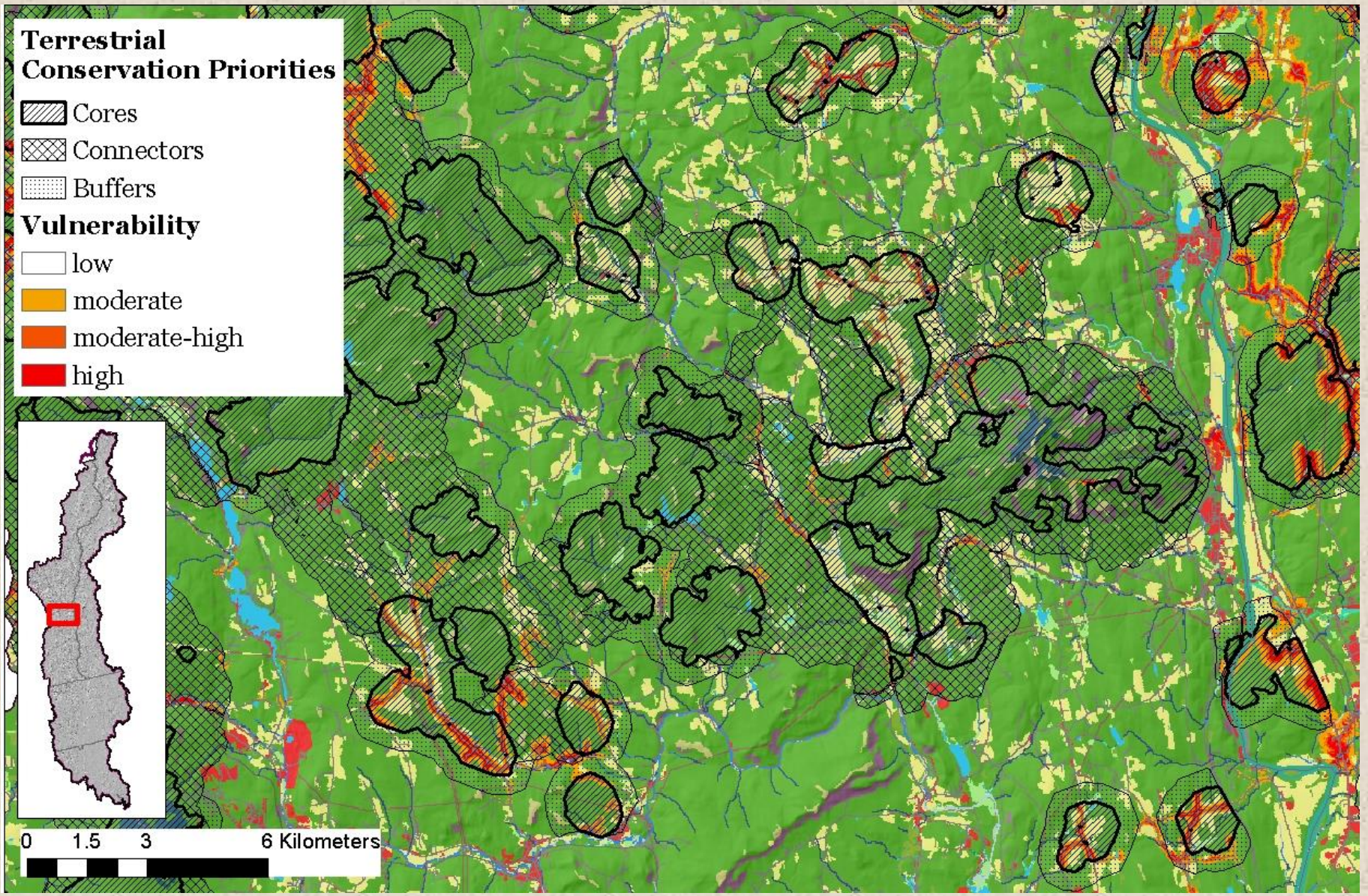
Conservation Tiers/Priorities

Species value



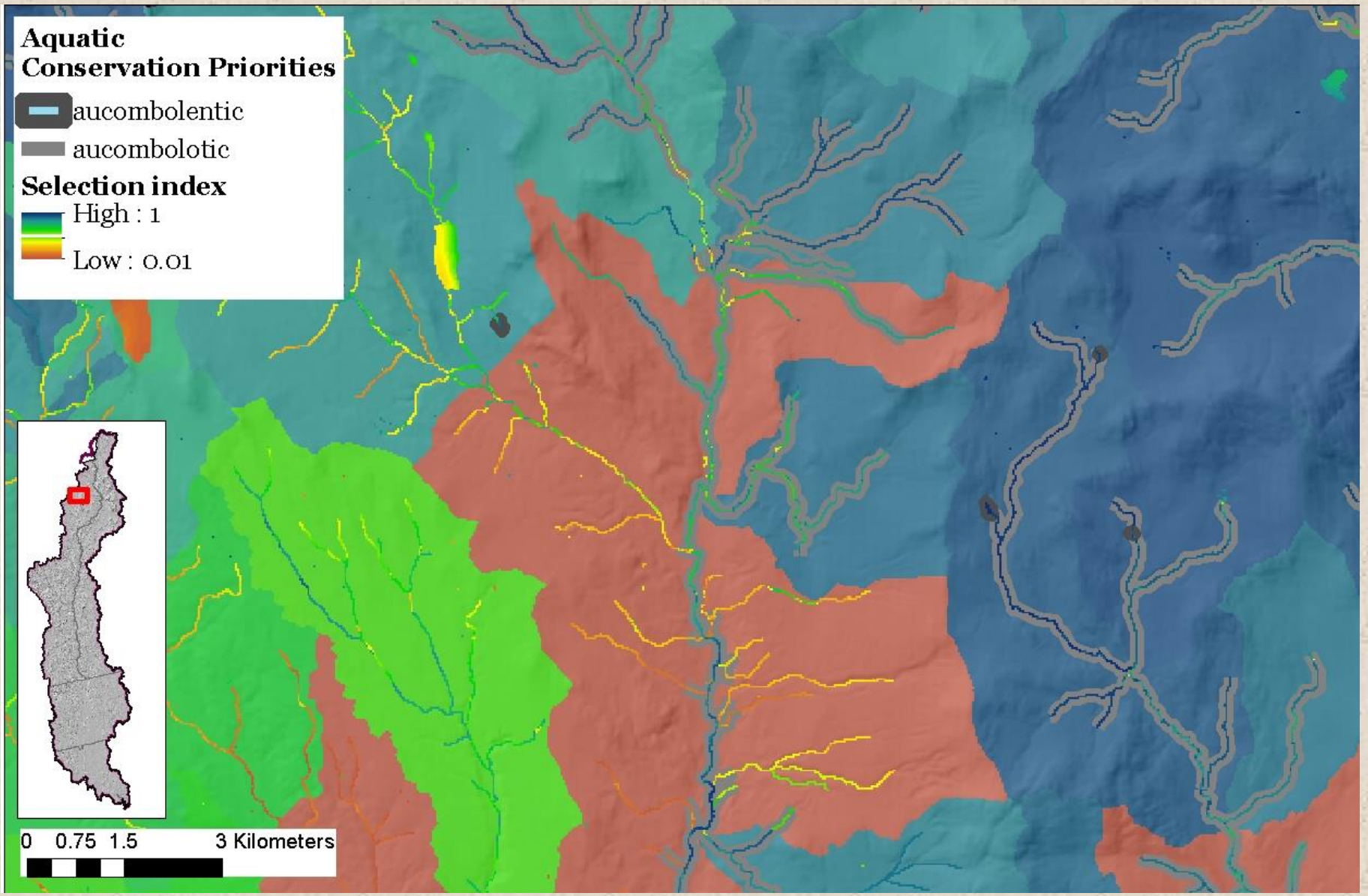
Conservation Tiers/Priorities

Species value

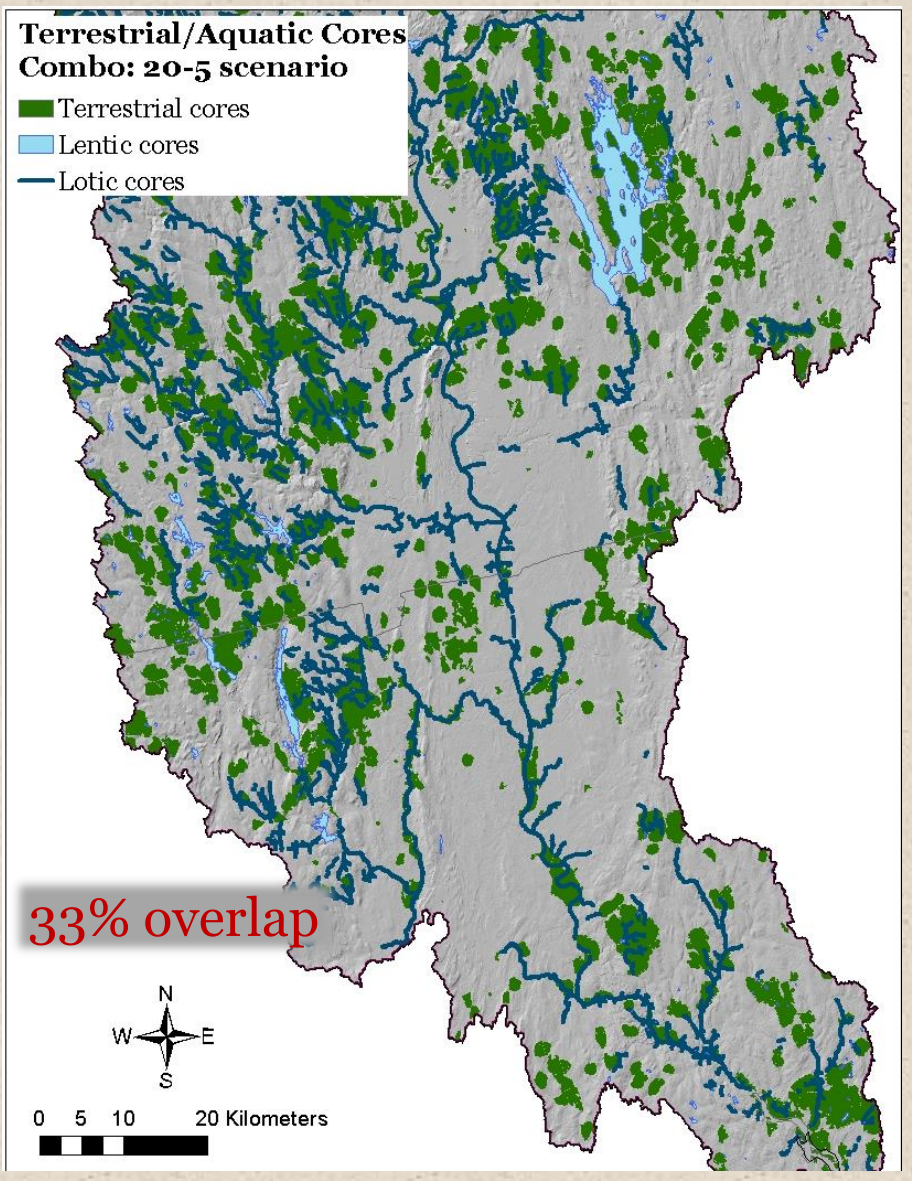


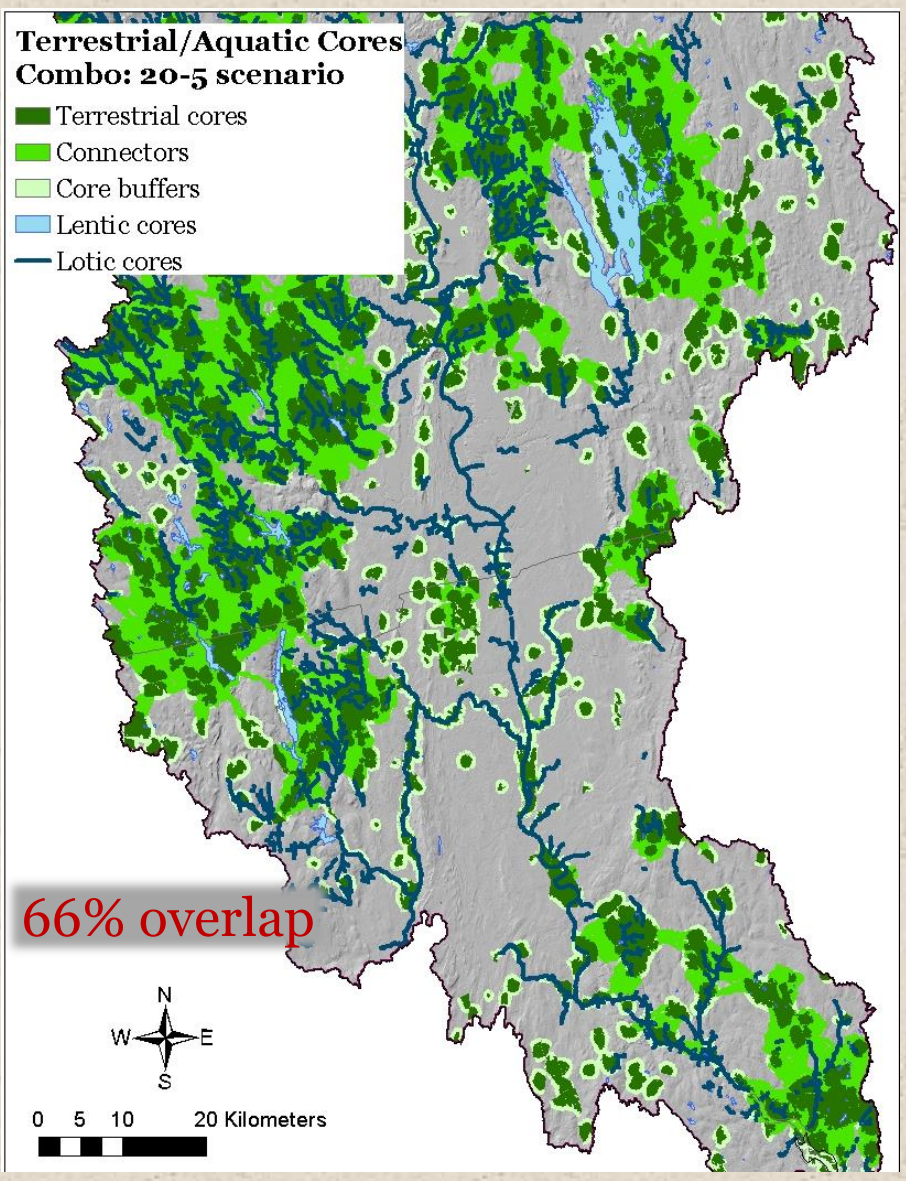
Conservation Tiers/Priorities

Species value



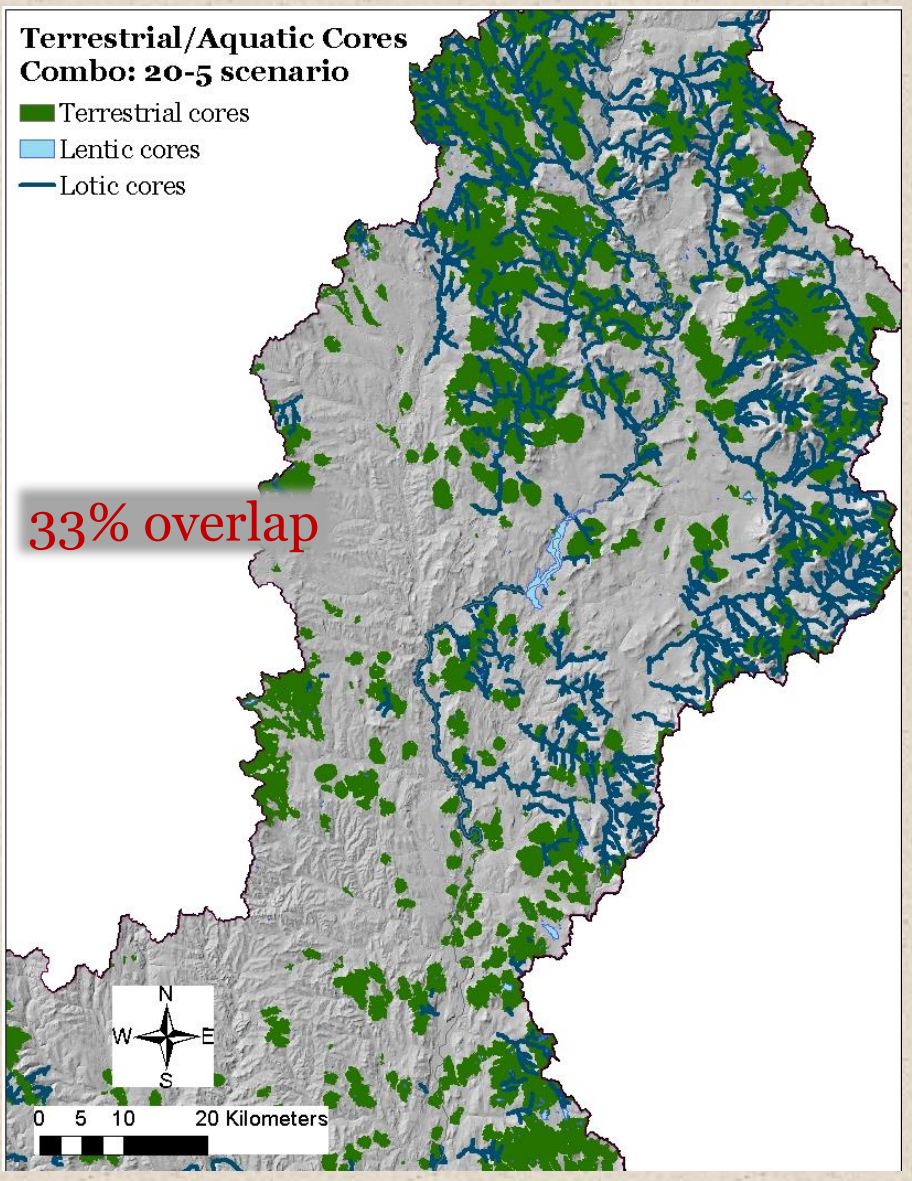
Combining Terrestrial and Aquatic Core Areas

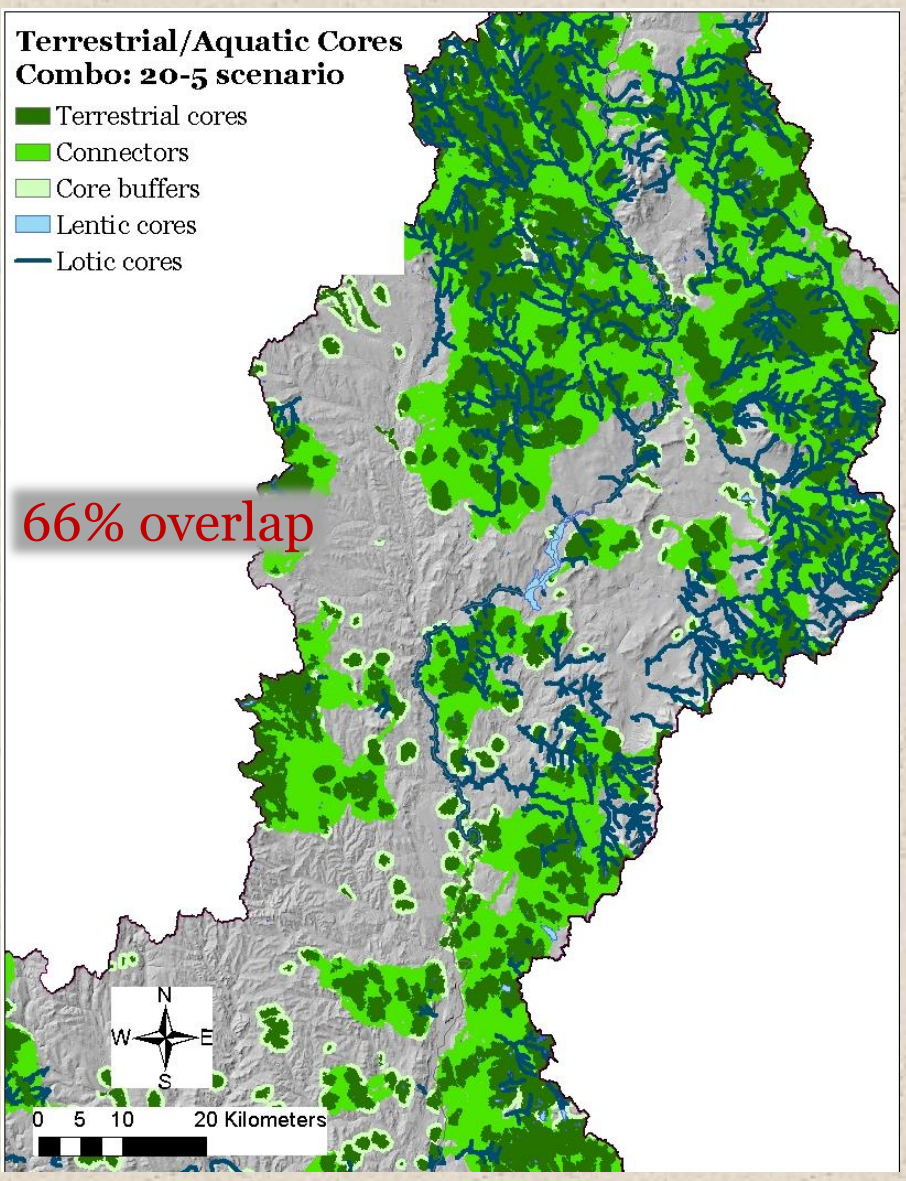




Combining Terrestrial and Aquatic

Core areas





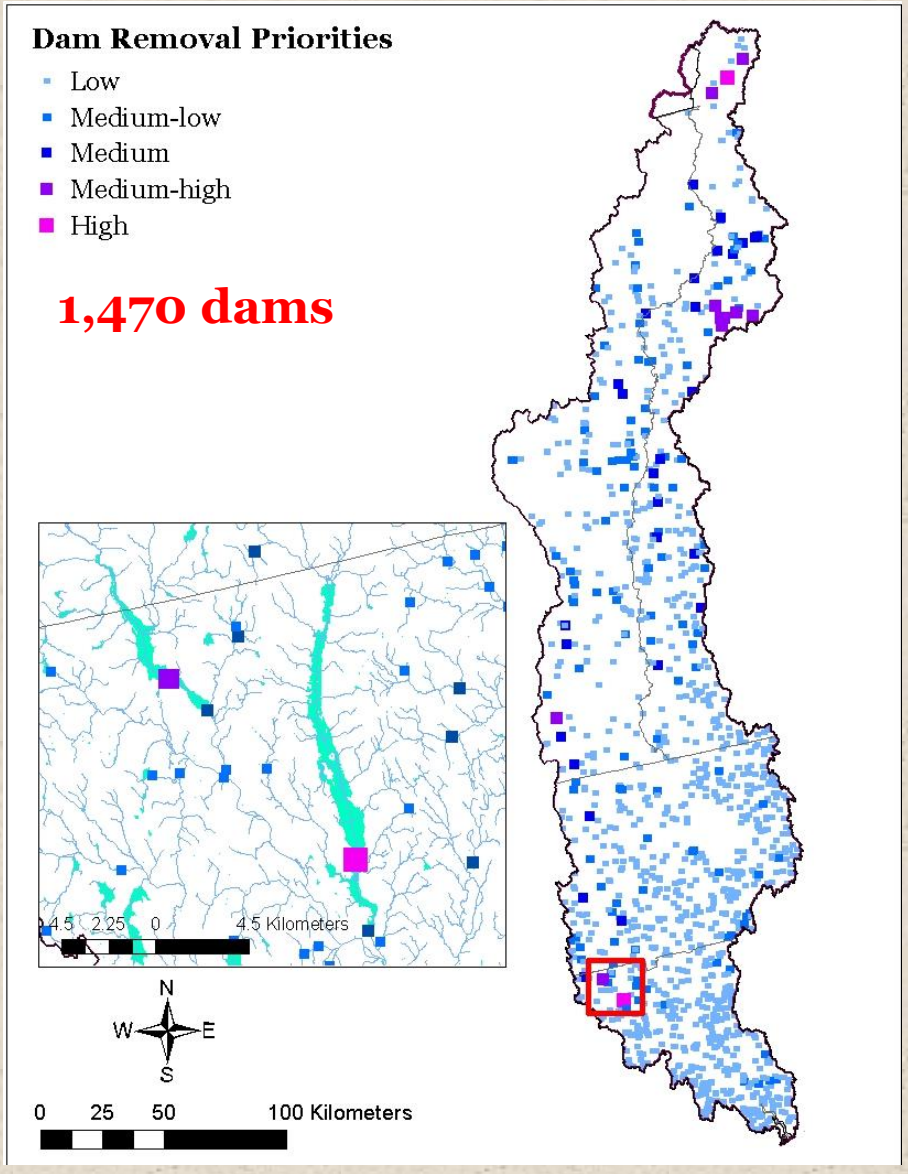
Restoration & Management

- **Restoration & management opportunities…** areas with high restoration or management potential
  - **Dam removal…** gradients in potential to improve aquatic connectivity
  - **Culvert upgrades…** gradients in potential to improve aquatic connectivity
  - **Terrestrial road passage structures…** gradients in potential to improve terrestrial connectivity
  - **Management priorities…** areas with management needs/opportunities to maintain or improve ecological integrity or species landscape capability

Restoration & Management

Dam removal

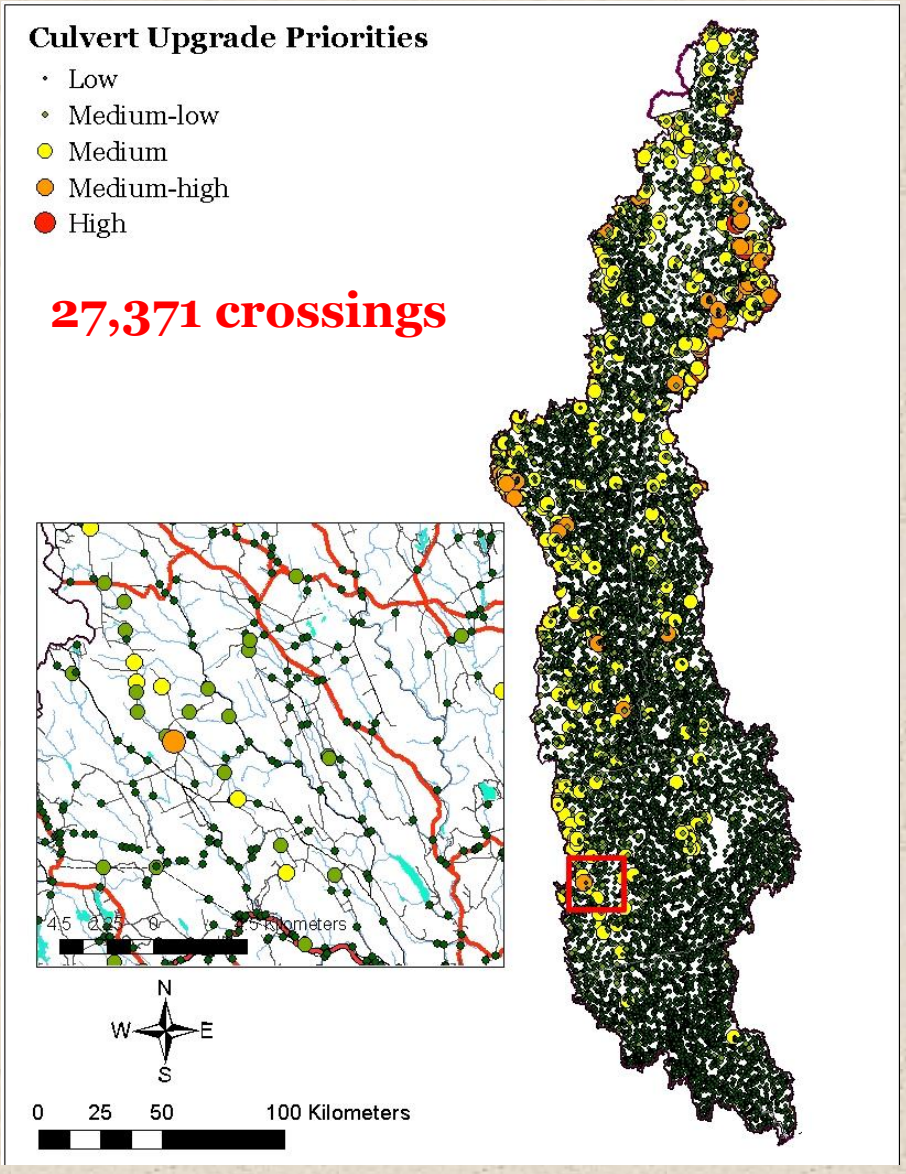
- Based on improvement in local aquatic connectedness resulting from removal of the dam (Δaqconnect)



Restoration & Management

Culvert upgrade

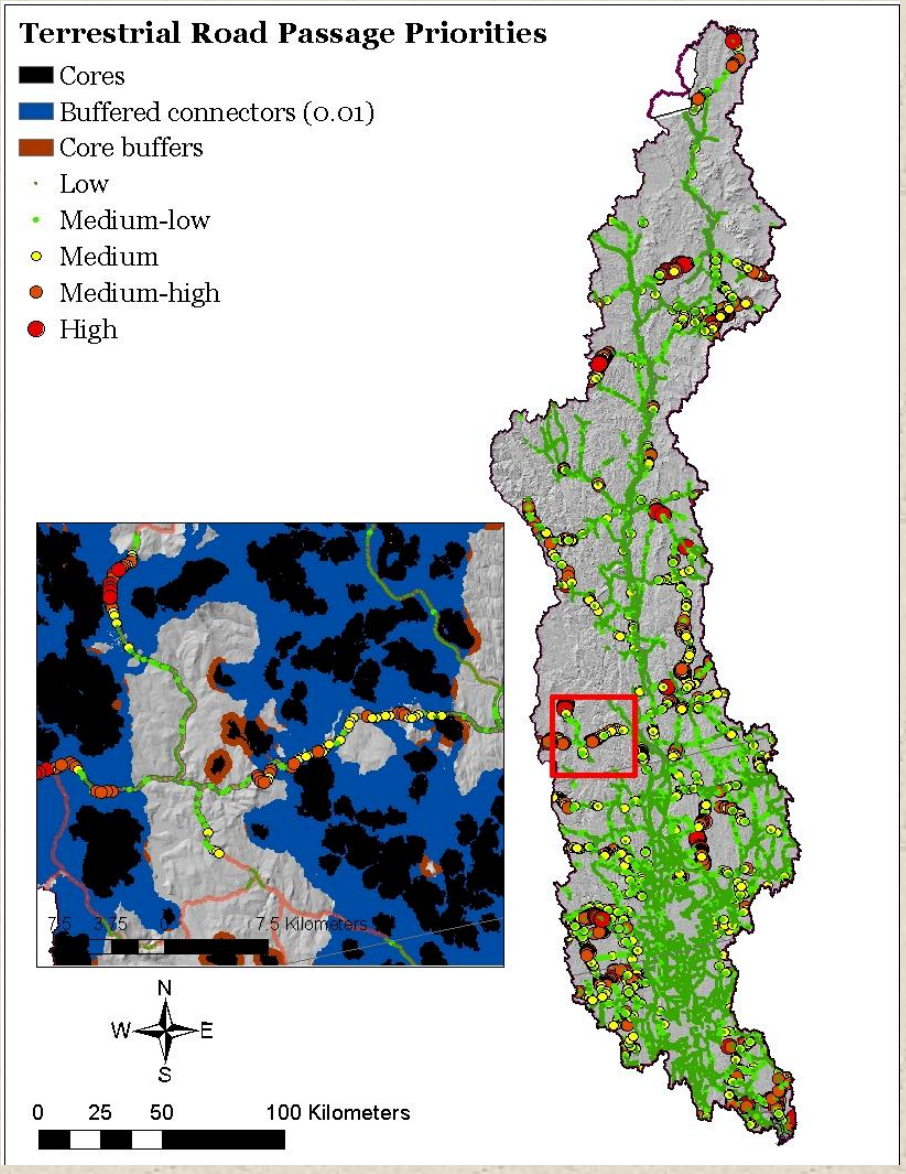
- Based on improvement in local aquatic connectedness resulting from replacing culvert with bridge (Δaqconnect)



Restoration & Management

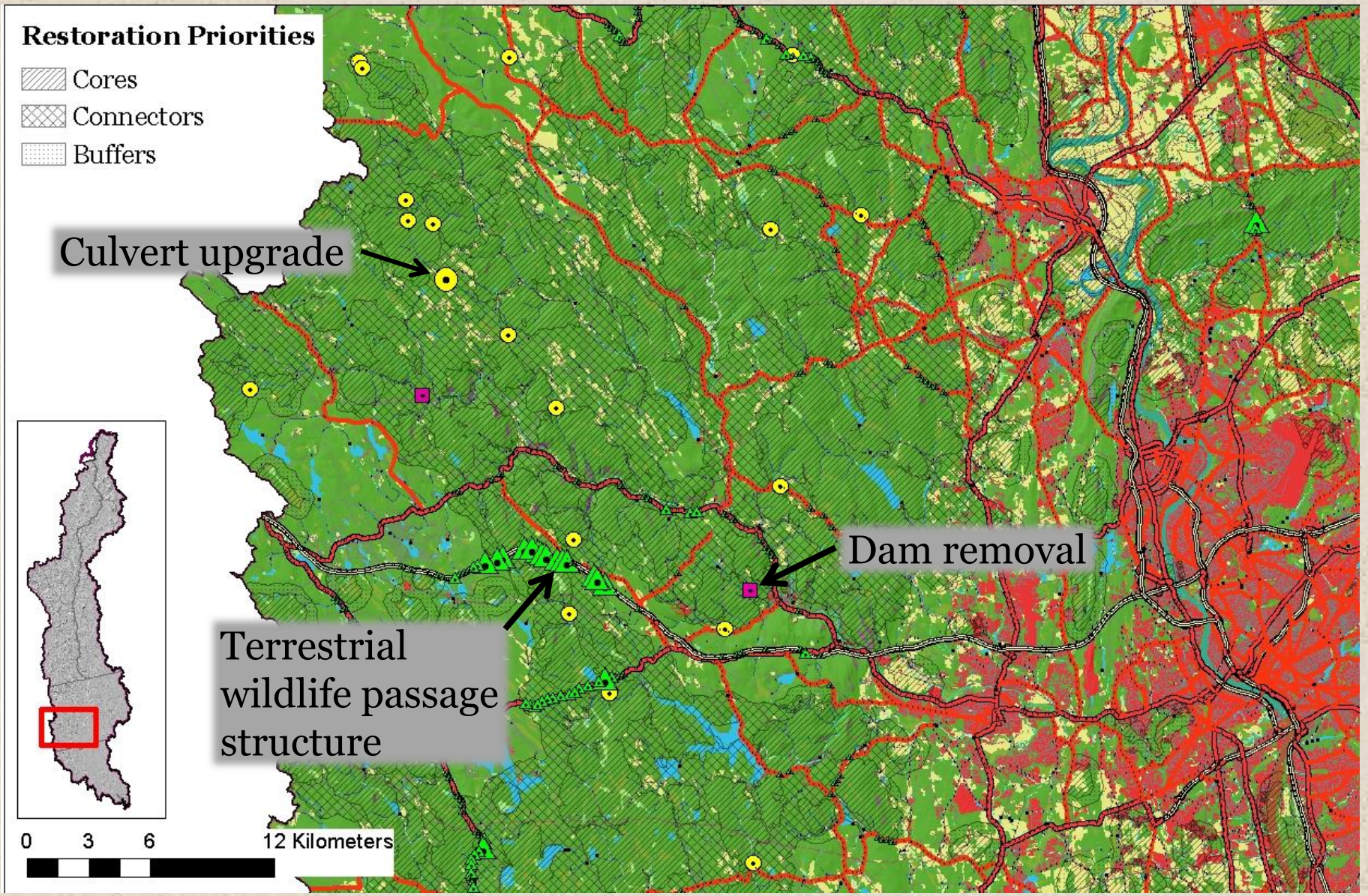
Terrestrial road passage structure

- Based on improvement in local connectedness resulting from installing a terrestrial road passage structure (Δconnect)



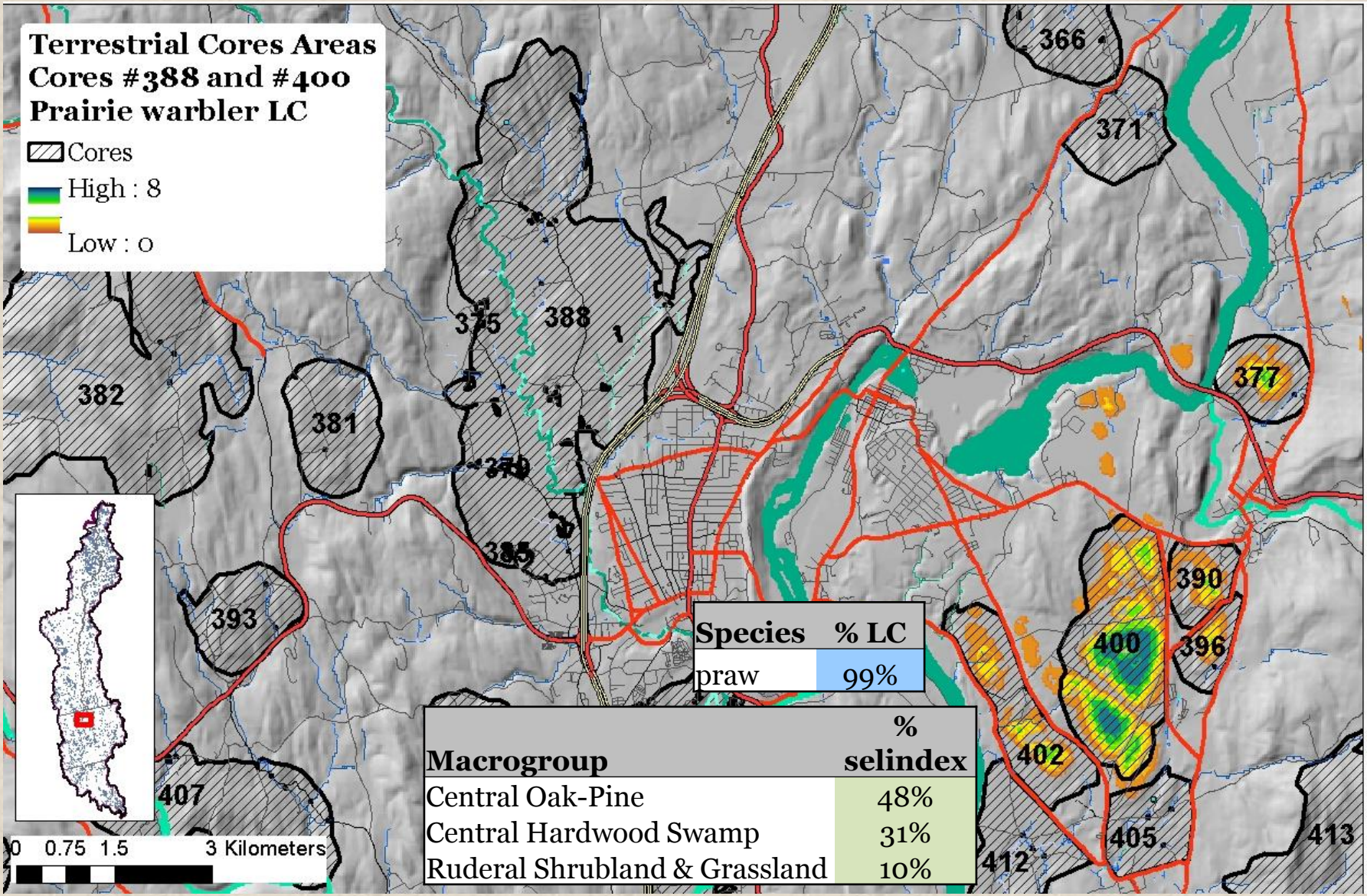
Restoration & Management

Terrestrial road passage structure



Restoration & Management

Management priorities



Species	% LC
praw	99%

Macrogroup	% selindex
Central Oak-Pine	48%
Central Hardwood Swamp	31%
Ruderal Shrubland & Grassland	10%

Model Validation

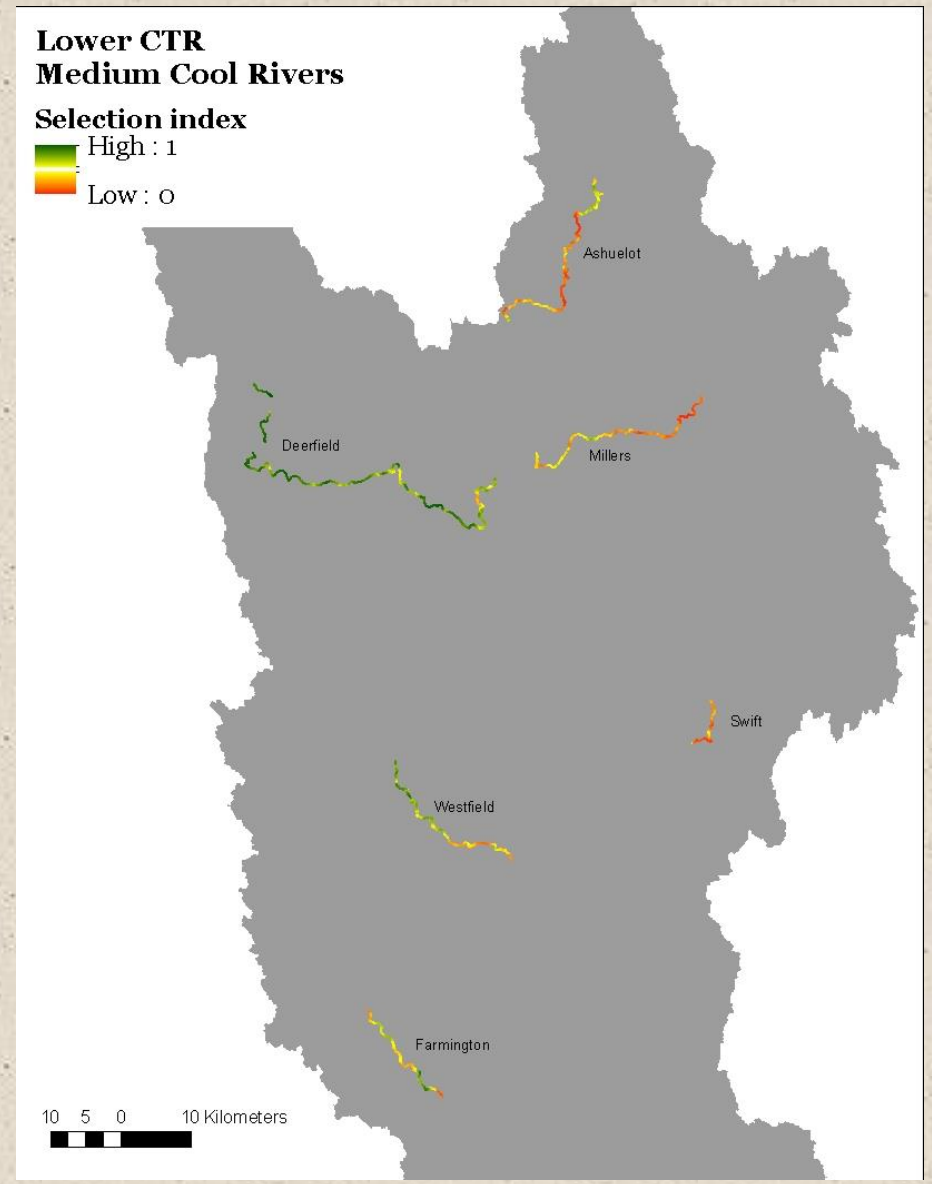
Expert assessment?

- "All models are wrong but some are useful" (George Box 1987)

Model Validation

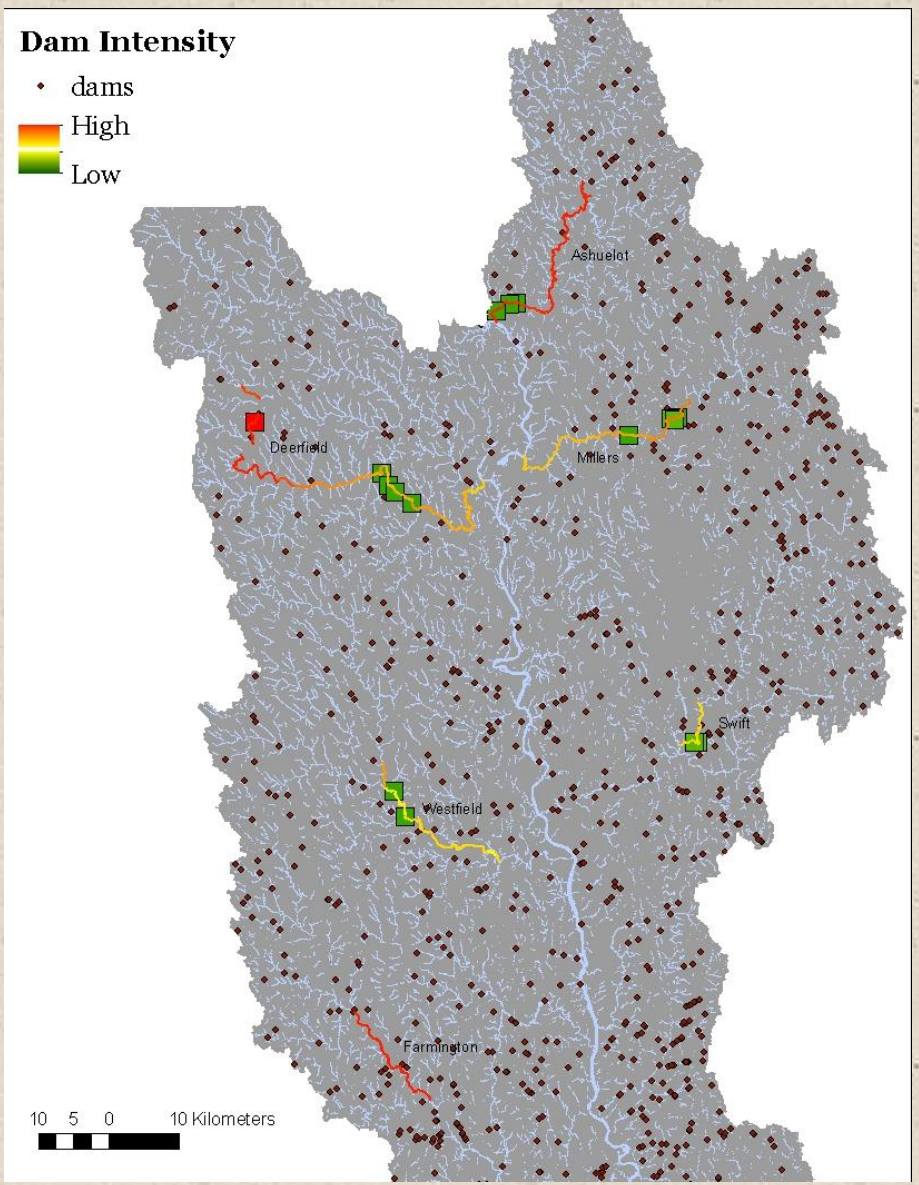
Example

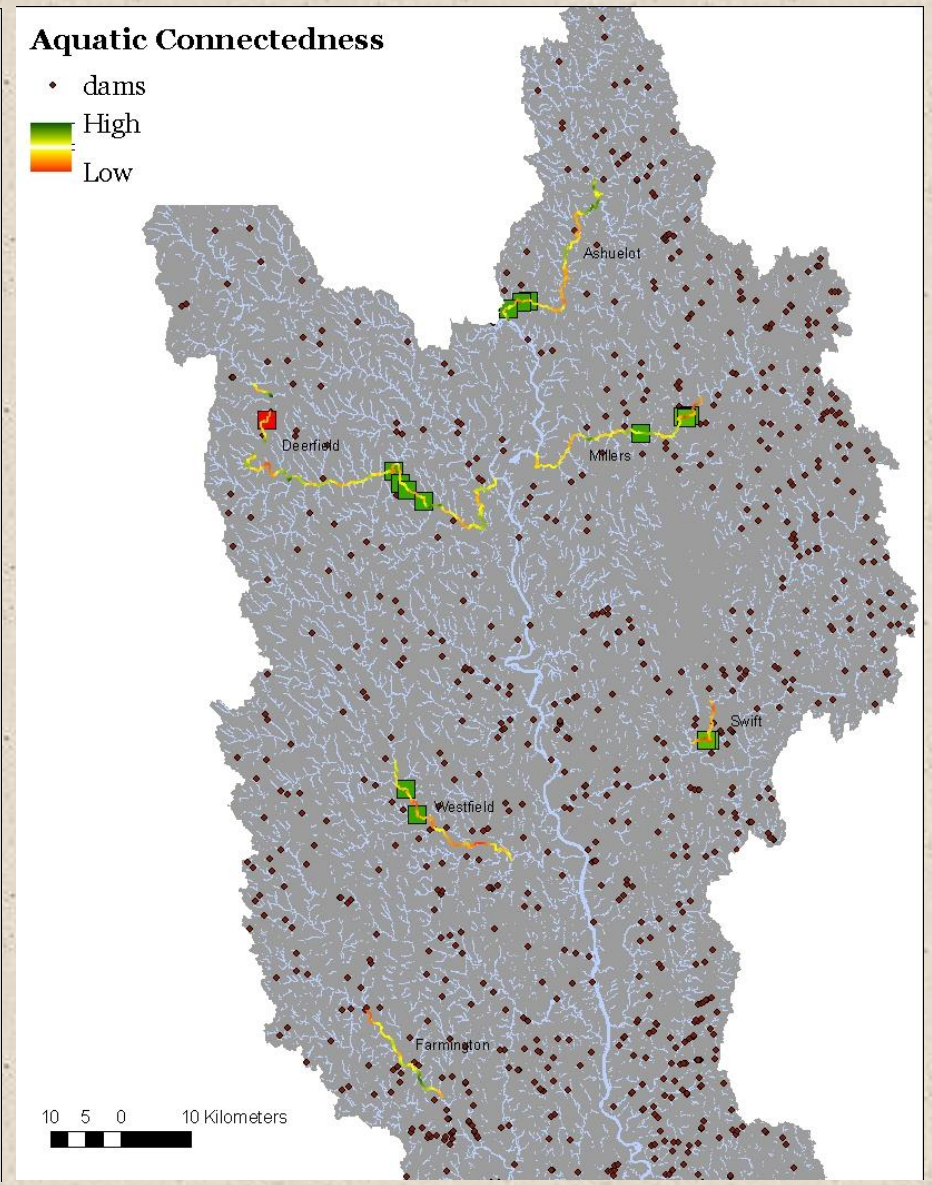
- For much of the Deerfield, IEI scaled by HUC6 is generally very high: often in the **0.90's**. Those same cells in regional IEI are mostly in the **0.60's**. There's simply not a lot of this stream class in this HUC6, and much of the best (based on IEI) is in the Deerfield.
- All of these river sections are mostly in pretty terrible landscape contexts compared to the Deerfield. The Deerfield has a lot of dams, but 4 of them supposedly have fish ladders. And all of these rivers have a lot of dams. The Deerfield has more, bigger, less stressed tribs than most of the others.



Model Validation

Example





Model Validation

Example

- ***Aquatic connectedness*** (22% of IEI; higher values are good): Aquatic connecteness is a mixed bag. The Deerfield seems similar to the Ashuelot, Millers, and Farmington, and way better than the lower Westfield and Swift.
- ***Dam intensity*** (17% of IEI; higher values are bad): The Deerfield is somewhere in the middle for dam intensity.
- The remaining 61% of IEI comes from *watershed habitat loss* and *imperviousness* (11% each), and *habitat loss*, *traffic*, *mowing & plowing*, *sediments*, *nutrients*, *edge predators*, and *connectedness* (all 5.5%). The Deerfield is likely to do well for most of these metrics, as it has a better watershed context than the other rivers.