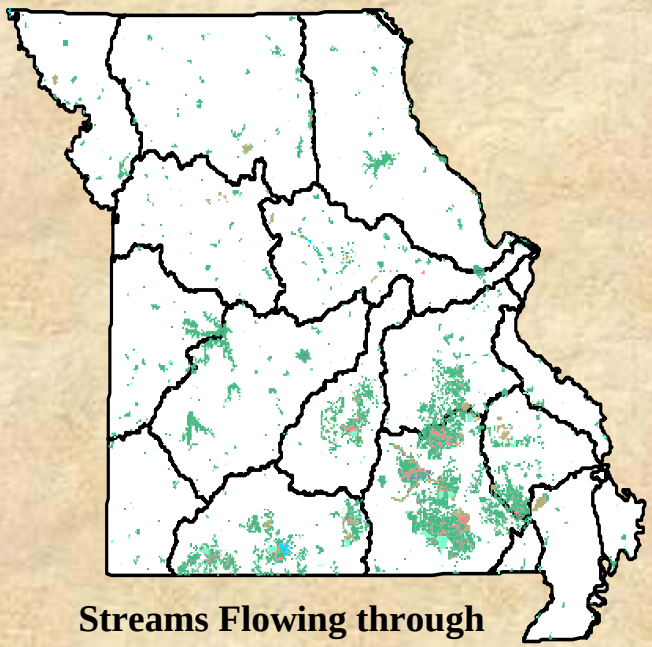
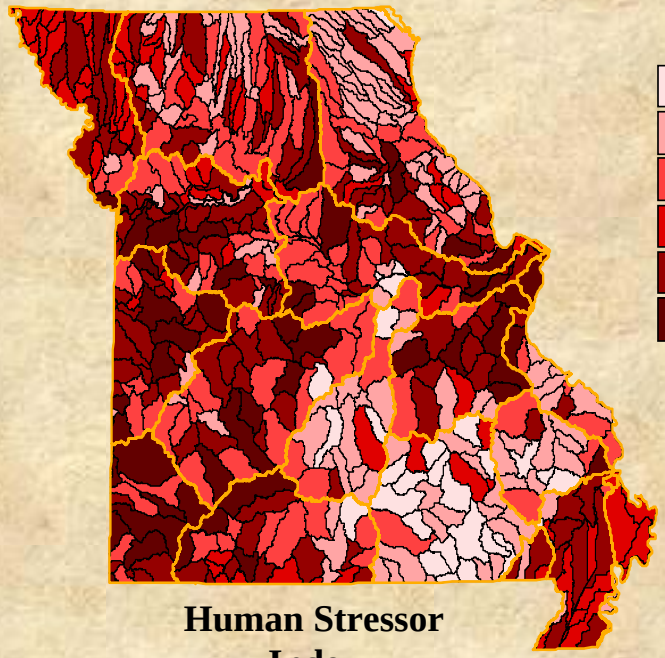
Identifying Conservation Gaps for Riverine Ecosystems

Assessing Multiple Forms of Public Ownership and Human Stressors



Streams Flowing through Public Lands



Human Stressor Index

High Quality

- 111 - 220
- 221 - 319
- 320 - 326
- 327 - 419
- 420 - 423
- 424 - 430

Low Quality

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Missouri Resource Assessment Partnership (MoRAP)
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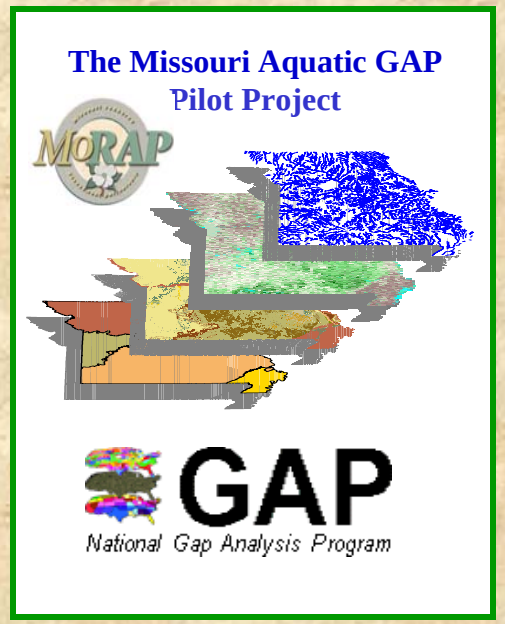
http://www.cerc.usgs.gov/morap/

Ecologically-Based Conservation Planning Requires

- Ecologically-defined Planning Regions and Assessment Units
- Specific conservation targets (biotic, abiotic, processes)
- Understanding of the spatial distribution of targets within Planning Regions
- Establish conservation goals for the Planning Region
  - Define what constitutes a conservation gap
- Review existing conservation areas (Gap Analysis)
- Establishing conservation priorities to fill gaps
  - Relative comparison of Assessment Units based on:
    - Importance, costs, threats, condition, and opportunity

General Approach



Step 1 Classify riverine ecosystems at multiple spatial scales

Step 2 Predict biological potential of each valley segment

Step 3 Generate public ownership statistics for each Valley Segment

Step 4 Generate human stressor data for each AES

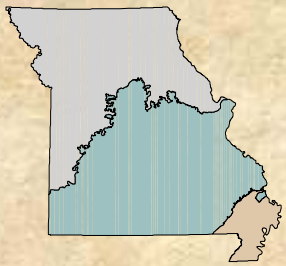
Step 5 Assess representation of VST's within AES's

Step 6 Assess representation of AES-Types within EDU's

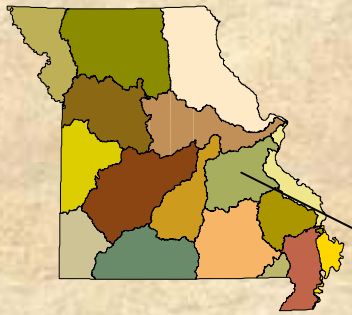
Step 7 Assess representation of EDU's within Aquatic Subregions

Step 1: Hierarchical Classification of Riverine Ecosystems

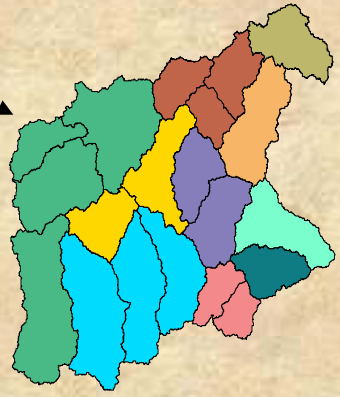
Level 4
Subregions



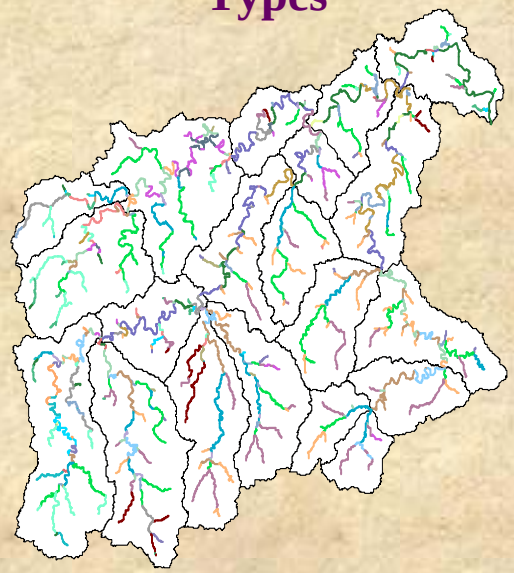
Level 5
Ecological Drainage Units



Level 6
Aquatic Ecological System Types



Level 7
Valley Segment Types

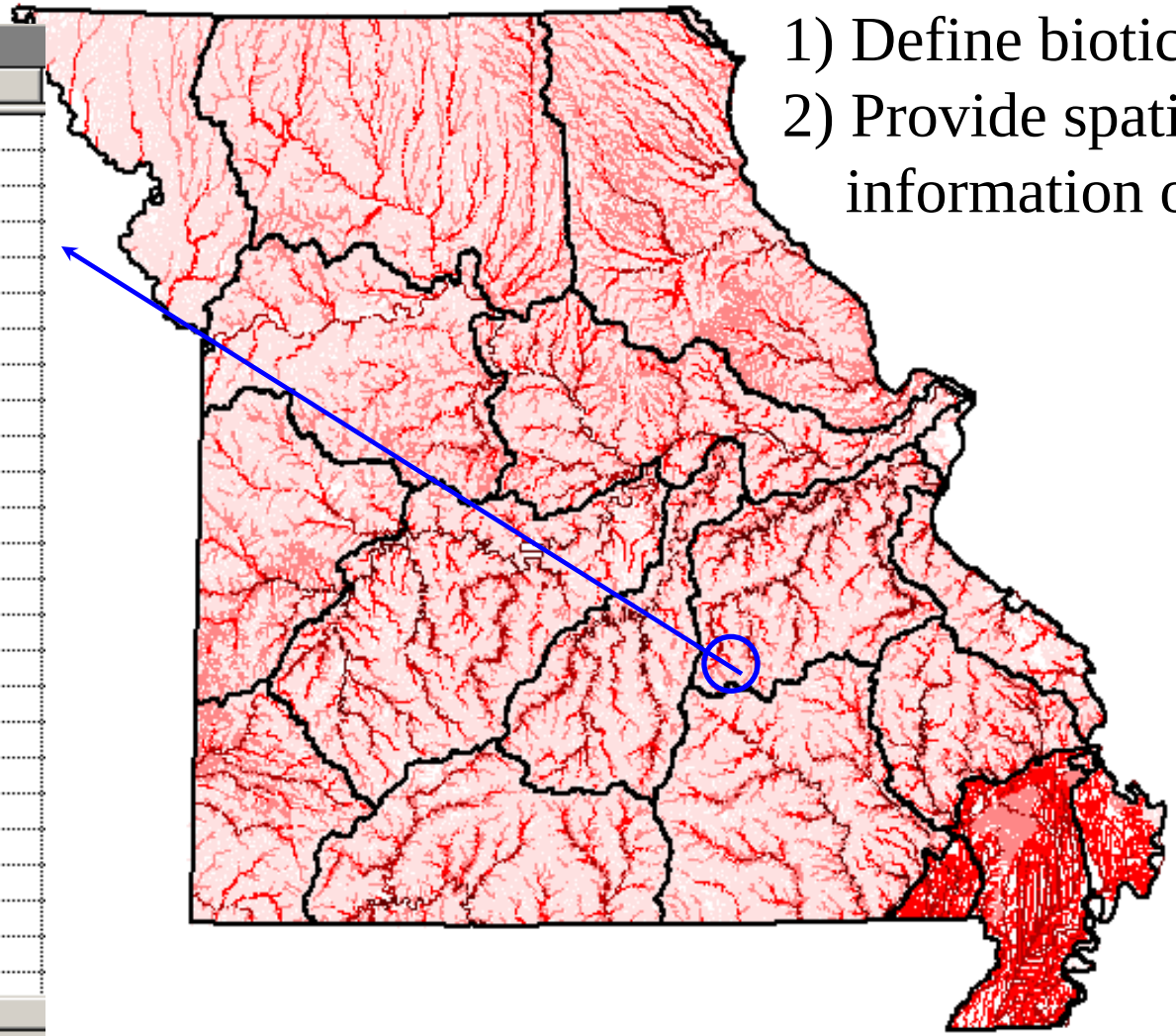


Purpose

- **Provide ecological context**
- **Provide planning/assessment units**
- **Provide abiotic targets**
- **Assist with species modeling**

Step 2: Predicting Biological Potential of each Valley Segment

Predicted Species



Purpose:

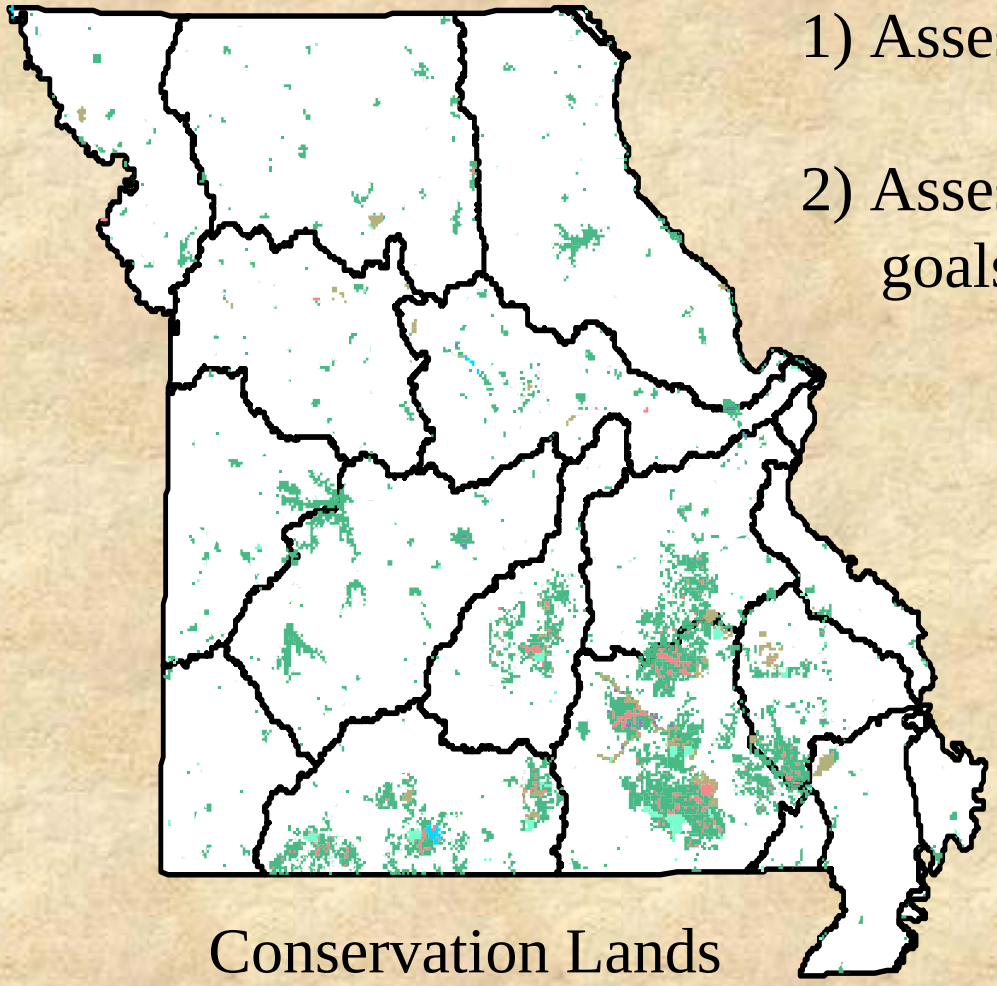
1) Define biotic targets
2) Provide spatially explicit information on targets

Step 3: Generating Ownership/Stewardship Statistics

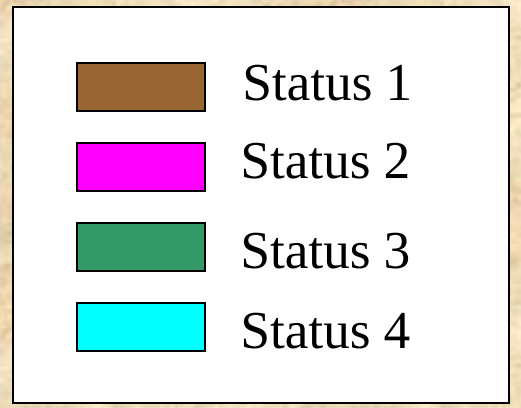
Purpose:

1) Assess representation of targets

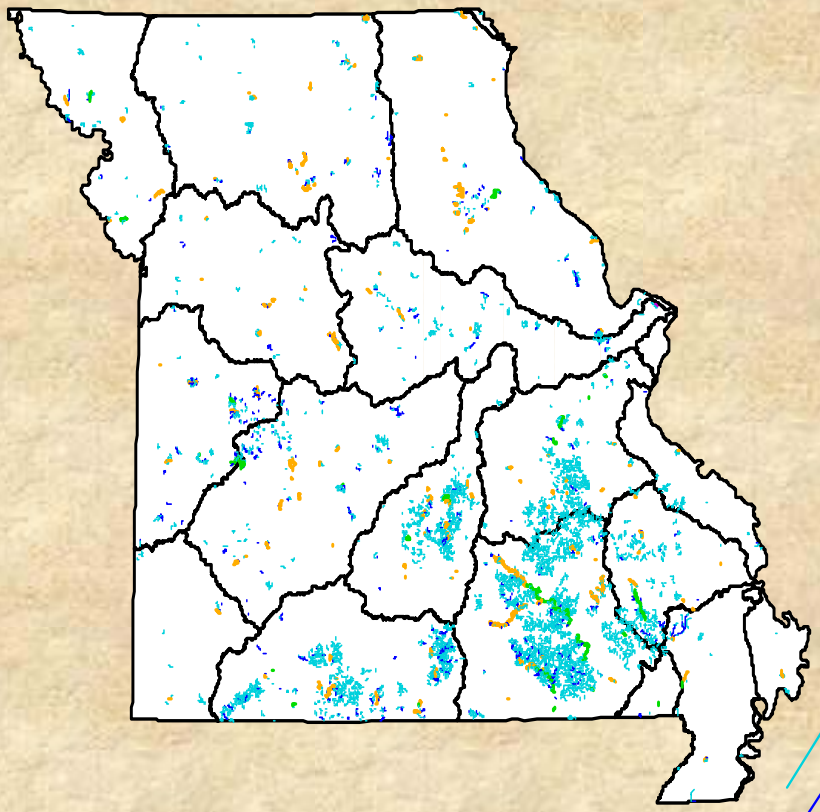
2) Assess achievement of conservation goals



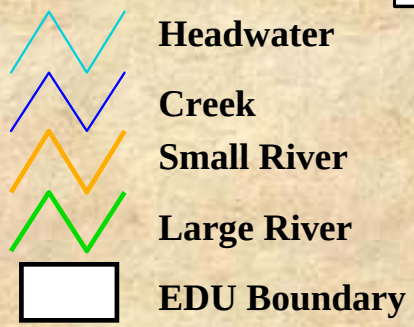
Conservation Lands

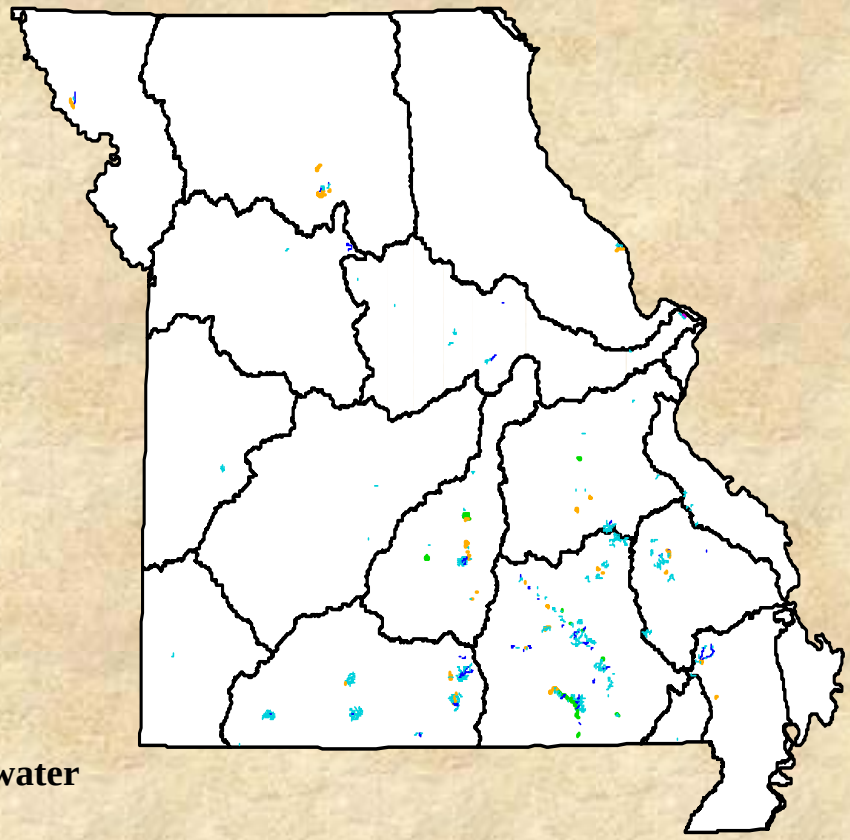


Assessing Local Ownership
(segments flowing through conservation lands)



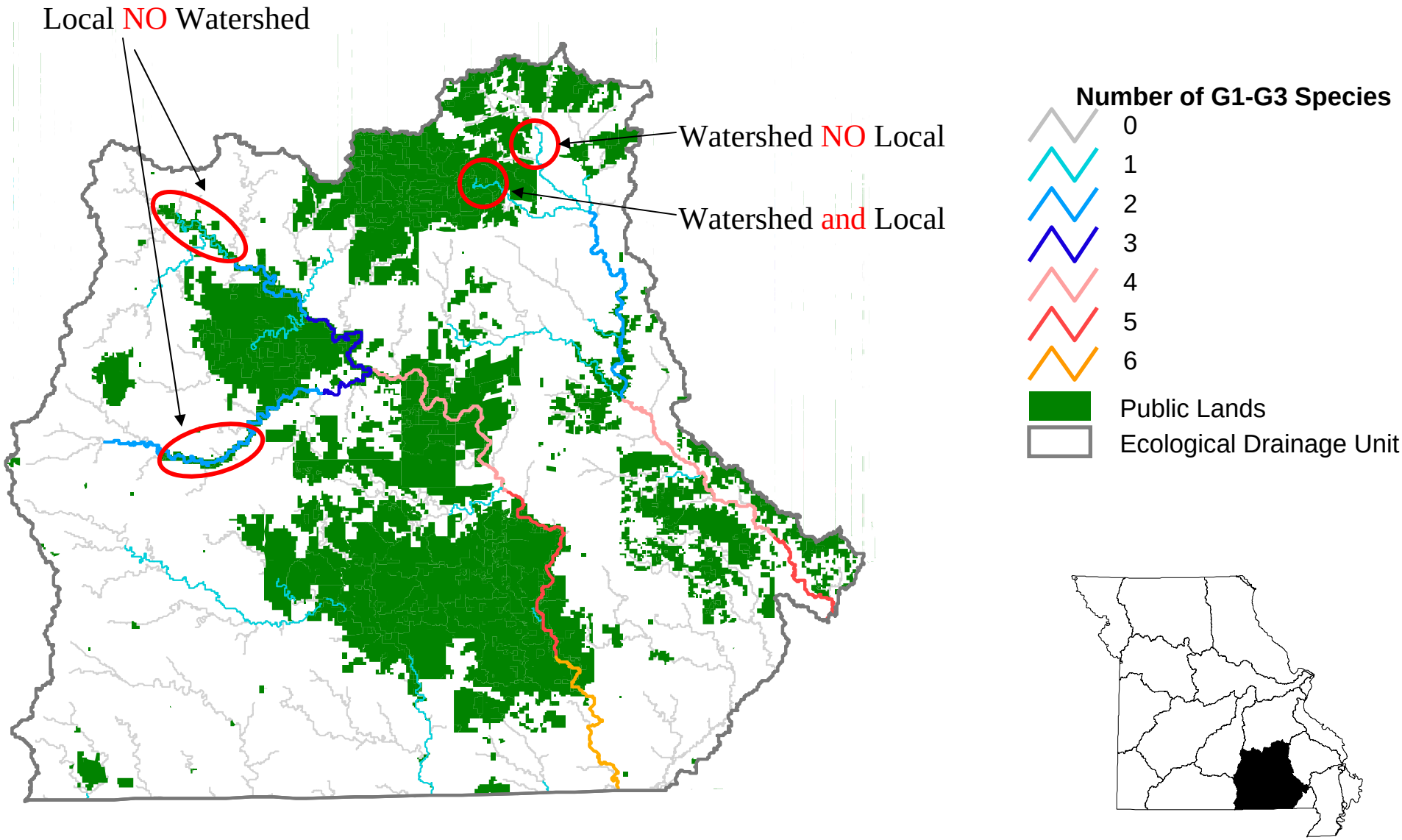
All Conservation Lands



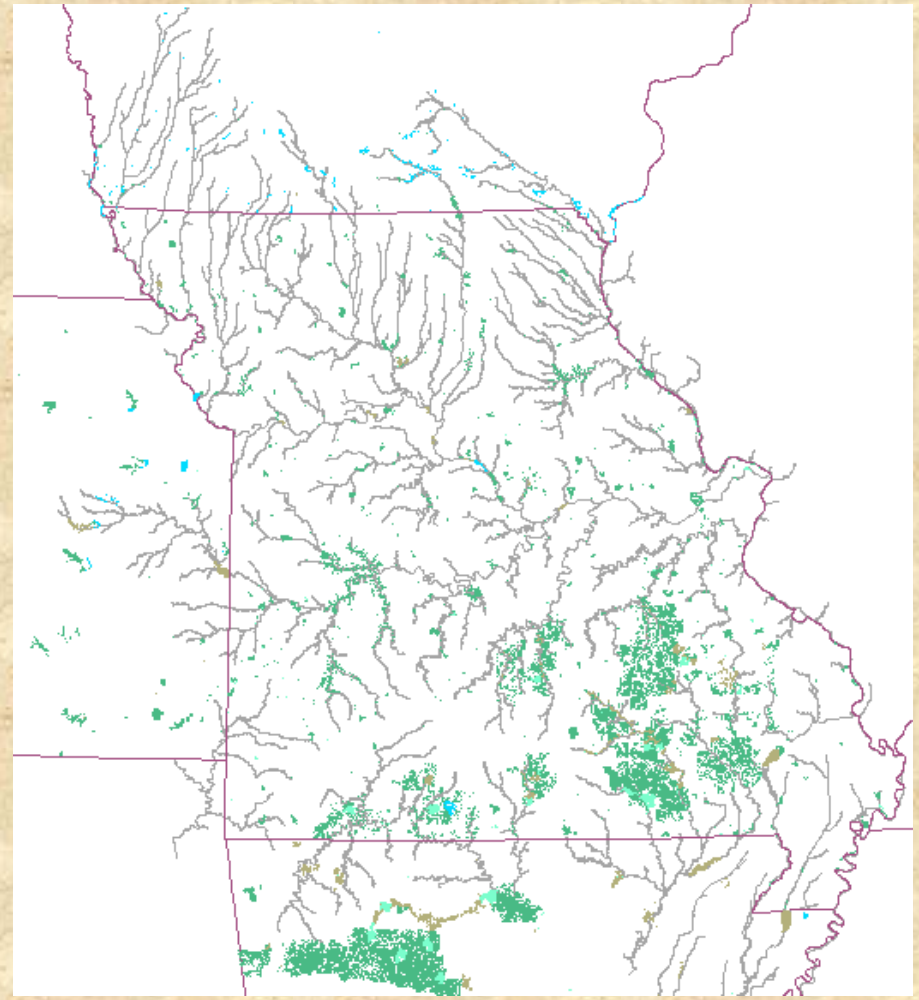


GAP 1 or 2 Lands

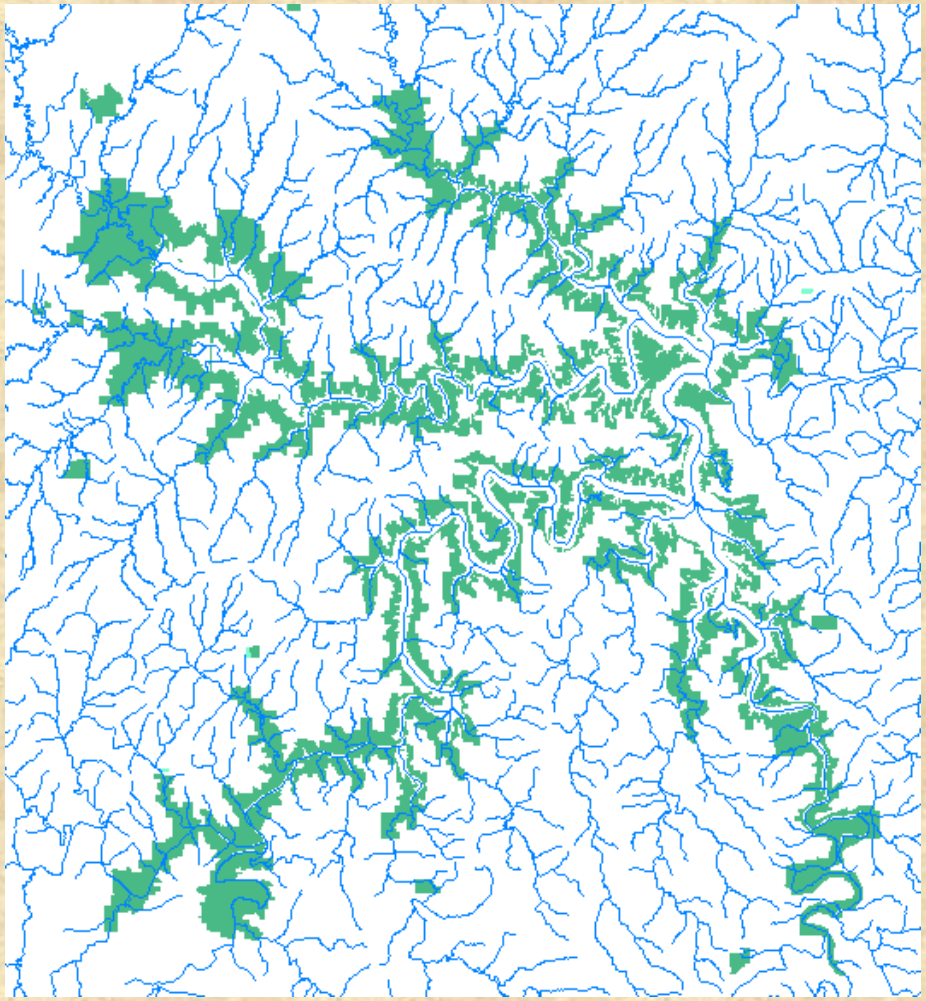
Local vs. Upstream Riparian vs.Watershed Ownership



Important Points

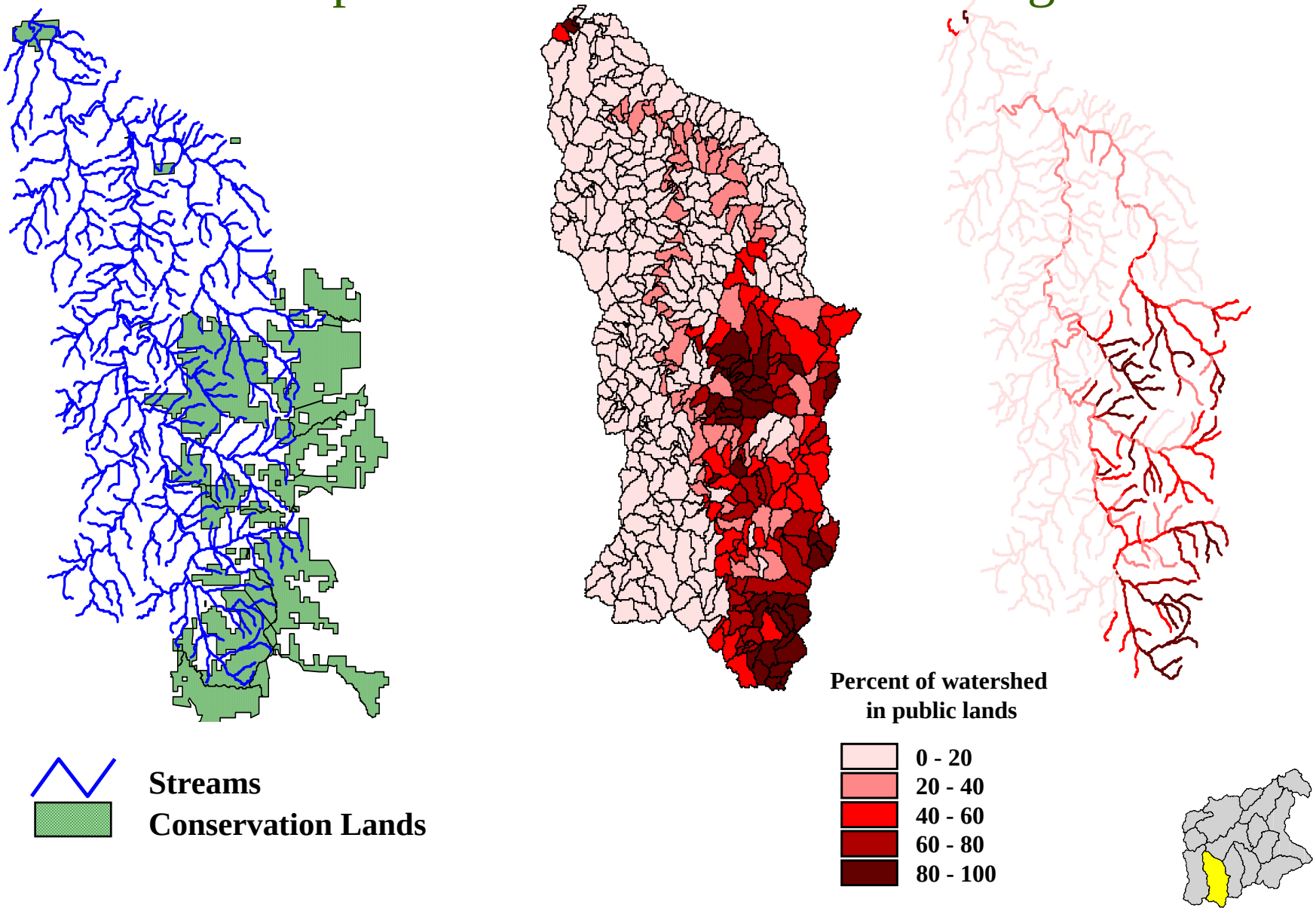


Included Conservation Lands
from Surrounding States

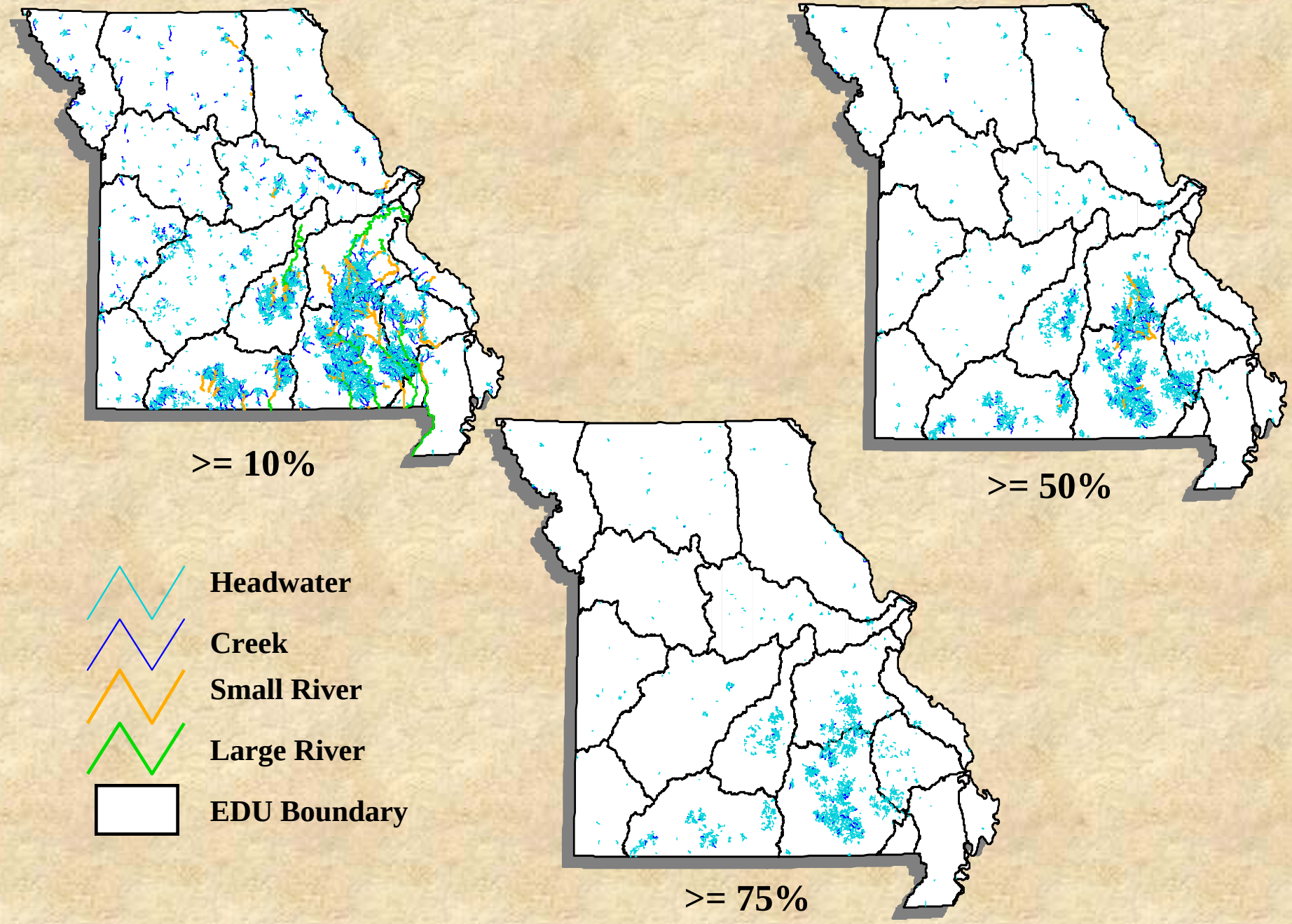


Clipped out Water
From Public Lands Surrounding Reservoirs

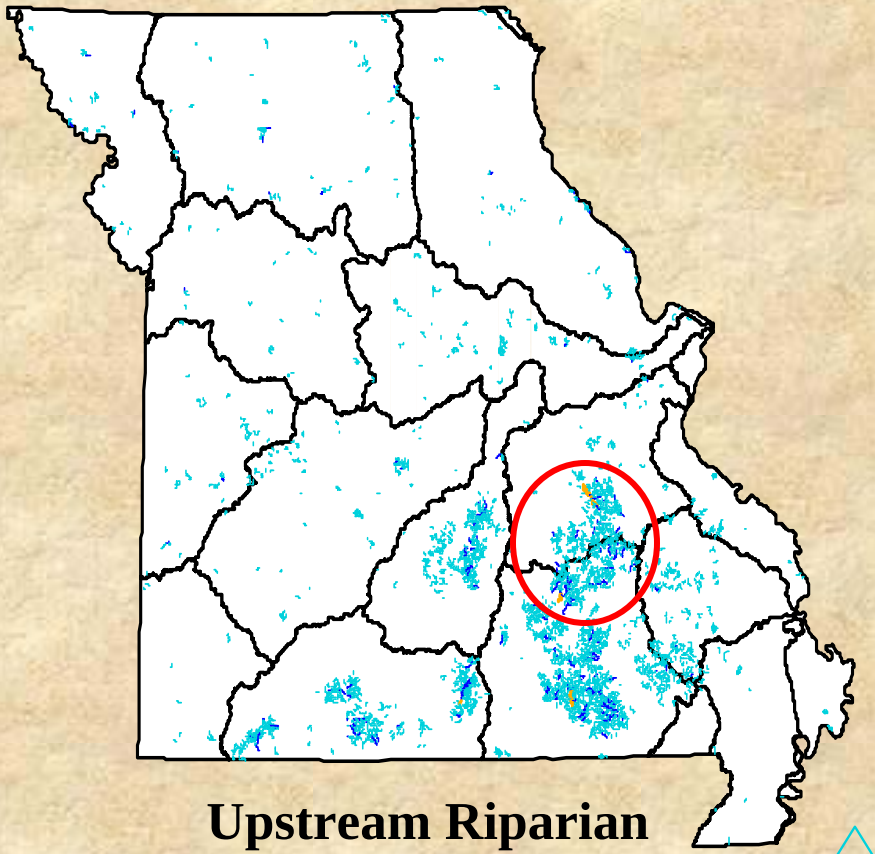
Generating Watershed and Upstream Riparian Ownership Statistics for Each Stream Segment



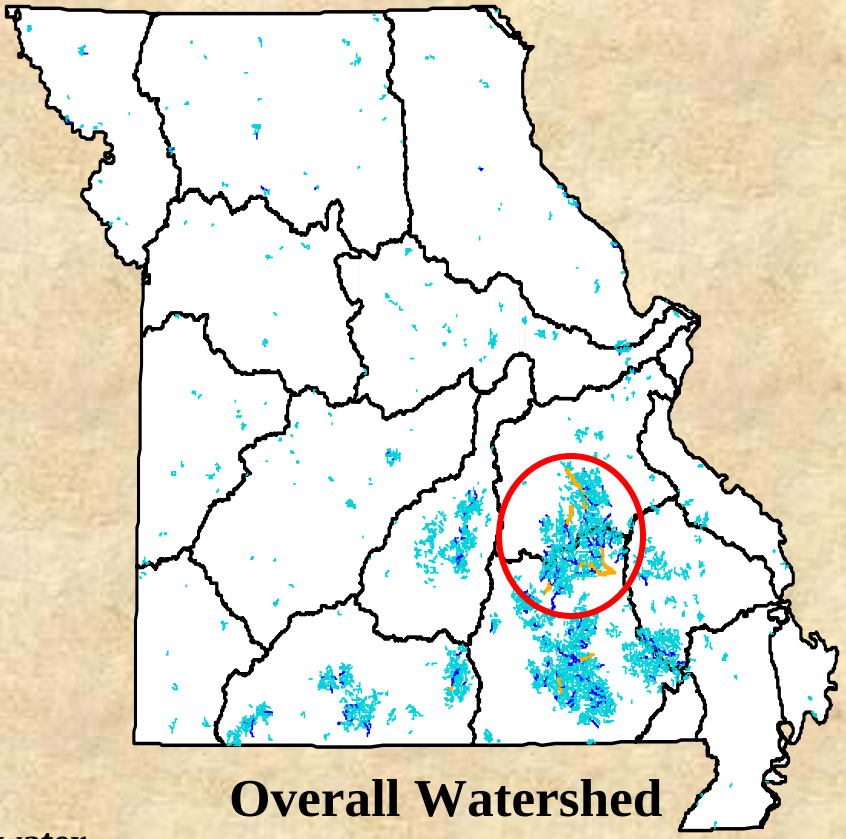
Assessing % of Watershed in Conservation Lands



Comparing Watershed and Upstream Riparian Ownership



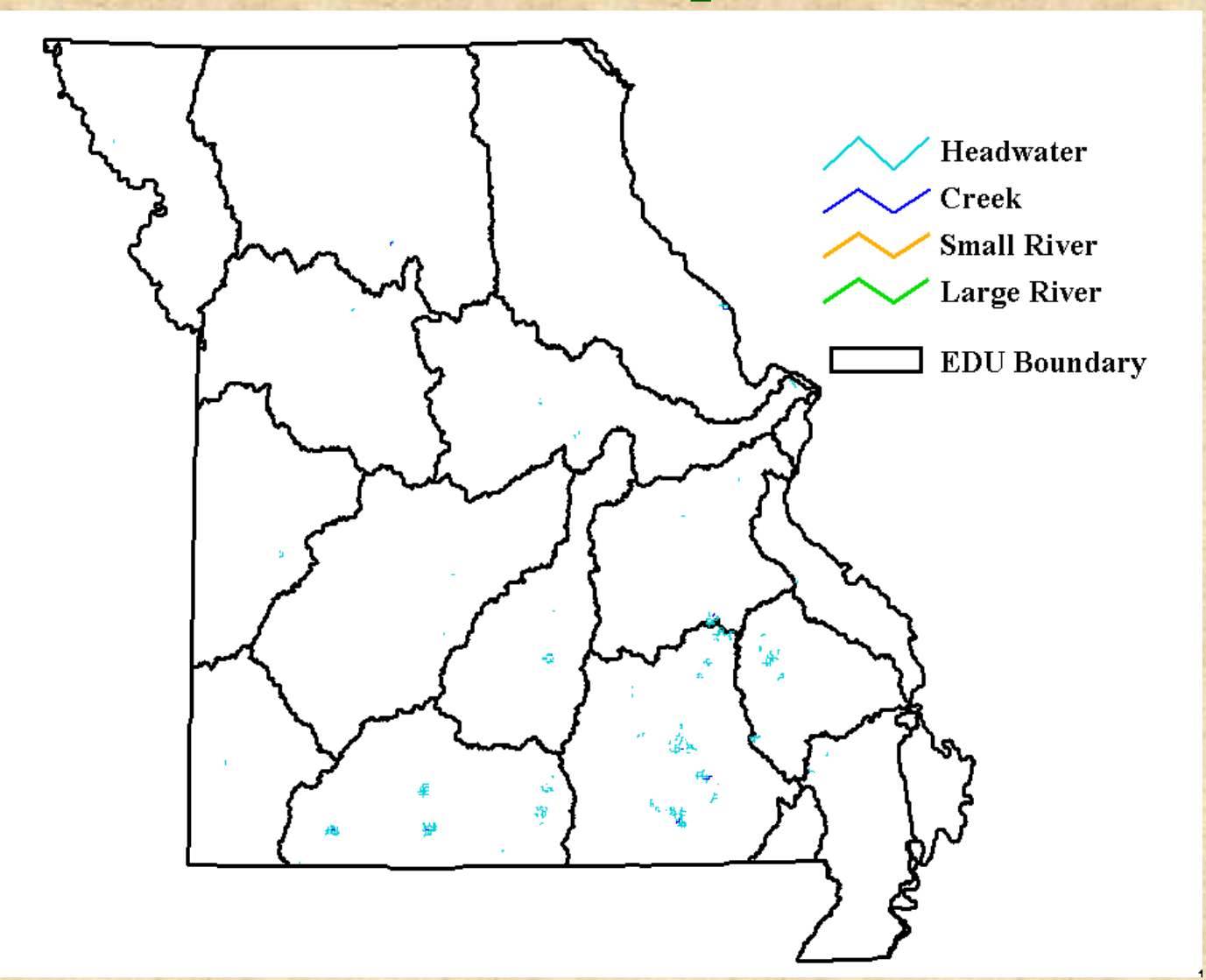
Upstream Riparian
≥ 50%



Overall Watershed
≥ 50%

Headwater
Creek
Small River
Large River
EDU Boundary

Combining Local and Watershed Ownership Data



Step 4: Accounting For Human Stressors

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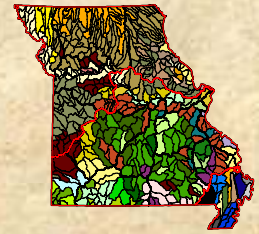
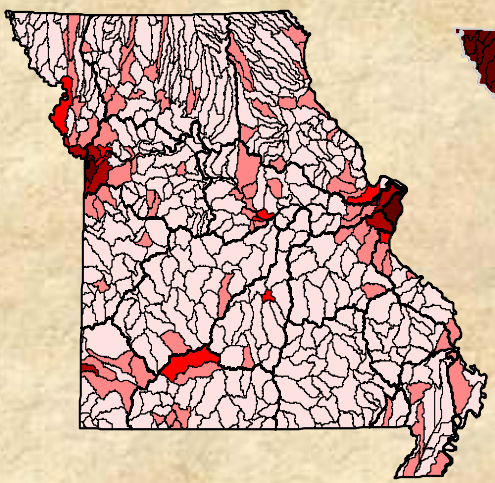


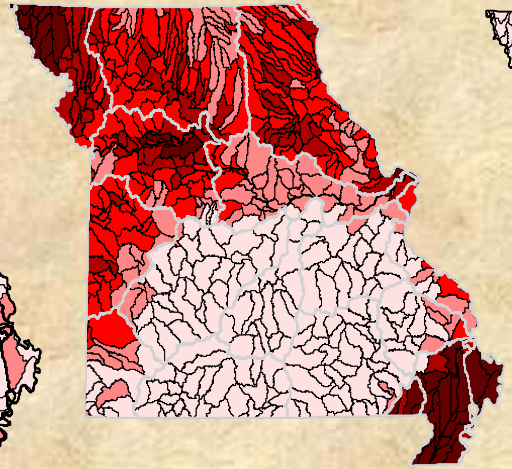
Purpose:

1) Assess representation of targets

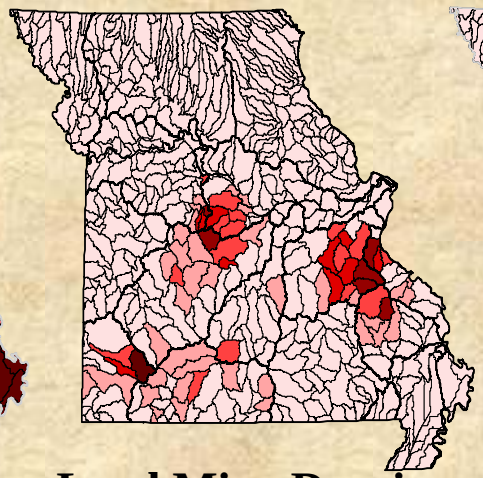
2) Assess achievement of conservation goals



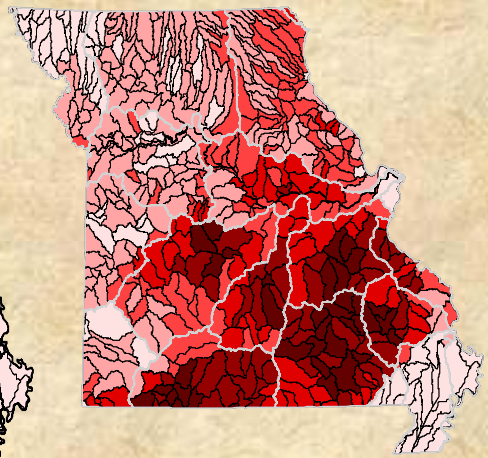
Percent Urban



Percent Cropland



Lead Mine Density



Riparian Forest

Attributes of Mo_aes_no_atts.shp

N_index_a	Pfor	Purb	Popchg	Stndcar7	Pfor_a	Pwetl	Pwetl_a	Purb_a	Pagp	Pagp_a	Pagc
63129600.0	4.6733	0.7236	1.950	0.02911	30719700.0	1.8081	11885400.0	4756500.0	21.1641	139122000.0	68.5054
44426700.0	8.3388	1.1371	-2.259	0.02734	28229400.0	1.6302	5518800.0	3849300.0	31.4877	106596000.0	54.2490
87714000.0	11.5990	1.8831	19.094	0.00987	53461800.0	1.6080	7411500.0	8679600.0	46.4294	214002000.0	32.3911
38376900.0	11.0445	0.1387	-3.261	0.00804	22499100.0	1.2021	2448900.0	282600.0	44.7170	91094400.0	36.2694
17636400.0	2.5608	0.6827	-10.089	0.00000	5620500.0	2.8572	6271200.0	1498500.0	17.7593	38979000.0	73.5226
117477000.0	12.7244	1.5937	9.233	0.03354	74214900.0	1.0420	6077700.0	9295200.0	50.6270	295281900.0	27.6202
46512000.0	13.4467	1.9184	-3.716	0.01482	33314400.0	1.8963	4698000.0	4752900.0	33.1771	82197000.0	46.1276
21305700.0	10.3359	2.0993	5.626	0.03312	14294700.0	2.0648	2855700.0	2903400.0	33.0934	45768600.0	49.2965
26120700.0	9.1666	0.0644	11.042	0.03643	15754500.0	1.8632	3202200.0	110700.0	42.8112	73578600.0	41.9058
17995500.0	7.3856	0.1121	-6.551	0.05027	9483300.0	1.9065	2448000.0	144000.0	31.8226	40860900.0	54.0503
65268000.0	7.8013	1.2999	15.010	0.04766	37684800.0	1.1018	5322600.0	6279300.0	39.2811	189751500.0	45.9077

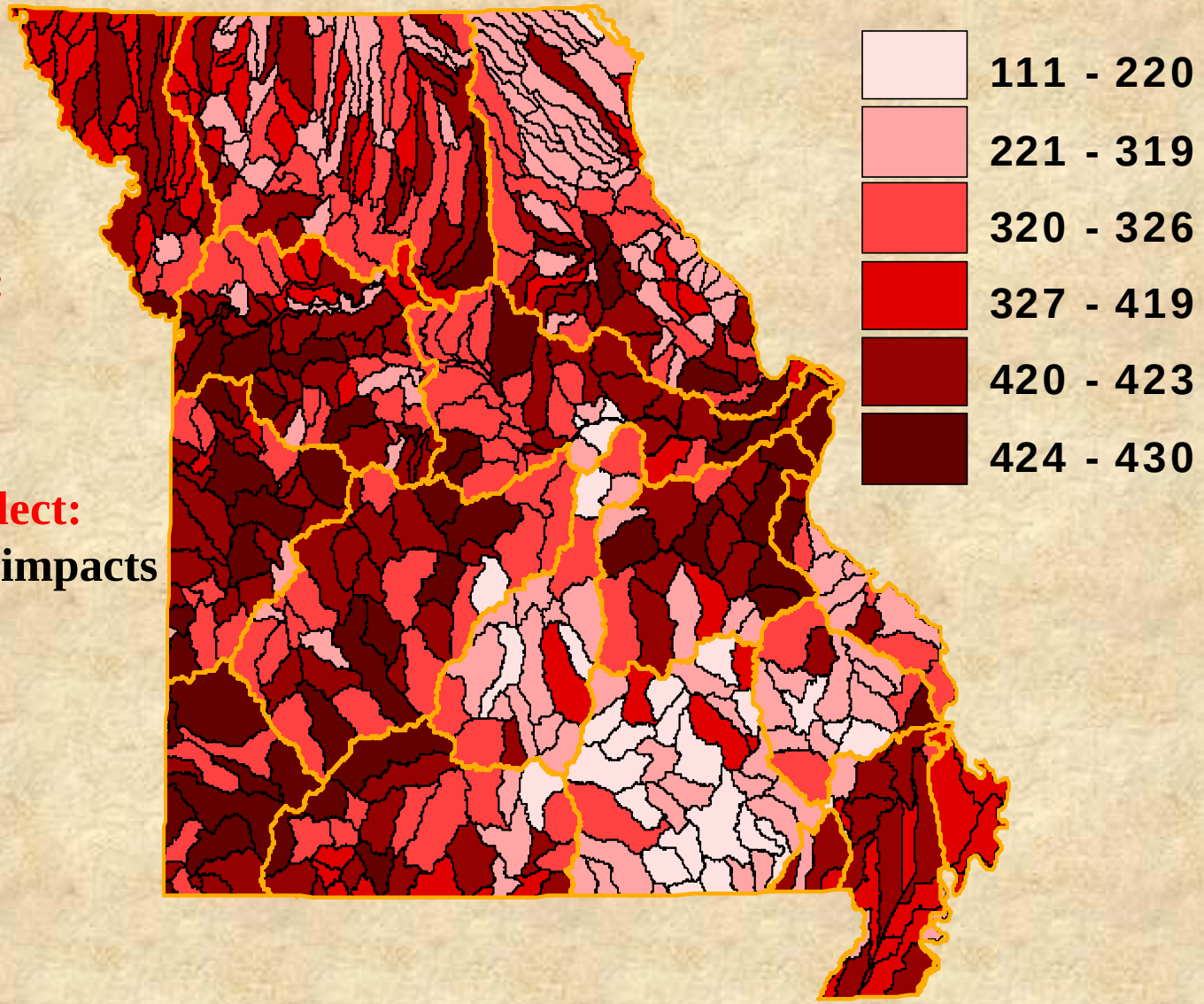
Variables Used in Human Stressor Index

- % Urban
- % Agriculture
- Density of Road/Stream crossings
- Population change
- Degree of fragmentation/hydrologic alteration
- Density of small impoundments
- Density of coal mines
- Density of lead mines
- Density of industrial discharges
- Density of Confined Animal Feeding Operations
- Number of Exotic Species

Human Stressor Index

First number reflects:
Highest magnitude of individual stressor

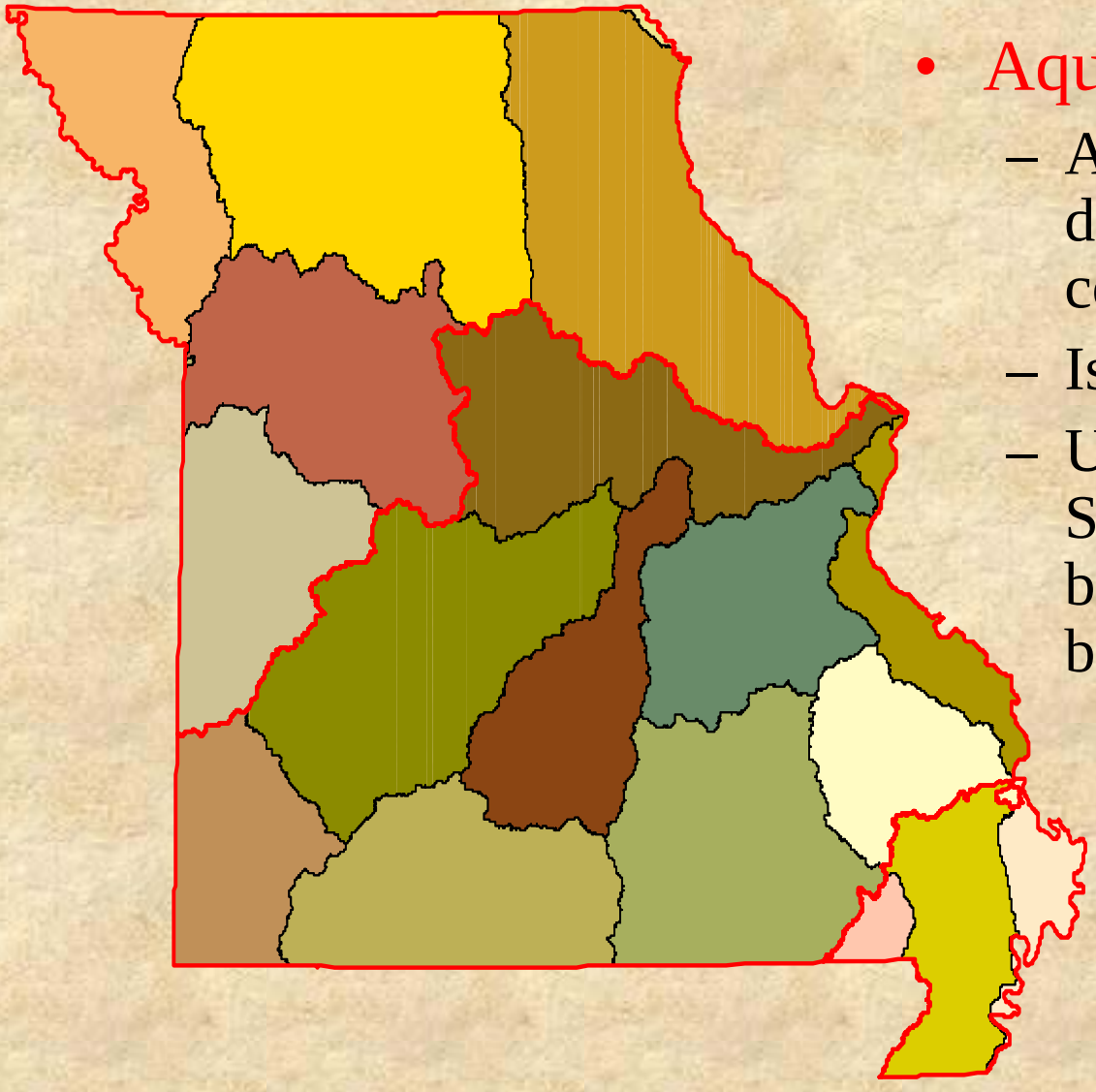
Last two numbers reflect:
Degree of cumulative impacts



So How Do We Use All of this Information to Identify Conservation Gaps?

- Must first identify Planning/Assessment Units
  - Planning: Aquatic Subregions, EDU's, and AES's
  - Assessment: EDU's, AES's, and VST's
- Then identify conservation targets
  - Abiotic
    - Aquatic Ecological System Types
    - Valley Segment Types
  - Biotic
    - Endemics
    - Species of Special concern
    - Characteristic species
      - Ecologically important species (top predators, major prey species)
      - Geographically distinct populations
- Finally must define what constitutes a "Gap"

What Defines a Gap?



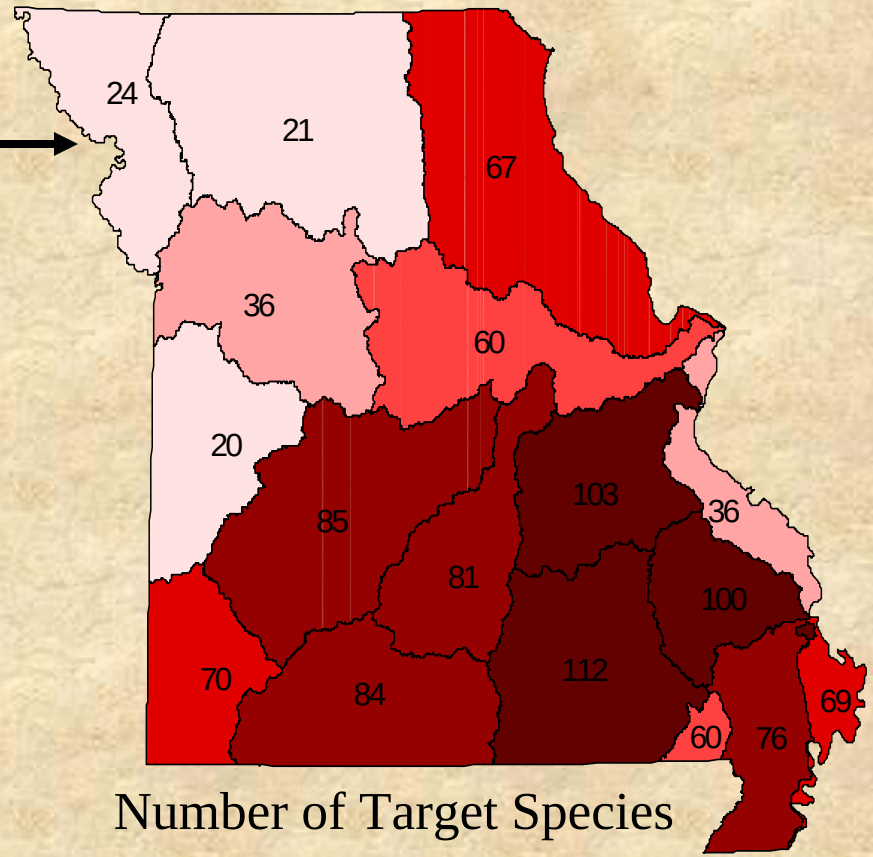
- Aquatic Subregion Level
  - All EDU's are ecologically distinct enough to warrant conservation
  - Islands in the landscape
  - Until all EDU's within a Subregion are effectively being conserved there will be a conservation gap

What Defines a Gap?

Scientific	Common
Acipenser fulvescens	lake sturgeon
Anodonta suborbiculata	flat floater
Arcidens confragosus	rock pocketbook
Cycleptus elongatus	blue sucker
Cyprinella lutrensis	red shiner
Fundulus zebrinus	plains killifish
Hiodon alosoides	goldeye
Hybognathus argyritis	western silvery minnow
Hybognathus hankinsoni	brassy minnow
Hybognathus placitus	plains minnow
Luxilus cornutus	common shiner
Macrhybopsis gelida	sturgeon chub
Macrhybopsis hyostoma	shoal chub
Macrhybopsis meeki	sicklefin chub
Macrhybopsis storeriana	silver chub
Notropis buchanani	ghost shiner
Notropis dorsalis	bigmouth shiner
Notropis topeka	Topeka shiner
Orconectes immunis	papershell crayfish
Pimephales promelas	fathead minnow
Platygobio gracilis	flathead chub
Polyodon spathula	paddlefish
Procambarus gracilis	grassland crayfish
Scaphirhynchus albus	pallid sturgeon

- Endemics
- Species of special concern
- Characteristic species

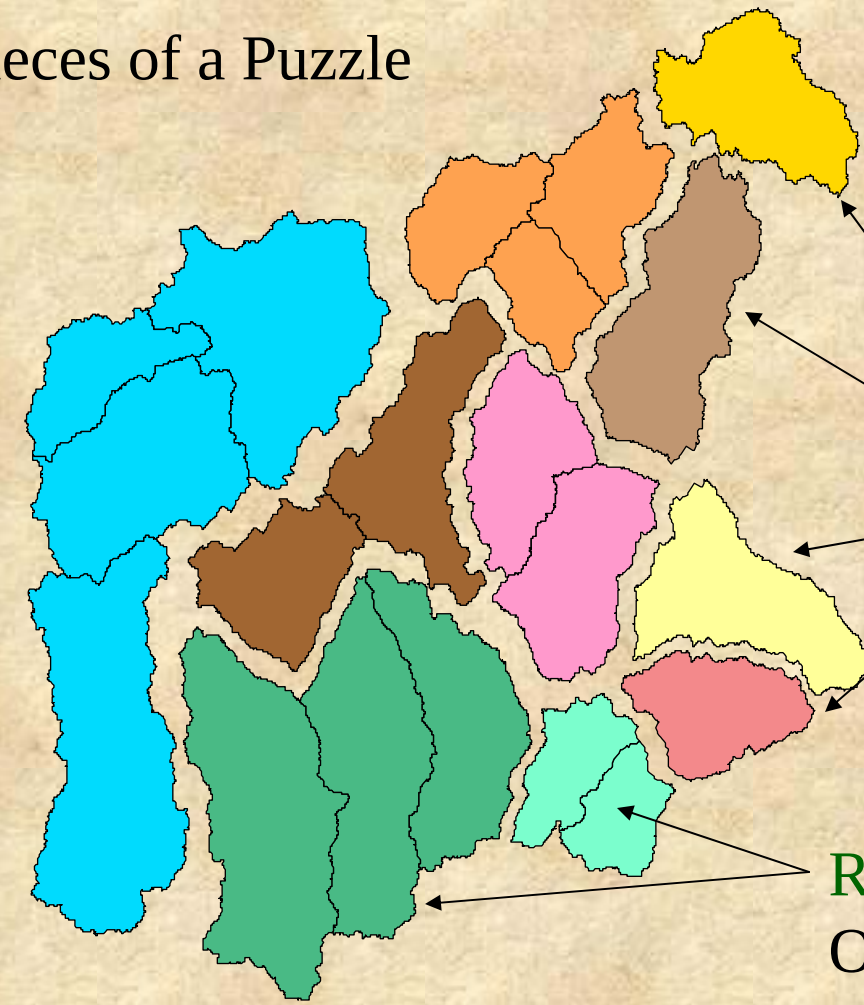
- EDU Level (biotic)
  - Representation of <u>all</u> Target Species



Number of Target Species

What Defines a Gap?

Pieces of a Puzzle

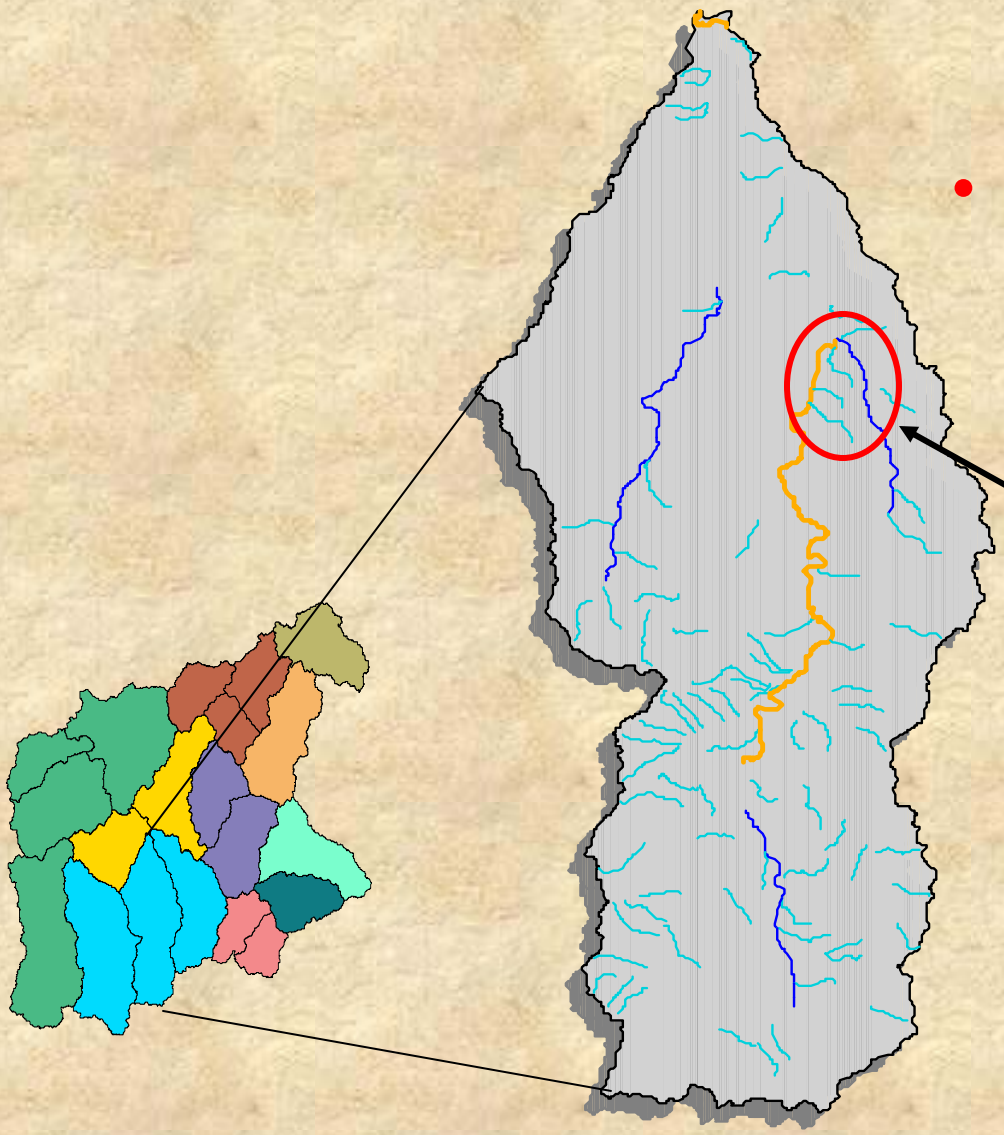


- EDU Level (abiotic)
  - Representation of all AES-Types

Distinct types:
Each one warrants conservation

Redundant types:
One individual AES warrants conservation

What Defines a Gap?



- AES Level
  - Representation of dominant VST's (by stream size)
  - <u>Within a single AES</u>
  - Should address issue of connectivity

Stream Size Classes

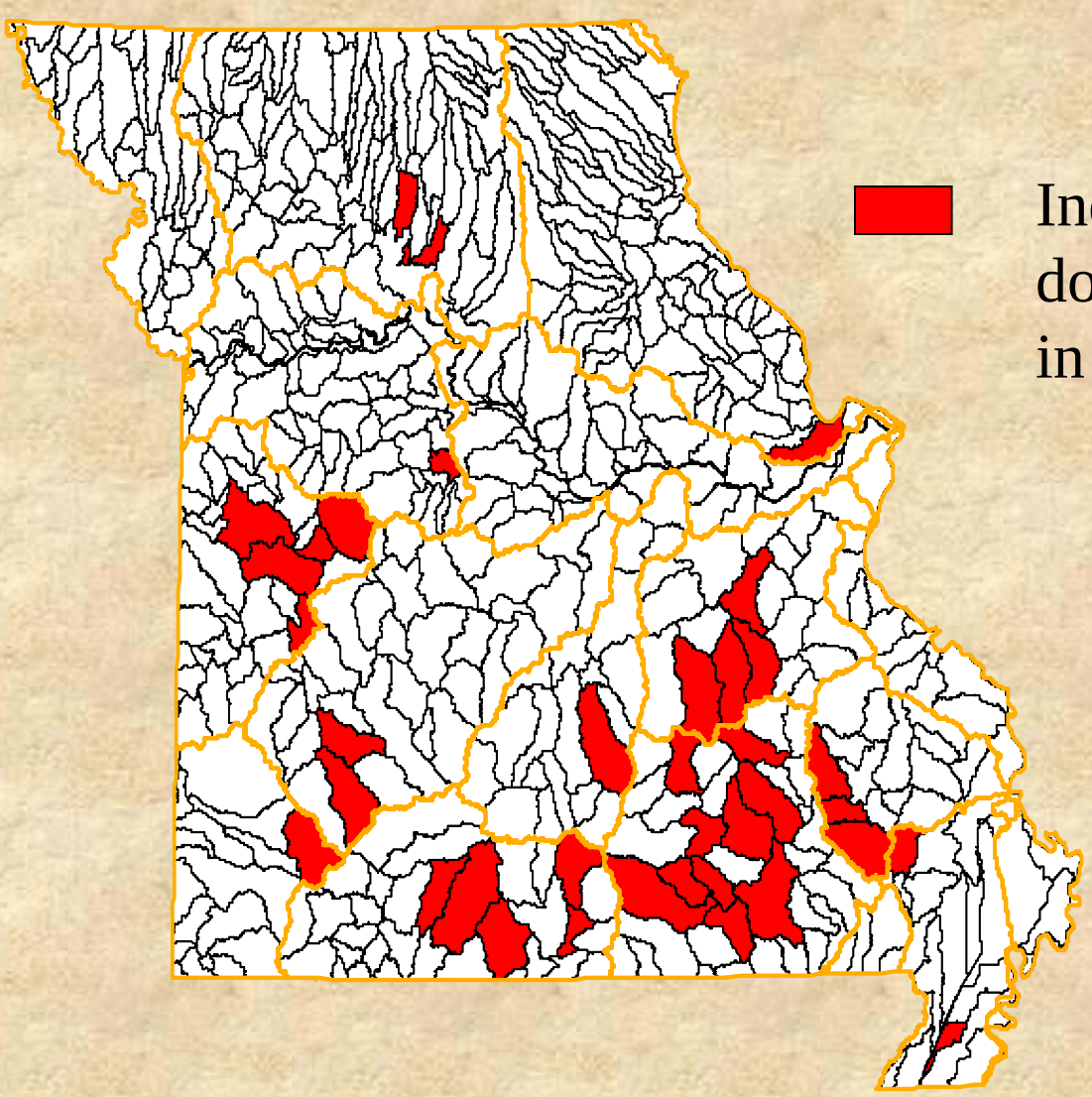
Headwater

Creek

Small River

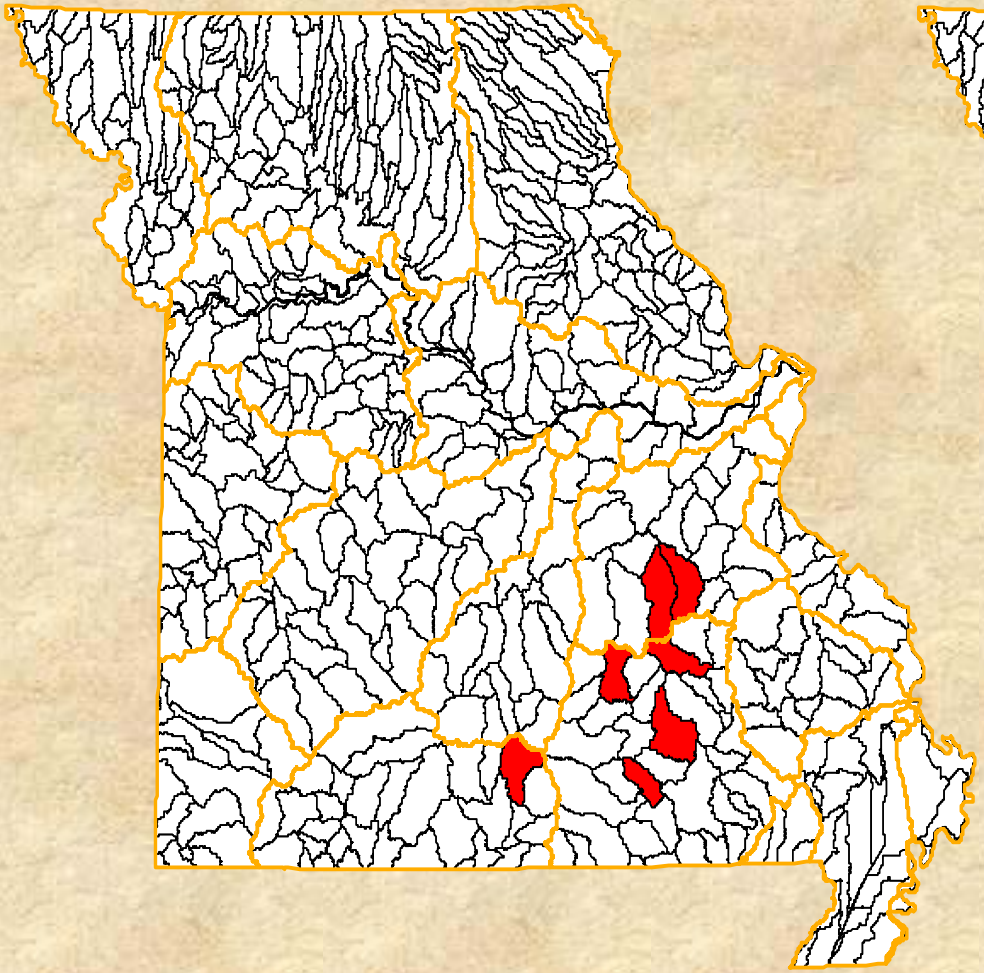
Dominant Valley Segment Types by Size Class For Huzzah River AES

Assessing Gaps in Abiotic Targets (AES Level)

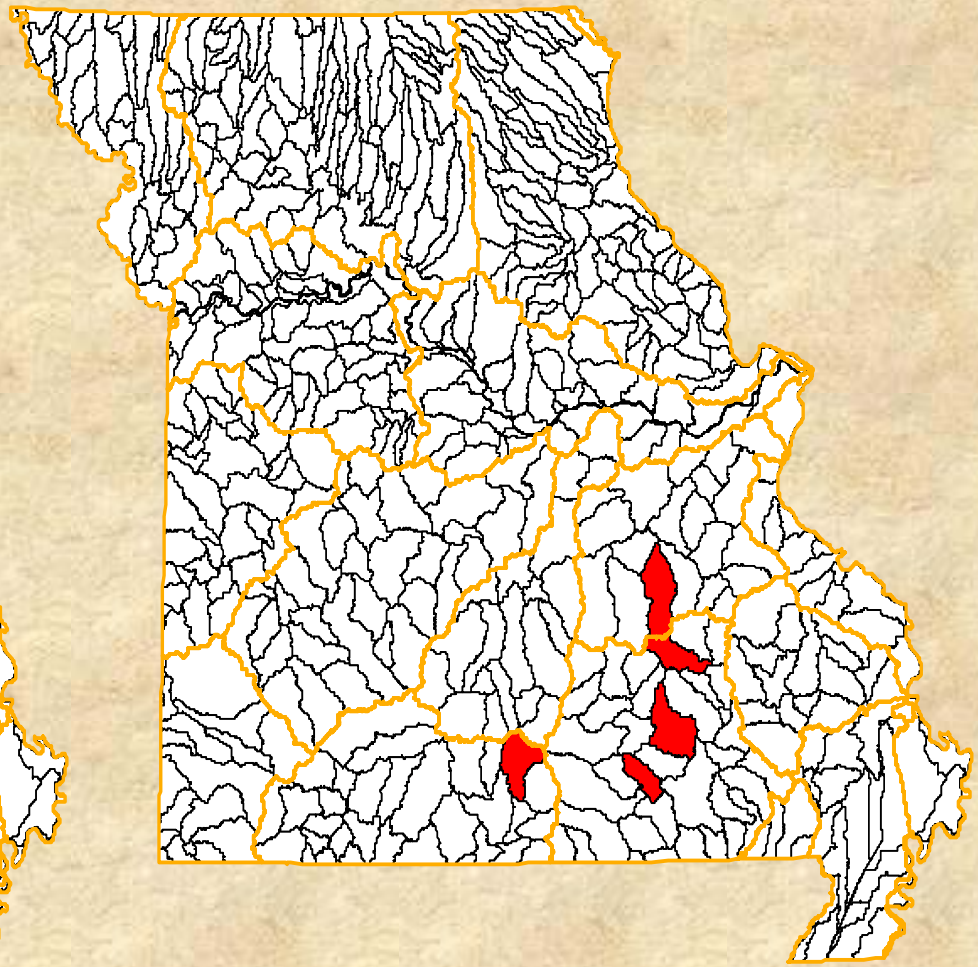


Individual AES's with all dominant VST's represented in conservation lands

Using More Stringent Criteria to Assess Gaps

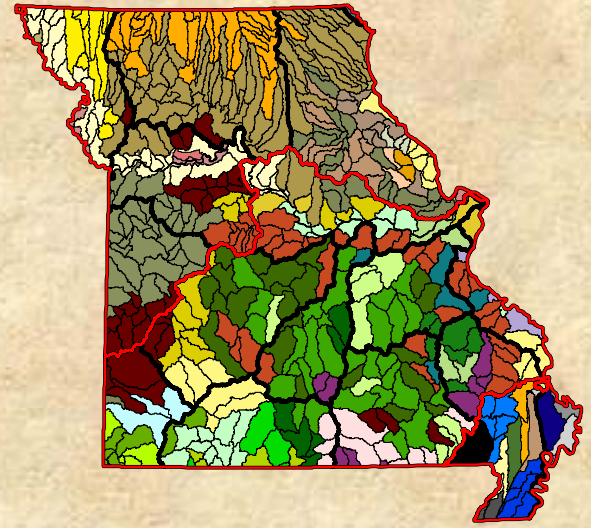


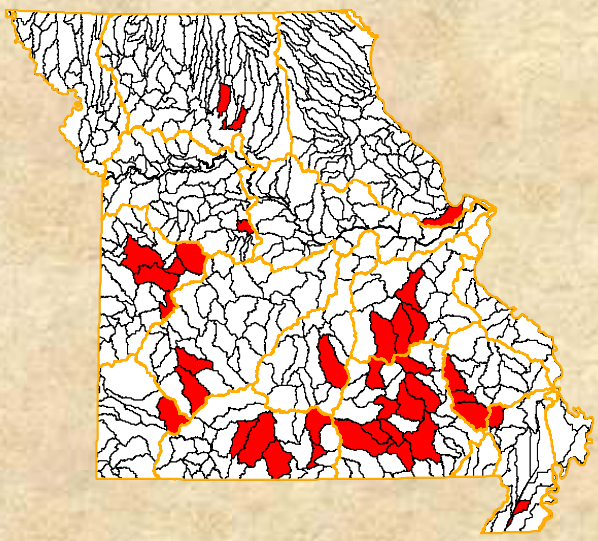
All dominant VST's represented locally with > 50% of their watershed in public ownership

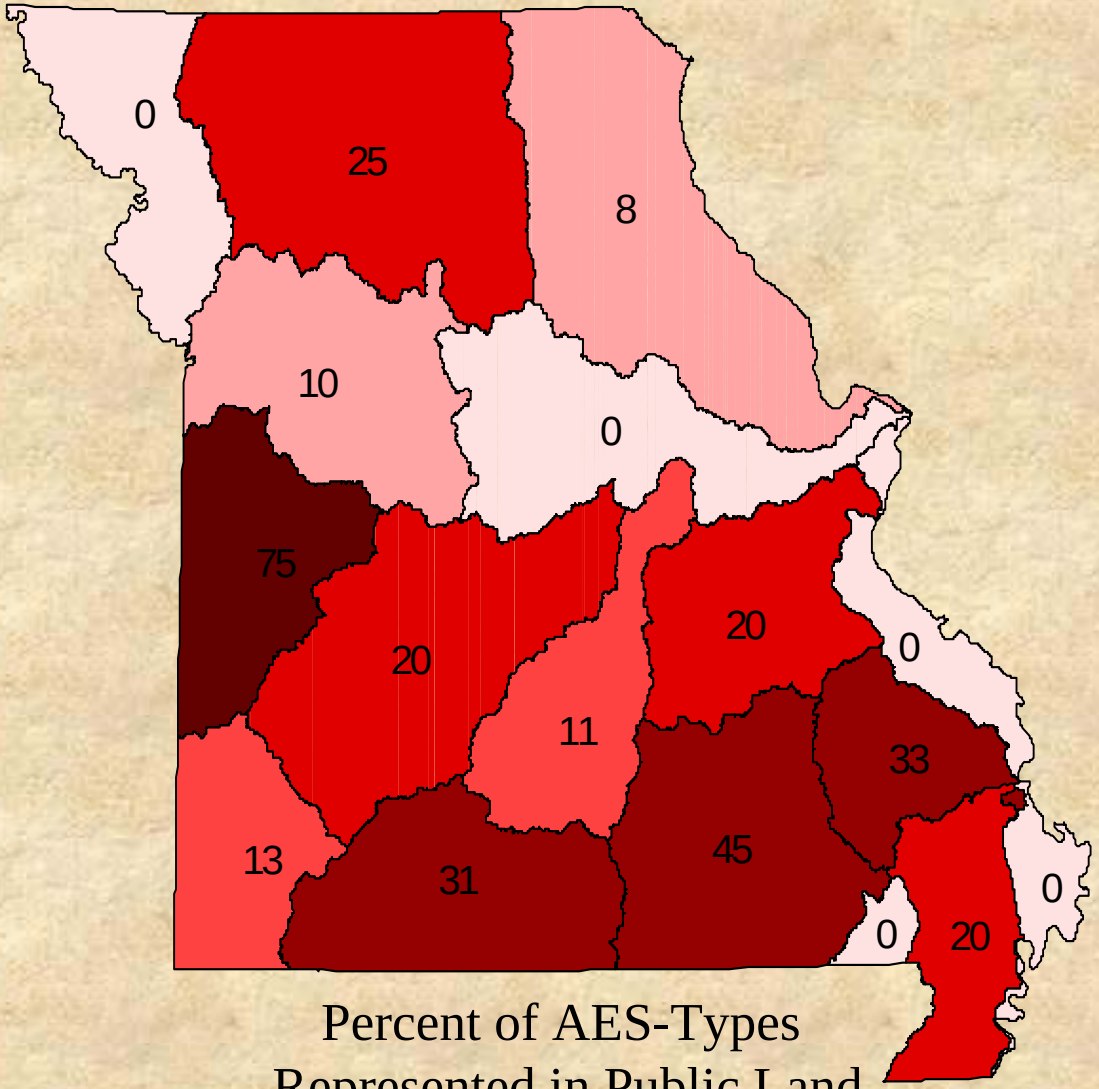


Those remaining after assessment of Human stressors

Assessing Gaps in Abiotic Targets (EDU Level)

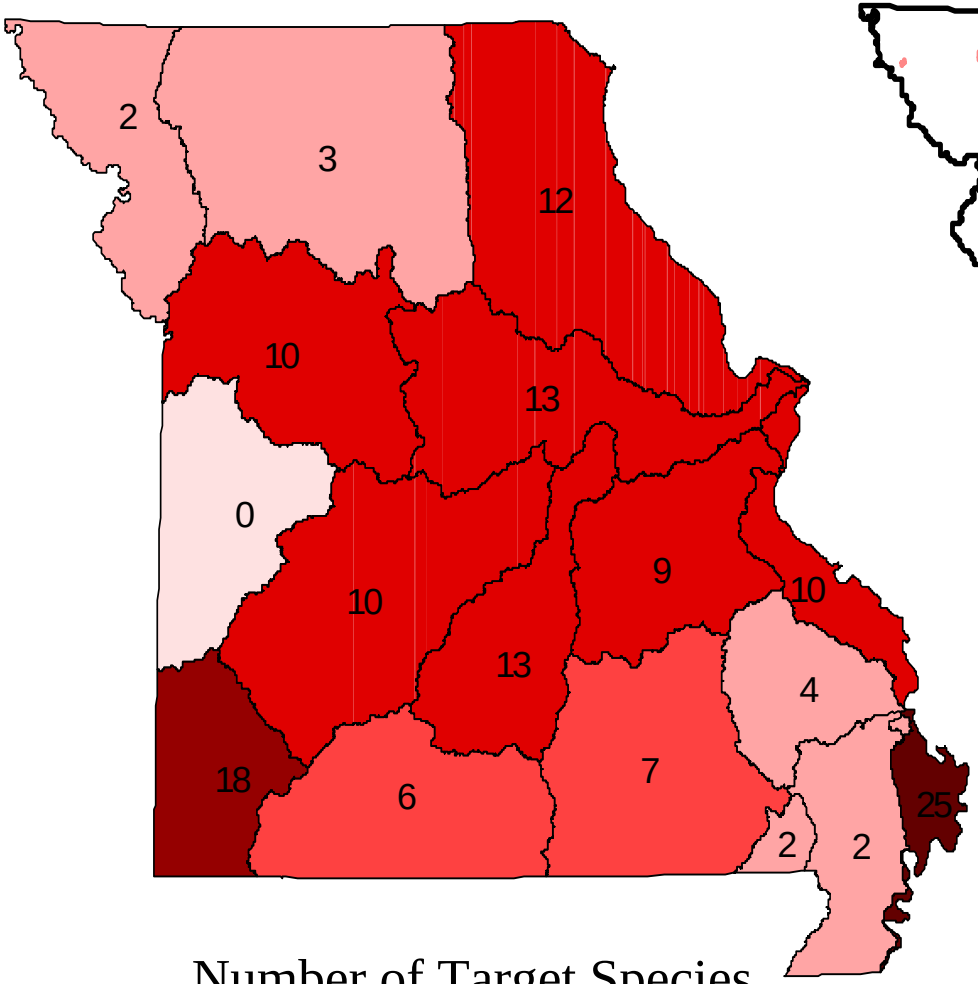




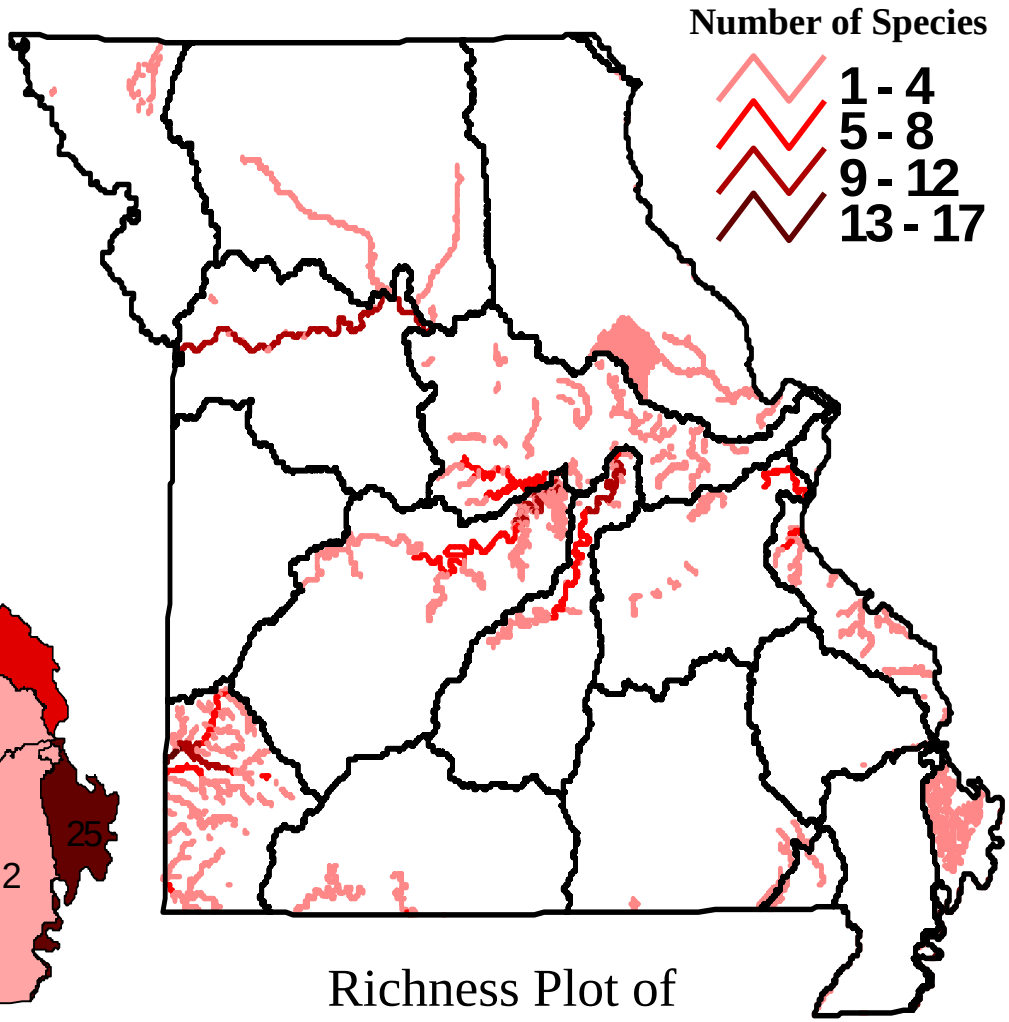


Percent of AES-Types Represented in Public Land

Assessing Gaps in Biotic Targets
(EDU Level)



Number of Target Species
Not Captured in Public Lands

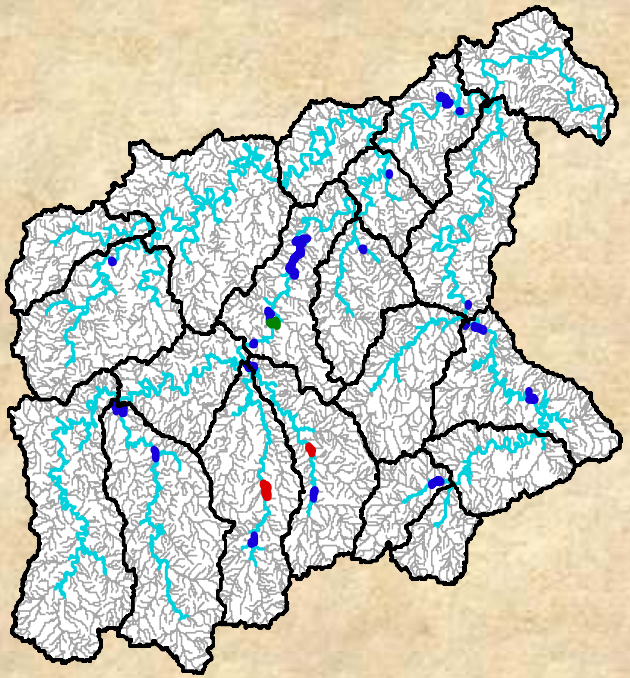


Richness Plot of
Target Species Not Captured
In Public Lands

Assessing Representation by Length of Stream

EDU_CODE	Vernacular	Scientific	Gap1	Gap2	Gap3	Gap4	Private	Total_Range
25	slenderhead darter	Percina phoxocephala	2.6	0.0	26.4	0.0	677.8	706.8
25	slippershell mussel	Alasmidonta viridis	2.9	10.0	114.8	0.0	2248.0	2375.7
25	smallmouth bass	Micropterus dolomieu	2.6	6.6	40.1	0.0	1367.2	1416.5
25	smallmouth buffalo	Ictiobus bubalus	0.0	0.0	4.1	0.0	163.3	167.4
25	snuffbox	Epioblasma triquetra	2.6	0.0	23.9	0.0	557.9	584.4

EDU_CODE	Vernacular	Scientific	Gap1_pct	Gap2_pct	Gap3_pct	Gap4_pct	Private_pct	Total_Range
25	slenderhead darter	Percina phoxocephala	0.4	0.0	3.7	0.0	95.9	706.8
25	slippershell mussel	Alasmidonta viridis	0.1	0.4	4.8	0.0	94.6	2375.7
25	smallmouth bass	Micropterus dolomieu	0.2	0.5	2.8	0.0	96.5	1416.5
25	smallmouth buffalo	Ictiobus bubalus	0.0	0.0	2.4	0.0	97.6	167.4
25	snuffbox	Epioblasma triquetra	0.4	0.0	4.1	0.0	95.5	584.4



Ozark/Meramec EDU

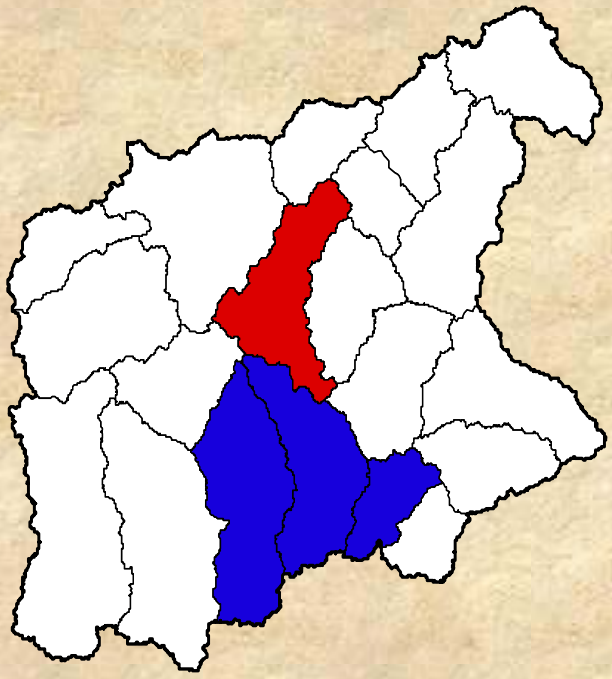
Smallmouth Bass
(*Micropterus dolomieu*)

- AES Boundaries
- Gap 1 Stream Segments
- Gap 2 Stream Segments
- Gap 3 Stream Segments
- Total Range
- Other Meramec EDU Stream Segments

Assessing Representation by the Number of Distinct Spatial Occurrences

EDU_Code	Distinct_Occurrences	Common
25	4	paper pondshell
25	4	northern studfish
25	4	mottled sculpin
25	4	longear sunfish
25	4	largescale stoneroller
25	4	largemouth bass
25	4	ellipse

EDU_Code	Common	GapStat	AESPolyId
25	lilliput	2	363
25	lilliput	2	364
25	logperch	1	375
25	longear sunfish	1	375
25	longear sunfish	2	363
25	longear sunfish	2	364
25	longear sunfish	2	372
25	longnose gar	1	375
25	mapleleaf	1	375

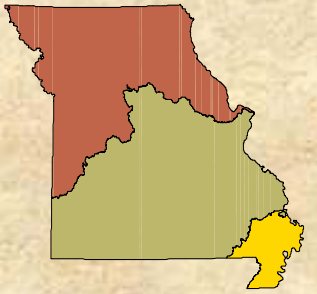


Ozark/Meramec EDU

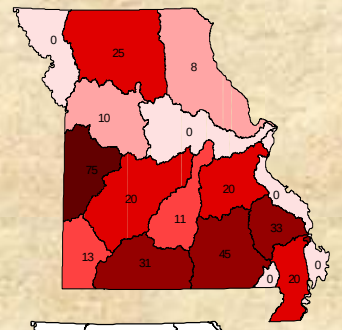
Longear Sunfish
(*Lepomis megalotis*)

- AES Boundaries
- Gap 1 Distinct Occurrence
- Gap 2 Distinct Occurrences

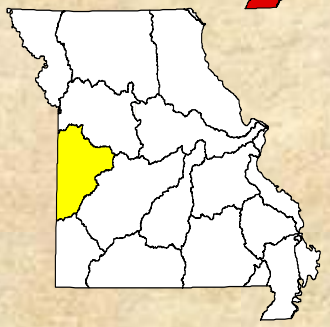
So Where are the Gaps? Everywhere!!



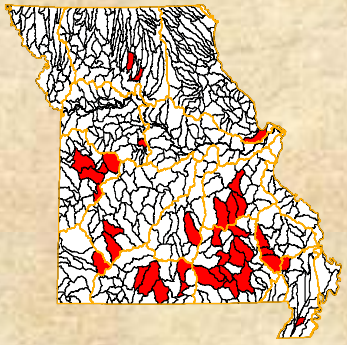
- None of the Aquatic Subregions are adequately represented
  - Likely never will be



- None of the EDU's are adequately represented based on abiotic targets



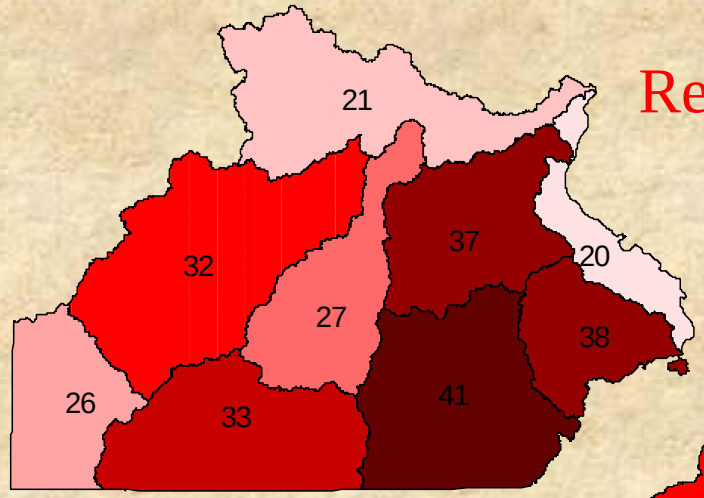
- Only one EDU is adequately represented based on biotic targets



- Only a handful of individual AES's and AES-Types are represented based on the <u>least restrictive criteria</u> (i.e., local ownership)

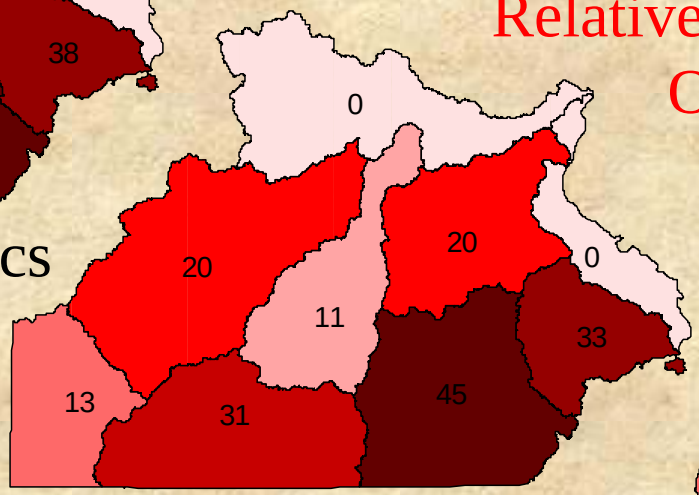
Assessing Gaps is "Easy"
Setting Priorities is Difficult

Relative Importance



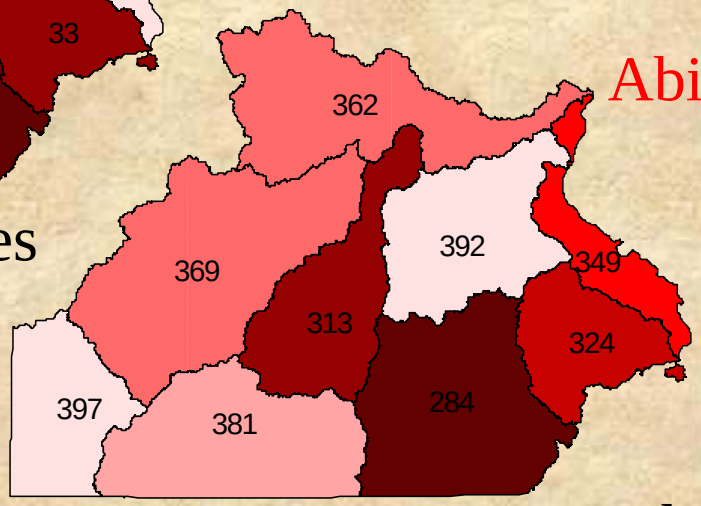
Richness of Endemics

Relative Need and Opportunity

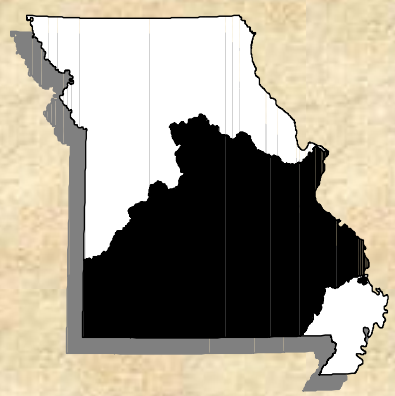


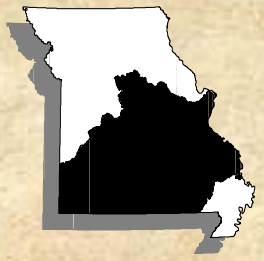
Percent AES-Types Conserved

Ability



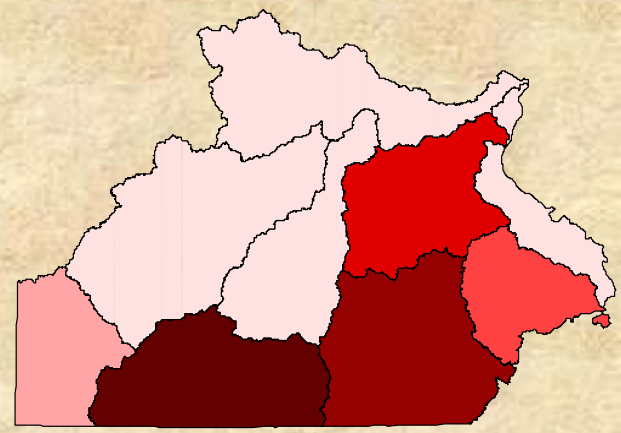
Average Human Stressor Index



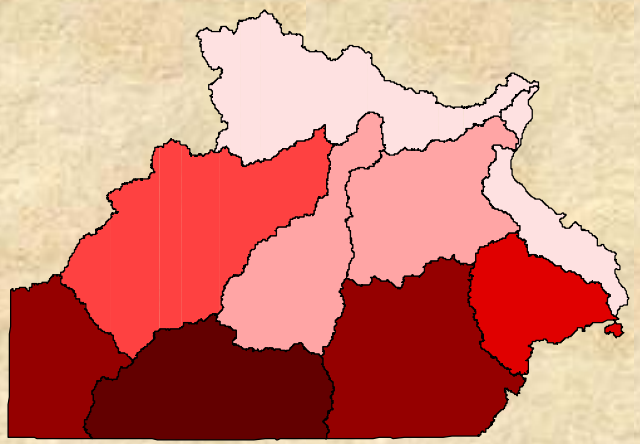


Different Taxa Provide Different Results

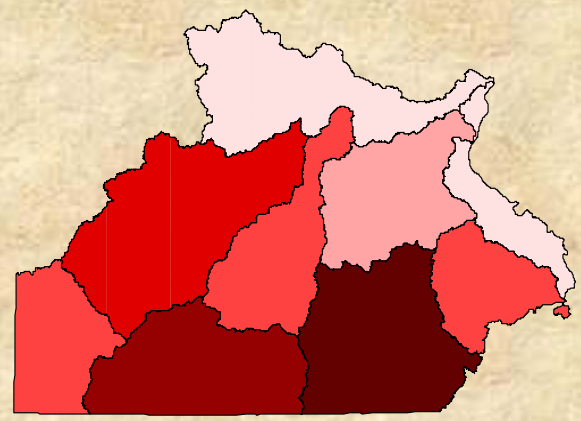
(Ranks based on Endemism)



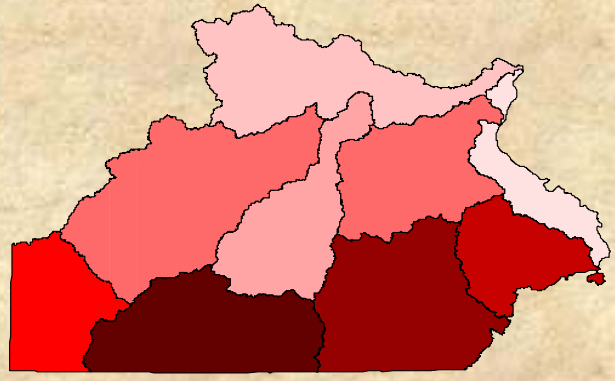
Crayfish



Mussels



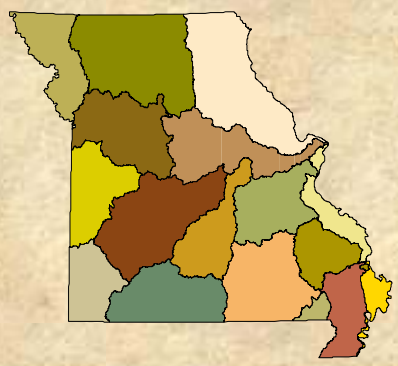
Fish



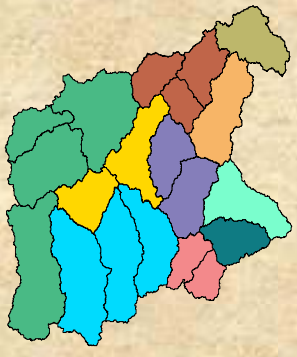
All 3 Taxa Combined

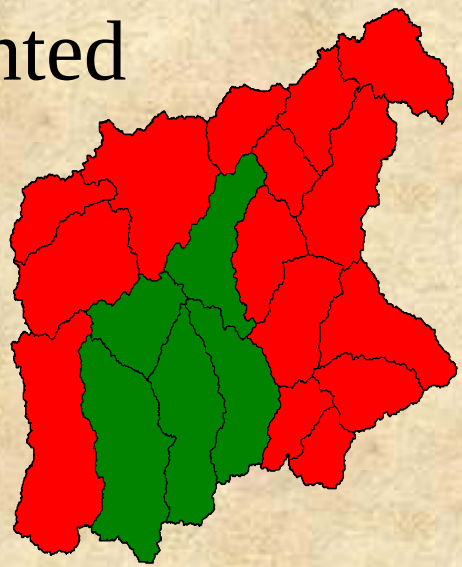
“Comprehensive”Biodiversity Conservation Plan

- Identify conservation gaps for each EDU



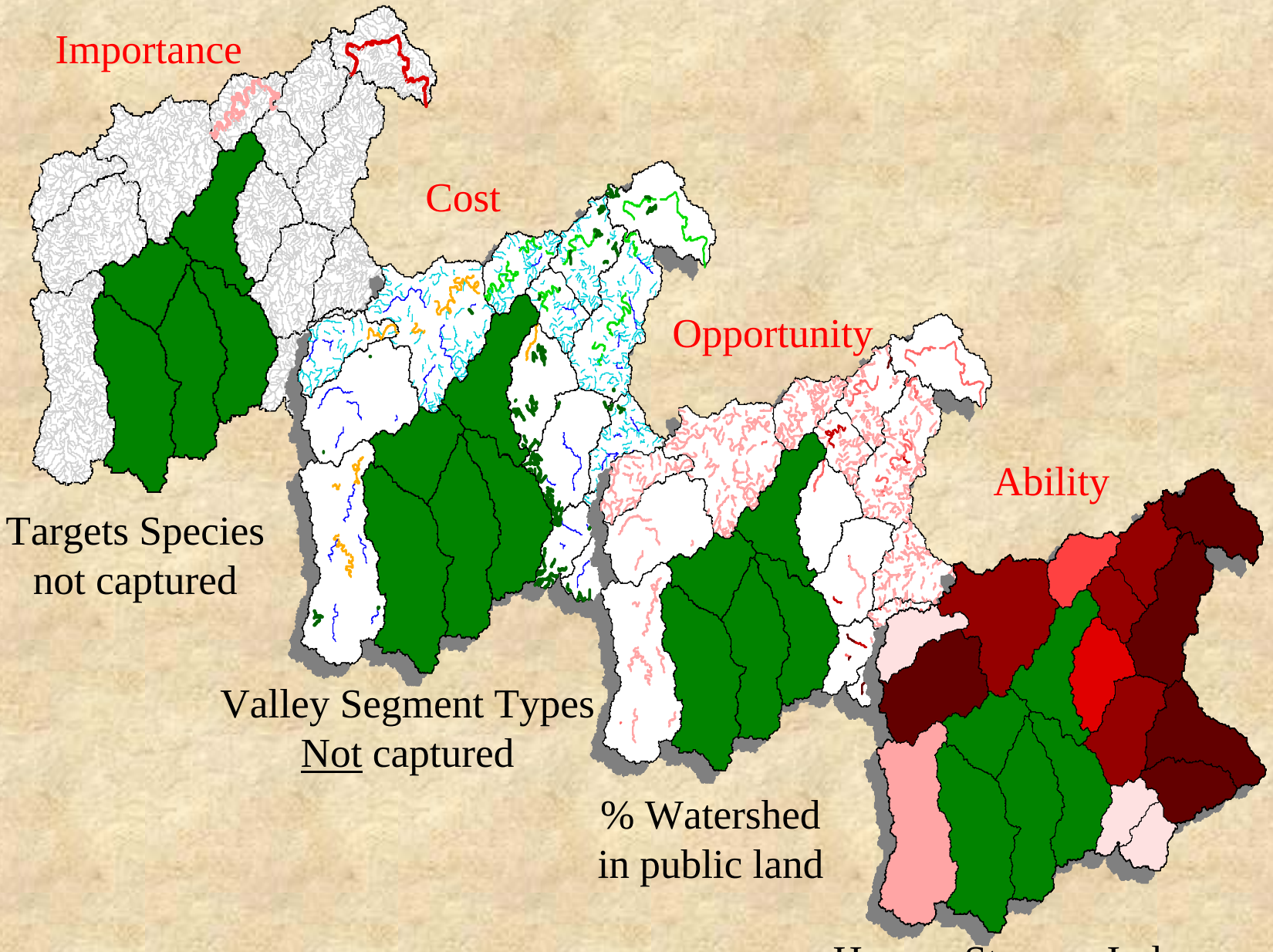
- Develop priorities for AES-Types and VST’s not represented



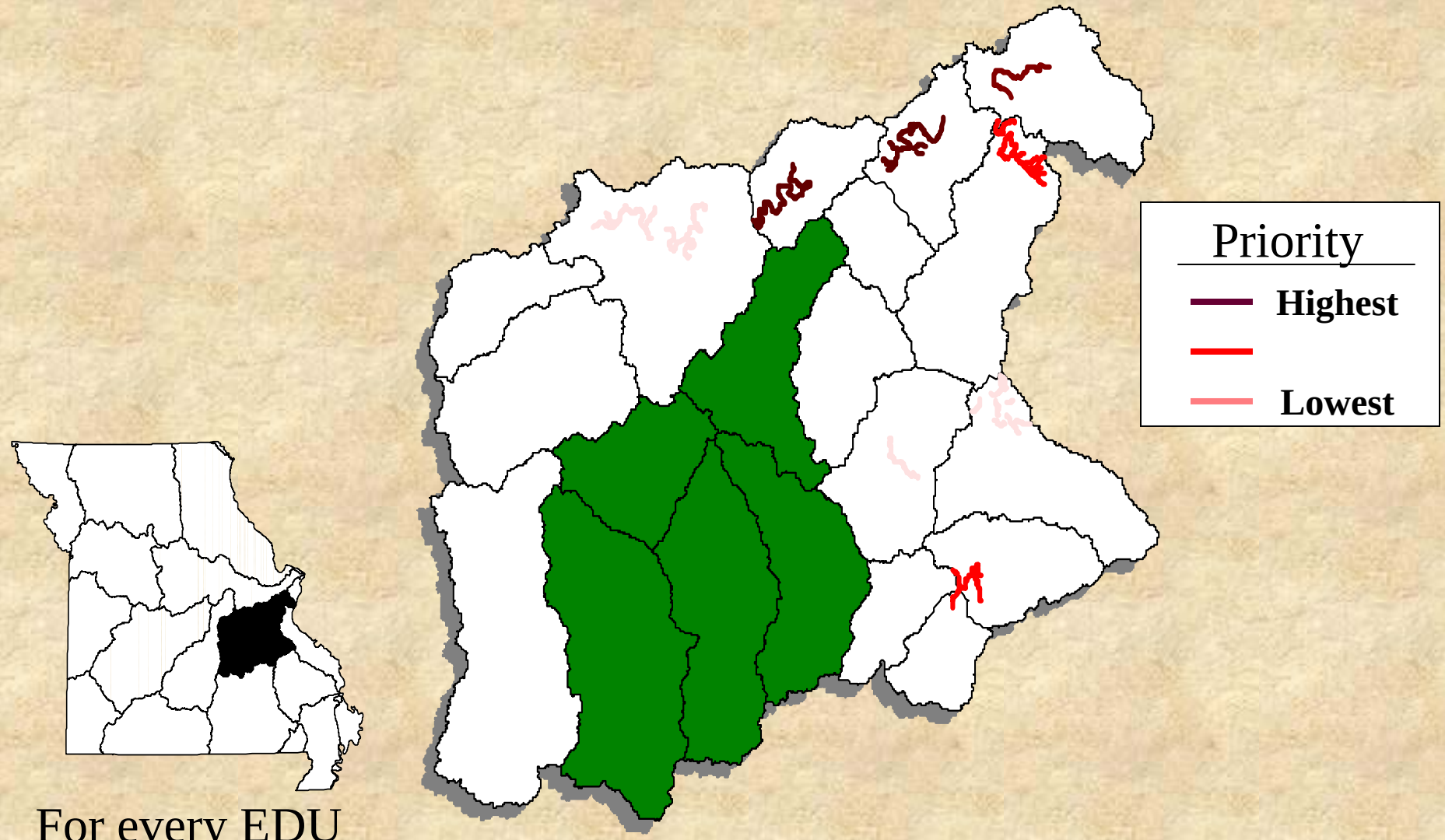


AES-Types Not Adequately Represented

Addressing the Critical Questions



Final Portfolio of Target Valley Segments Ranked by Various Factors



For every EDU

Lessons Learned and Recommendations

- Assessing conservation gaps in riverine ecosystems is not a straightforward task
- Must consider watershed and upstream riparian ownership
- Must also consider human stressors since many "represented" targets exist in relatively degraded state
- Missouri is full of gaps
- In many places, like Missouri, protected areas alone will not protect freshwater biodiversity
- Identifying gaps is easy, the difficult part is establishing priorities to fill gaps
  - Must assess importance, costs, condition, threats, and opportunities
  - Must develop decision support systems and systematic conservation planning algorithms suited to riverine ecosystems

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