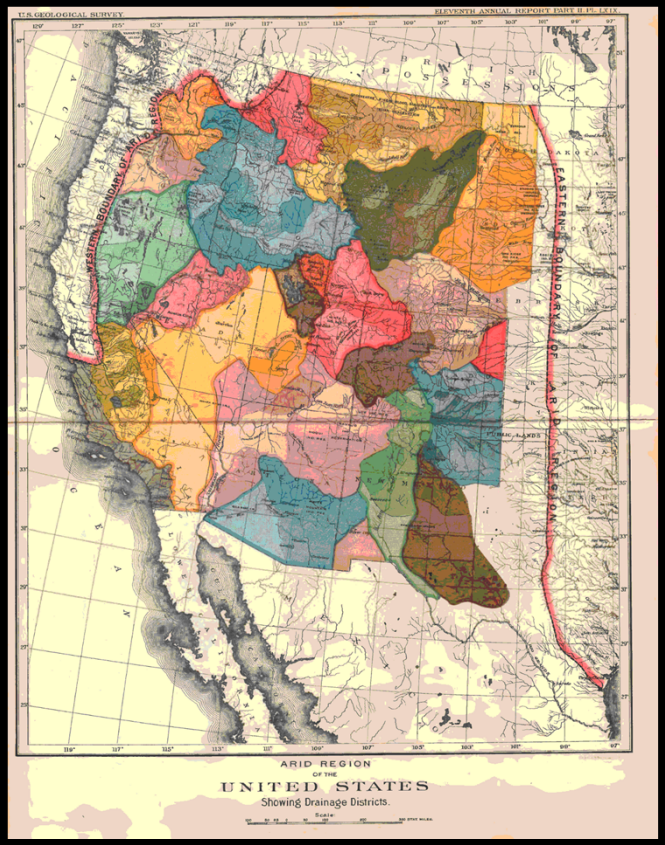


LCCVP – Bozeman meeting

David M. Theobald, Ph.D.
Department of Fish, Wildlife, and Conservation Biology
Colorado State University
Fort Collins, Colorado, USA 80523-1474

Outline

- Land *use* change (SERGoM v2)
  - Updates, modifications
  - Linkages with impervious surface and TOPS
  - Schedule
- Landscape facets (w/Bill M.)

Vulnerability framework

Glick & Stein 2011. *Climate change vulnerability assessment*

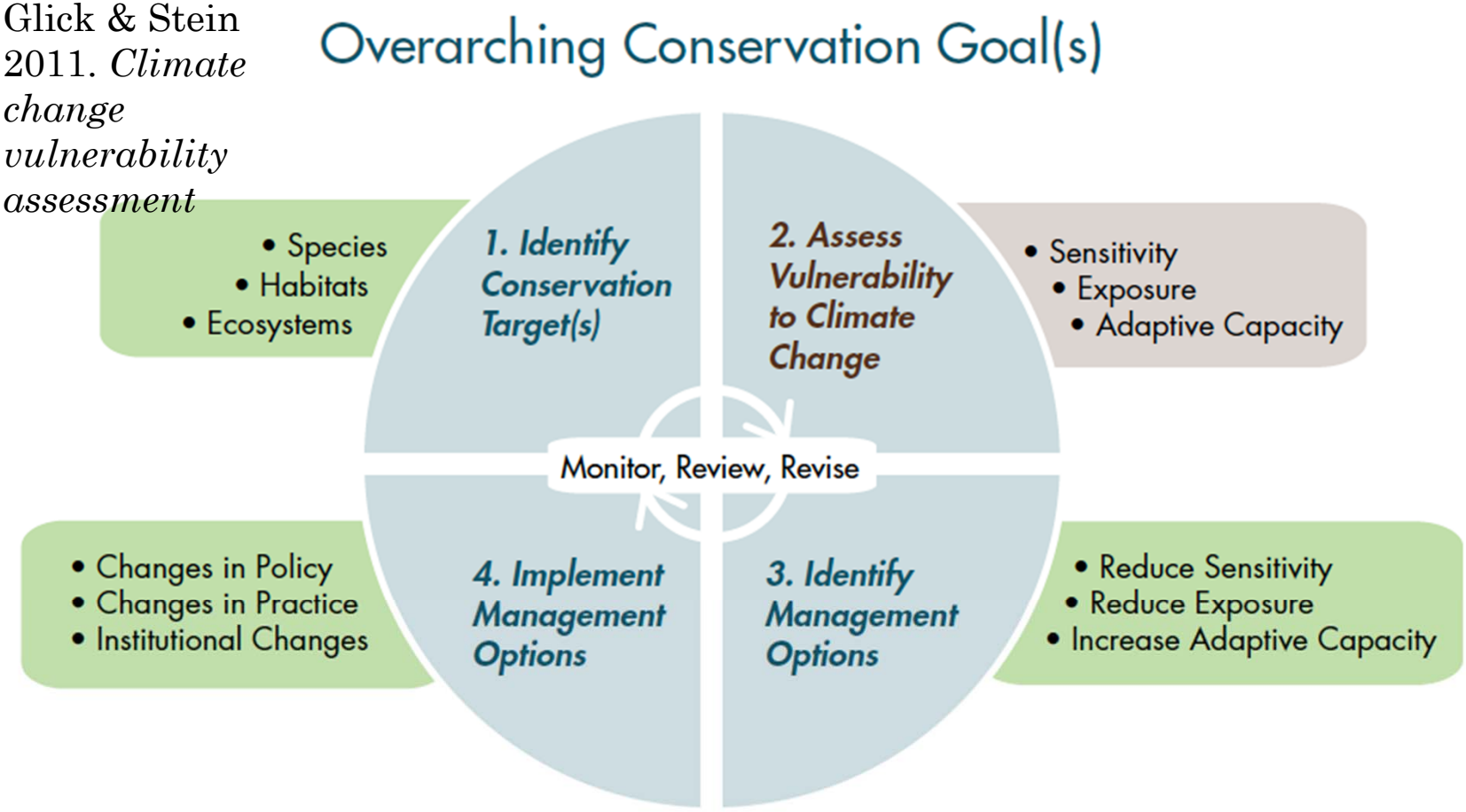


Figure 1.1. Framework for Developing Climate Change Adaptation Strategies

Vulnerability framework

Climate

Land use change

Glick & Stein 2011. *Climate change vulnerability assessment*

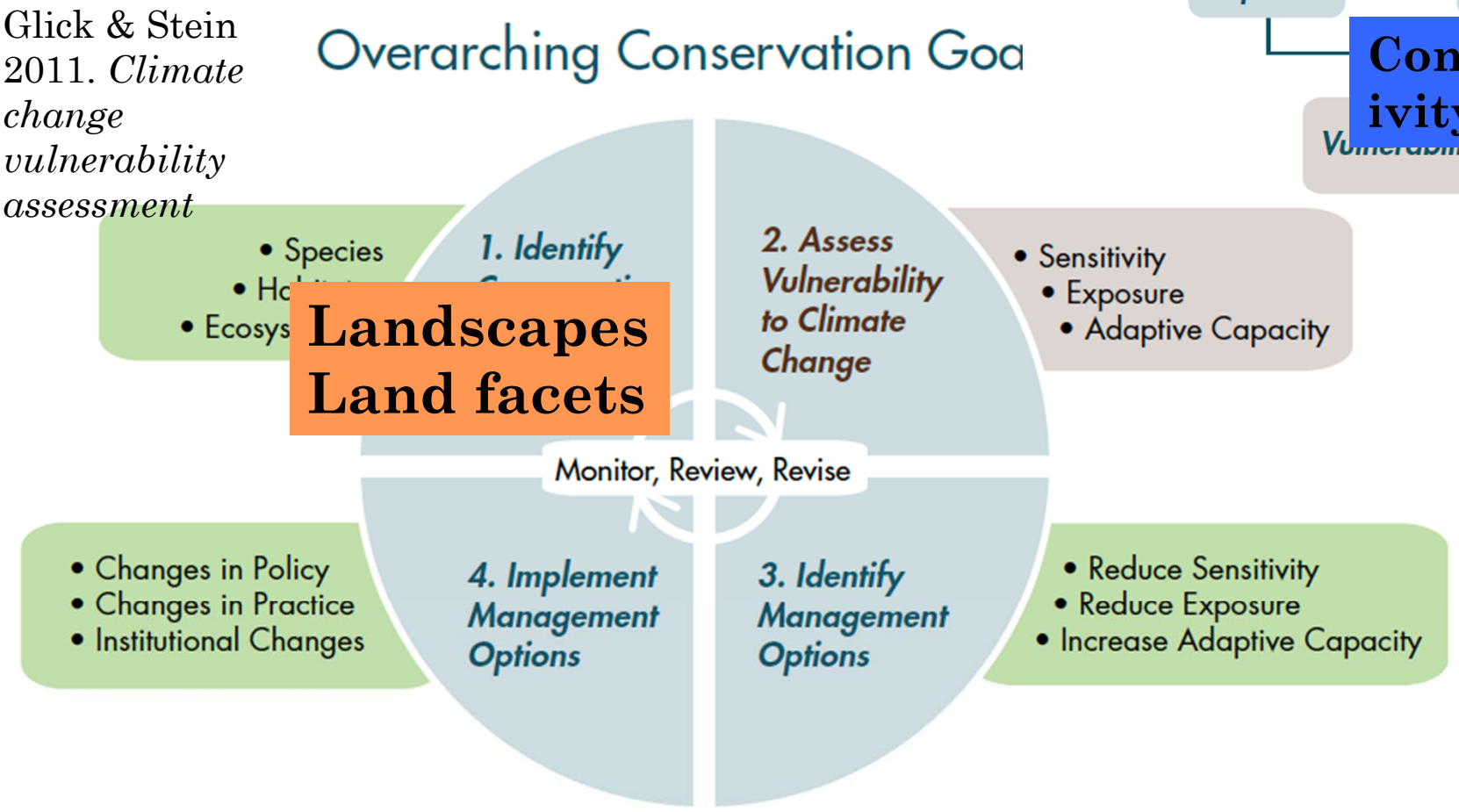


Figure 1.1. Framework for Developing Climate Change Adaptation Strategies

SERGoM v2

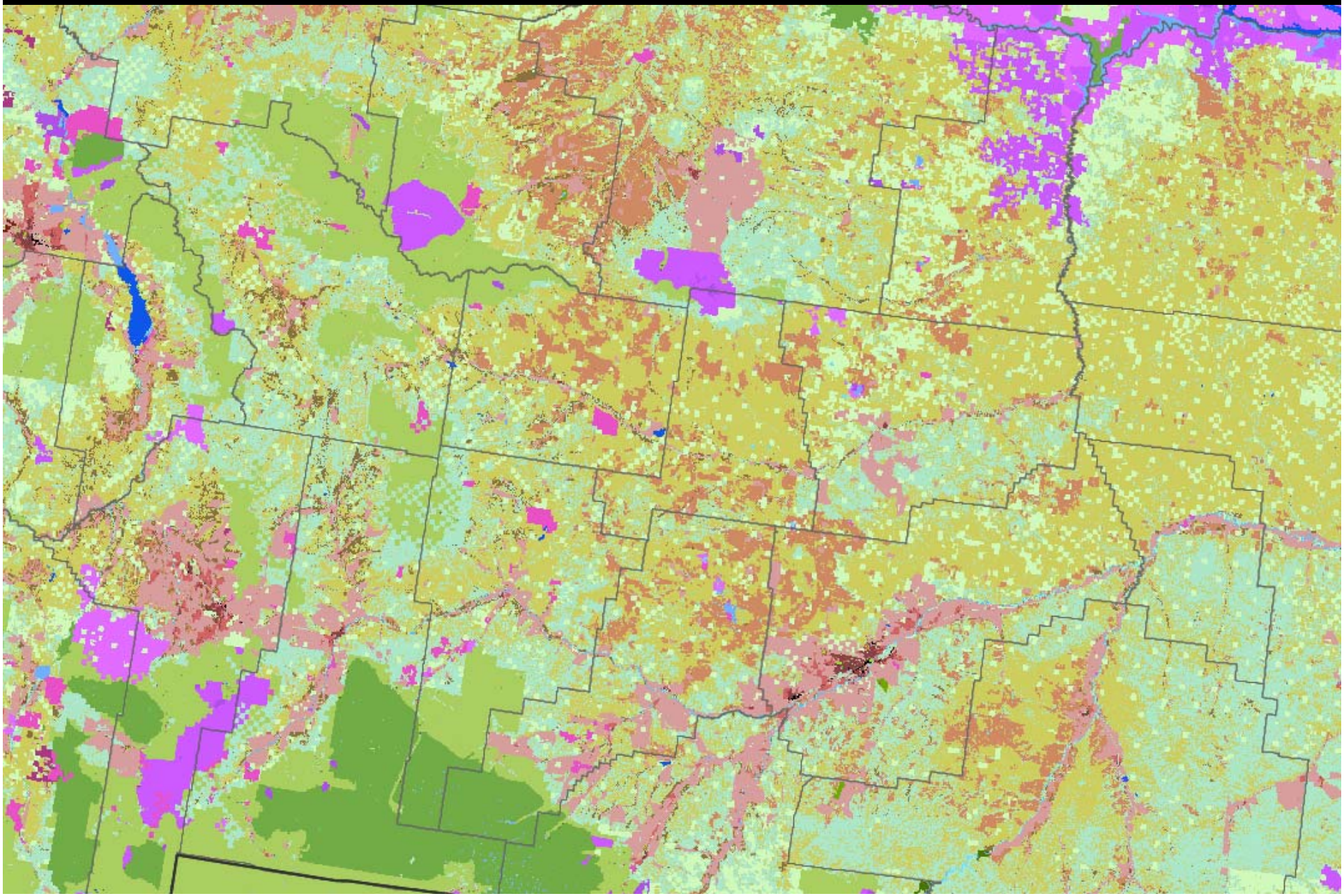
- Updates of data:
  - 2010 census, TIGER 2010, NLCD 2006, LEHD, PAD-US, groundwater wells
- Modifications
  - 90 m, registered with NLCD 2006 extent (~30 m?)
  - Transportation infrastructure replace travel time with capacity (lanes x speed limit)
  - Beyond housing density → land *use* classes
  - Expose empirical transition probabilities to allow scenario generation

Land use classes

Land use classes in the ICLUS/SERGoM v2 model.

Code	Group	Class Name	Description	Chip	NRI class
0	Water	River, stream	Running waters	water	Water
1		Lake	Natural "standing" waters	Water	Water
2		Reservoir	"Standing" water with dam or other human structure controlling flow	Water	water
3	Rec/conservation	Recreation	Parks, natural areas, campgrounds, wilderness, etc.	Undeveloped /Recreation	Federal, state, local, CRP?
4	Extractive	Extractive timber	Timber production	Resource ext	Forest
5		Extractive grazing	Grazing (and other resource extraction e.g. oil & gas)	Resource extraction	Rangeland
6		Extractive pastureland	Pasture	Agriculture	Pastureland
7		Extractive cropland	Cropland	Agriculture	Cropland
8		Extractive mining	Mineral resources	Resource ext	?
9	Urban/built-up	Urban parks/open space	Parks with structures (fields, courts, golf courses, cemeteries). No housing units.	Residential	Urban (large)
10		Residential (exurban low)	Exurban housing density 1 per 10-40 ac)	Residential	?
11		Residential (exurban)	Exurban housing density 1 per 2.5-10 ac)	Residential	Urban (large)
12		Residential (suburban)	Housing density 1 per 0.6-2.5 ac		Urban (small)
13		Residential (medium)	Housing density 1 per 0.1-0.6 ac	Residential	Urban (small)
14		Residential (high)	Housing density 1 per >0.1 ac	Residential	Urban (small)
15		Mixed residential and commercial	Residential housing medium or higher and density of employees > xx	Mixed use	Urban (small)
16		Commercial and Institutional	Commercial complexes, office buildings, schools,., churches, govt., military	Mixed use – institutional	Urban (small)
17		Industrial and utility	Industrial parks, factories, power plants, land fills, transportation	Mixed use - industrial	Urban (small)
18	Trans.	Transportation	Interstates, highways, railways, airports	Trans.	Trans.

GNLCC



- Links to TOPS and impervious surface…
- Housing density → impervious surface
- Land use → impervious surface
- Transportation vs. Urban
- Directly connected impervious area vs. total impervious
- Best Management Practices
  - 15-95% effective in disconnecting
  - Adoption rates?
- Scale – 1 km

Schedule

- Preliminary LUC of 2010 and 2000 [March]
- Historical classes (to ~1900) [May]
- Forecast (base-case to 2100) [June]
- Scenarios A1, A2, B1, B2 [Aug]

questions

- Used NASA NGA resources?
- Sampling network to coordinate efforts, example from WGA Expert Survey

Landscape facets

- Map/measure “landscape facets”
- Immediate opportunities for national analysis

Figure 4: Ecological Land Unit Components

Elevation

Code	Range (ft)
1000	0 – 800
2000	800 – 1700
3000	1700 – 2500
4000	2500 – 4000

Geology

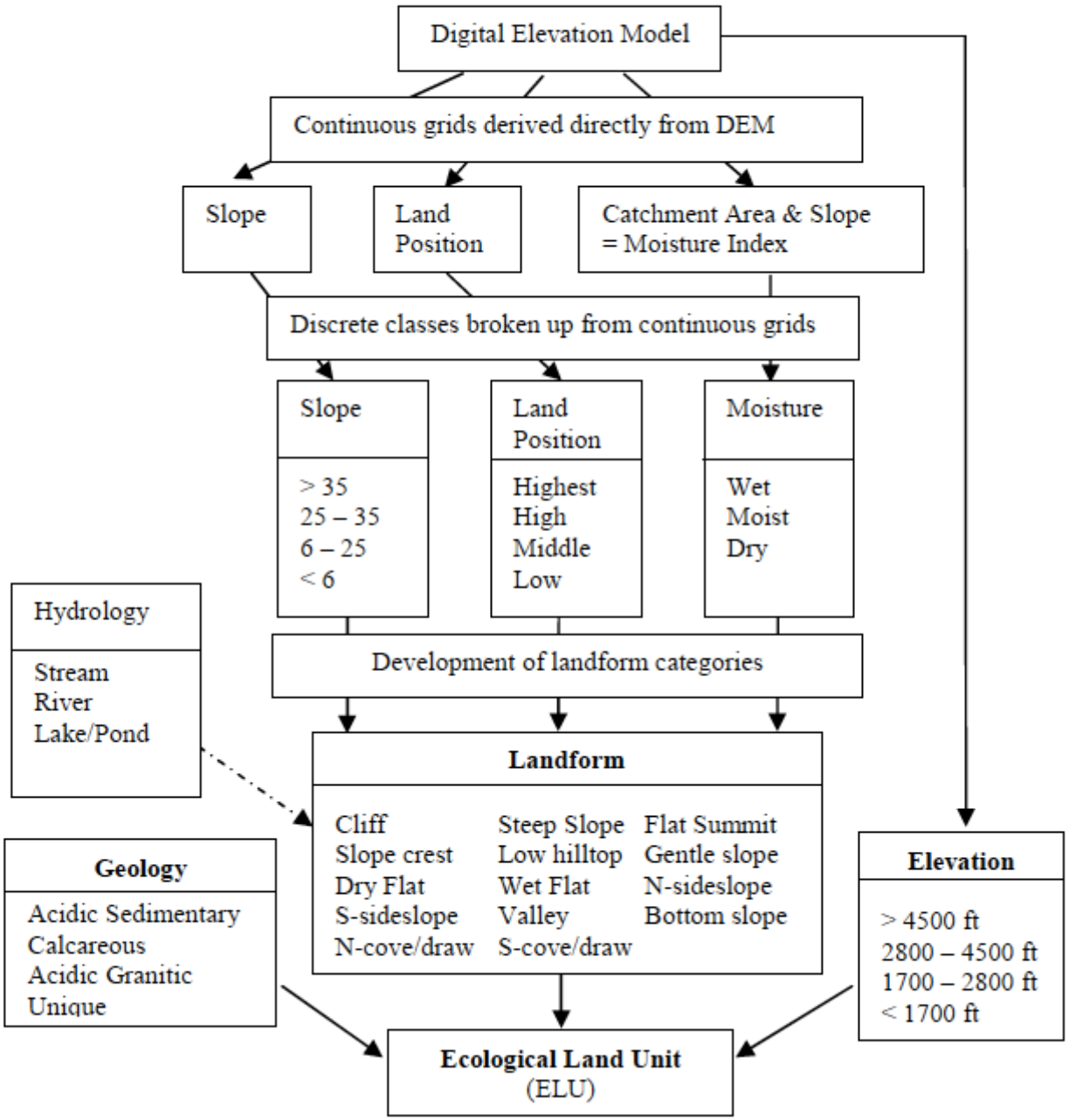
Code	Type
100	Acidic Sedamentary/Metased.
200	Acidic Shale
300	Calcareous Sedamentary/Metased.
400	Moderately Calc. Sed/Metased.
500	Acidic/Granitic
600	Mafic/Intermediate Granitic
700	Ultramafic
800	Outwash forest/wetland
900	Fine Sediments

Landform

Code	Type
4	Steep Slope
5	Cliff
11	Flat Summit/Ridge top
13	Slope Crest
21	Low Hilltop (flat)
22	Low Hill (gentle slope)
23	N-Facing Side slope
24	S-Facing Side slope
30	Dry Flat
31	Wet Flat
32	Valley/Toe Slope
41	Bottom of Steep Slope
43	N-Facing Cove/Draw
44	S-Facing Cove/Draw

ELU = Elevation Code + Geology Code + Landform Code

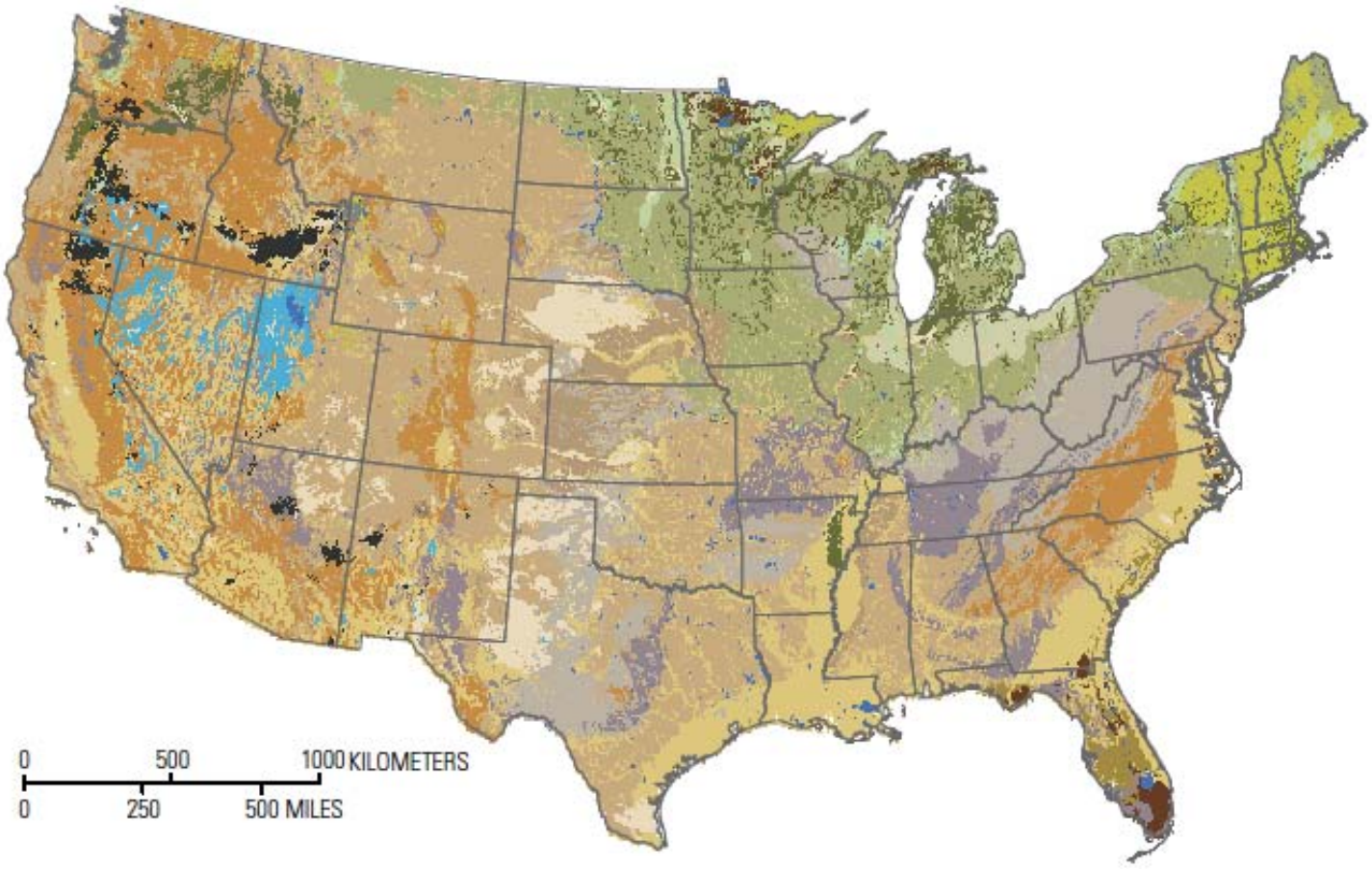
Figure 5: Flow Diagram of ELU development *(Anderson, Merrill and Biasi, 1998)*



Our approach

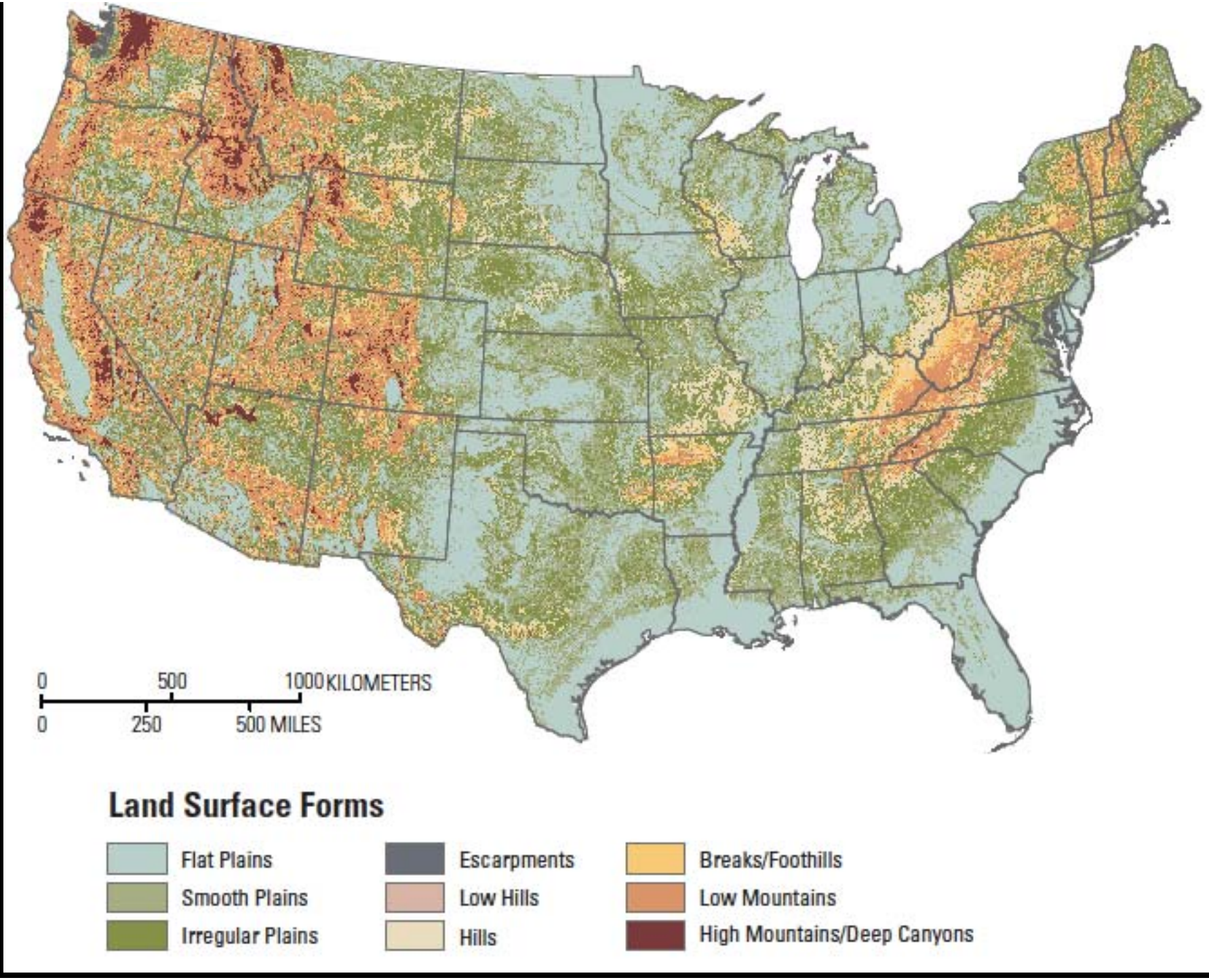
- Landscape units attempt to capture general spatial variation of physiography, and the intent is to use the number of unique types as a broad surrogate of biodiversityare comprised of three major physiographic variables:
  - lithology (parent material),
  - landform, and
  - aspect

- We used the lithology dataset from the



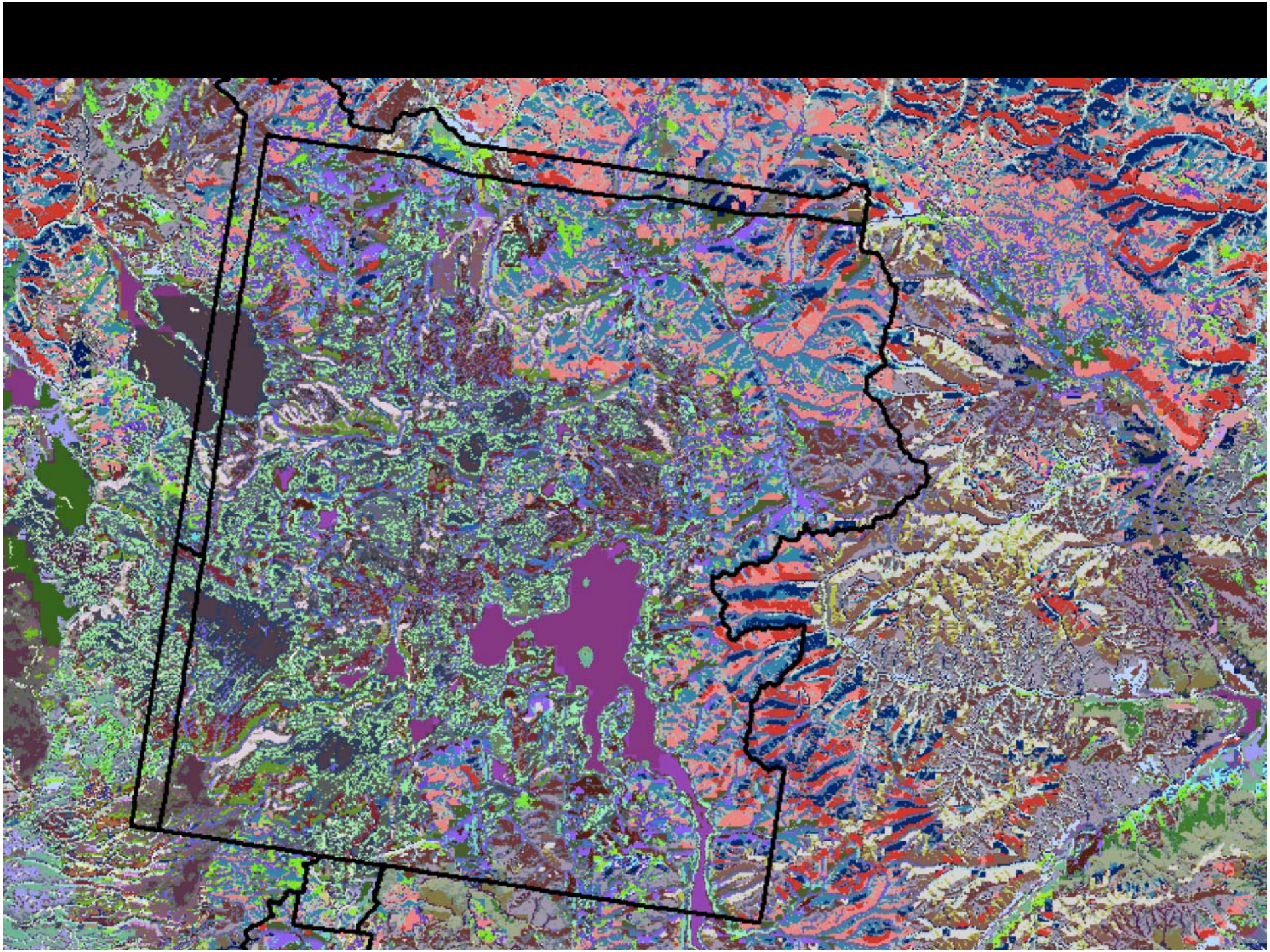
Surficial Materials Lithology

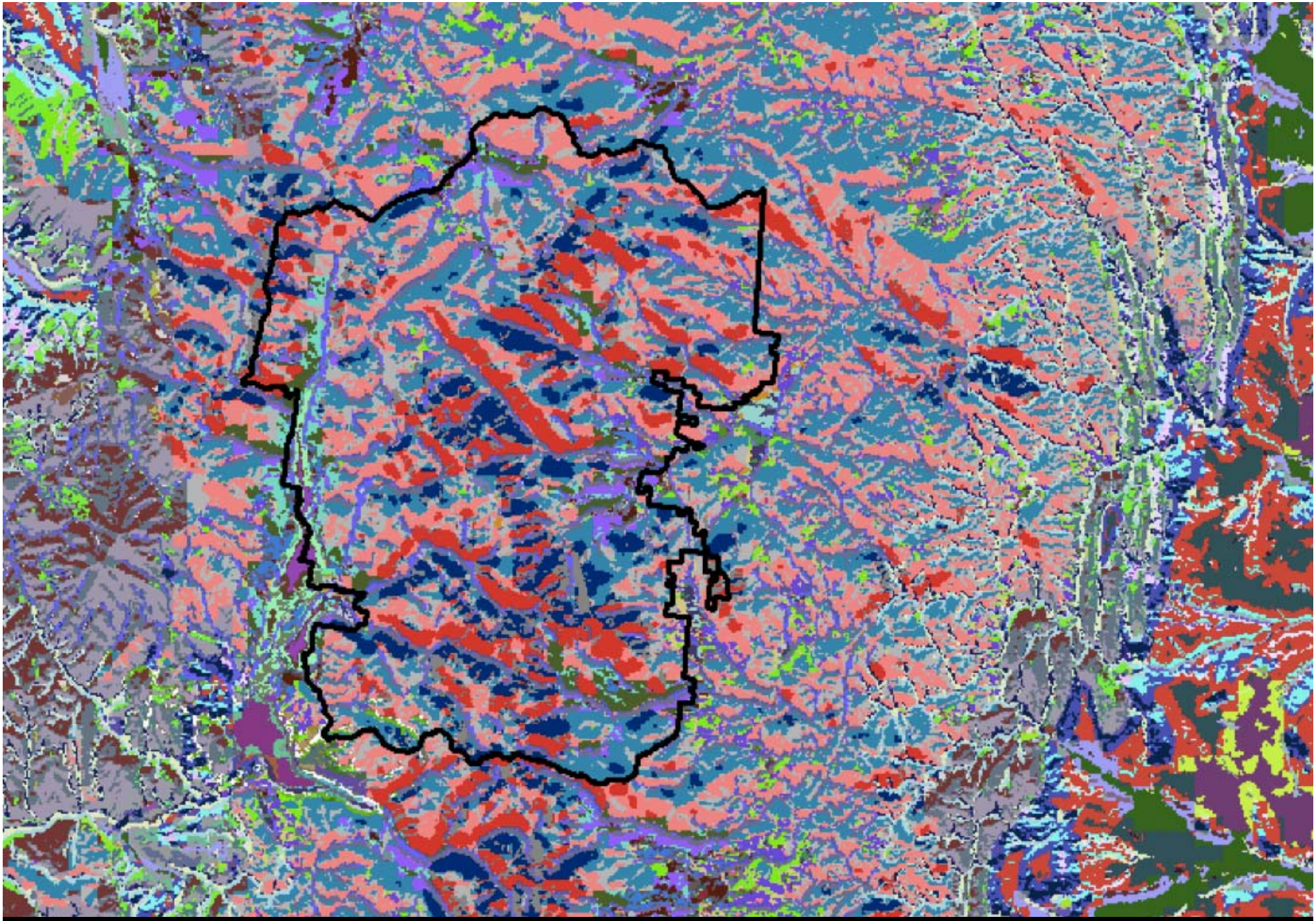
- Carbonate Residual Material
- Non-Carbonate Residual Material
- Alkaline Intrusive Volcanic Rock
- Silicic Residual Material
- Extrusive Volcanic Rock
- Colluvial Sediment
- Glacial Till, Clayey
- Glacial Till, Loamy
- Glacial Till, Coarse-Textured
- Glacial Outwash and Glacial Lake Sediment, Coarse-Textured
- Glacial Lake Sediment, Fine-Textured
- Hydric, Peat and Muck
- Eolian Sediment, Coarse-Textured (Sand Dunes)
- Eolian Sediment, Fine-Textured (Glacial Loess)
- Saline Lake Sediment
- Alluvium and Fine-Textured Coastal Zone Sediment
- Coastal Zone Sediment, Coarse-Textured
- Water


0 500 1000 KILOMETERS
0 250 500 MILES
Land Surface Forms
Flat Plains
Smooth Plains
Irregular Plains
Escarpments
Low Hills
Hills
Breaks/Foothills
Low Mountains
High Mountains/Deep Canyons

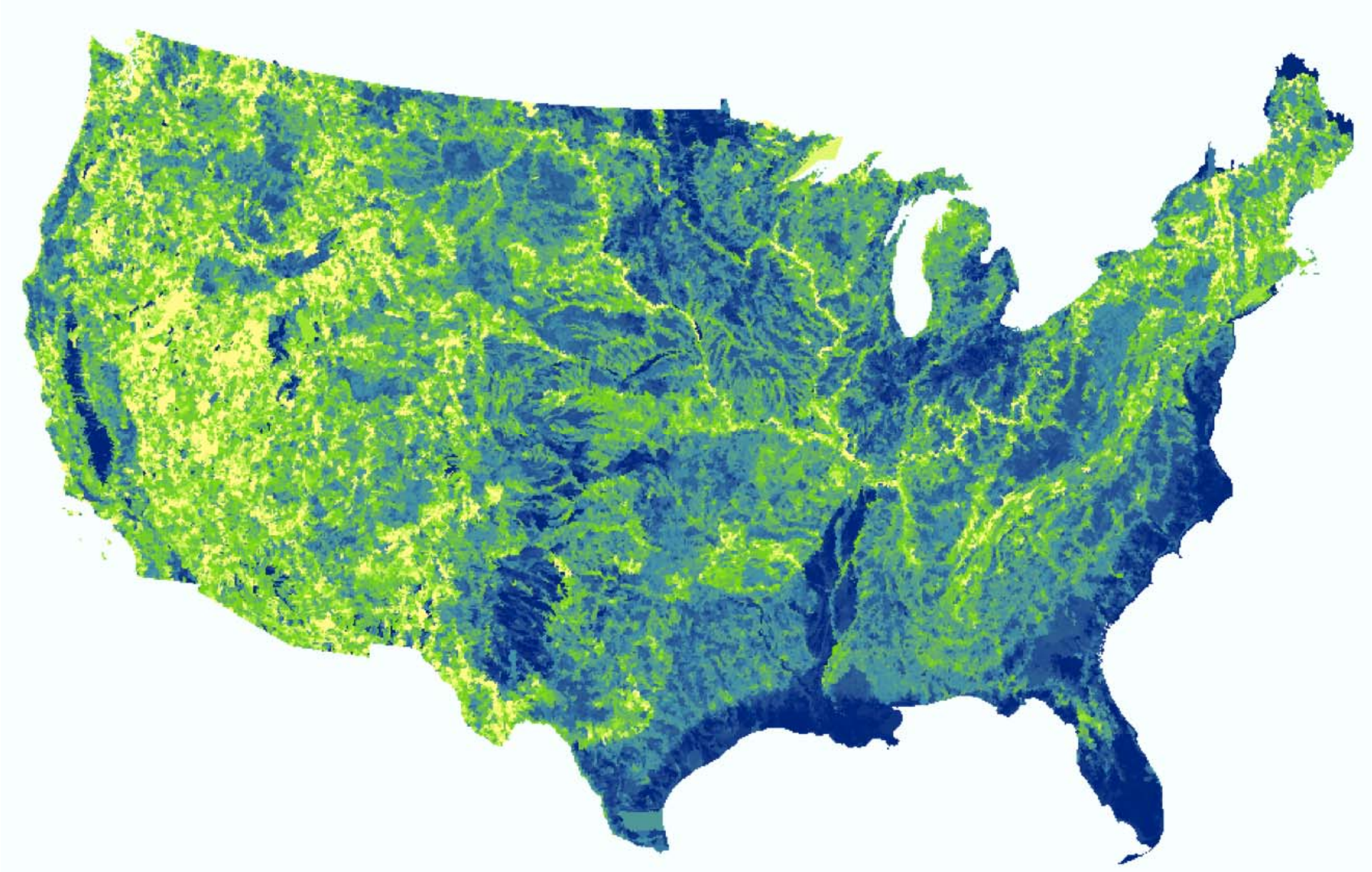
Landscape units methods

- Aspect from a 90 m resolution DEM
- Classified three aspect classes: dominantly south-facing aspects (SW, S, and SE), dominantly north-facing (NW, N, and NE), and low slope (< 3%) or E/W.
- Combined but constrained the combinations logically so that alluvial/colluvial lithology types would not reasonably co-occur with high mountains/canyons, and conversely valley bottoms
- 646 unique combos





Landscape unit richness - HUC12



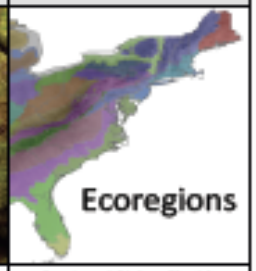
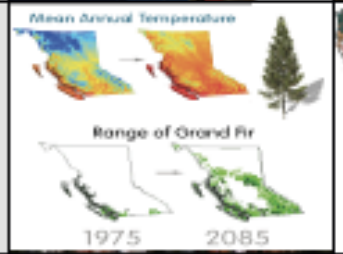
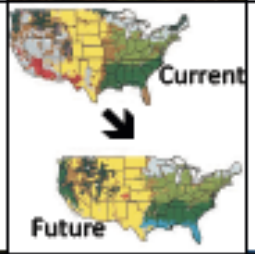
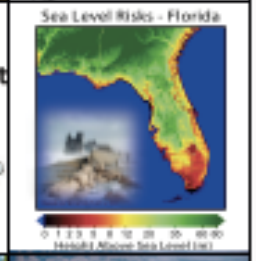
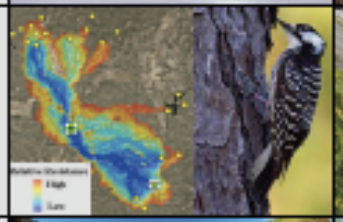
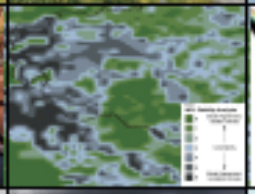
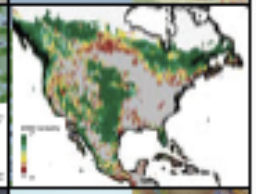
The end (of land change)

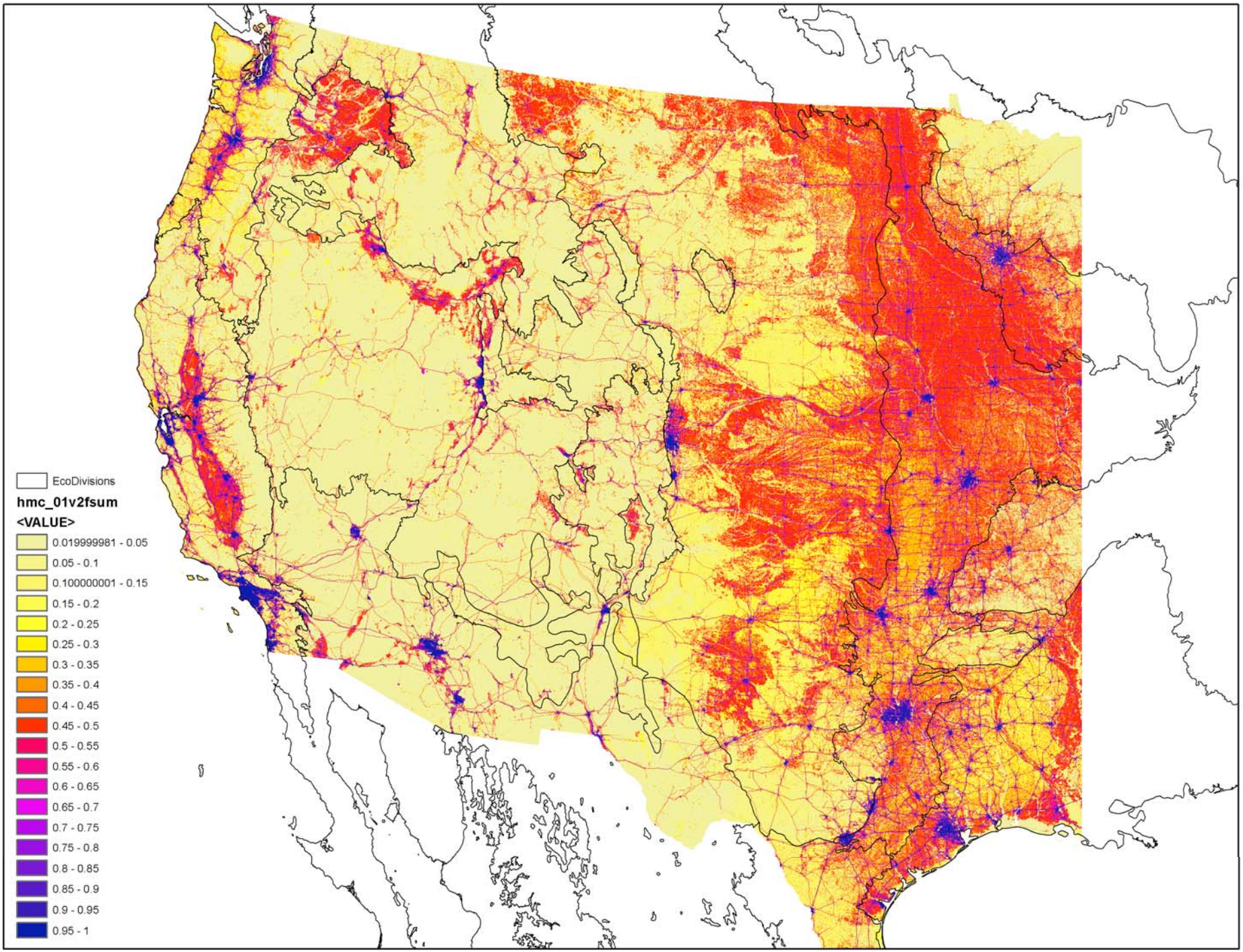
Outline

- Connectivity
  - Emphasis on multiple-levels of ecological organization (esp. landscape)
  - WGA comparison of modeling approaches
  - Terrestrial, riparian, ecological systems, climate dynamics and movement
  - !Aquatic, riparian

Yale framework

Levels of Ecological Organization

Adaptation Strategies:	Species and populations	Ecosystems	Landscapes
Protect current patterns of biodiversity (baseline)			
Project future patterns of biodiversity			
Maintain Ecological Process			
Maintain and restore ecological connectivity			
Protect climate refugia			
Protect the ecological stage (enduring features)			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hmc_01v2fsum
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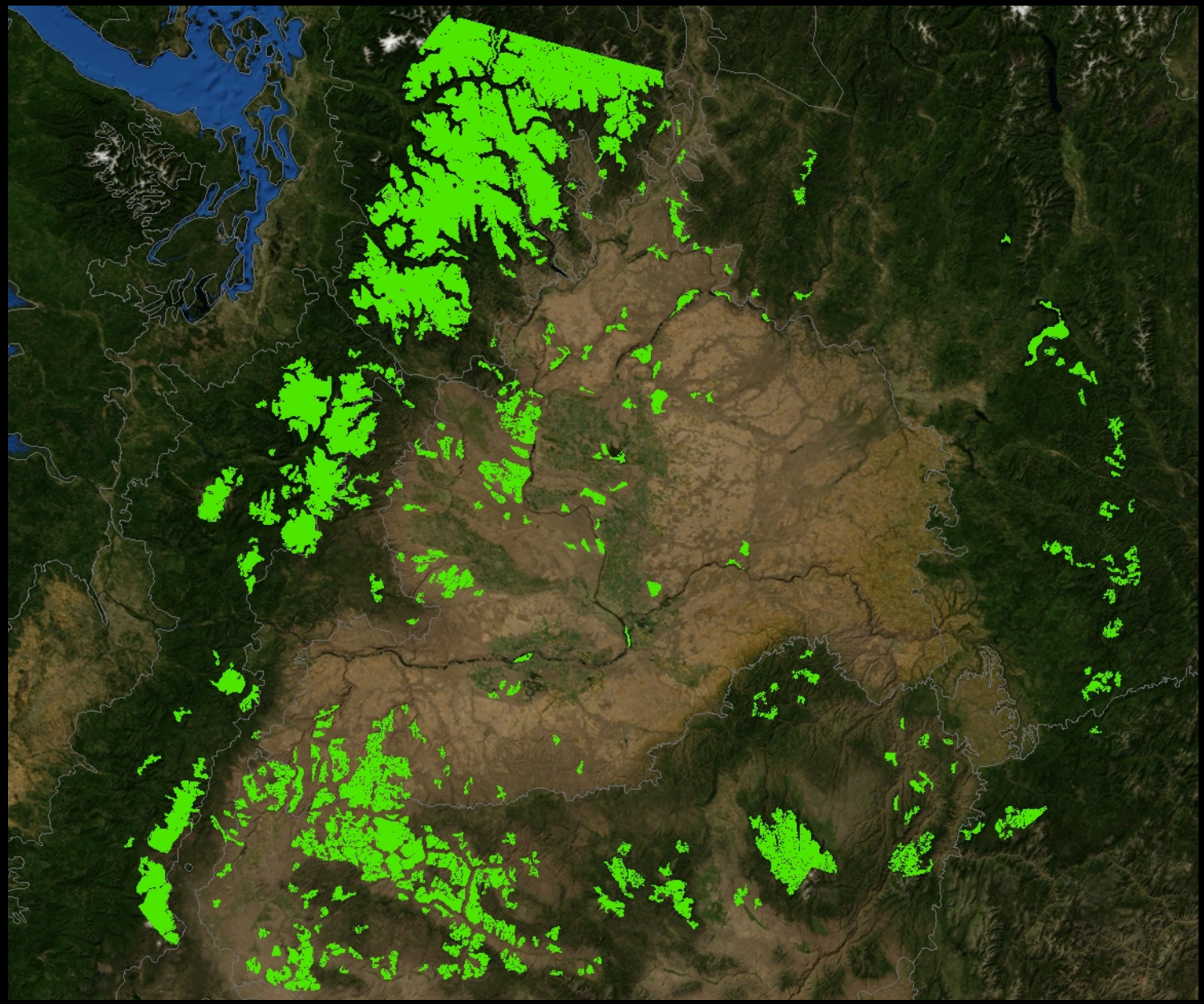
0.2 - 0.25
0.25 - 0.3
0.3 - 0.35
0.35 - 0.4
0.4 - 0.45
0.45 - 0.5
0.5 - 0.55
0.55 - 0.6
0.6 - 0.65
0.65 - 0.7
0.7 - 0.75
0.75 - 0.8
0.8 - 0.85
0.85 - 0.9
0.9 - 0.95
0.95 - 1

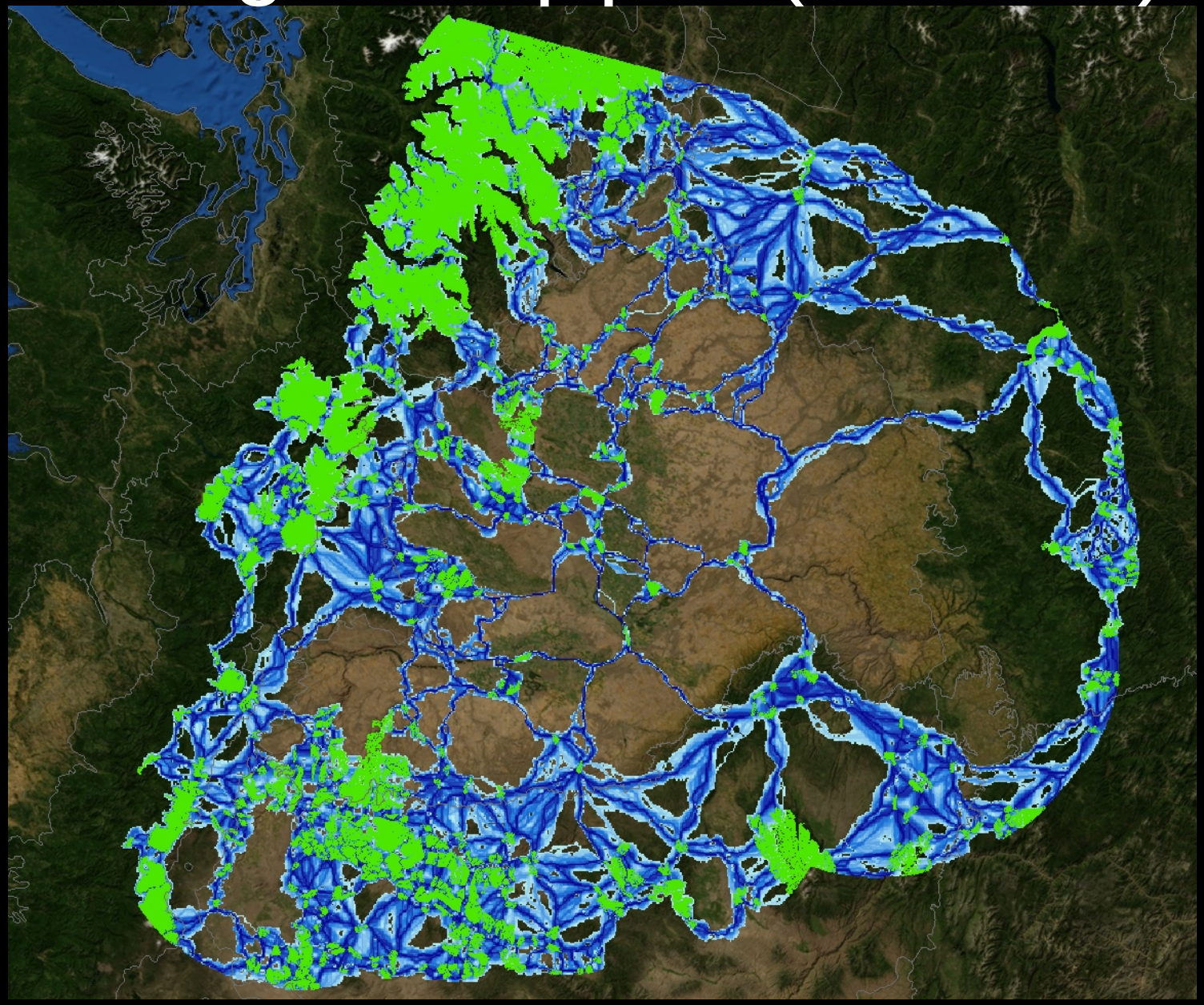
Comparison of methods

Type	Model	Inputs	Outputs
Core-corridor	LinkageMapper	LIBs Resistance surface	Corridors Current flow w/in corridors Centrality
	Circuitscape from all cores	LIBs Resistance surface	Current flow across surface
Gradient	Landscape Permeability (multi-scale)	Resistance surface	gLIBs Landscape permeability Centrality lines
	Landscape permeability (random-start)	Resistance surface	gLIBs Landscape permeability Centrality lines
	Centrality (Connectivity Analysis Toolkit)	Resistance surface	Centrality surface of hexagons

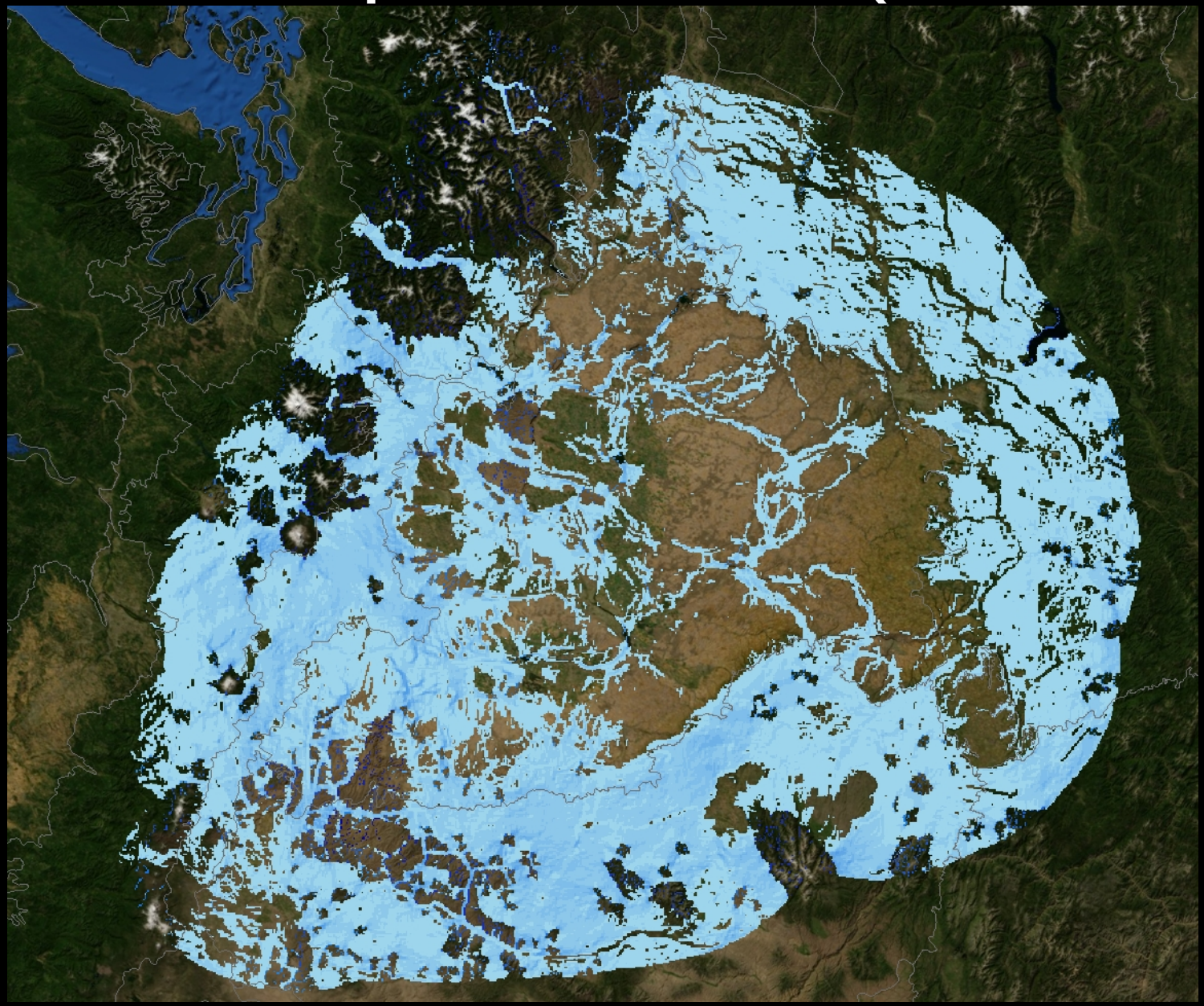
Large intact blocks



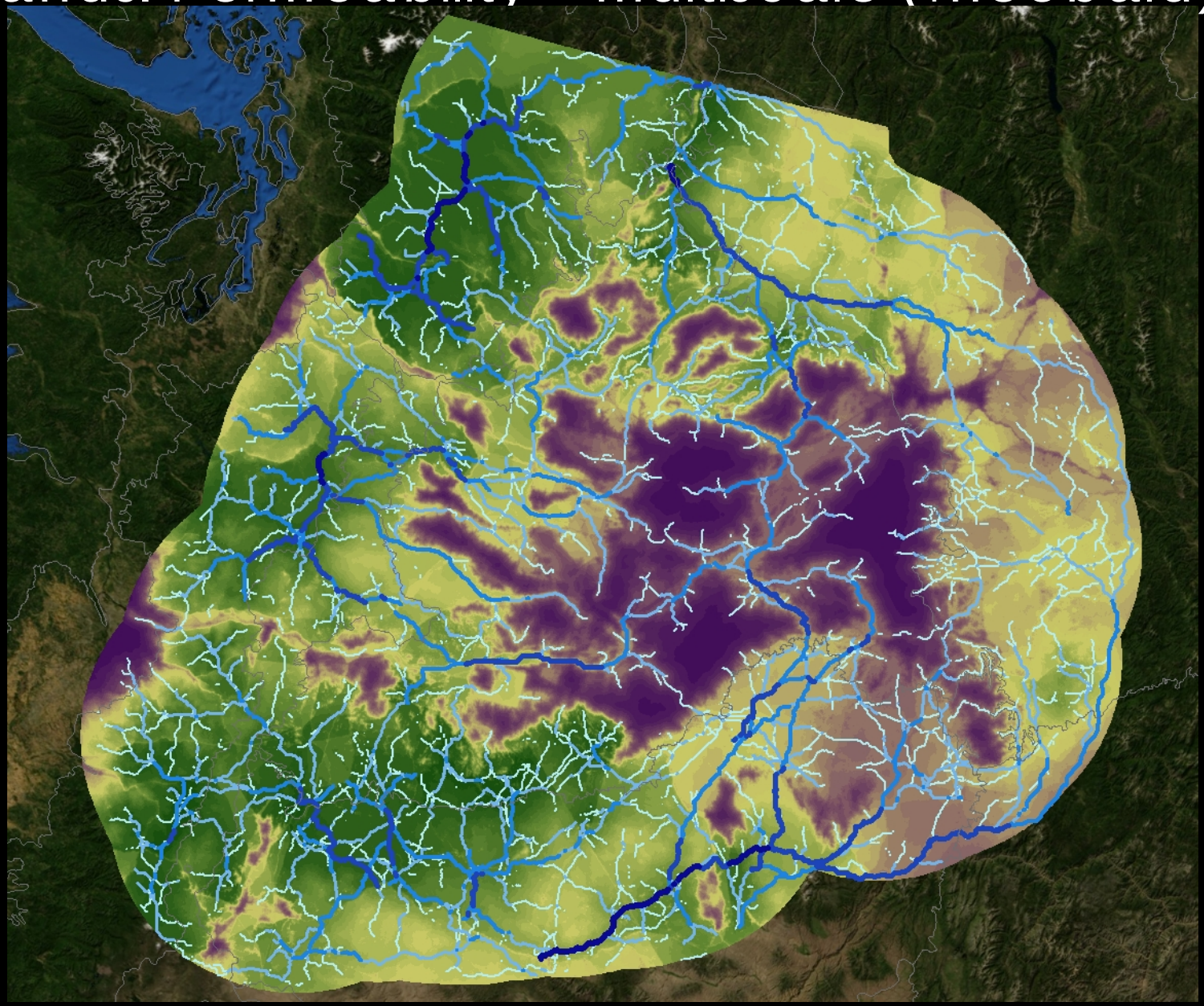
Linkage Mapper (McRae)



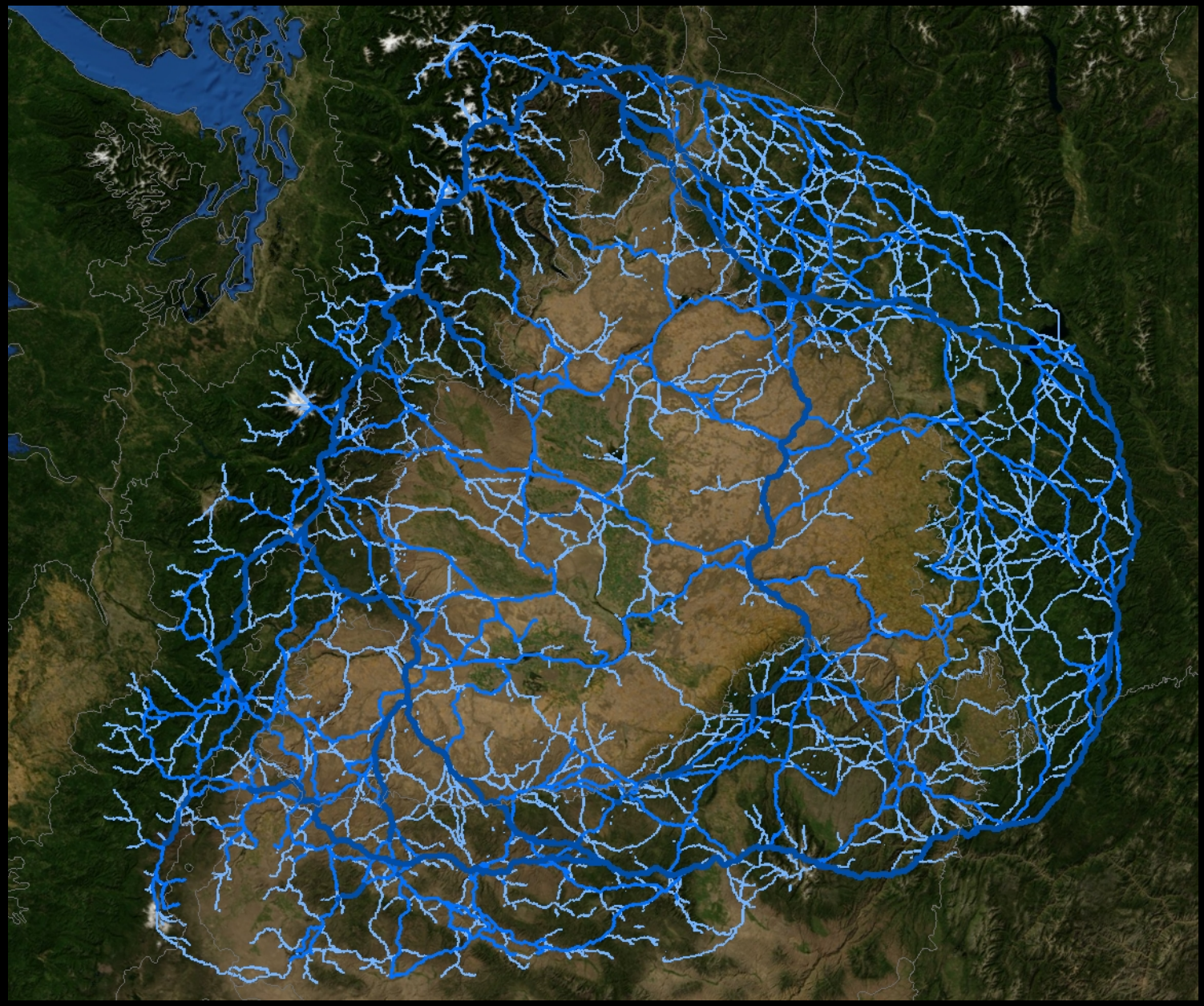
Circuitscape – cores (Dickson)



Lands. Permeability – multiscale (Theobald)



Lands. Permeability – random (Theobald/Reed)



Centrality CAT (Carroll)