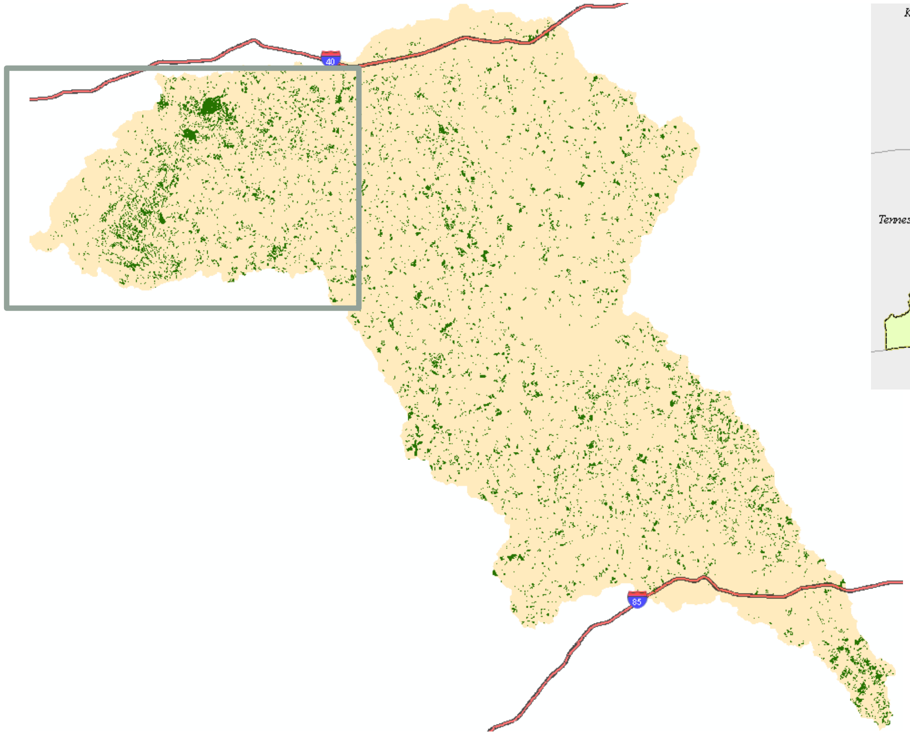
GEOSPATIAL HABITAT ASSESSMENT TOOLKIT

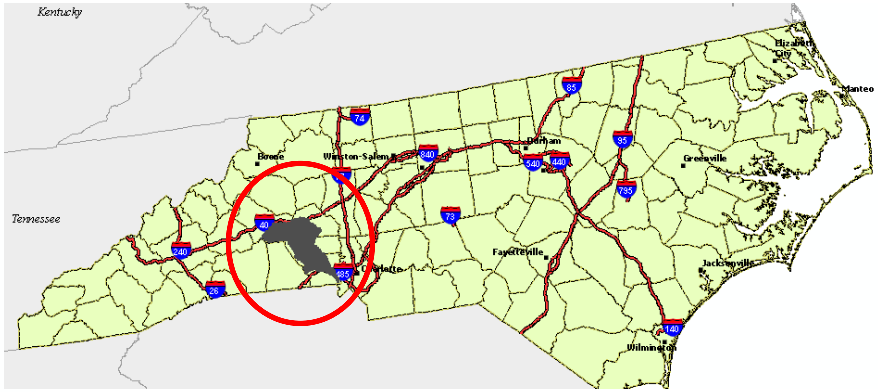
Version 0.015

June 20, 2012

Case study: Salamander

- Area of interest: South Fork Catawba R. basin

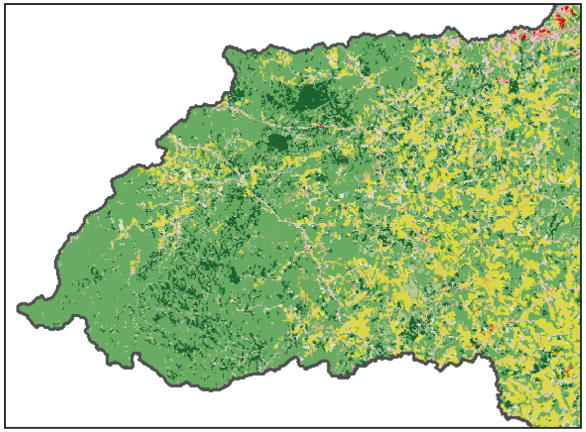




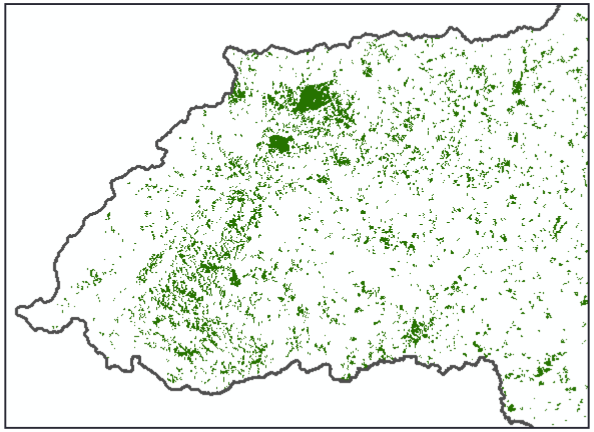
- Habitat: NLCD evergreen forest patches > 5 HA

Step 1: Creating habitat patches

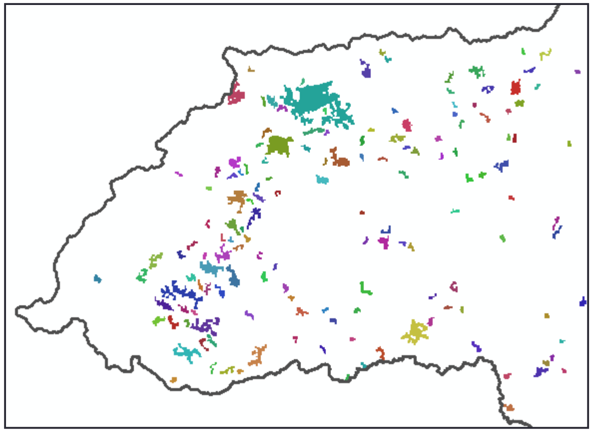
a) Isolate habitat from NLCD (all evergreen pixels)
b) Group contiguous habitat cells into patches
c) Remove patches smaller than 5 HA



2006 NLCD



Evergreen pixels



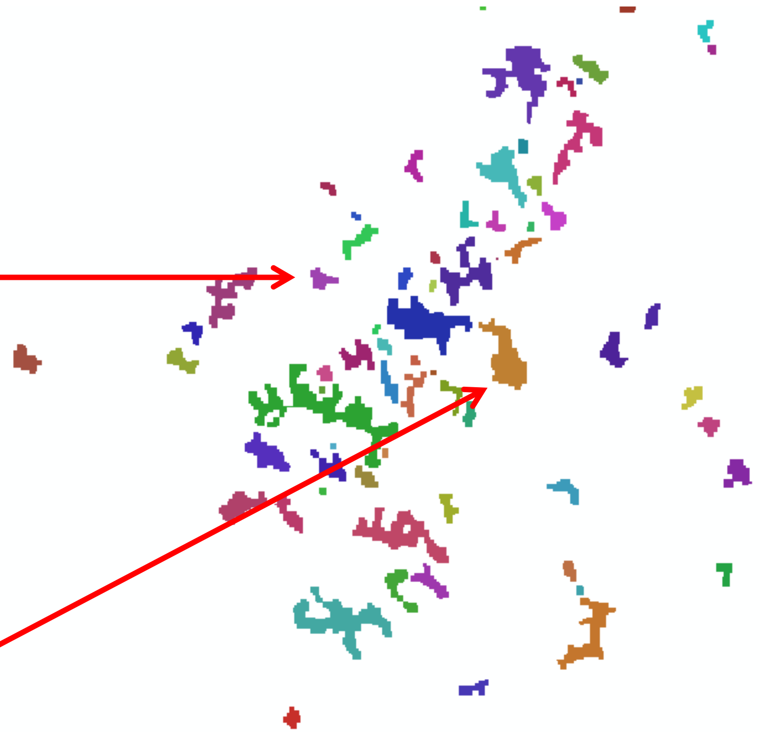
Evergreen patches > 5HA
n = 458

Step 2: Calculate patch geometry

- Patch area
- Patch core area (edge = 60m)
- Core:Area ratio
- Shape index

PatchID	166
PatchArea_HA	7
CoreArea_HA	2
CoreAreaRatio	0.2841
ShapeIndex	0.75047

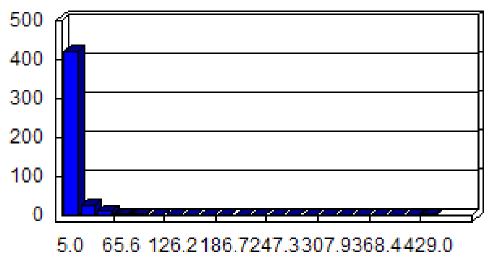
PatchID	175
PatchArea_HA	35
CoreArea_HA	18
CoreAreaRatio	0.5302
ShapeIndex	0.60454



Step 2: Calculate patch geometry

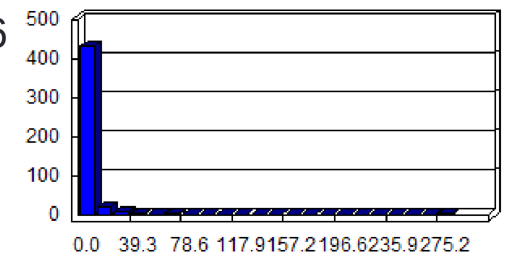
Patch Area (HA)

Minimum: 5.0
Maximum: 436
Sum: 6034
Mean: 13.17
St Dev: 22.78



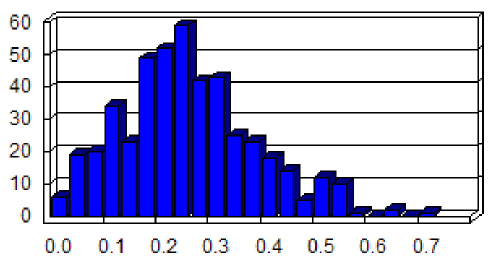
Core Area (HA)

Minimum: 0
Maximum: 280
Sum: 2106
Mean: 4.6
St Dev: 14.3



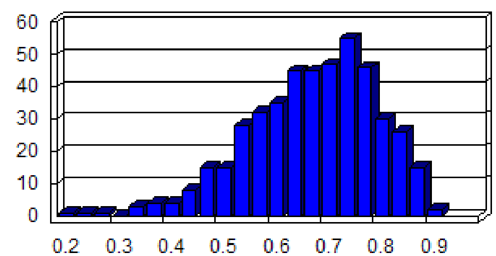
Core Area Index

Minimum: 0
Maximum: 0.706
Mean: 0.257
St Dev: 0.125



Shape Index

Minimum: 0.243
Maximum: 0.934
Mean: 0.710
St Dev: 0.118

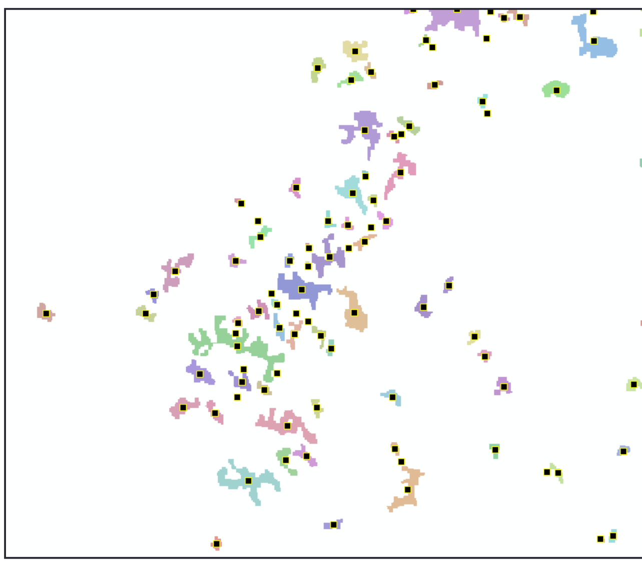


Step 3: Calculate patch connectivity

a) Create an **edge list** (Euclidean or Cost distance)
   - Create cost raster if using the cost distance approach
b) Draw **edges/least cost paths** between patches
c) Summarize graph to determine **connectivity distance**:
   - Plot graph diameter at threshold distance intervals
d) Calculate **centrality metrics**:
   - *Degree* (number of patches within the distance threshold)
   - *Betweenness* (frequency in least cost paths among patch pairs)
   - *Closeness* (avg. distance to neighbors relative to other patches)
e) Calculate **connected habitat area**:
   - Total area within the distance threshold
   - Inverse distance weighted area set to $d_{0.01}$ at distance threshold

Step 3a/b: Creating an edge list

- <u>Euclidean distance method:</u>
  - Measures straight-line distance between patch centroids
  - Very fast and does not require data on travel costs
  - Hope to improve by measuring distances between patch *edges*

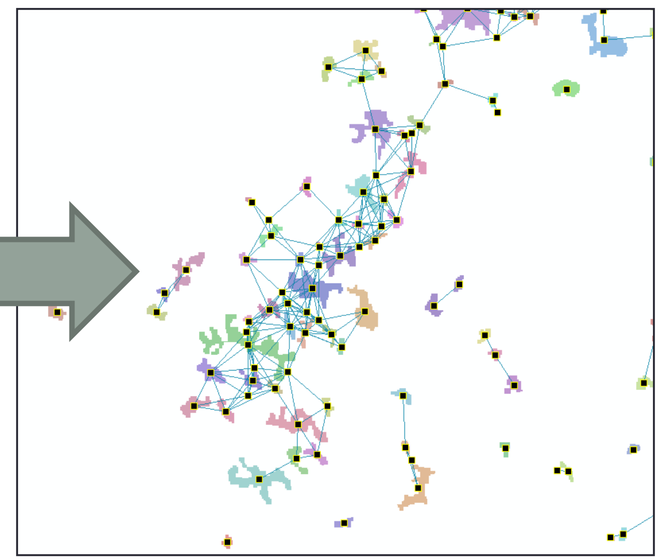


Patch Centroids

SalEdgeList

FromID	ToID	Distance
1	493	62362
1	490	62084
1	497	64481
1	496	64131
1	495	64144
1	494	63006
1	492	62937
1	491	63165
1	489	62427
1	487	60493
1	482	59525
1	484	59690

Edge list



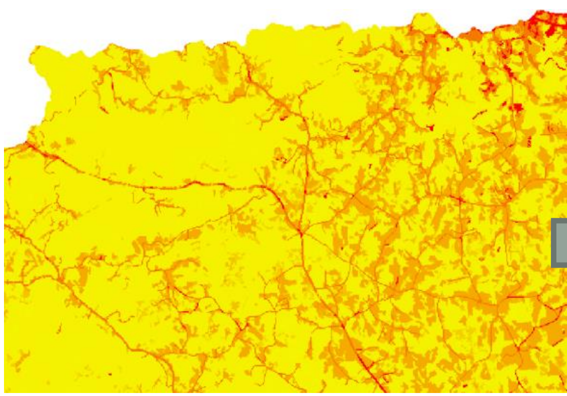
Patch Edges

Step 3a/b: Creating an edge list

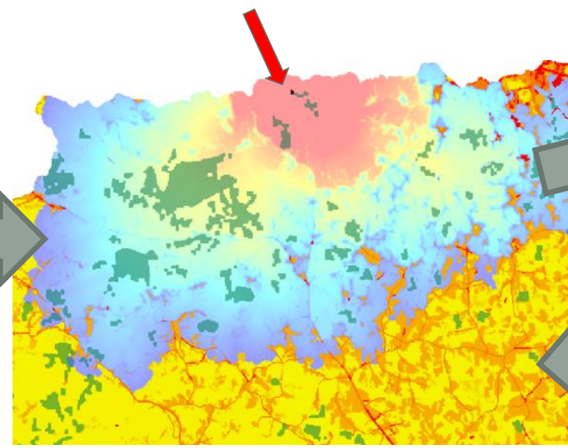
- <u>Cost distance method</u>:
  - Requires a travel cost raster (information on resistances)
  - Takes significantly longer to calculate, but potentially more precise
  - Requires recalculation whenever costs change

FromID	ToID	Cost
1	2	68245.9
3	4	4498.6
3	19	56962.52
3	39	57742.26
4	19	50529
4	39	52522.3
5	6	300
5	7	60474.01
5	8	59961.88
5	9	2849.48
5	11	63101.07
5	12	4704.34

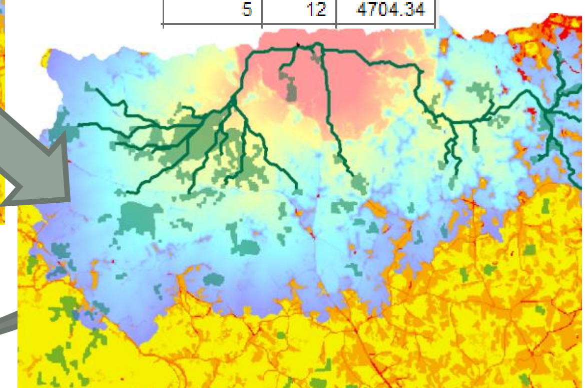
Edge list



Cost raster



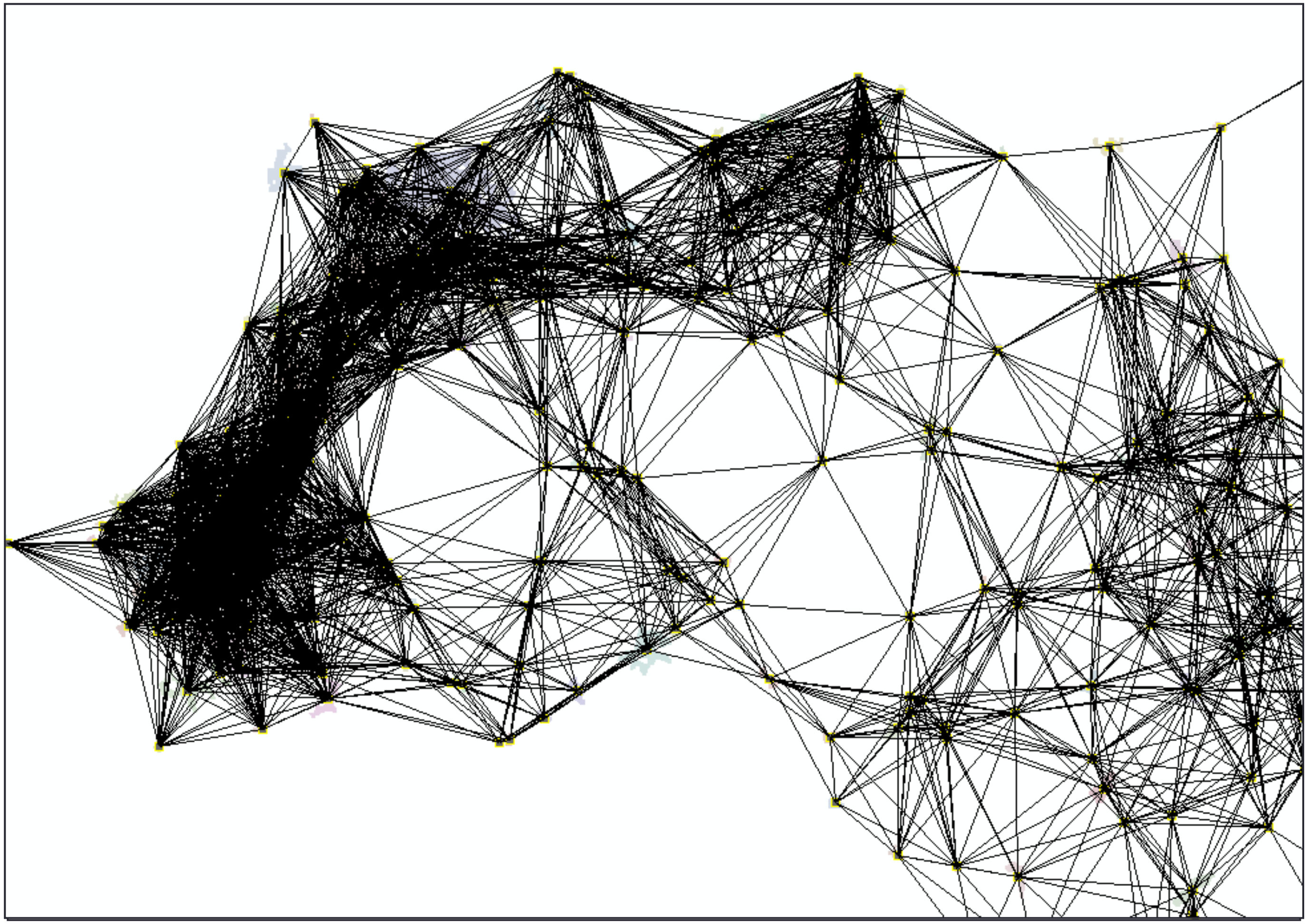
Cost distance from patch



Least cost paths to patch

Iterate through all patches

Step 3c: Summarize graph



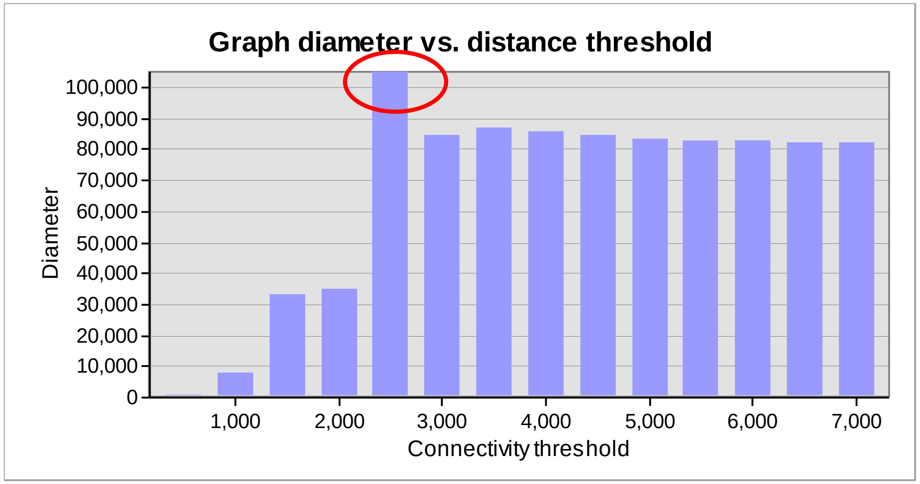
Threshold = **5** km; Diameter = **20**; # Components = **1**

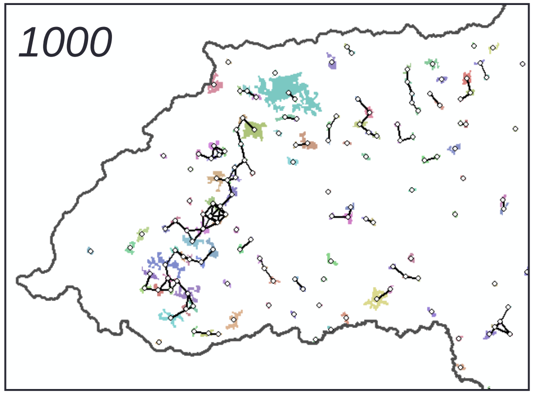
Step 3c: Summarize graph

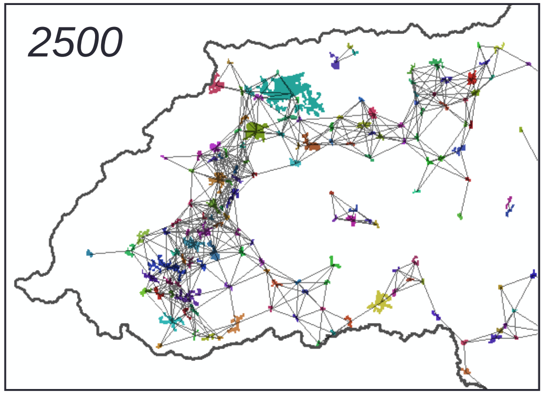
- Calculate graph diameter & number of components across a set interval of connectivity thresholds

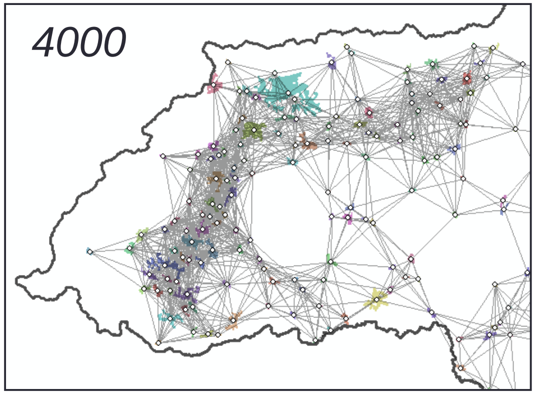
Graph Summary TXT

Distance	NComps	Diameter
500	431	851
1000	251	7874
1500	113	32895
2000	59	34604
2500	28	104867
3000	9	84514
3500	2	87165
4000	1	85987
4500	1	84682
5000	1	83088
5500	1	82844
6000	1	82559



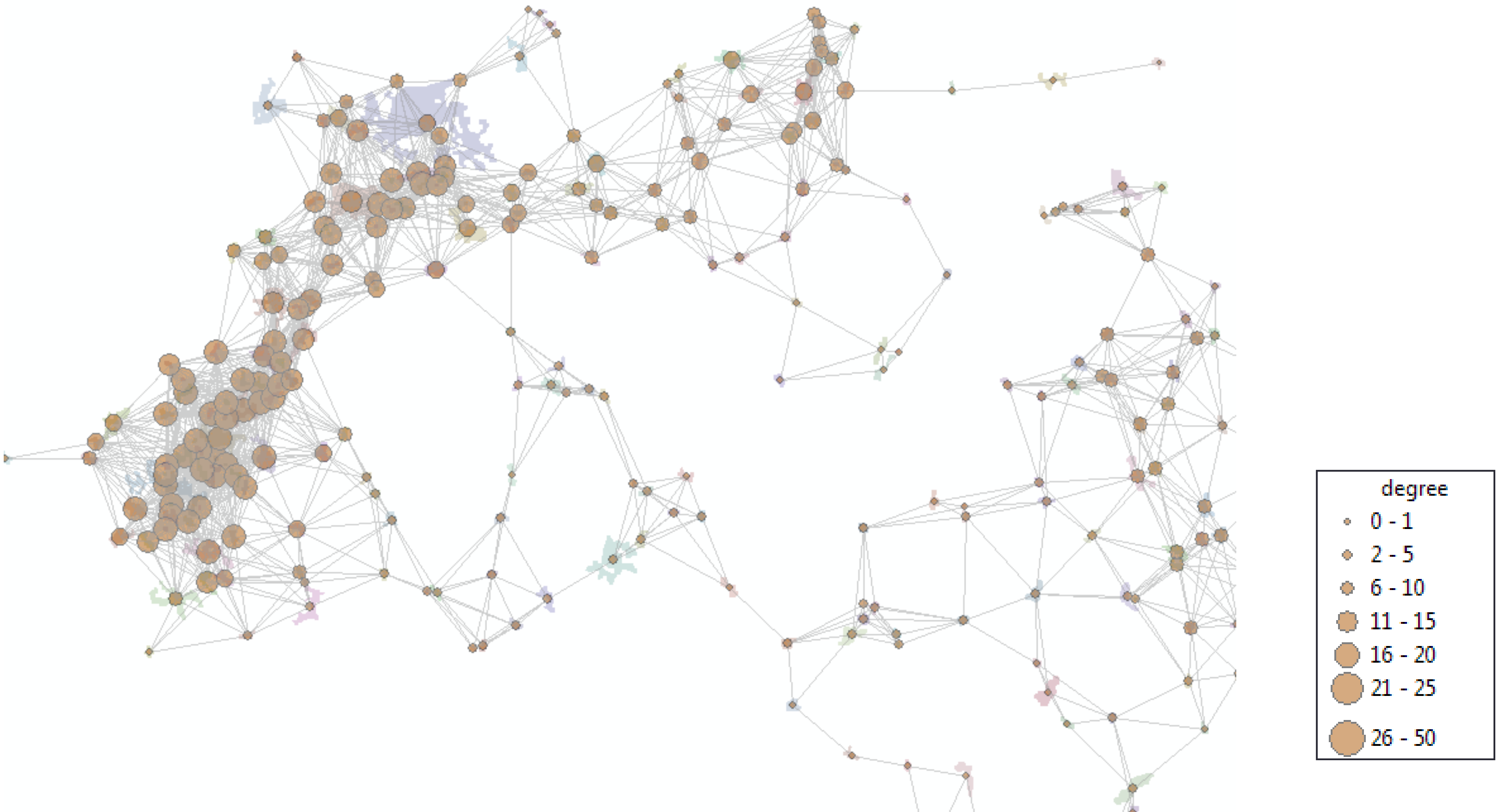






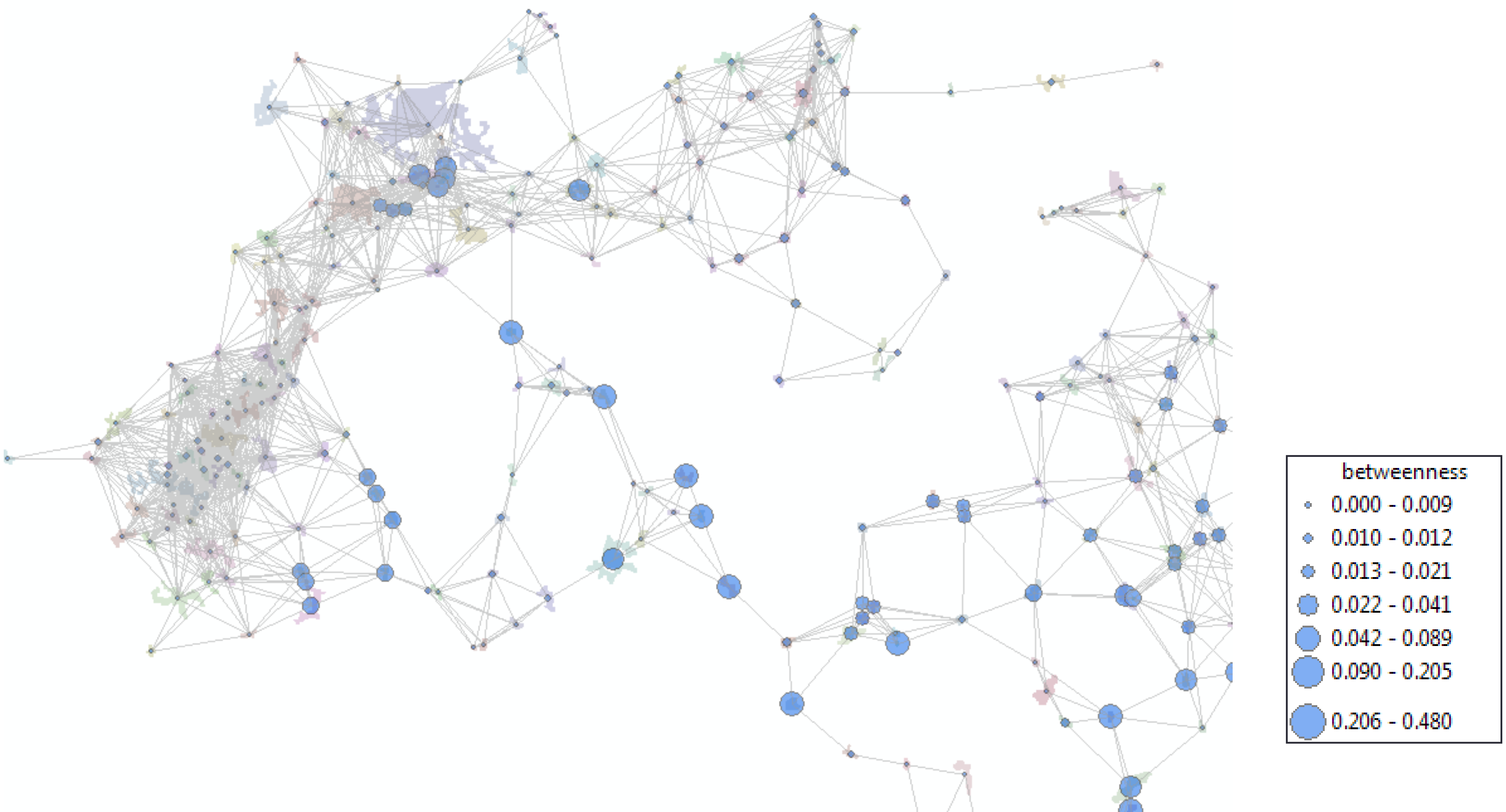
Step 3d: Centrality metrics

- <u>Degree centrality</u>:
  # patches within connectivity threshold to a given patch



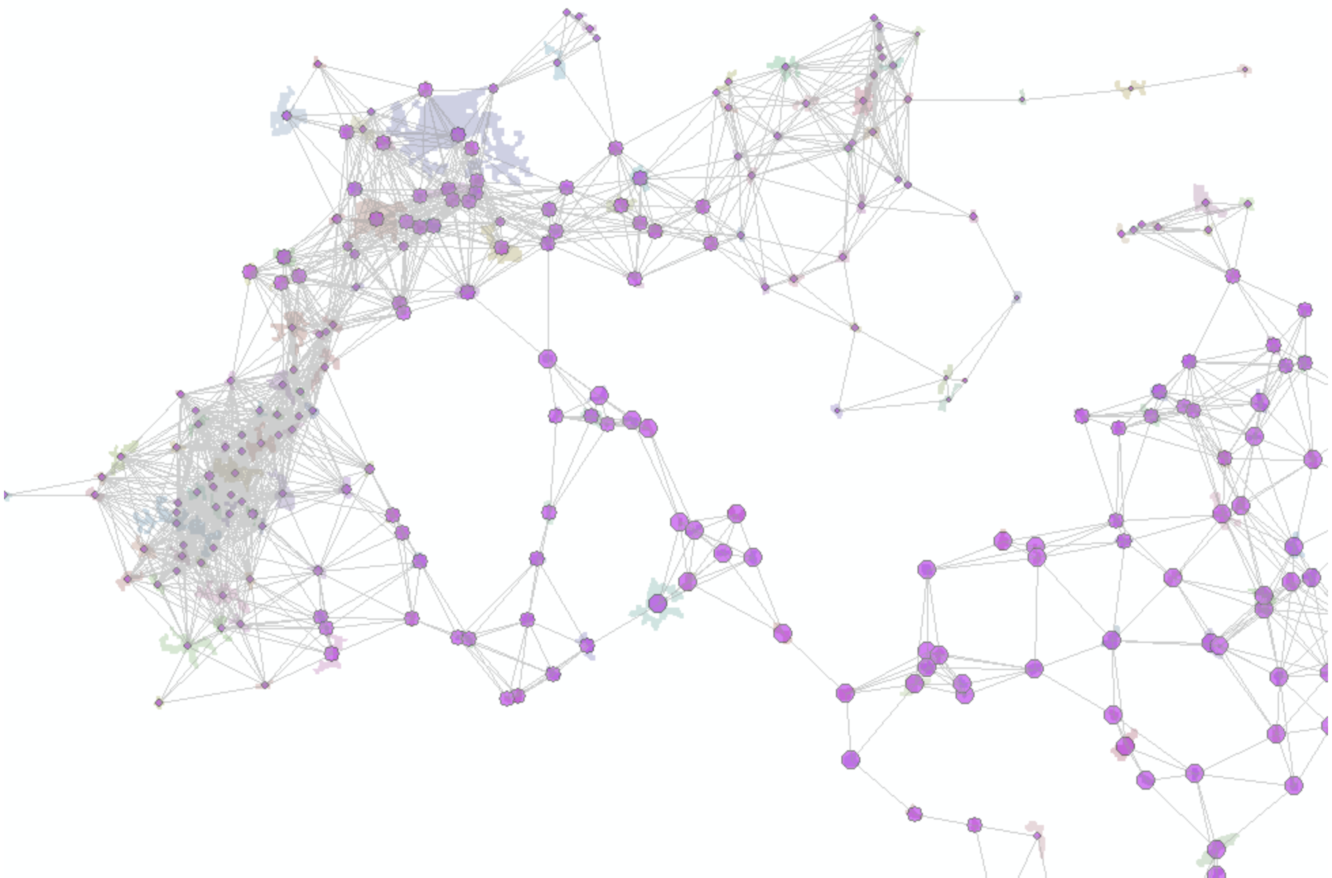
Step 3d: Centrality metrics

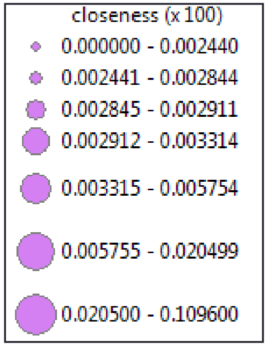
- Betweenness centrality:
  Frequency a patch is found in the LCP between other patches



Step 3d: Centrality metrics

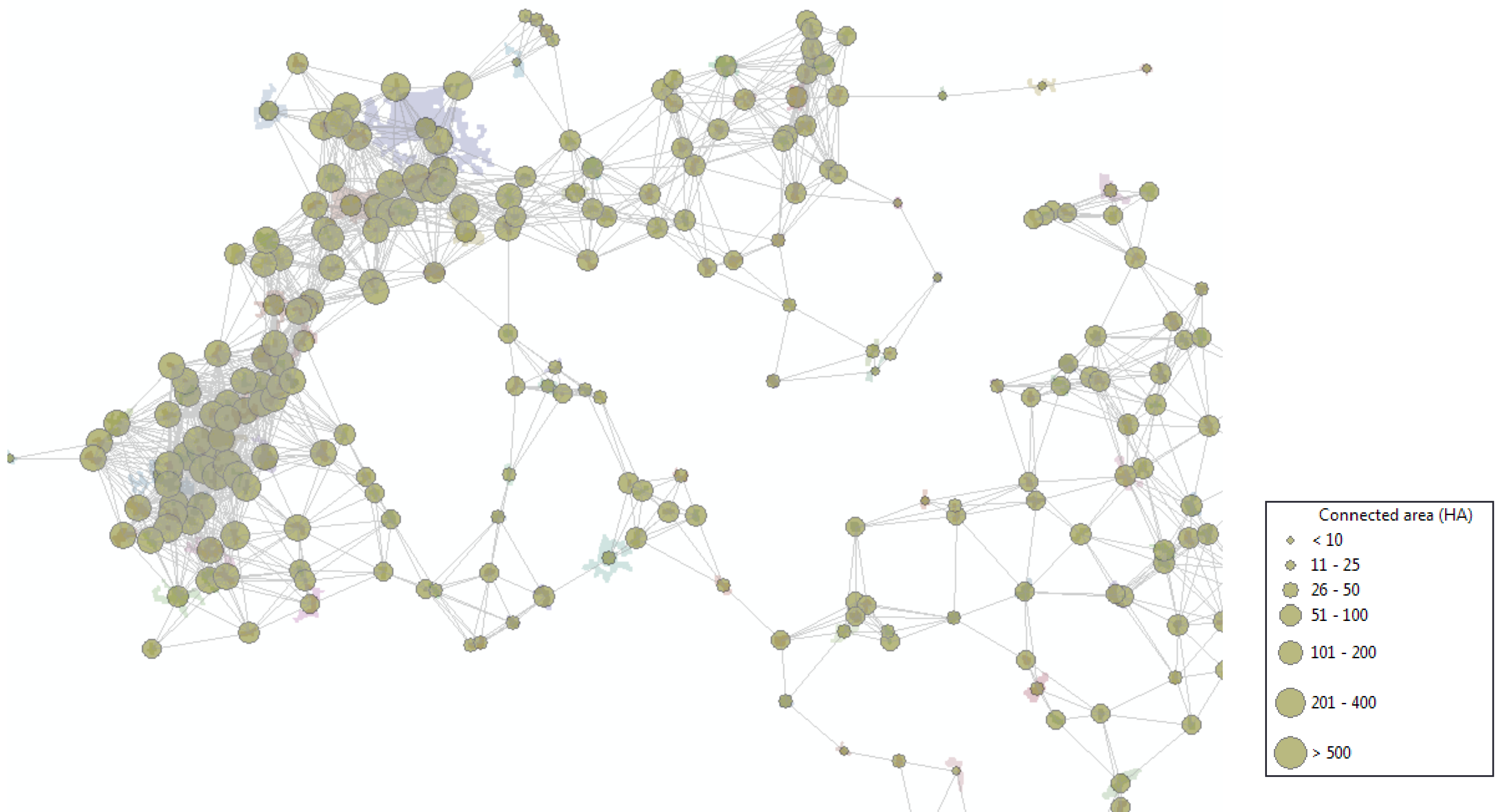
- <u>Closeness centrality</u>:
  Avg. distance to neighbors relative to other patches





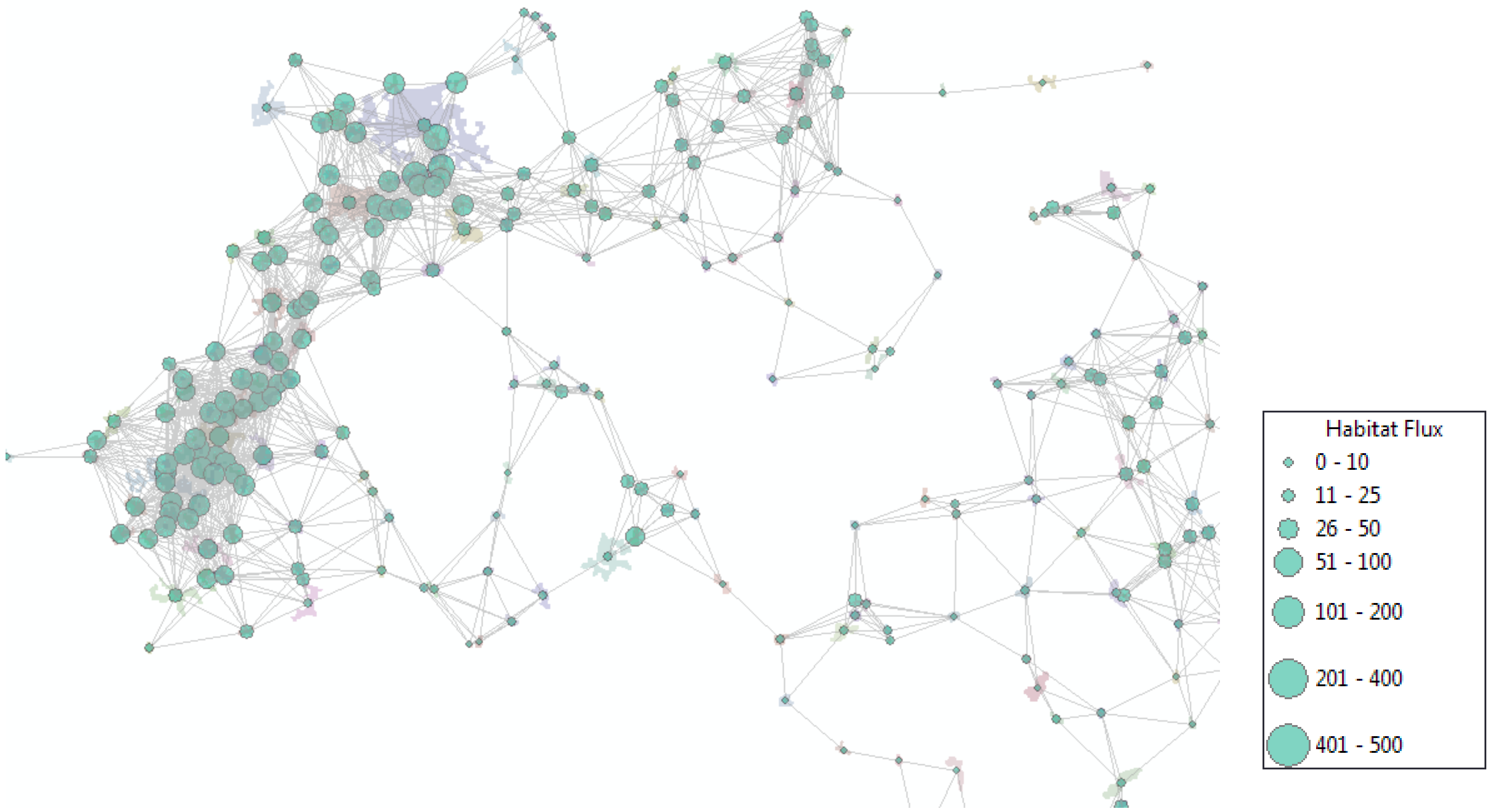
Step 3e: Connected habitat area

- <u>Connected area (HA)</u>:
  Total patch area within the connectivity threshold (3 km)



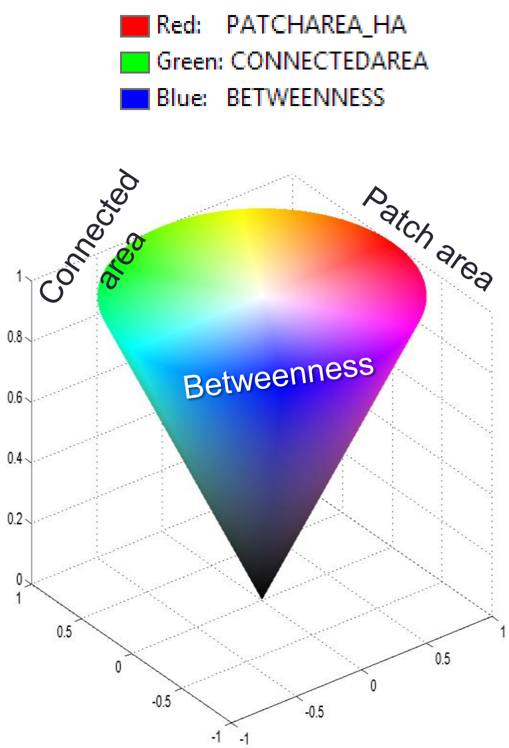
Step 3e: Connected habitat area

- <u>Probably connected area</u>:
  Inverse distance weighted area within connectivity threshold (3 km)

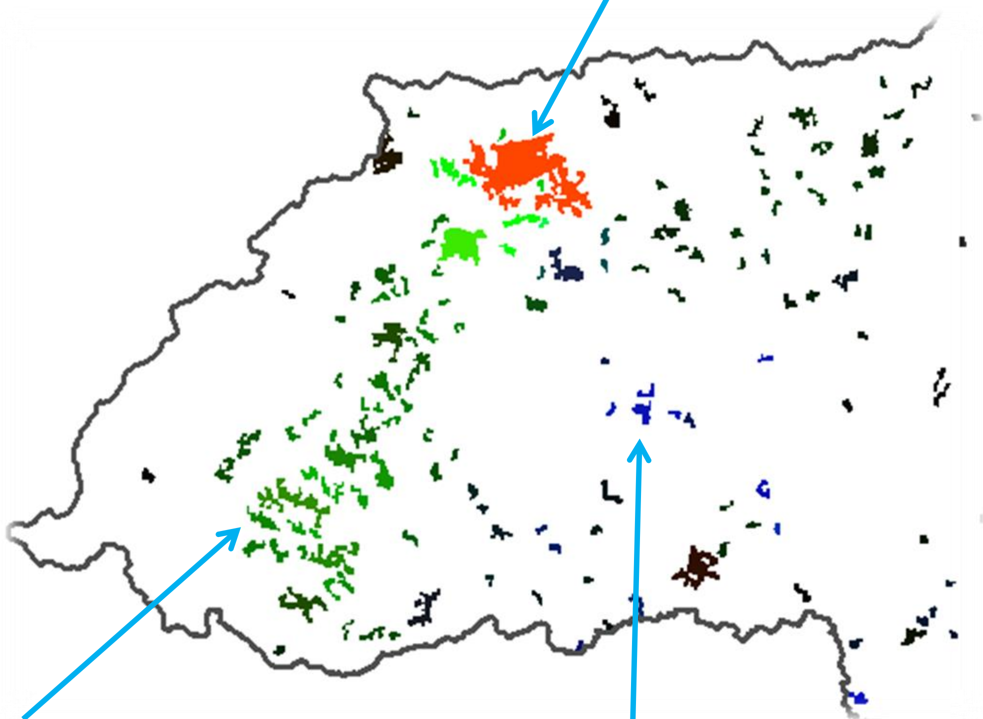


Step 4: Creating a patch composite

- Allows viewing of multiple attributes



Large & connected, but not central

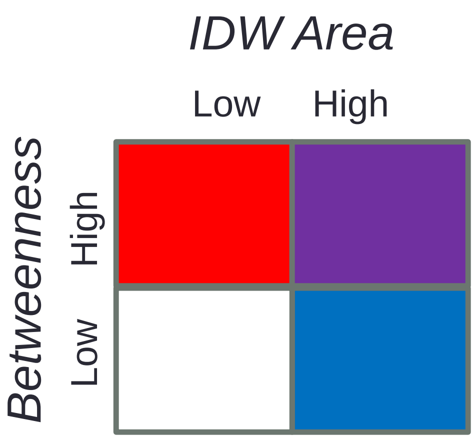


Small, non-central, but lots connected

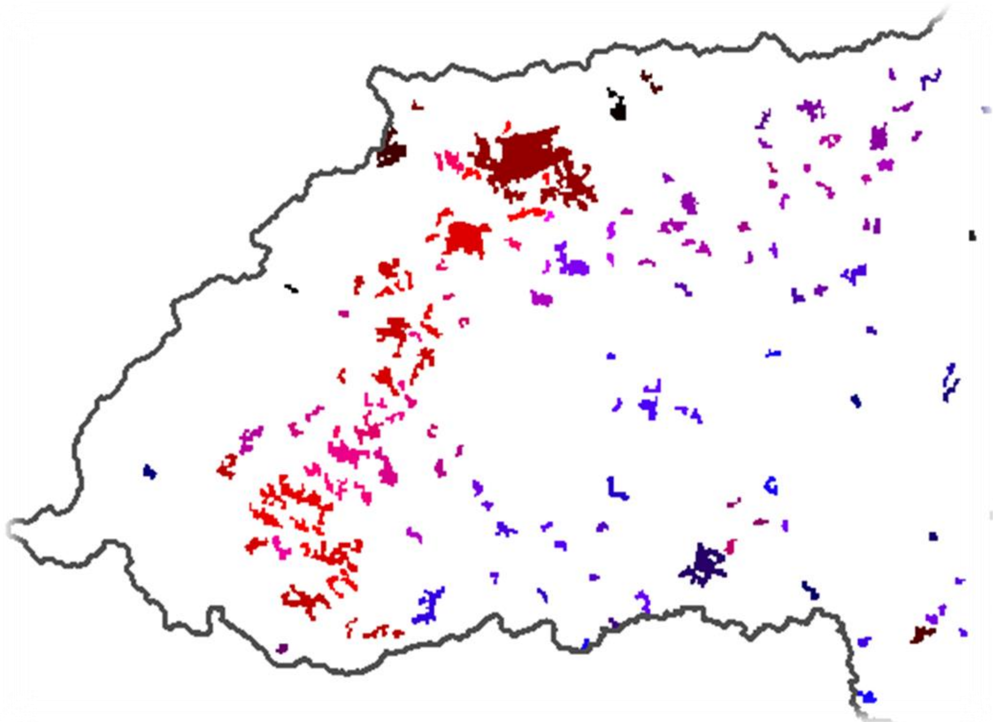
Central, but small & not connected

Step 4: Creating a patch composite

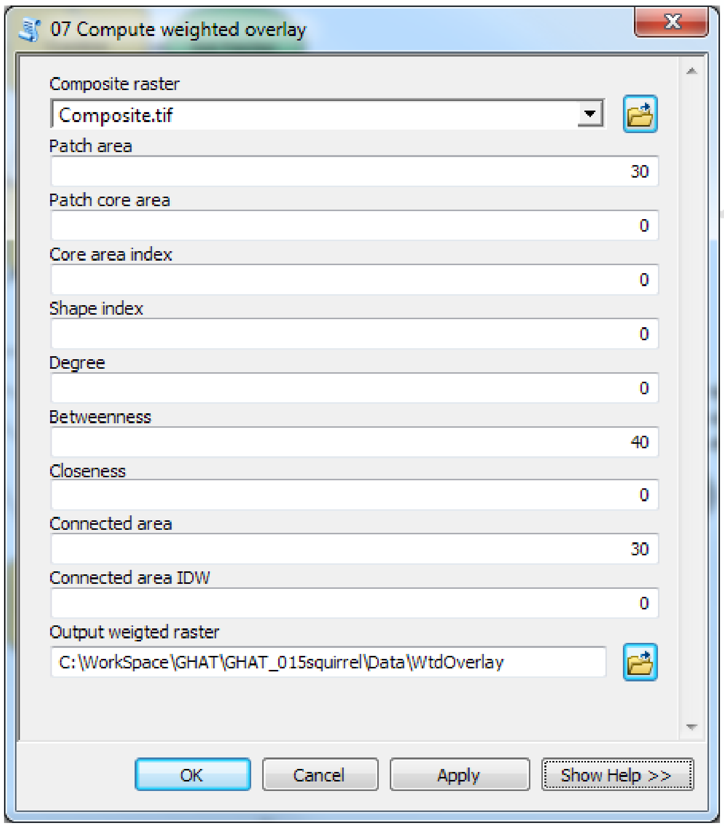
- Allows viewing of multiple attributes



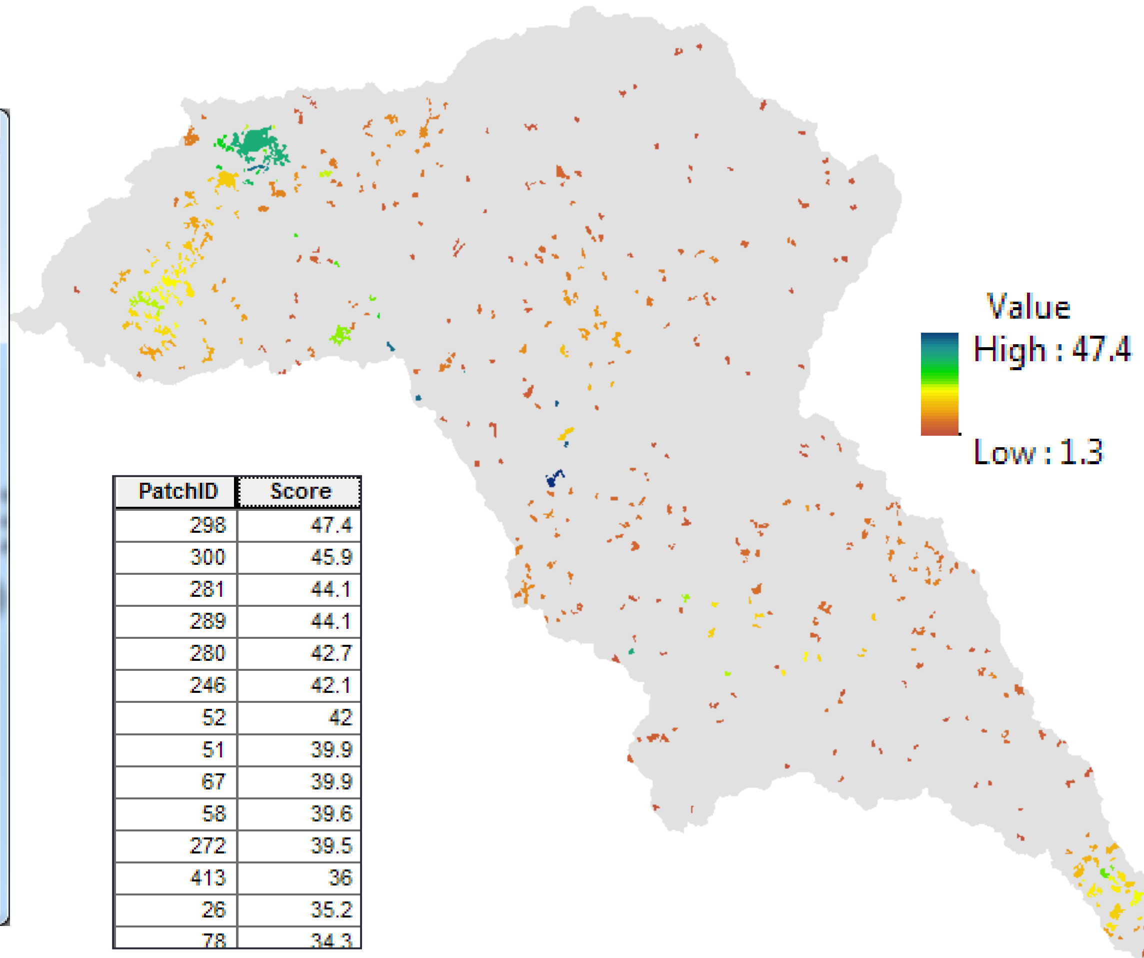
Red: IDWAREA
Green: NONE
Blue: BETWEENNESS



Step 5: Compute a weighted overlay



PatchID	Score
298	47.4
300	45.9
281	44.1
289	44.1
280	42.7
246	42.1
52	42
51	39.9
67	39.9
58	39.6
272	39.5
413	36
26	35.2
78	34.3

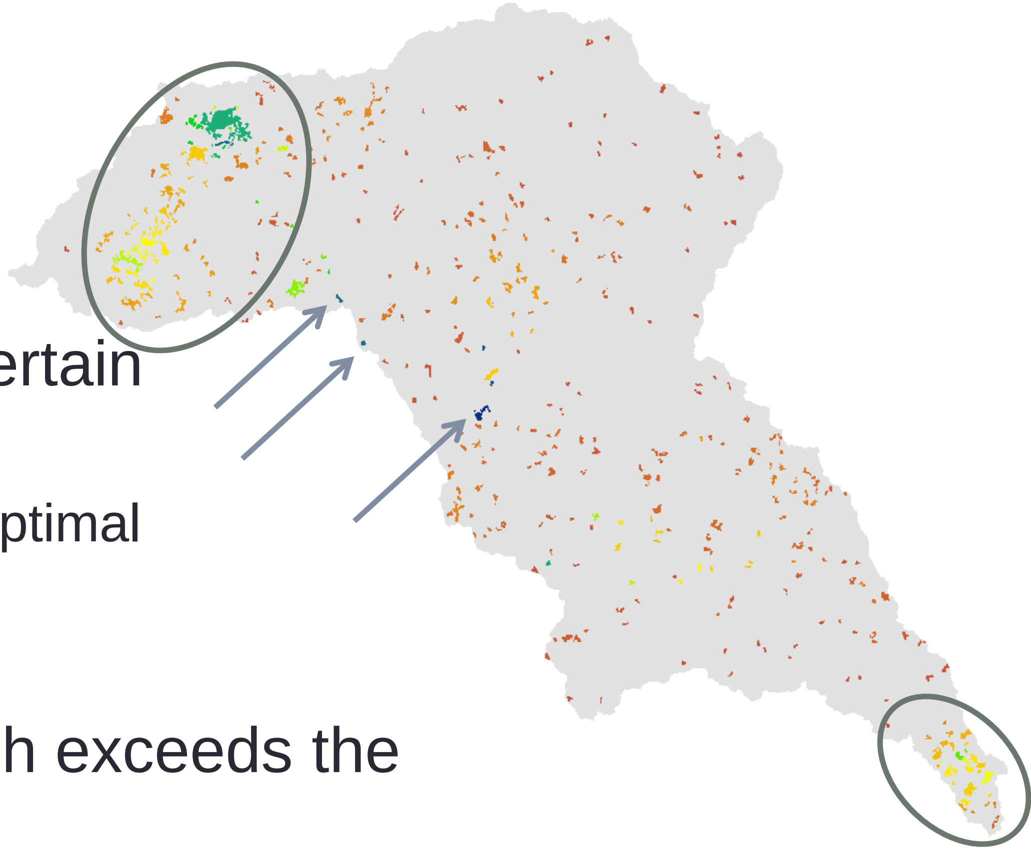


Still to come

- Connectivity to **protected areas**
  - Euclidean/cost distance to nearest protected area
  - Centrality metrics to connectivity areas (degree, betweennes, closeness)
- Patch ranking on **threat**
  - Identify areas of urbanization from 2006-2001 NLCD difference
  - Calculate focal mean of urbanization (% urbanization within 3 km)
- Joining of patch rankings with other services:
  - **Water quality** (upstream impairments; downstream intakes)
  - **Recreation** (service area/travel time to patch)
- Connectivity speed/accuracy improvements
  - Patch to patch Euclidean distance (vs. centroid-centroid)

Conclusion: Salamander

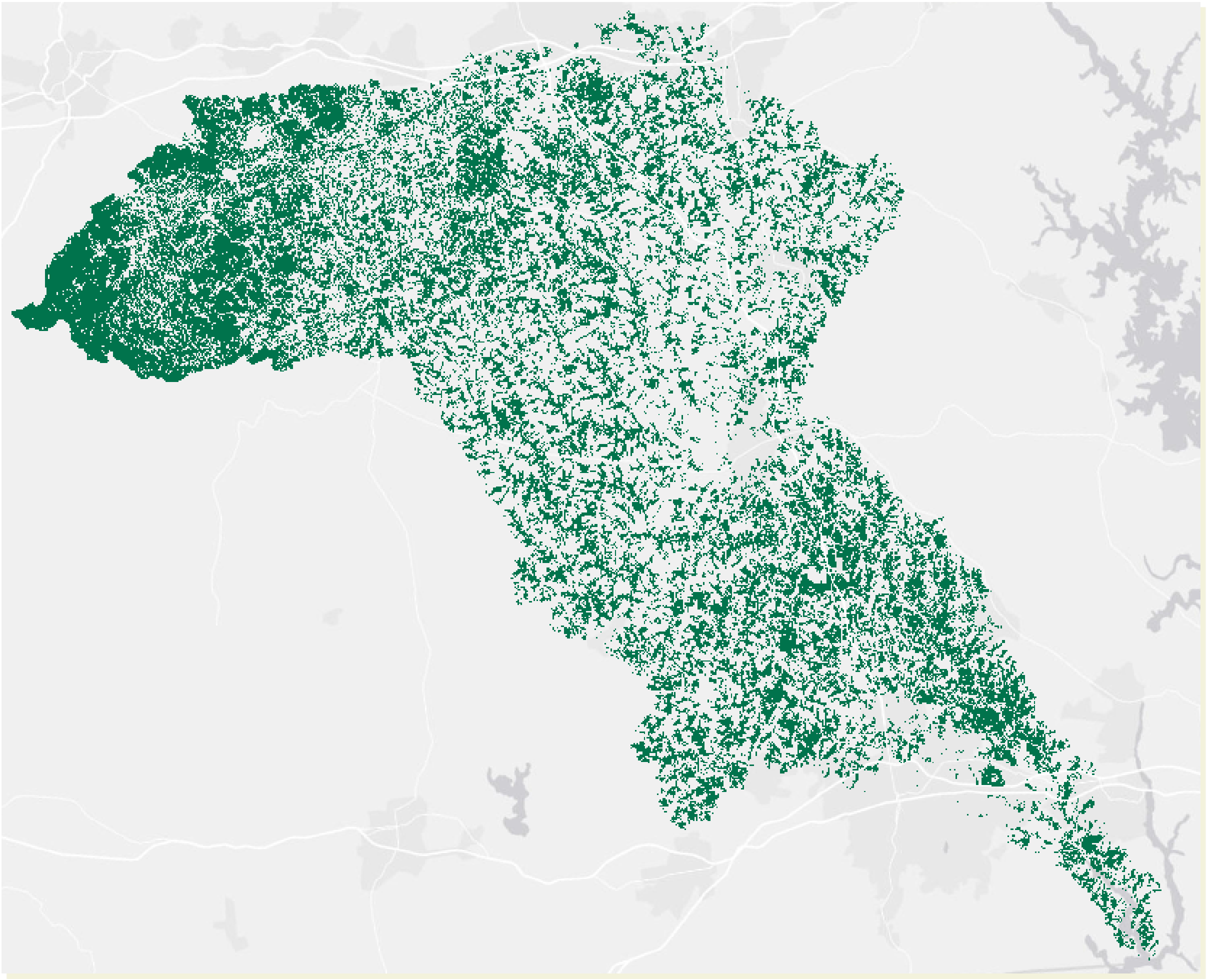
- High priority patches are identified based on:
  - Area/core area/shape
  - Centrality
  - Proximity to other areas



- But no metric on saving certain *portfolio* of patches.
  - Benefit of nabbing two sub-optimal patches over taking the best.
- No mechanism when patch exceeds the area one can conserve.

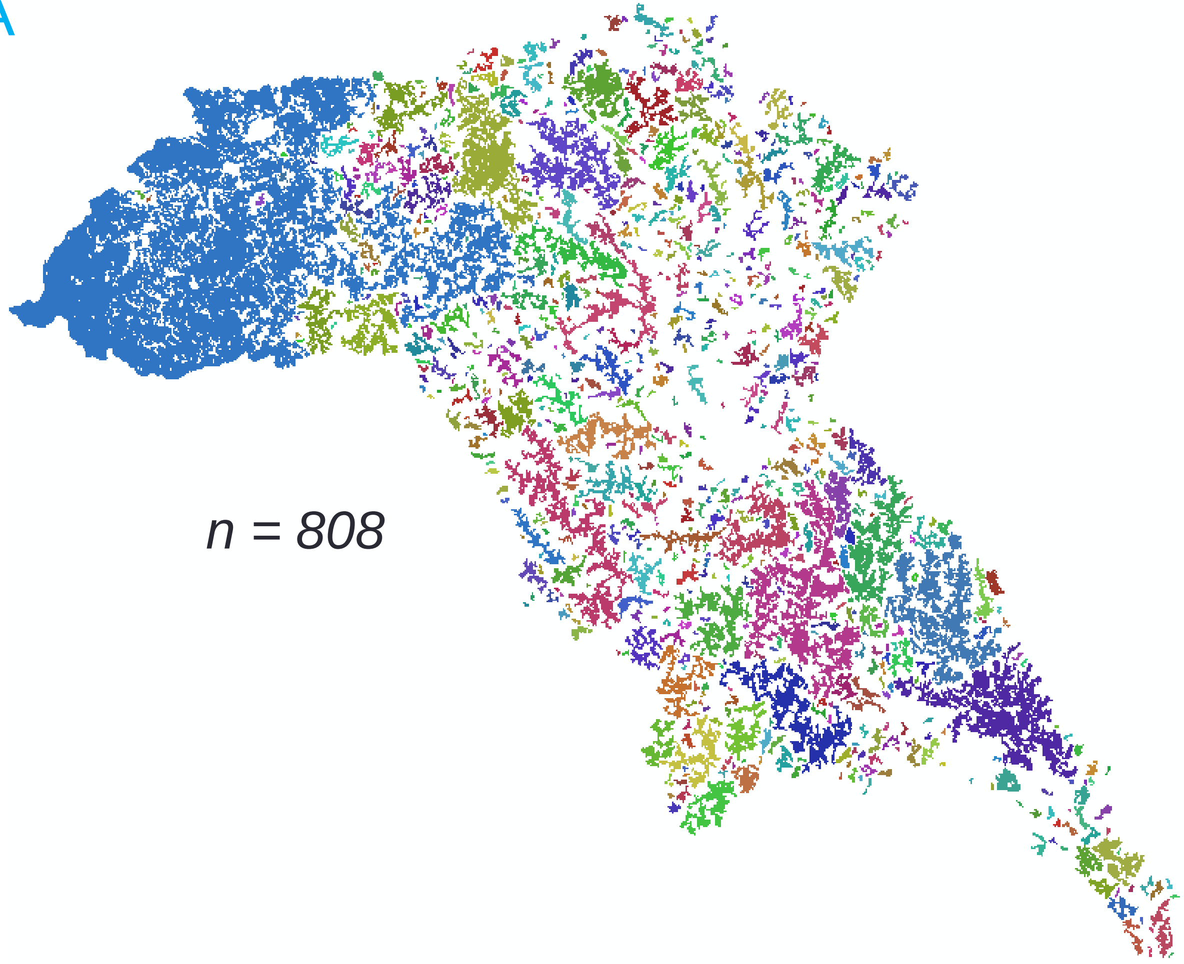
Case: Flying Squirrel

- Habitat: Deciduous forest



Squirrel patches

- Habitat: Deciduous forest
- Min patch size: 5 HA



n = 808

Squirrel patch size/shape

Patch Area

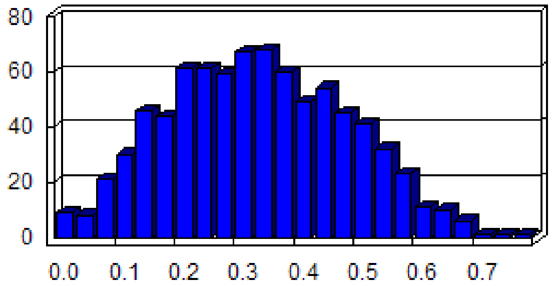
Minimum:	5.04
Maximum:	22492
Sum:	69208
Mean:	85.65
St Dev:	813.83

Core Area

Minimum:	0
Maximum:	16571
Sum:	39854
Mean:	49.32
St Dev:	593.56

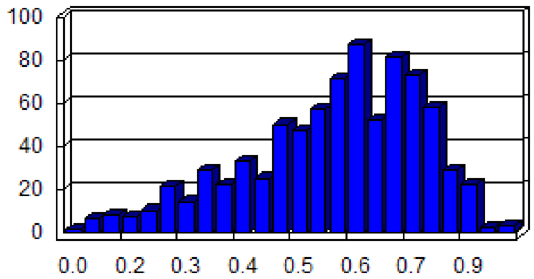
Core:Area Ratio

Minimum:	0
Maximum:	0.737
Mean:	0.320
St Dev:	0.142



Shape Index

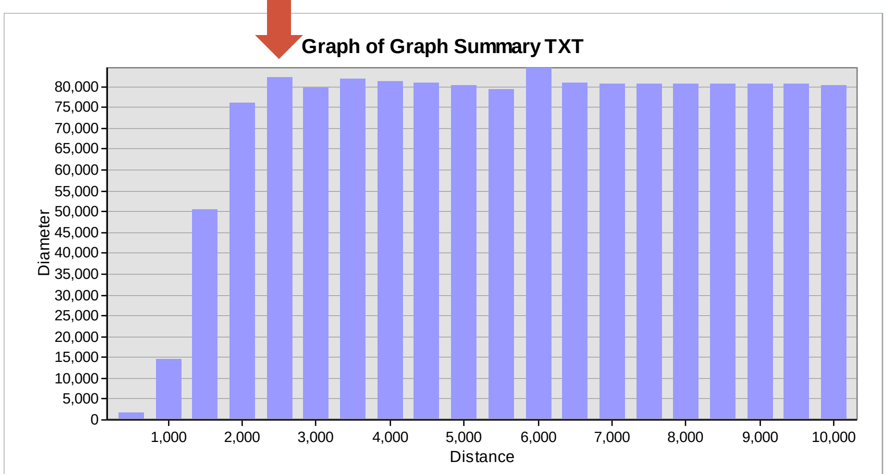
Minimum:	0.050
Maximum:	0.952
Mean:	0.604
St Dev:	0.178

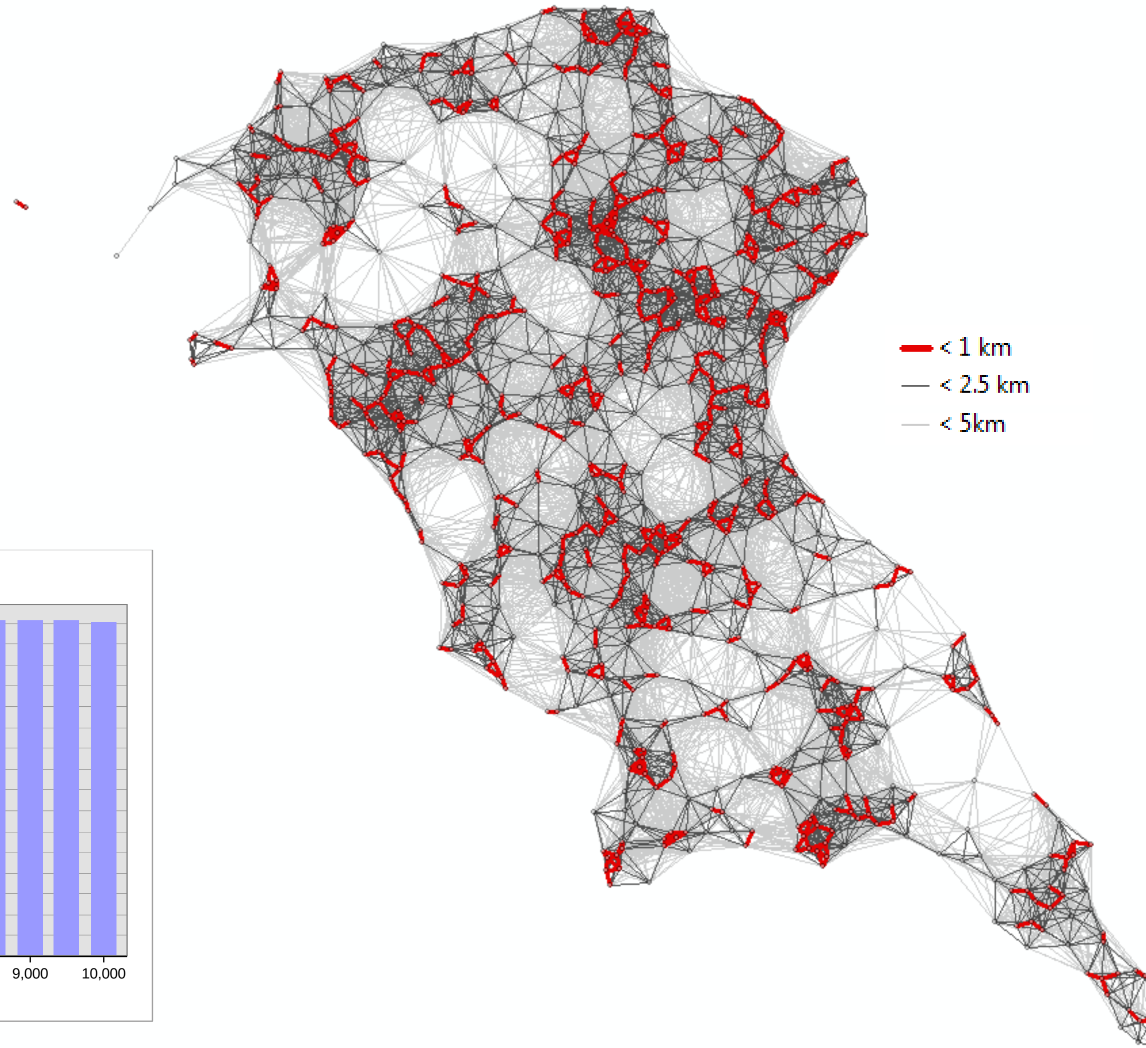


Patch connectivity

Graph Summary TXT

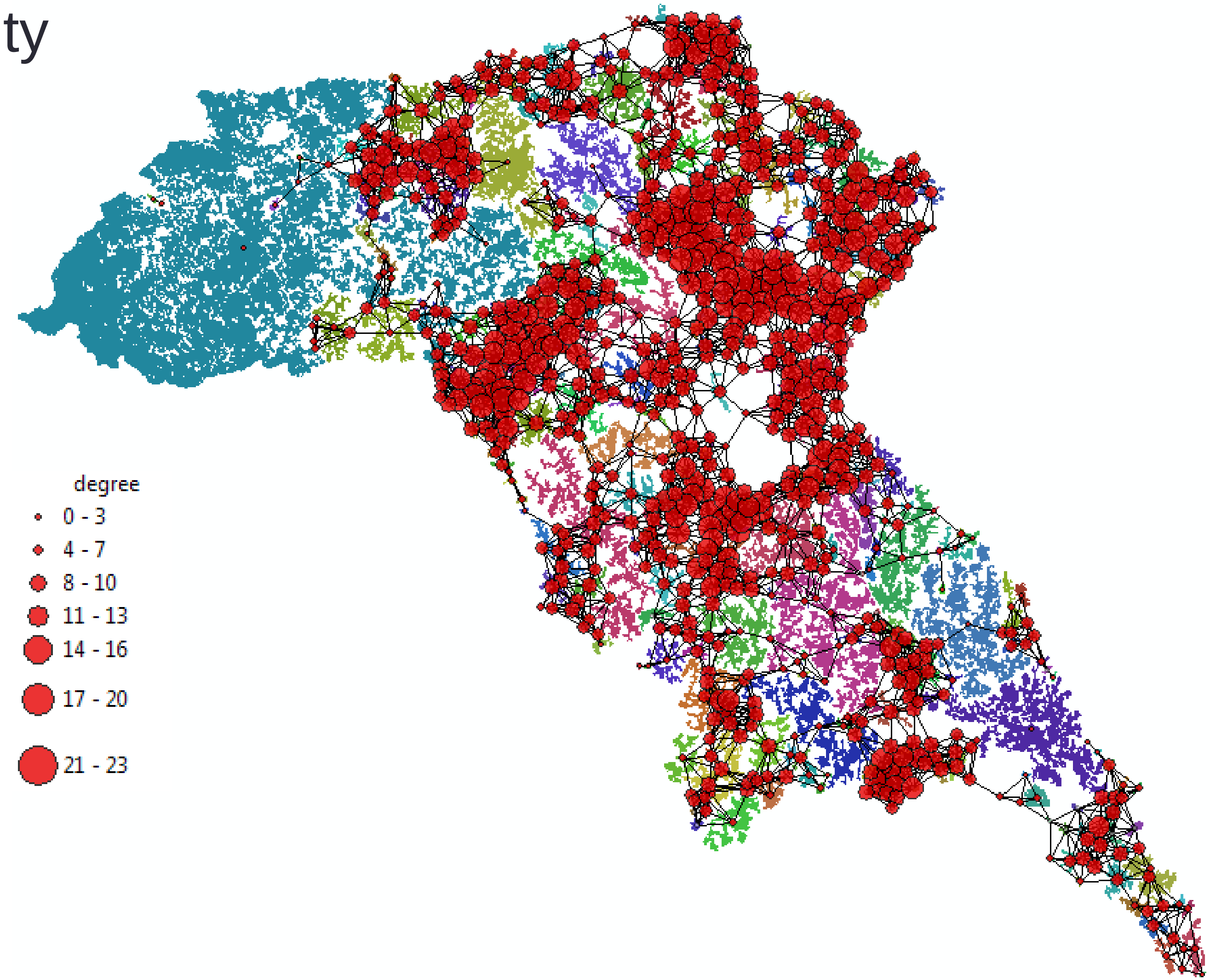
Distance	NComps	Diameter
500	744	1614
1000	267	14503
1500	61	50475
2000	16	75907
2500	4	82253
3000	3	79453
3500	2	81836
4000	2	81237
4500	2	80894
5000	2	80219
5500	2	79394
6000	1	84390





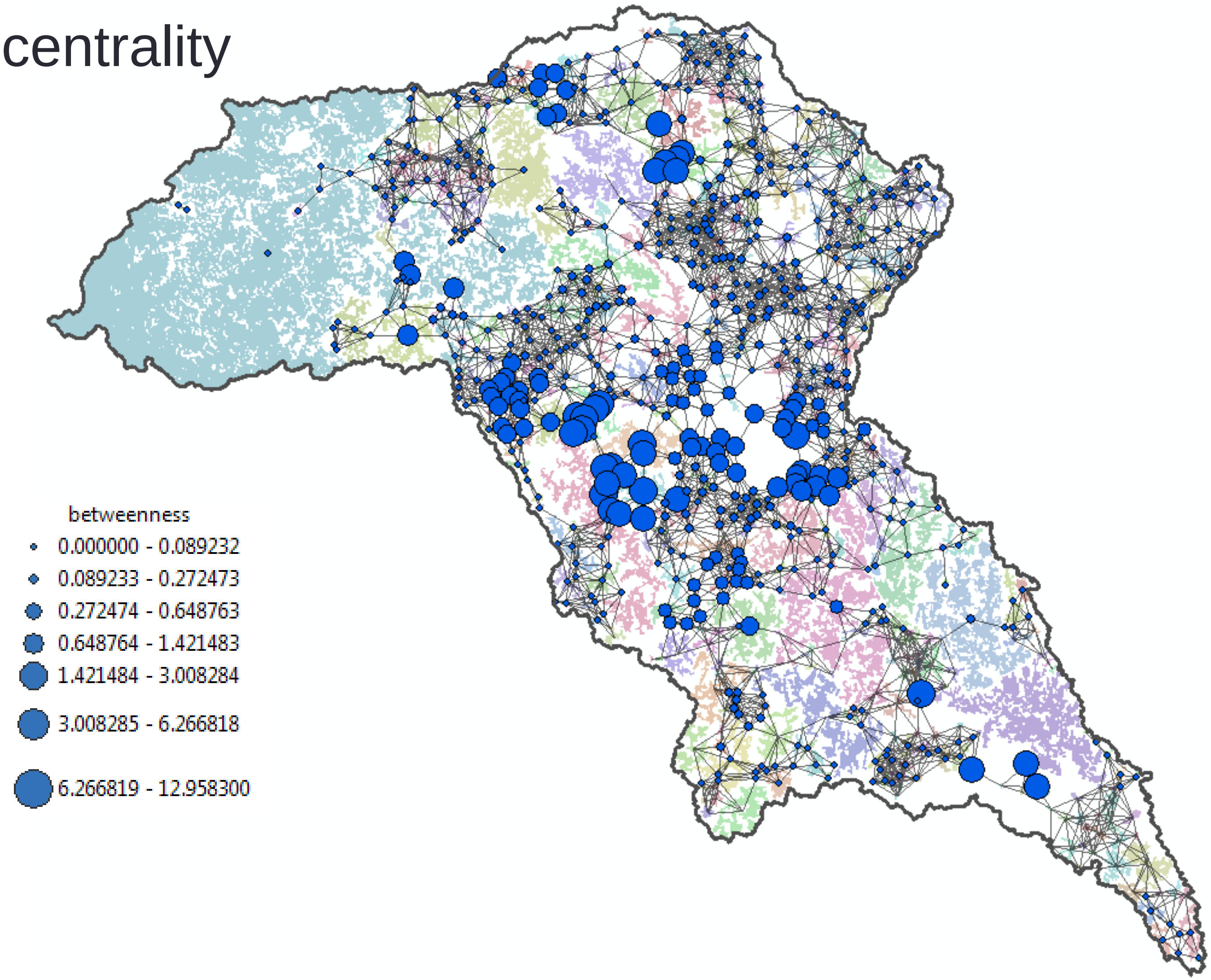
Patch centrality

- Degree centrality



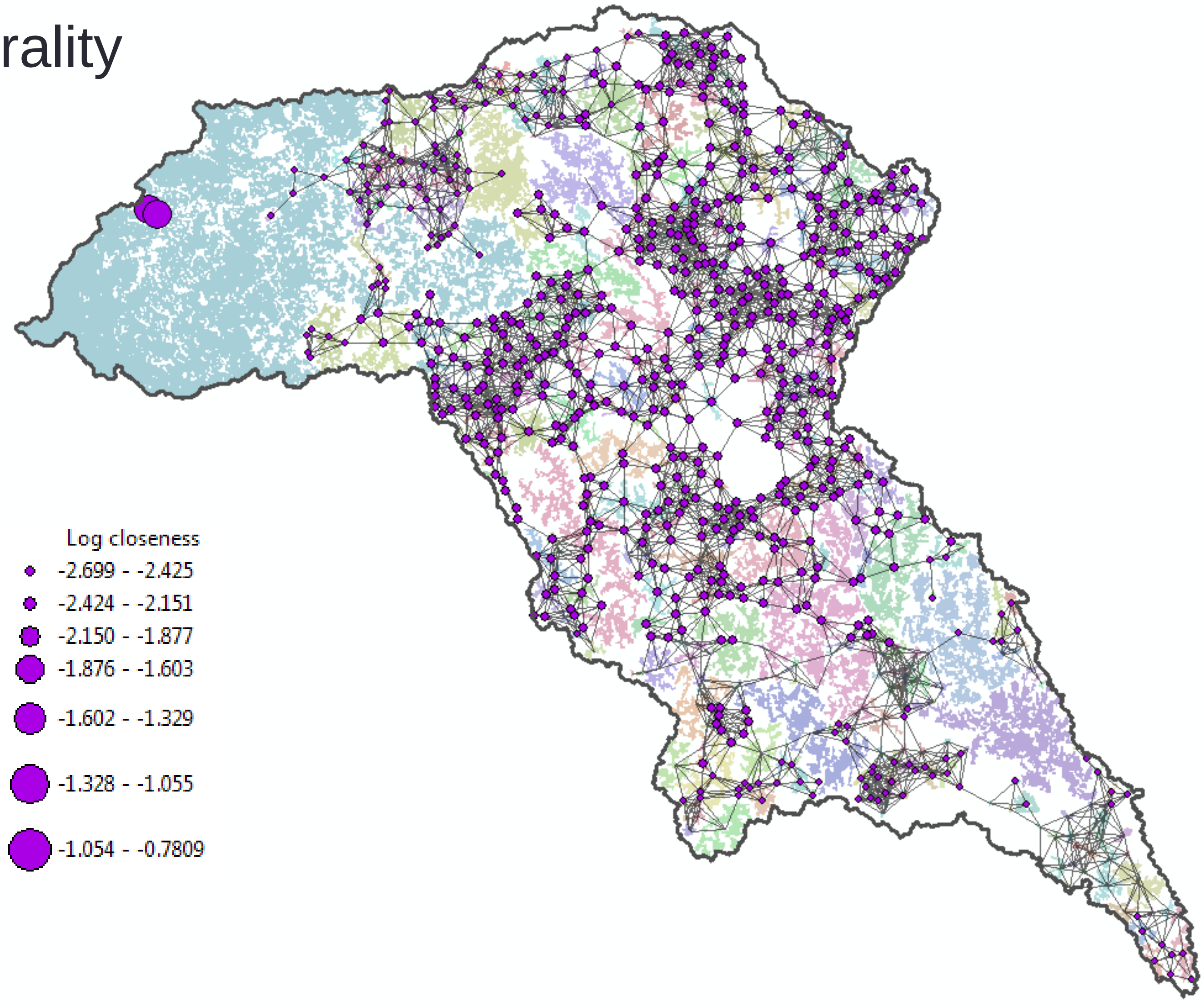
Patch centrality

- Betweenness centrality



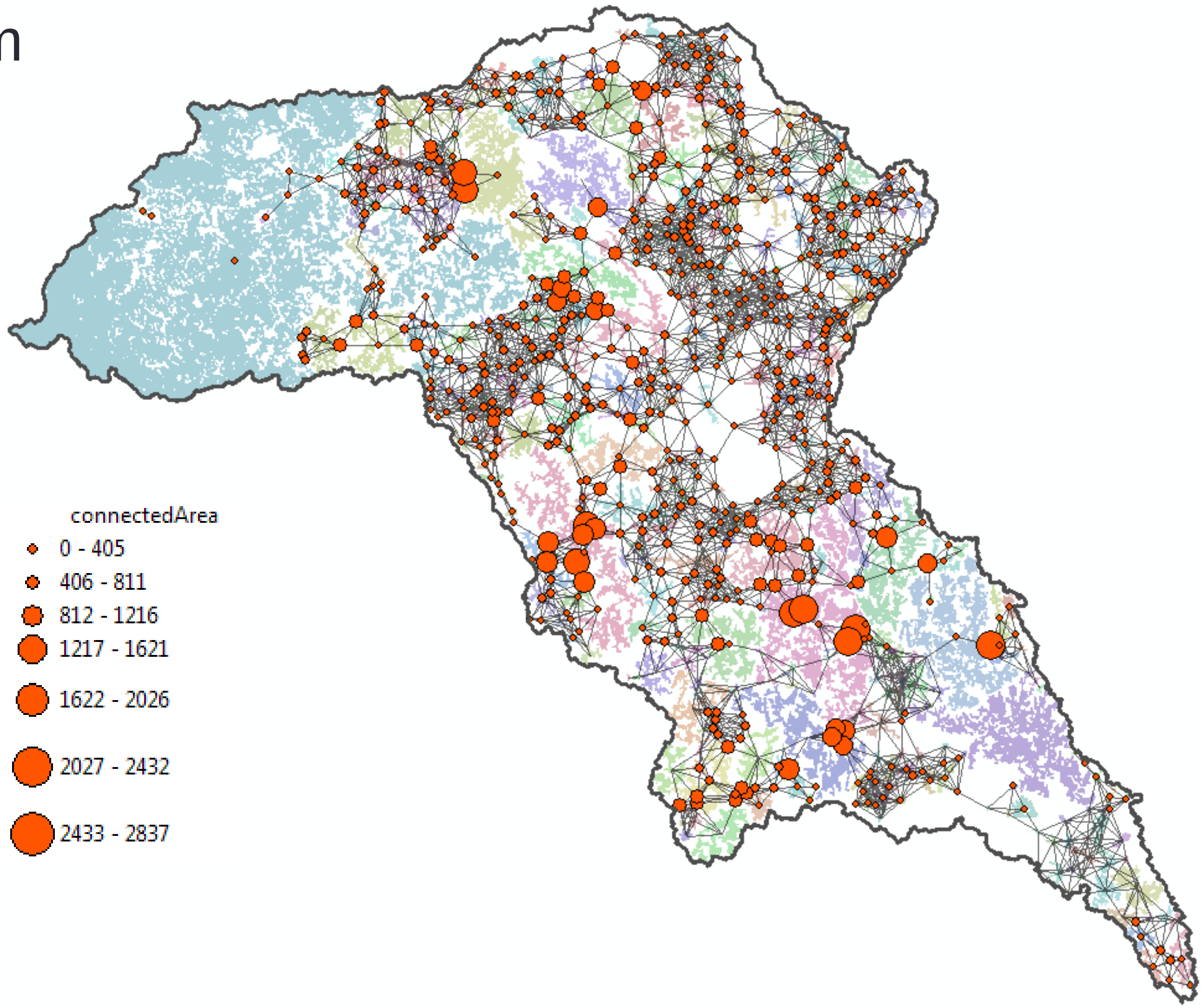
Patch centrality

- Closeness centrality



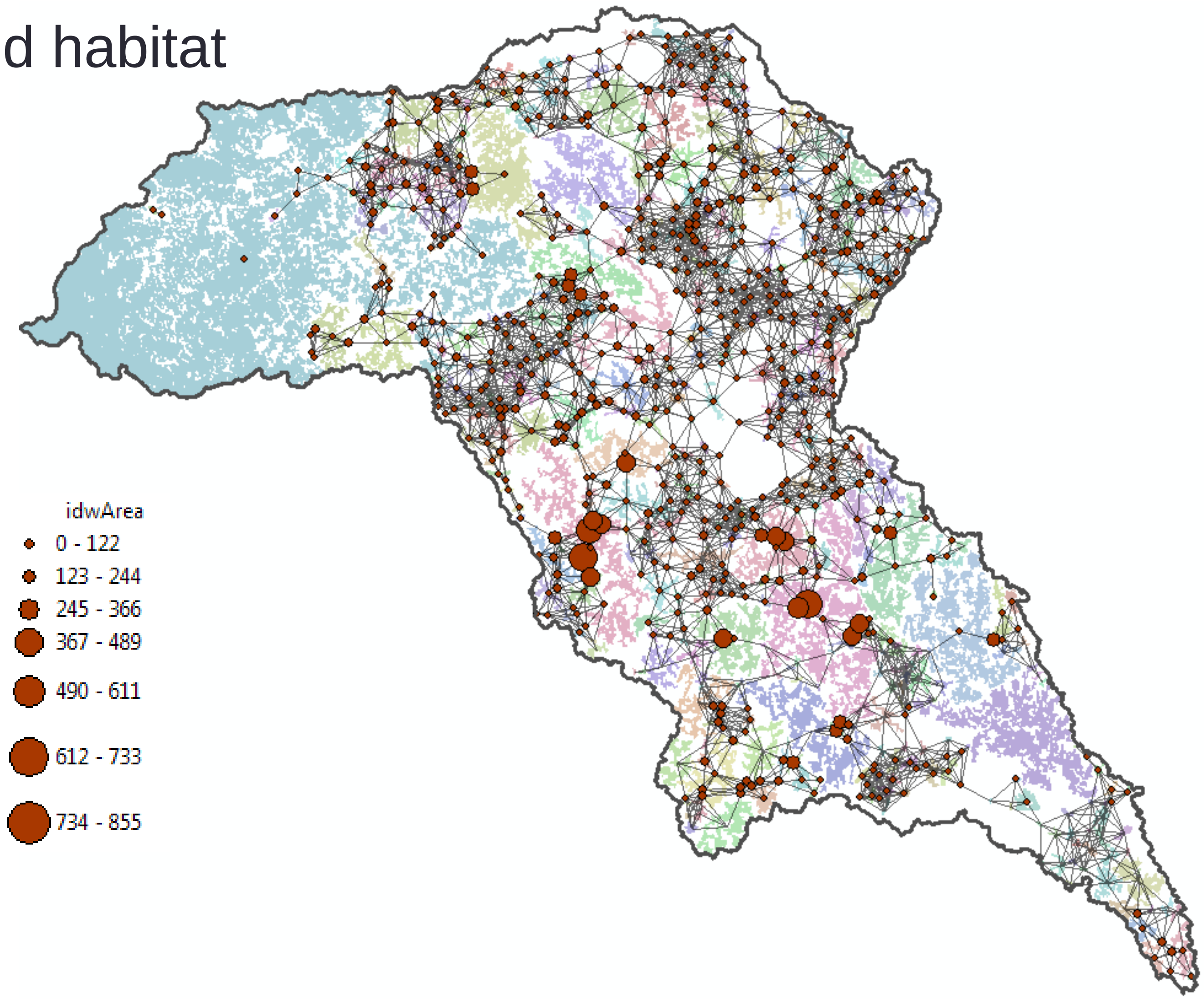
Patch connected area

- Area w/in 2.5 km

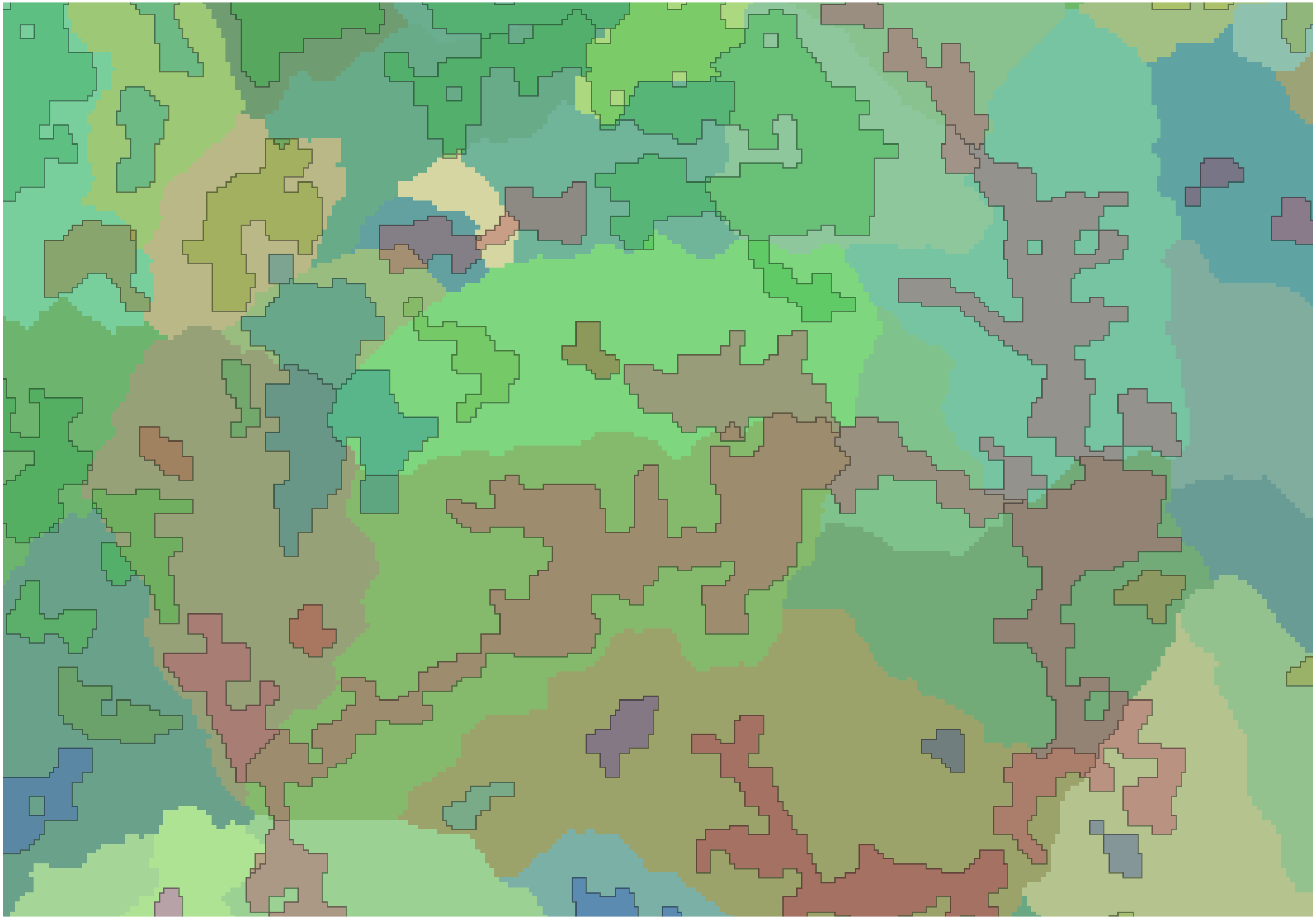


Patch connected area

- Likely connected habitat (Distance wtd.)

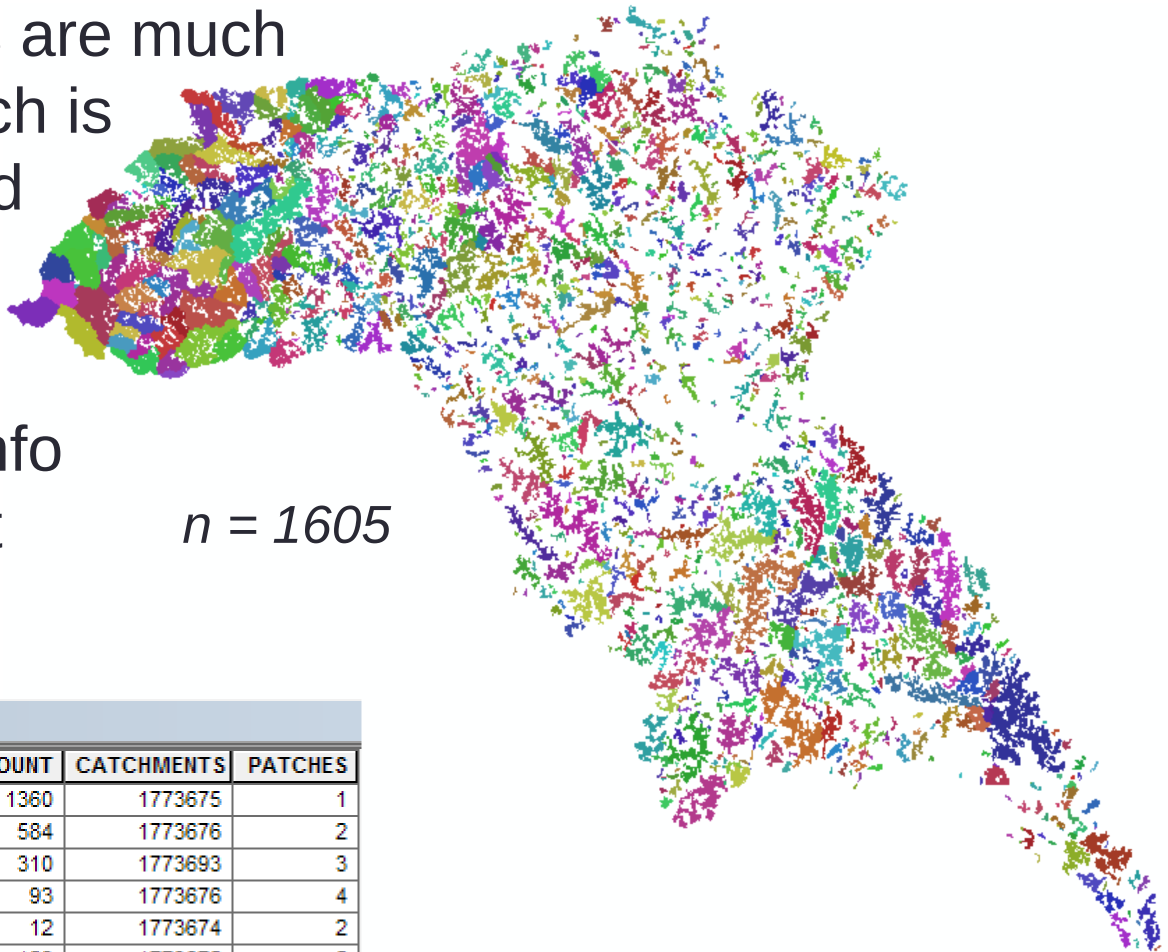


Sub-patches



Sub-patches

- Patches overlaid with planning units (NHD catchments) since many patches are much larger than that which is likely to be protected at one time.



n = 1605

- Each pixel retains info on which catchment and which patch it overlays

Sub Patches

Rowid	VALUE *	COUNT	CATCHMENTS	PATCHES
0	1	1360	1773675	1
1	2	584	1773676	2
2	3	310	1773693	3
3	4	93	1773676	4
4	5	12	1773674	2
5	6	153	1773675	5

Sub-patches

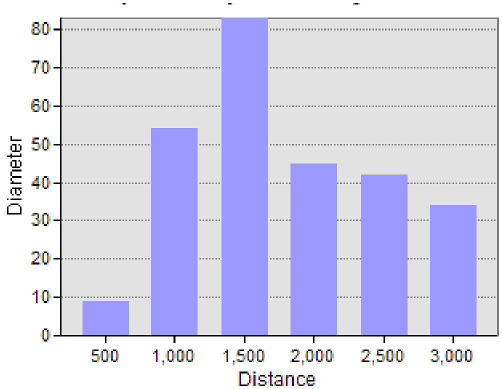
- Prioritize sub-patches based on:
  - Total habitat area and/or core habitat area it includes
  - Total habitat area and/or core habitat area it "touches"
  - Area wtd. mean core:area ratio and/or shape index of patches
  - Connectivity to patches in neighboring planning units

- Challenges:
  - Connectivity is useful only if connected patches are conserved.
    - Raise "conservation score" when connected patches are protected

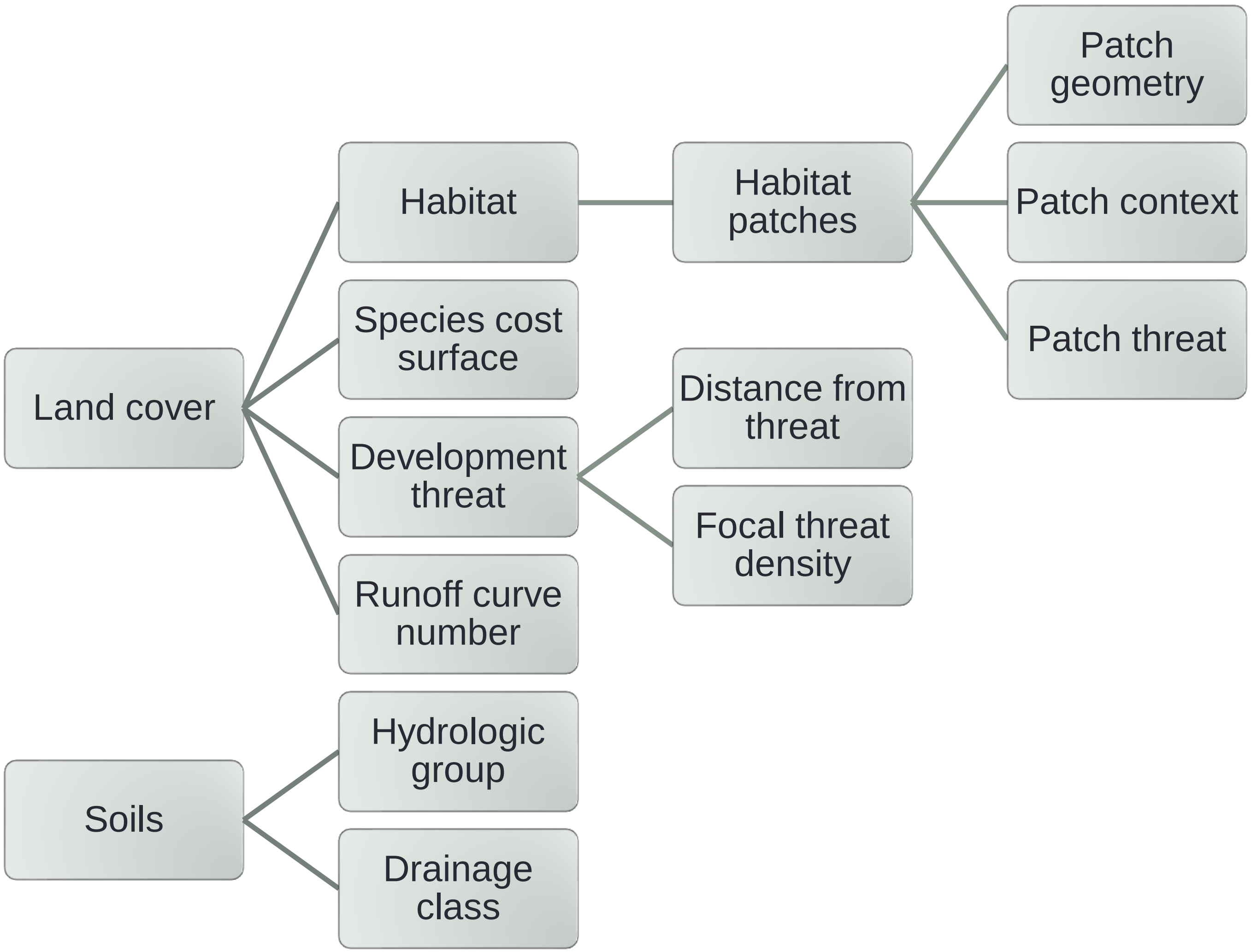
Sub-patch connectivity

Graph Summary TXT

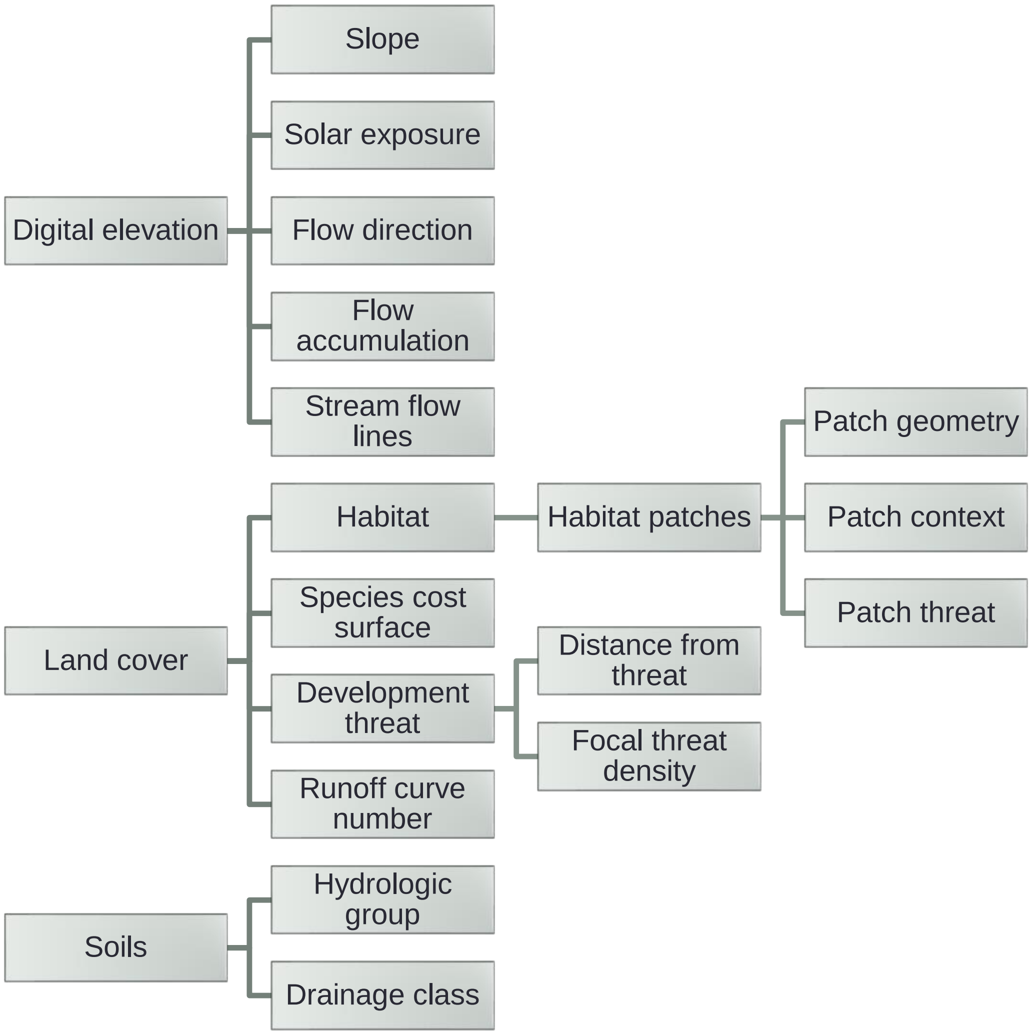
Distance	NComps	Diameter
500	1148	9
1000	275	54
1500	33	83
2000	2	45
2500	1	42
3000	1	34



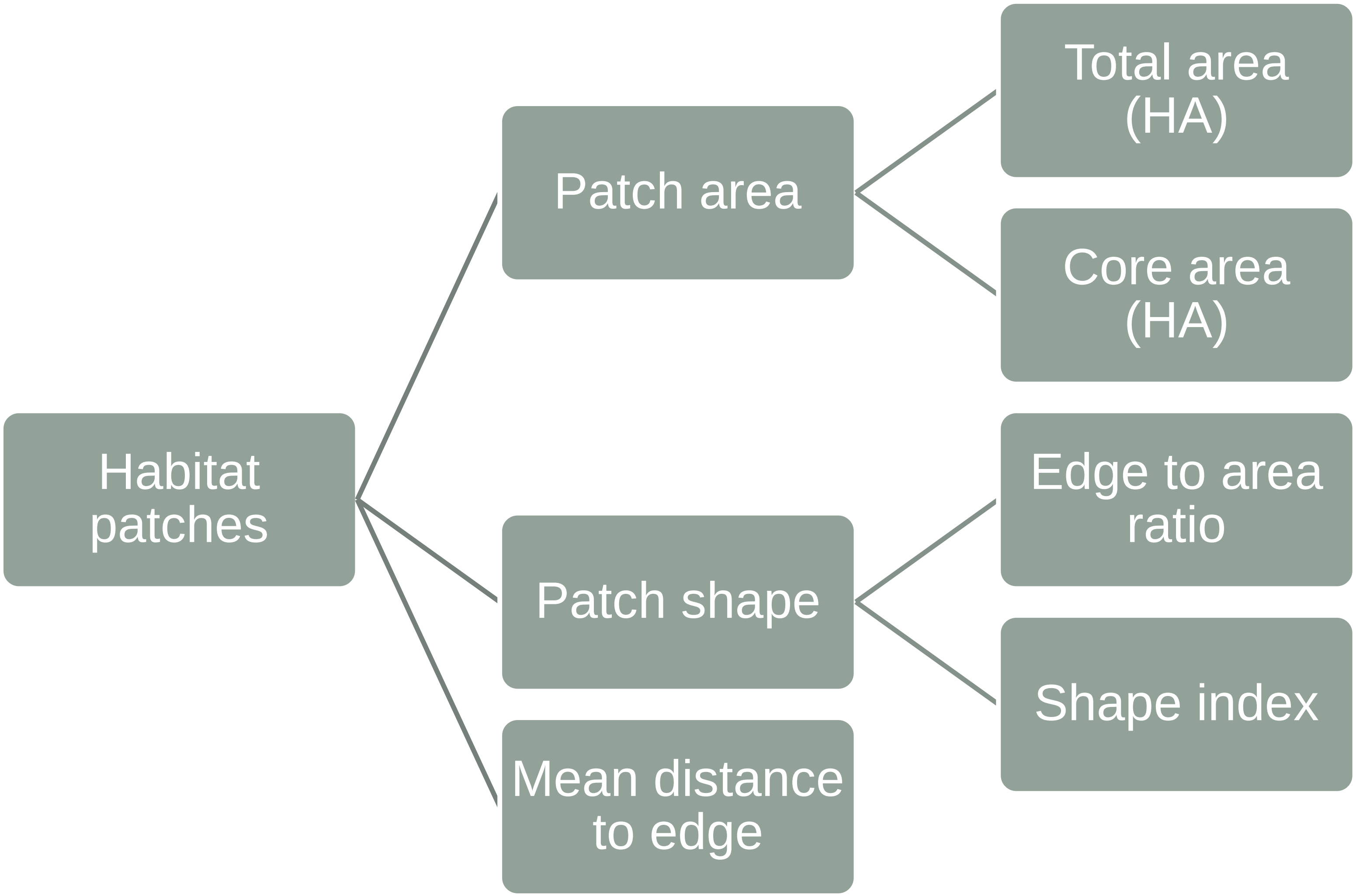
Assembling the data layers



Assembling the data layers



Patch geometry



Patch context