Developing Synoptic Human Threat Indicators for Assessing the Ecological Integrity of Freshwater Ecosystems

4th Regional Oversight Committee Meetings

St. Joseph, MO

August 30th, 2007

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Region 7 Wetland Program Development Grant
Missouri DNR 319 Grant

MoRAP

Missouri Department of Natural Resources

United States Environmental Protection Agency

Overview

- Background and project goal
- Review of last meeting
- EPA Region 7 HTI development and progress
  - Literature Review
  - Agriculture Chemical analysis
  - Distance weighting
  - Fragmentation
  - Population change
  - Headwater Impoundments
  - Error Checking
- Working meeting and discussions

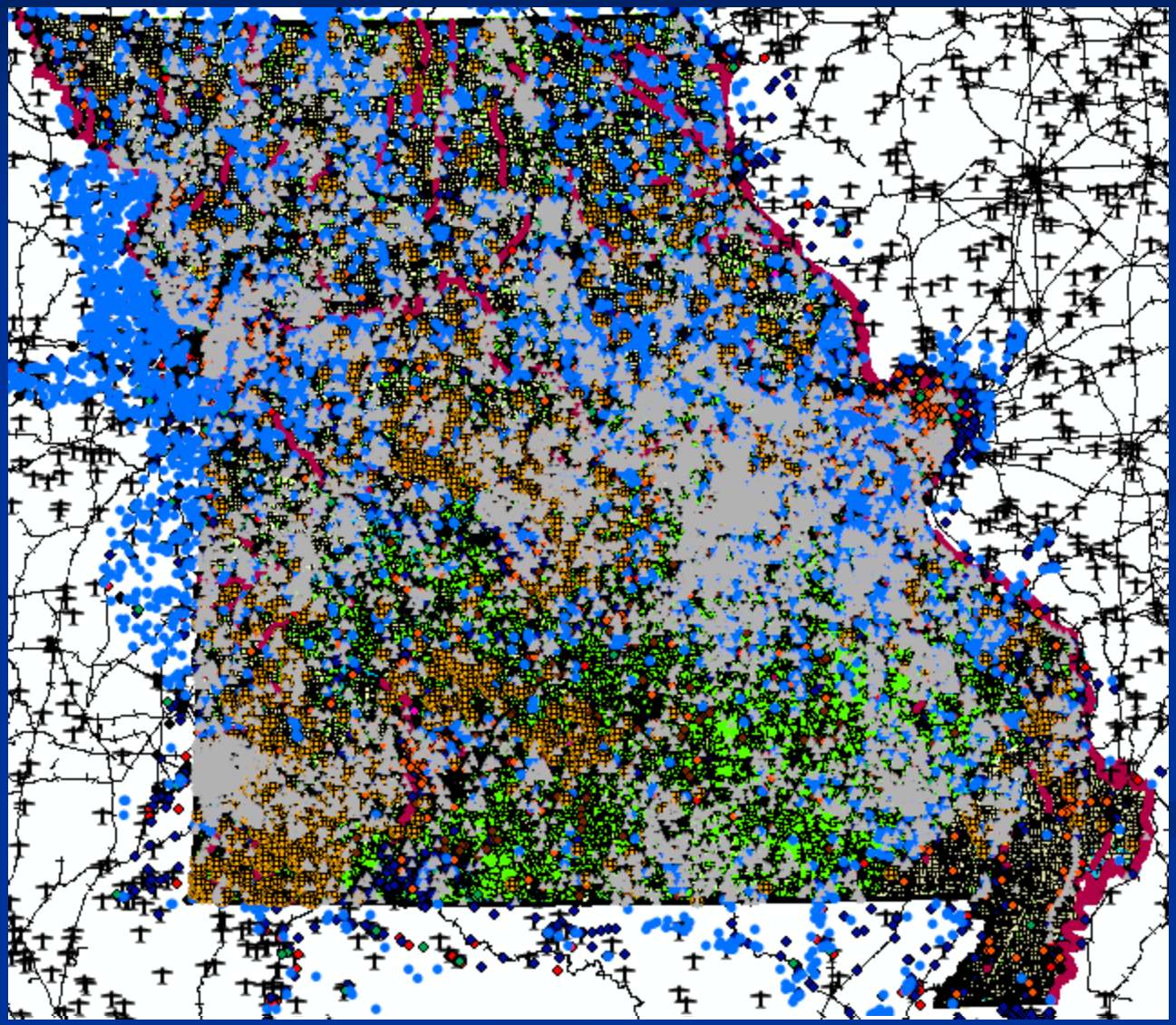
Background/Key Question of Where

Review – What we are trying to accomplish

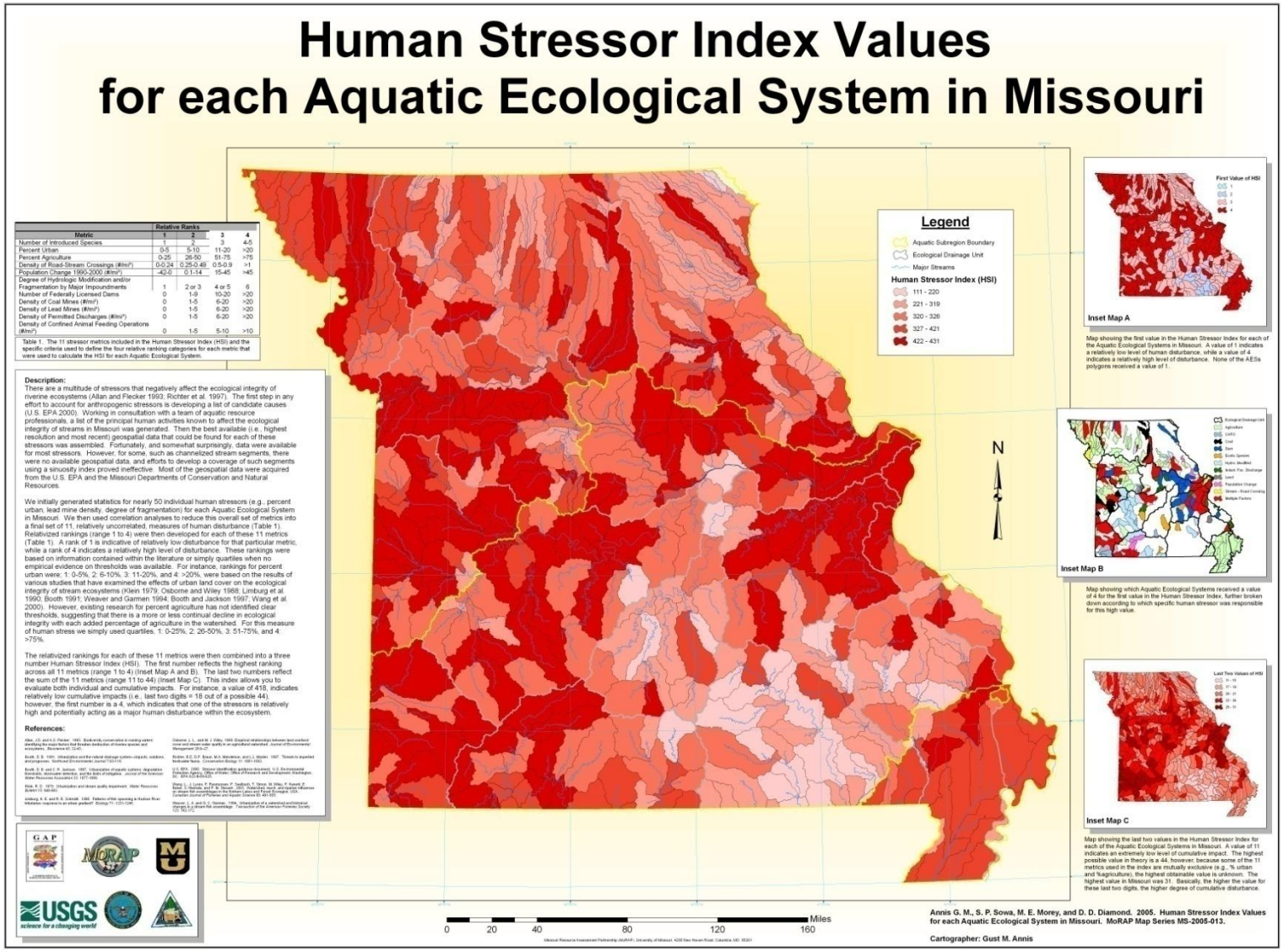
Goal:
Develop reach scale GIS-based Synoptic Human Stressor Indices (HSI) for assessing ecological integrity of freshwater ecosystems

Human Stressors (Missouri Example)

- Land Use
- Municipalities
- Railroads
- 303d Streams
- Airports
- Toxic Release
- Superfund
- Point Sources
- In-stream gravel mines
- Landfills
- Industrial Facility Discharges
- Hazardous Waste Generators
- Drinking Water Supplies
- Dams
- CAFOs
- Mines
- Roads



Building Upon Process from Missouri



Metric	Relative Ranks 1	2	3	4
Number of Introduced Species	1	2	3	4-5
Percent Urban	0-5	5-10	11-20	>20
Percent Agriculture	0-25	26-50	51-75	>75
Density of Road-Stream Crossings (#/km²)	0.0-.24	0.25-0.49	0.5-0.9	>1
Population Change 1990-2000 (#/km²)	-42-0	0.1-14	15-45	>45
Degree of Hydrologic Modification and/or Fragmentation by Major Impoundments	1	2 or 3	4 or 5	6
Number of Federally Licensed Dams	0	1-9	10-20	>20
Density of Coal Mines (#/km²)	0	1-5	6-20	>20
Density of Lead Mines (#/km²)	0	1-5	6-20	>20
Density of Permitted Discharges (#/km²)	0	1-5	6-20	>20
Density of Confined Animal Feeding Operations (#/km²)	0	1-5	5-10	>10

Table 1. The 11 stressor metrics included in the Human Stressor Index (HSI) and the specific criteria used to define the four relative ranking categories for each metric that were used to calculate the HSI for each Aquatic Ecological System.

There are a multitude of stressors that negatively affect the ecological integrity of riverine ecosystems (Allan and Flecker 1993; Richter et al. 1997). The first step in any effort to account for anthropogenic stressors is developing a list of candidate causes (U.S. EPA 2000). Working in consultation with a team of aquatic resource professionals, a list of the principal human activities known to affect the ecological integrity of streams in Missouri was generated. Then the best available (i.e., highest resolution and most recent) geospatial data that could be found for each of these stressors was assembled. Fortunately, and somewhat surprisingly, data were available for most stressors. However, for some, such as channelized stream segments, there were no available geospatial data, and efforts to develop a coverage of such segments using a sinuosity index proved ineffective. Most of the geospatial data were acquired from the U.S. EPA and the Missouri Departments of Conservation and Natural Resources.

We initially generated statistics for nearly 50 individual human stressors (e.g., percent urban, lead mine density, degree of fragmentation) for each Aquatic Ecological System in Missouri. We then used correlation analyses to reduce this overall set of metrics into a final set of 11, relatively uncorrelated, measures of human disturbance (Table 1). Relativized rankings (range 1 to 4) were then developed for each of these 11 metrics (Table 1). A rank of 1 is indicative of relatively low disturbance for that particular metric, while a rank of 4 indicates a relatively high level of disturbance. These rankings were based on information contained within the literature or simply quartiles when no empirical evidence on thresholds was available. For instance, rankings for percent urban were; 1: 0-5%, 2: 6-10%, 3: 11-20%, and 4: >20%, were based on the results of various studies that have examined the effects of urban land cover on the ecological integrity of stream ecosystems (Klein 1979; Osborne and Wiley 1988; Limburg et al. 1990; Booth 1991; Weaver and Garmen 1994; Booth and Jackson 1997; Wang et al. 2000). However, existing research for percent agriculture has not identified clear thresholds, suggesting that there is a more or less continual decline in ecological integrity with each added percentage of agriculture in the watershed. For this measure of human stress we simply used quartiles, 1: 0-25%, 2: 26-50%, 3: 51-75%, and 4. >75%.

The relativized rankings for each of these 11 metrics were then combined into a three number Human Stressor Index (HSI). The first number reflects the highest ranking across all 11 metrics (range 1 to 4) (Inset Map A and B). The last two numbers reflect the sum of the 11 metrics (range 11 to 44) (Inset Map C). This index allows you to evaluate both individual and cumulative impacts. For instance, a value of 418, indicates relatively low cumulative impacts (i.e., last two digits = 18 out of a possible 44), however, the first number is a 4, which indicates that one of the stressors is relatively high and potentially acting as a major human disturbance within the ecosystem.

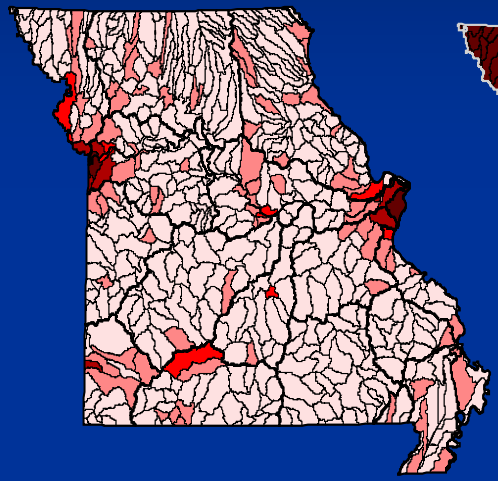
Map showing the first value in the Human Stressor Index for each of the Aquatic Ecological Systems in Missouri. A value of 1 indicates a relatively low level of human disturbance, while a value of 4 indicates a relatively high level of disturbance. None of the AESs polygons received a value of 1.

Map showing which Aquatic Ecological Systems received a value of 4 for the first value in the Human Stressor Index, further broken down according to which specific human stressor was responsible for this high value.

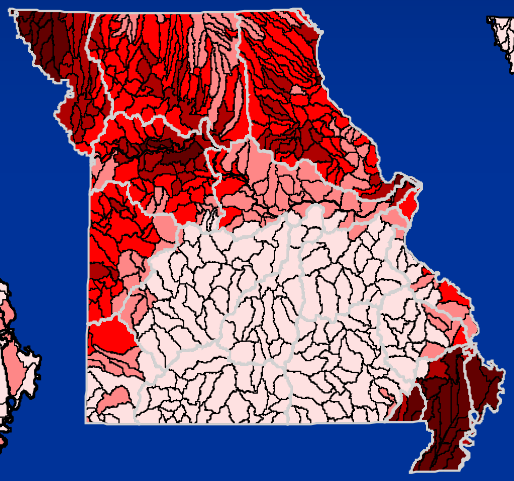
Map showing the last two values in the Human Stressor Index for each of the Aquatic Ecological Systems in Missouri. A value of 11 indicates an extremely low level of cumulative impact. The highest possible value in theory is a 44, however, because some of the 11 metrics used in the index are mutually exclusive (e.g., % urban and %agriculture), the highest obtainable value is unknown. The highest value in Missouri was 31. Basically, the higher the value for these last two digits, the higher degree of cumulative disturbance.

Accounting For Human Threats

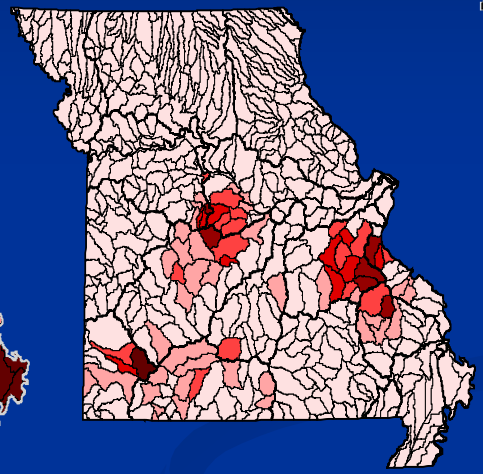
Assessment Unit:
Sub-watershed (337 Sq. Km average)



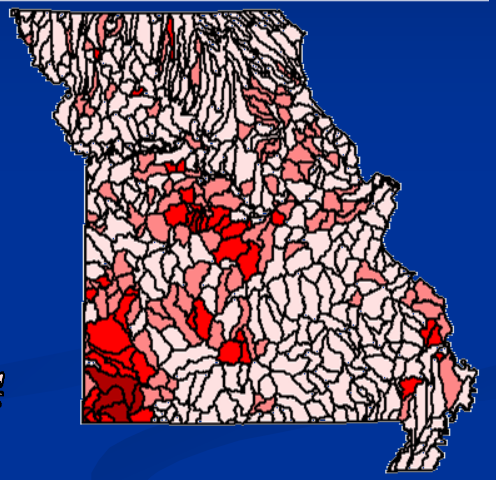
Percent Urban



Percent Cropland



Lead Mine Density



CAFO Density

Attributes of Mo_aes_no_atts.shp

N_index_a	Pfor	Purb	Popchg	Stndcar	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 Threat Index and Associated Ranks

	Relative Ranks			
Metric	**1**	**2**	**3**	**4**
Number of Introduced Species	1	2	3	4-5
Percent Urban	0-5	5-10	11-20	>20
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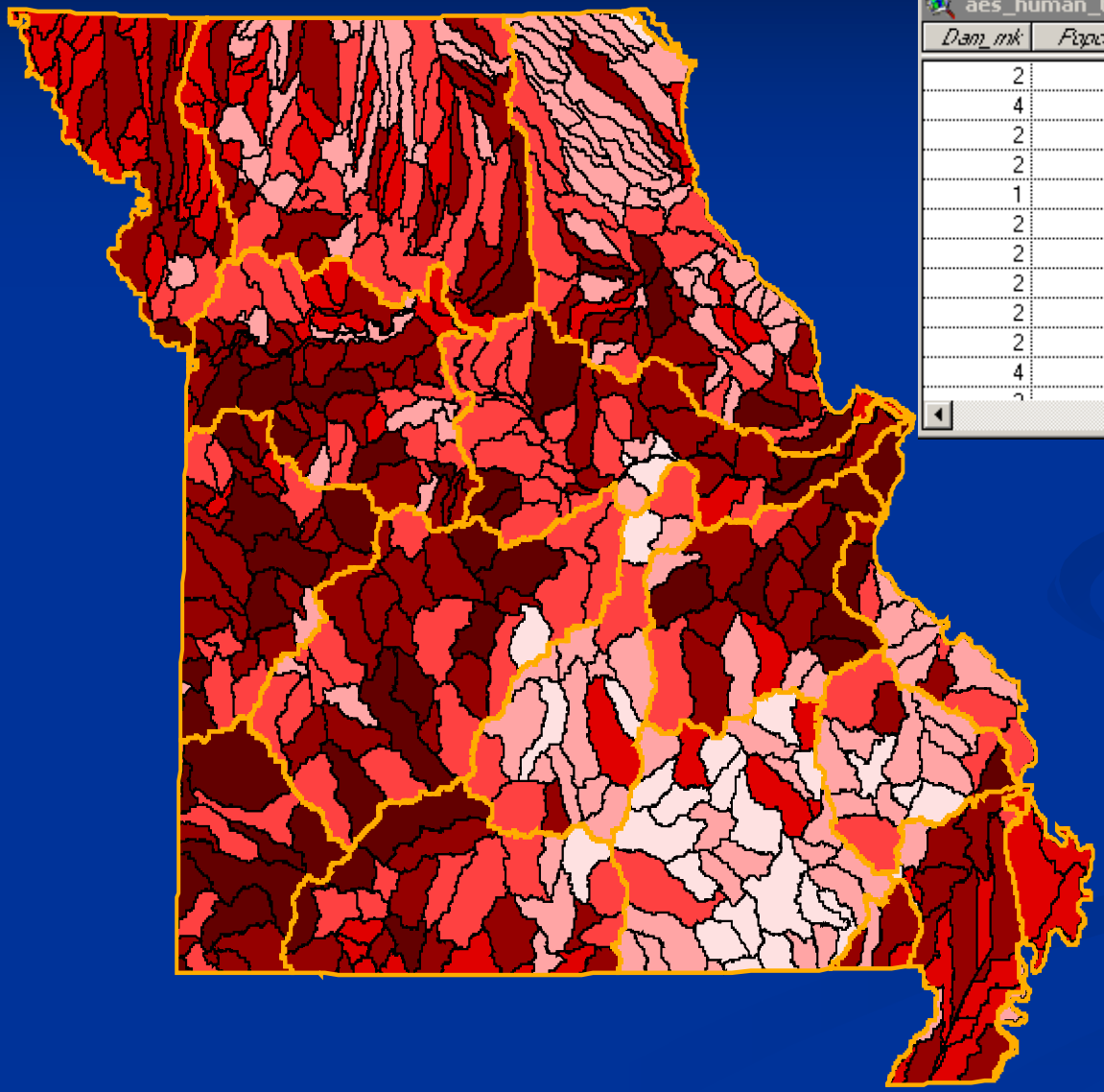
Density of Permitted Discharges (#/mi²)	0	1-5	6-20	>20
Density of Confined Animal Feeding Operations (#/mi²)	0	1-5	5-10	>10

Human Threat Index (HTI)



aes_human_threat_matrix_index.dbf

Dam_mk	Psychg_mk	Coal_mk	Lead_mk	Cafo_mk	Max	Sum	HTI
2	2	3	1	2	4	24	424
4	1	3	1	2	4	23	423
2	3	3	1	2	4	25	425
2	1	2	1	2	4	19	419
1	1	2	1	1	4	18	418
2	2	2	1	3	4	24	424
2	1	2	2	2	4	23	423
2	2	2	1	3	4	22	422
2	2	1	1	2	4	20	420
2	1	3	1	3	4	22	422
4	3	3	1	2	4	27	427

111 - 220

221 - 319

320 - 326

327 - 419

420 - 423

424 - 430

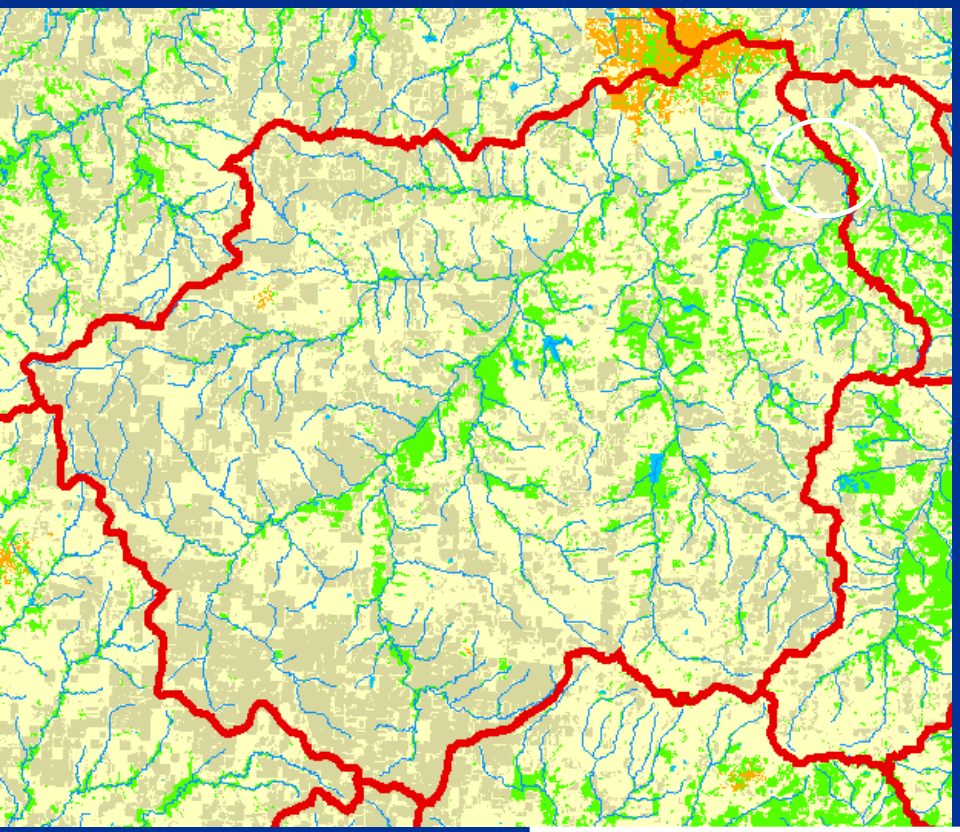
Limitations with Missouri HTI

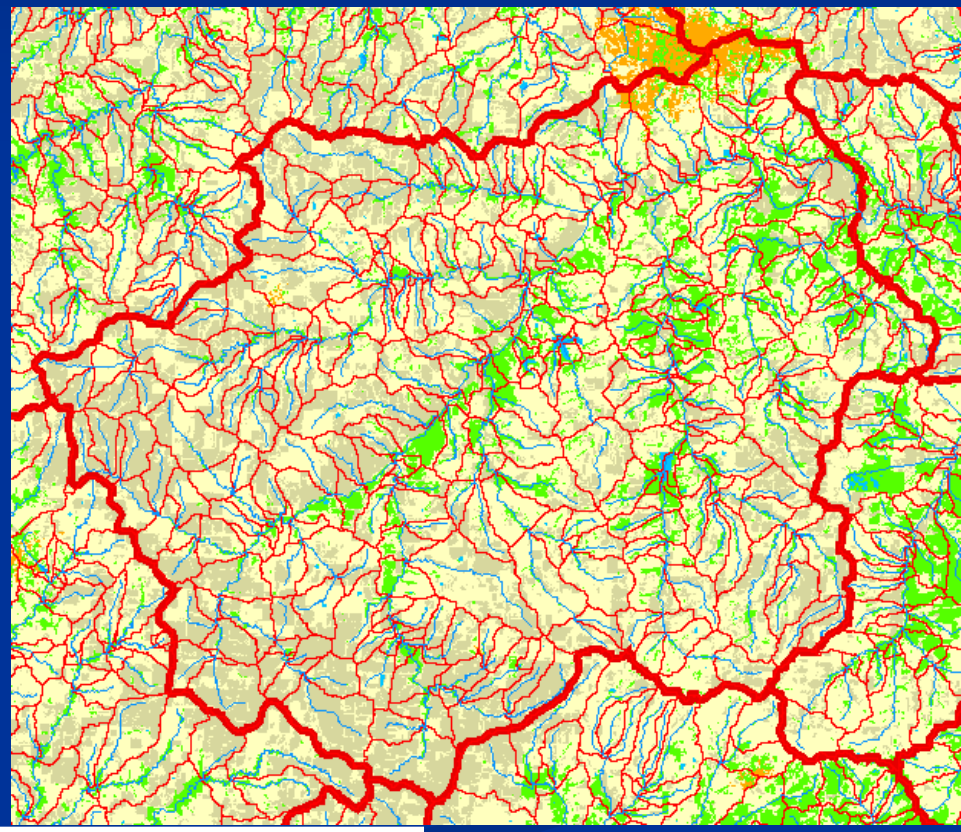
1. Large assessment unit
2. Does not account for contributing area outside of individual sub-watershed polygon
3. Limited number of “threat” datasets as input
4. Treats all stressors equally
   - Weighting (ex., 3xUrban vs. 1xAg)
5. Does not account for spatial considerations
6. Does not account for principal ecological effects
   - (Physical habitat, water quality, flow regime, energy/nutrient dynamics, biotic interactions)
7. Data availability and quality

Problem:
Large Assessment Unit

Problem: Only accurately quantifies conditions at outlet

Solution: Utilize higher resolution assessment unit (segment shed)



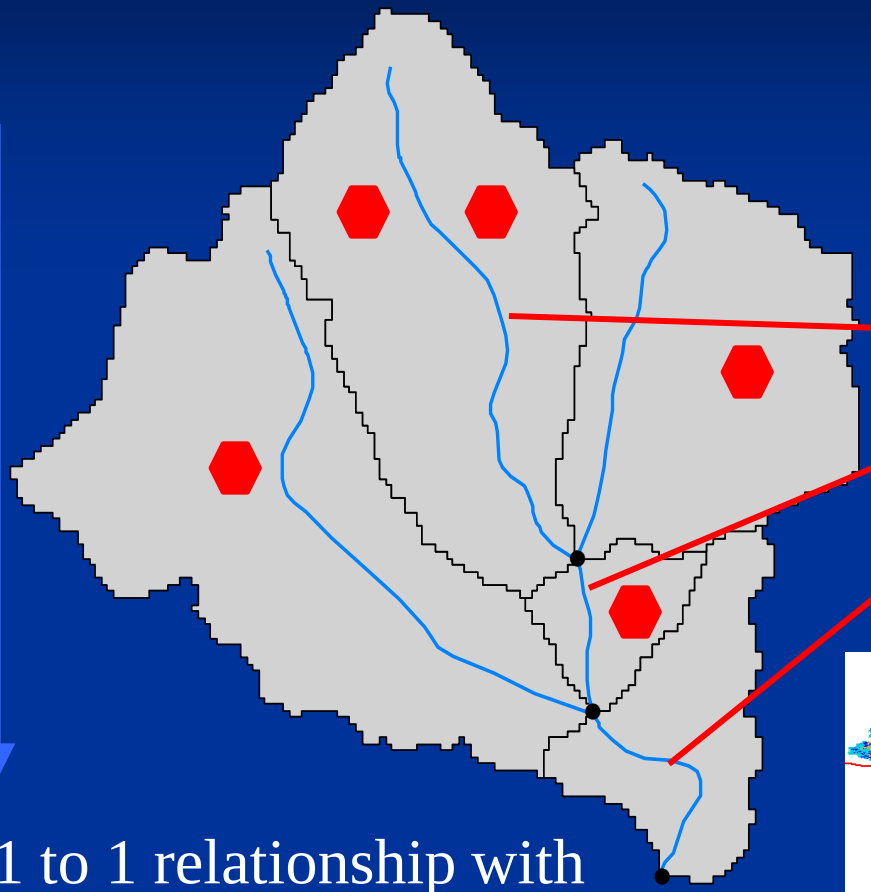


Streams
Assessment Polygon

Urban
Row and Close Grown Crop
Grassland
Forest and Woodland
Swamp and Marsh
Open Water

Streams
Assessment Polygon

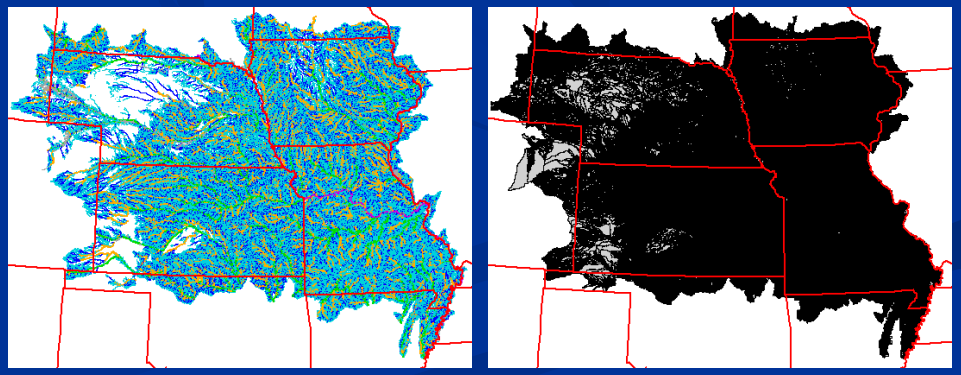
Improvement: Consider Everything Upstream



Toxic Releases

# Local	# In Upstream Drainage
2	0
1	3
0	5

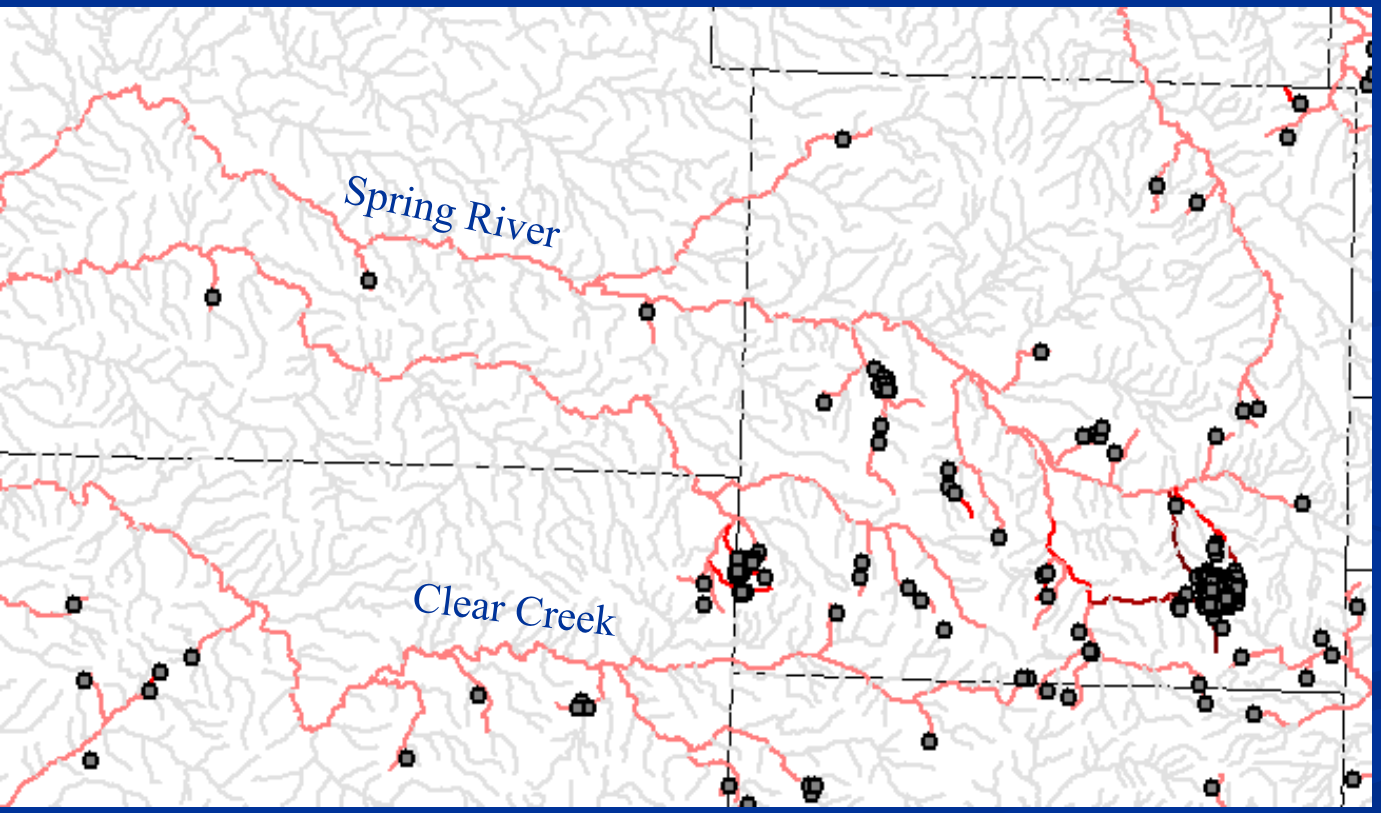
- 1 to 1 relationship with stream segments
- Almost any properties of the watershed can be linked to the stream network for

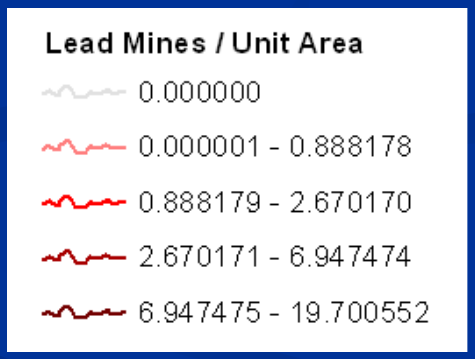


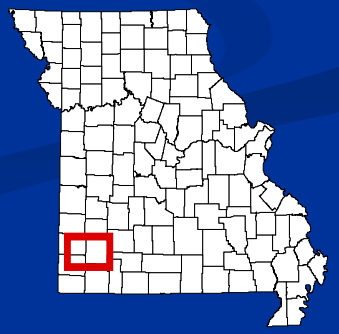
385,000 primary channel stream segments and corresponding

Detailed Information About the Drainage Above Every Segment

Lead Mining in Southwest







Improvements:
More Threat Datasets

Agriculture:
- Cropland
- Pasture/rangeland
- Row crop chemicals
- Pasture chemicals
- CAFO

Stream alteration:
- Dams
- Major reservoirs
- Headwater impoundments
- Channelization
- Distance to reservoir
- Fragmentation

Transportation:
- Airports
- Length of road
- Road – stream crossings
- Length of Railroads
- Rail – stream crossings

Human infrastructure:
- Population change
- Power lines
- Pipelines
- Wells
- Military sites
- Impervious surface

Discharge:
- LUST
- Superfund sites
- TRI
- NPDES
- Landfills
- Waste water treatment

Mining:
- Lead mines
- Coal mines
- Other mines
- Oil & gas wells

Biota:
- Introduced species

Improvements: Weighting

Threats	Physical Habitat			Key
	Mean	Mode		0 = No Impact
Channelization	3.0	3		1 = Low Impact
Instream Sand And Gravel Mines	2.9	3		2 = Moderate Impact
Major Reservoirs	2.8	3		3 = High Impact
Navigation (Channel and Bank Maintenance)				
Row Crop Agriculture				
Impervious Surface				
Headwater Impoundments (Impoundments on Second-Order and Smaller Streams)				
Introduced Plants				
Water Withdrawals				
Roads (Paved And Gravel)				
Flow Diversions (No Return Flow)				
Dispersal Barriers / Low Head Dams				
Artificial Drainage (Agricultural Field Drainage)				
Military Sites (With Regard to Land Disturbance)				
Flow Diversions (With Return Flow)				
Road-Stream Crossing (Culverts And Low-Water)				
Upland Mining				
Ranging Livestock				
Storm Water Systems				
Bridges				
CAFO				
Golf Course				
Point Source Discharges (NPDES: Municipal, Agricultural, And Industrial)				

Threats	Water Quality			Key
	Mean	Mode		0 = No Impact
Waste Water Treatment Facility	2.8	3		1 = Low Impact
Point Source Discharges (NPDES: Municipal, Agricultural, And Industrial)				2 = Moderate Impact
CAFO				
Row Crop Agriculture				
Toxic Releases				
Storm Water Systems				
Artificial Drainage (Agricultural Field Drainage)				
Road Salt Applications				
Major Reservoirs				
Upland Mining				
Impervious Surface				
Golf Course				
Military Sites (With Regard to Chemical Contamination)				
Flow Diversions (With Return Flow)				
Rail Yards (Fuel And Coal Dust)				
Headwater Impoundments (Impoundments on Second-Order and Smaller Streams)				
Septic Tanks / Lagoons				
Instream Sand And Gravel Mines				
Roads (Paved And Gravel)				
Oil And Gas Wells				
Salt Scars (From Old Abandoned Oil And Gas Wells)				
Airports (National and International)				
Landfills				

Threats	Flow Regime			Key
	Mean	Mode		0 = No Impact
Major Reservoirs	2.8	3		1 = Low Impact
Flow Diversions (No Return Flow)				
Impervious Surface				
Channelization				
Storm Water Systems				
Water Withdrawals				
Headwater Impoundments (Impoundments on Second-Order and Smaller Streams)				
Artificial Drainage (Agricultural Field Drainage)				
Navigation (Channel and Bank Maintenance)				
Flow Diversions (With Return Flow)				
Row Crop Agriculture				
Roads (Paved And Gravel)				
Waste Water Treatment Facility				
Dispersal Barriers / Low Head Dams				
Point Source Discharges (NPDES: Municipal, Agricultural, And Industrial)				
Instream Sand And Gravel Mines				
Airports (National and International)				
Road-Stream Crossing (Culverts And Low-Water)				
Upland Mining				
Military Sites (With Regard to Land Disturbance)				
Bridges				
Golf Course				

Threats	Energy / Nutrient			Key
	Mean	Mode		0 = No Impact
CAFO	2.6	3		1 = Low Impact
Waste Water Treatment Facility				
Point Source Discharges (NPDES: Municipal, Agricultural, And Industrial)				
Row Crop Agriculture				
Major Reservoirs				
Artificial Drainage (Agricultural Field Drainage)				
Storm Water Systems				
Headwater Impoundments (Impoundments on Second-Order and Smaller Streams)				
Septic Tanks / Lagoons				
Golf Course				
Introduced Plants				
Channelization				
Flow Diversions (With Return Flow)				
Impervious Surface				
Ranging Livestock				
Introduced Aquatic Animals				
Navigation (Channel and Bank Maintenance)				
Pasture And Range Land				
Flow Diversions (No Return Flow)				
Upland Mining				
Dispersal Barriers / Low Head Dams				
Roads (Paved And Gravel)				
Water Withdrawals				
Instream Sand And Gravel Mines				
Landfills				

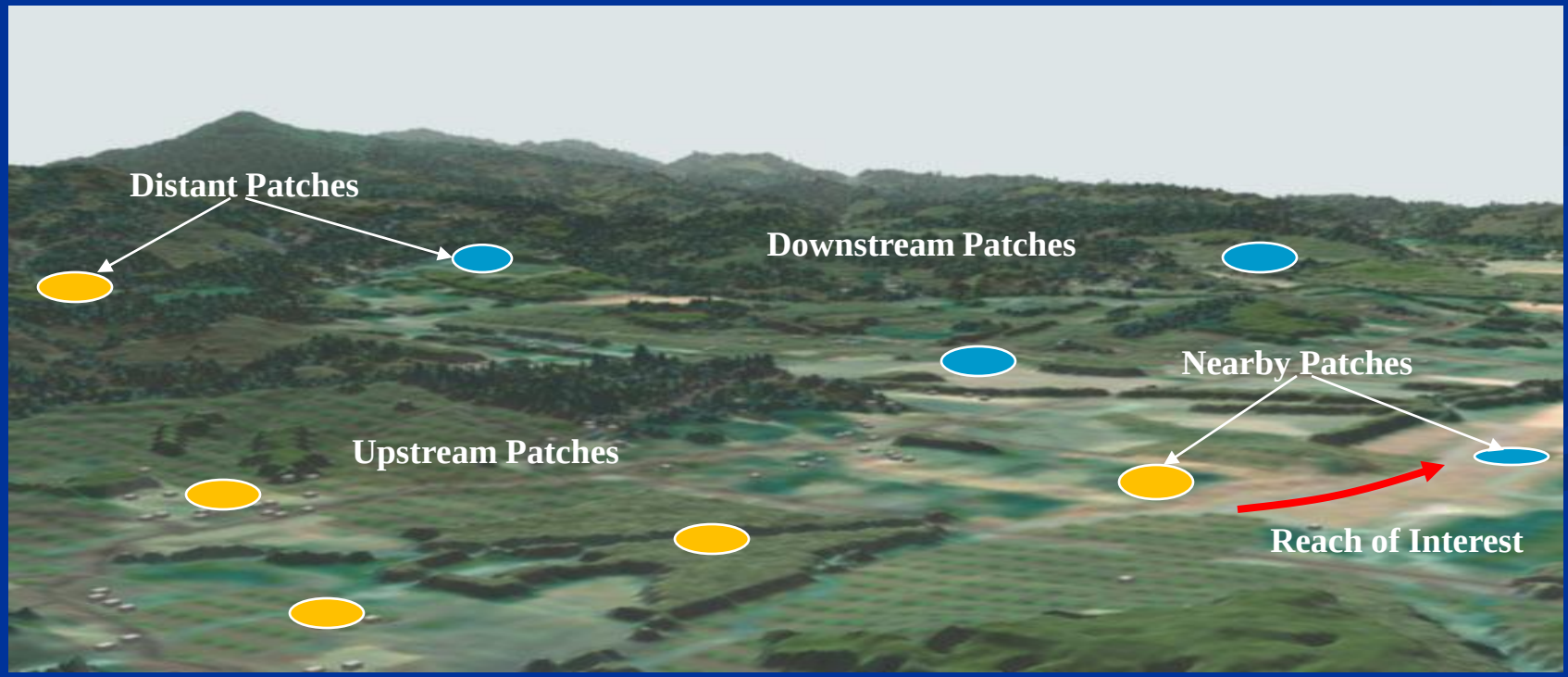
Threats	Biotic Interactions			Key
	Mean	Mode		0 = No Impact
Introduced Aquatic Animals	2.9	3		1 = Low Impact
Major Reservoirs	2.8	3		2 = Moderate Impact
Introduced Plants	2.6	3		3 = High Impact
Headwater Impoundments (Impoundments on Second-Order and Smaller Streams)	2.4	3		
Channelization	2.3	3		
Dispersal Barriers / Low Head Dams	2.3	3		
Waste Water Treatment Facility	2.2	2,3		
Point Source Discharges (NPDES: Municipal, Agricultural, And Industrial)	2.1	3		
Row Crop Agriculture	2.0	1,3		
Instream Sand And Gravel Mines	2.0	2,3		
CAFO	1.9	1		
Navigation (Channel and Bank Maintenance)	1.8	1		
Toxic Releases	1.8	3		
Water Withdrawals	1.8	2		
Artificial Drainage (Agricultural Field Drainage)	1.8	1		
Road-Stream Crossing (Culverts And Low-Water)	1.8	2		
Impervious Surface	1.7	2		
Roads (Paved And Gravel)	1.7	2		
Flow Diversions (With Return Flow)	1.7	1,2		
Storm Water Systems	1.6	2		
Flow Diversions (No Return Flow)	1.6	2		
Golf Course	1.5	1		
Upland Mining	1.4			
Ranging Livestock	1.4	1		

Principal Ecological Effects

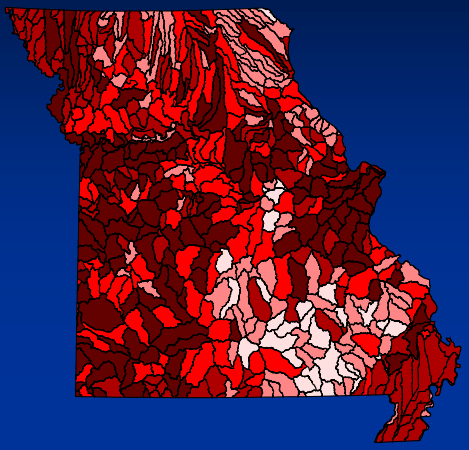
Point source pollution					
Level of Influence	Physical Habitat	Water Quality	Flow Regime	Energy/Nutrient	Biotic Interactions
Low	X		X		
Medium					
High		X		X	X

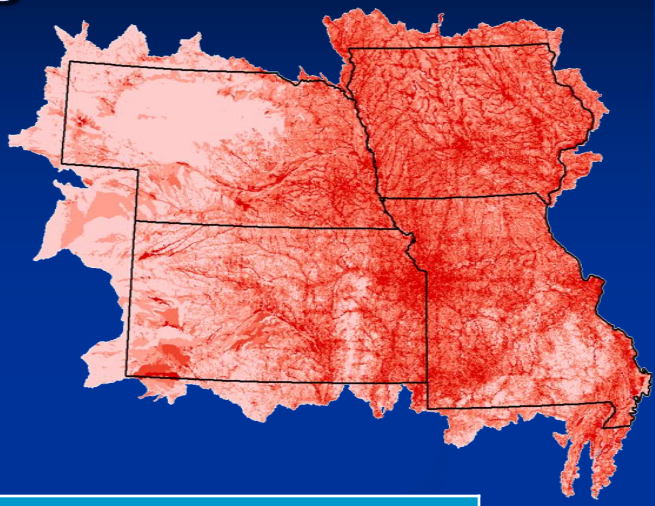
Improvements:

Spatial Distribution of Individual Threats is Important



Comparative Example of Accounting for Human Threats





Key Enhancements

	MO	EPA Region 7 (IA, KS, MO, NE)
Size of assessment unit (average)	337 sq km	2 sq km
# of "threats" quantified	11	~40+
Considers entire contributing area	No	Yes
Distance to "threat" considered	No	Yes
Weighting	No	Yes
Account principal ecological effects	No	Yes
Useful for "on the ground" management	Limited	Yes

Review of Last Meeting

Key Discussion Points

1. Much discussion on ranking and weighting
2. Some felt that weighting should be used minimally because of bias
3. Many people felt that the “raw” data and metrics were more important than the index (HTI).
4. May be best to develop a separate HTI for local vs. watershed
5. Develop separate HTI’s for each of the elements of biological integrity
6. Some felt that a meaningful HTI across Region 7 would be difficult to construct

Review of Last Meeting

Further Thinking

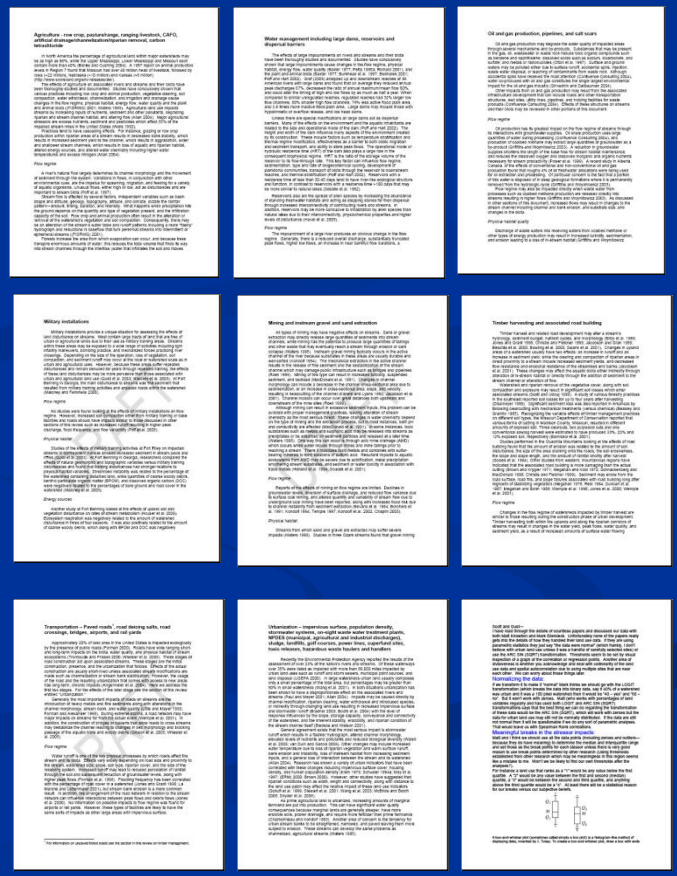
- We will try to assign a “data reliability” ranking to each input data set we use. Include comments.

Update

- MoDNR (319) funds have come through
- Literature review
- Agricultural chemical data sets
- Distance weighting
- Fragmentation
- Population change
- Headwater impoundments – source datasets
- Error checking
- Data issues

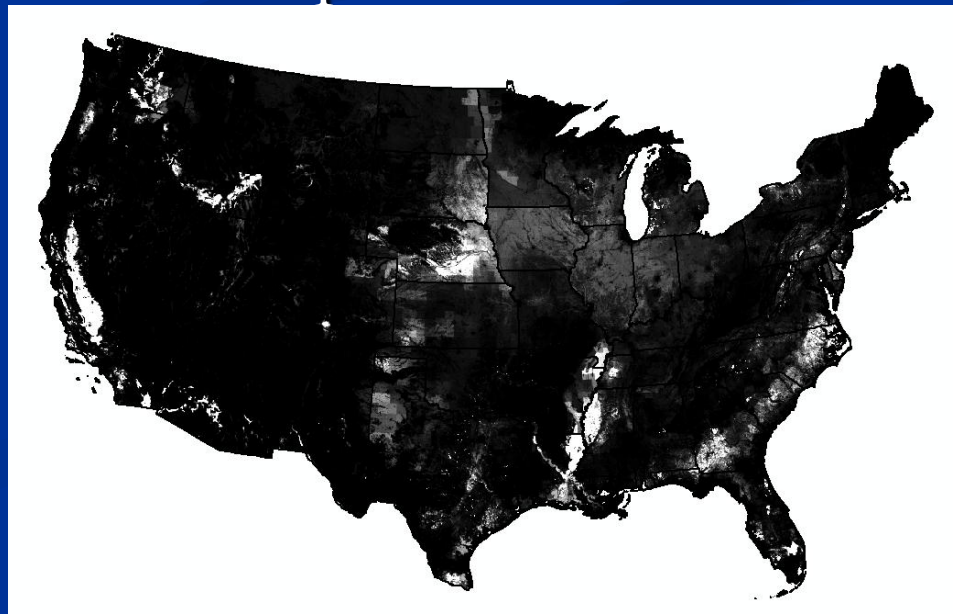
Literature Review
Completed excepting assimilation

- Agriculture
- Dams
- Data manipulation & ranking
- Gas & oil wells
- Military sites
- Mining
- Timber harvest
- Transportation
- Urbanization



Agricultural Chemicals

- USGS Grids of agricultural pesticide use in the conterminous United States, 1997. Published 2007. 1 km pixels.
- 43 pesticides each as individual grid
- Kilograms applied to specific crops

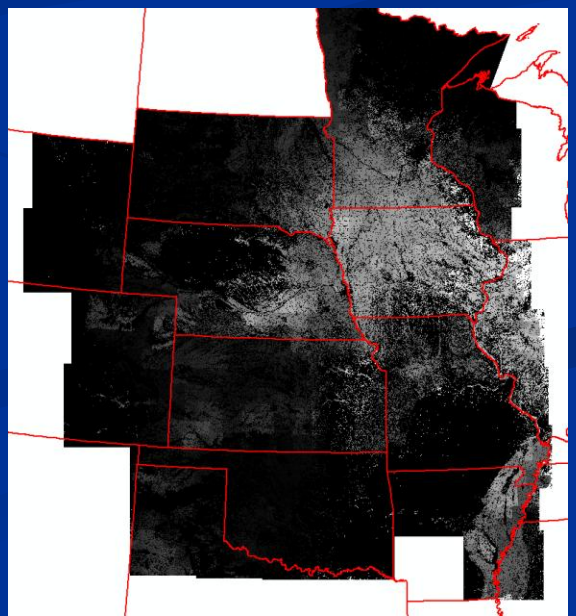


Agricultural Chemicals

Pesticide Code
2,4-D 1302
ACETOCHLOR 3000
ACIFLUORFEN 1002
ALACHLOR 1863
ATRAZINE 1980
BENOMYL 5001
BENTAZON 1287
BROMOXYNIL 1116
BUTYLATE 1839
CARBOFURAN 6007
CHLORIMURON 4008
CHLORPYRIFOS 6009
CYANAZINE 1369
DIAZINON 6014
DIURON 1991
EPTC 1414
ETHALFLURALIN 9009
ETHOPROP 6023
FLUOMETURON 1998
FONOFOS 6028
LINURON 1993
METHOMYL 6038
METHYL PARATHION 6042
METOLACHLOR 1011
METRIBUZIN 1975
MOLINATE 1417
NICOSULFURON 7007
NORFLURAZON 1018
ORYZALIN 1873
OXAMYL 6045
PEBULATE 1419
PHORATE 6050
PRONAMIDE 1888
PROPACHLOR 1191
PROPANIL 1282
PROPARGITE 6055
PROPICONAZOLE 5020
SIMAZINE 1981
TERBACIL 1109
TERBUFOS 6060
THIOBENCARB 1903
TRIALLATE 1790
TRIFLURALIN 1361

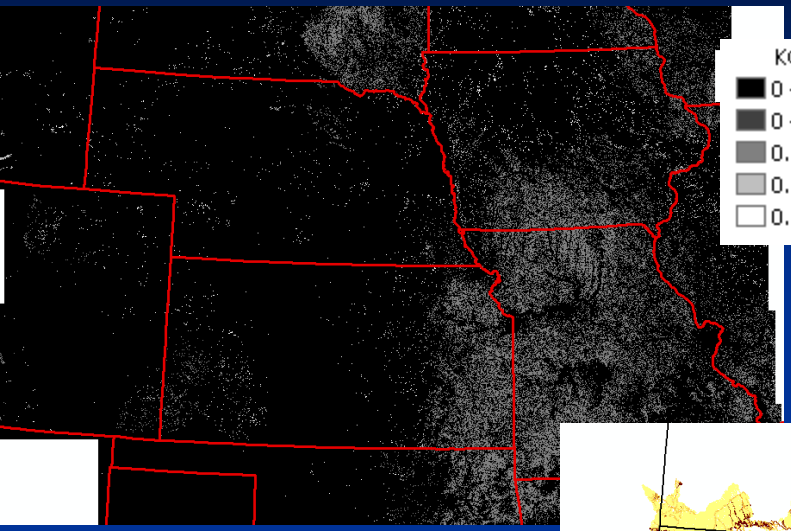
Agricultural Chemicals

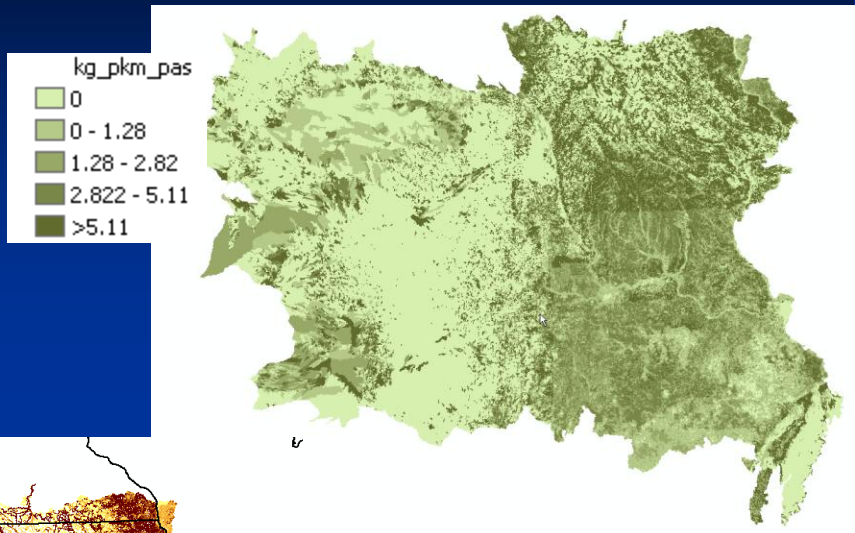
- We took same basic idea and tied pesticides to NLCD land cover classes
  - Row crop
  - Pasture/hay
- County sales (pounds) from Agricultural Census data
- 30 meter pixel size

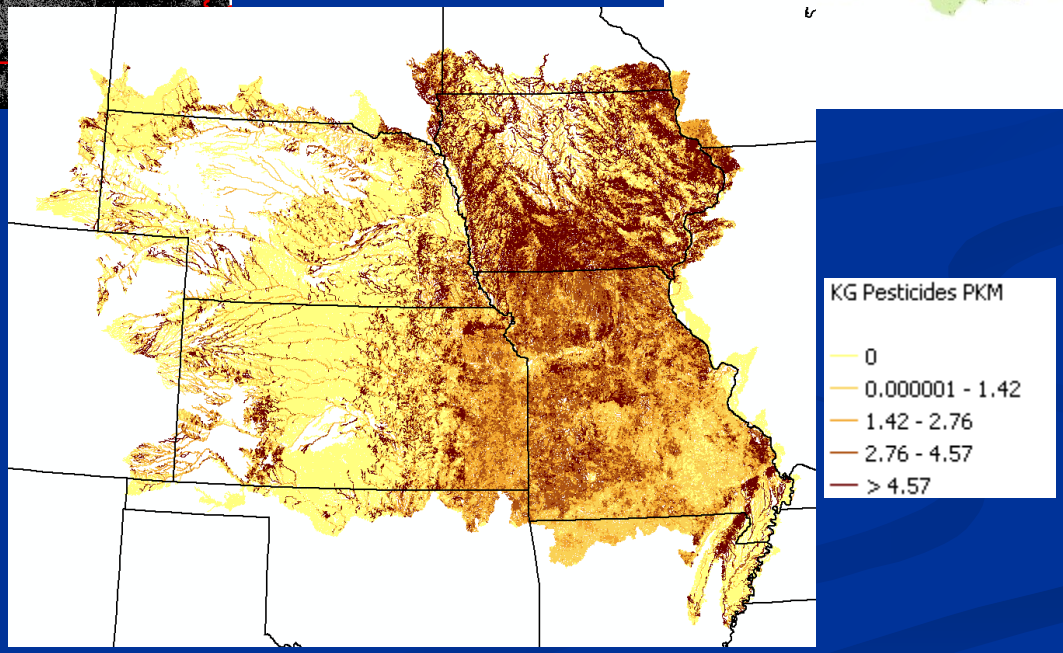


Cropland Agricultural Chemicals (all)

Agricultural Pesticide Use - Pasture

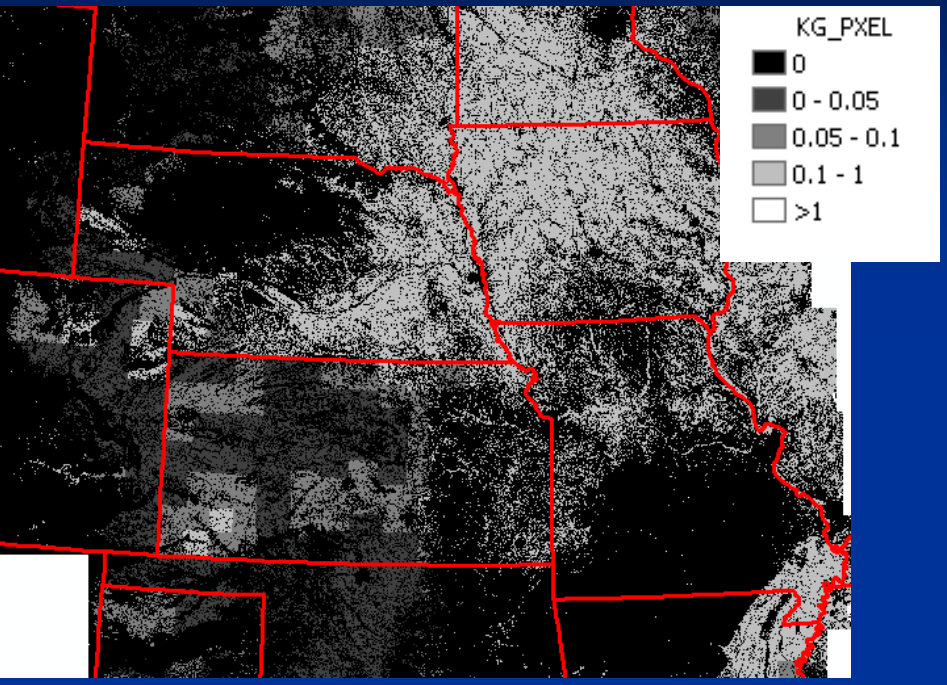


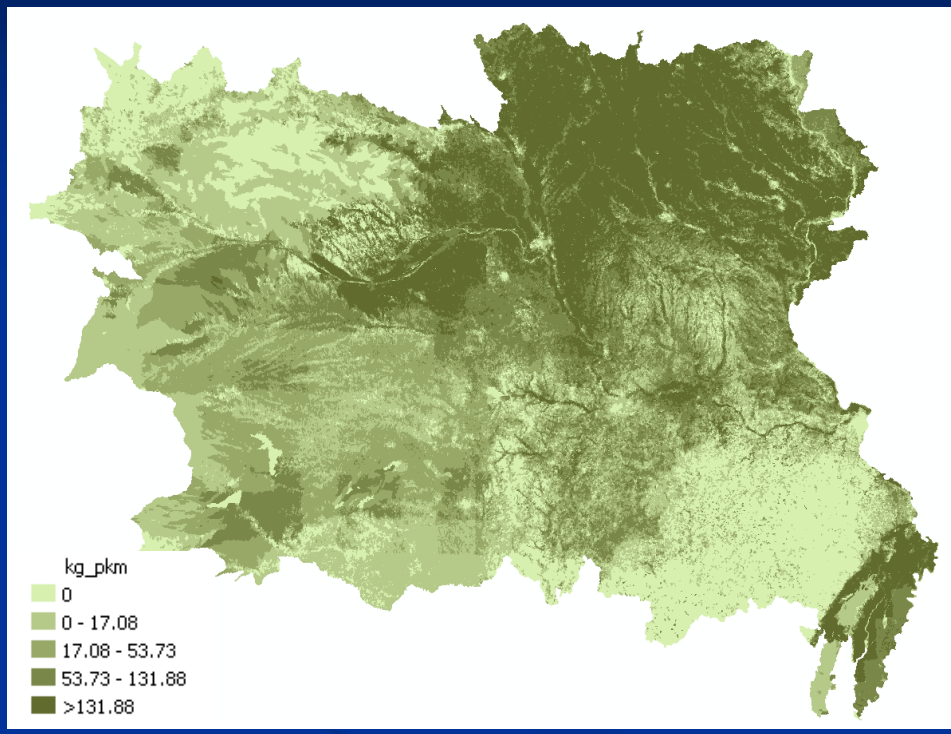




Used Agricultural Census data by county to determine the percentage and amount of chemical that was used on pasture within the county. This value was used in conjunction with land cover to create a grid that displayed the amount of pesticides used per pixel.

Agricultural Pesticide Use - Cropland

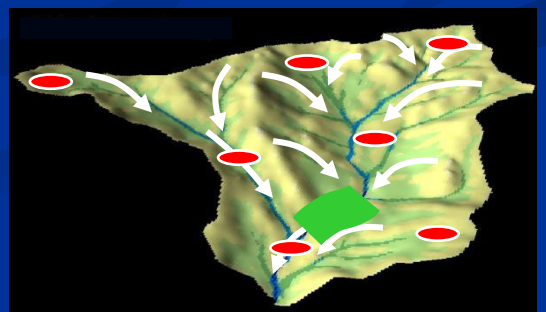




Has not yet been accumulated

Accounting for Distance

- Explored several promising methods but . . .
  - Functional Linkage of Water basins and Streams (FLoWS) v1 tool did not work for us
  - Wrote an AML program, but won't process an extremely large file
  - Various user-written GIS tools all had shortcomings
- VBA in Microsoft Access



Accounting for Distance

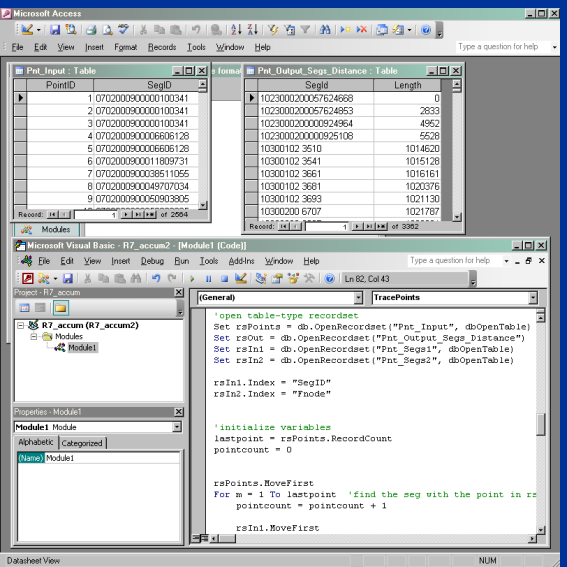
- Wanted average distance to all upstream stressors (i.e. mines)
- Additionally, wanted the minimum and maximum distances
- Must run on a very large file

Solution

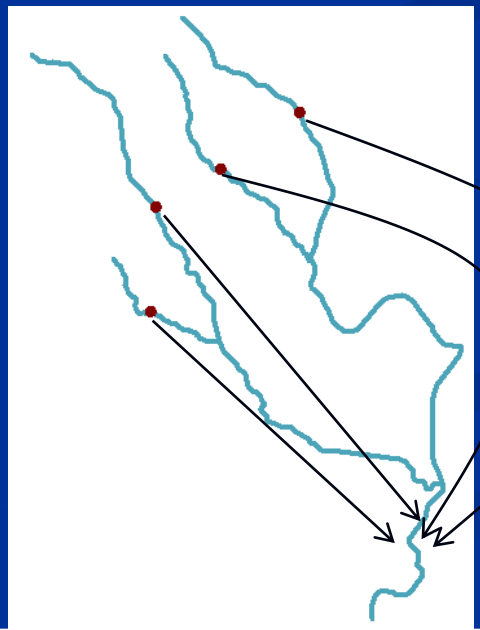
- Mike Morey used Visual Basic for Applications (VBA) for MS Access to write a sub-procedure that will calculate the distance from each stream segment to every “stressor” upstream

Accounting for Distance (VBA)

- Required a dbf with:
  - Steam segment identifier
  - A tag if a segment contained a “stressor” locally
  - Length of stream segment
  - From node #
  - To node #



Distance to Threat



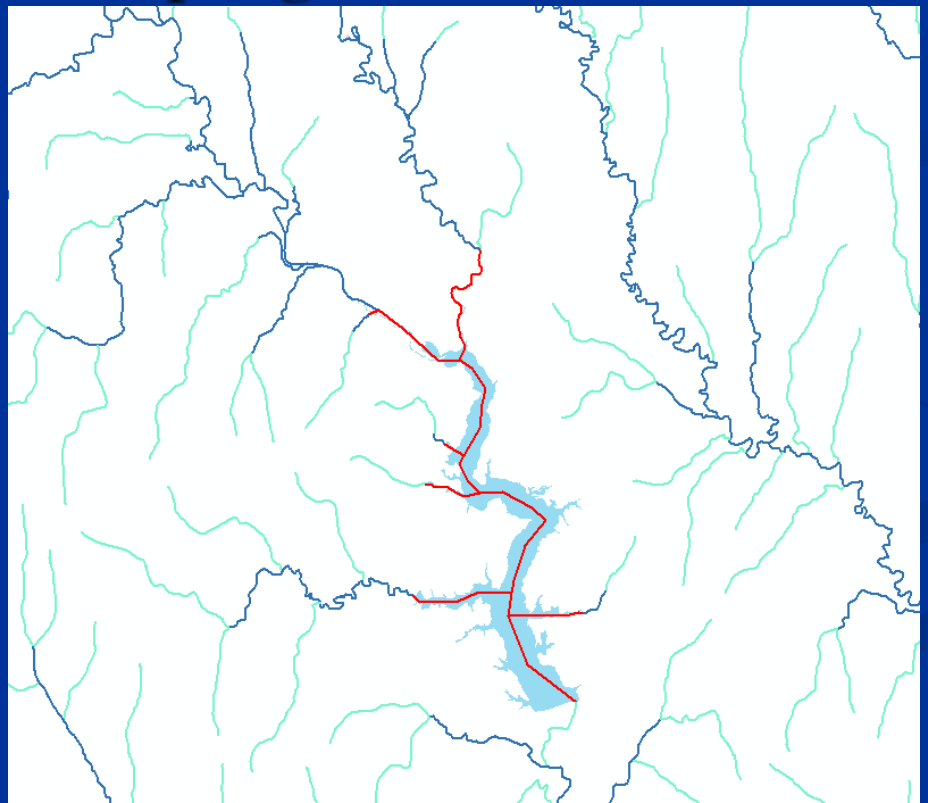
1. Count
2. Density
3. Minimum distance
4. Maximum distance
5. Average distance

Accounting for Distance (VBA)

- This method works well for localized or point type stressors
- Probably does not make sense for all stressors (i.e. road-stream crossings)
- Does not work for continuous surface type stressors like land use

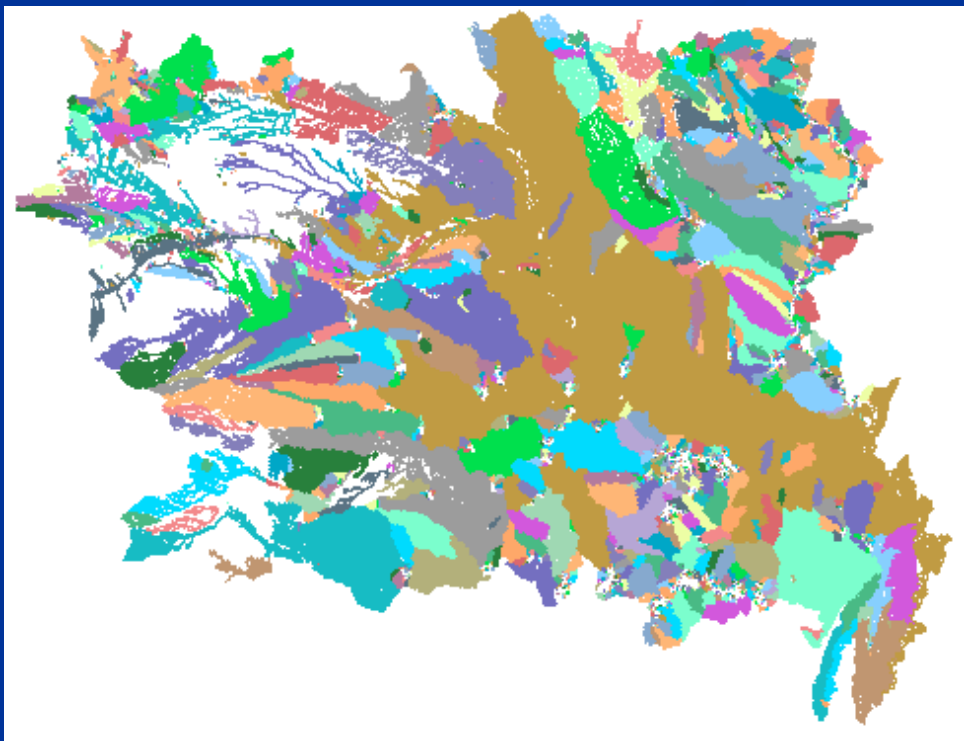
Fragmentation

- How fragmented are the steam networks due to dams/impoundments?
- How far downstream is the nearest dam/impoundment?
- Wrote MS Access program answers these questions.

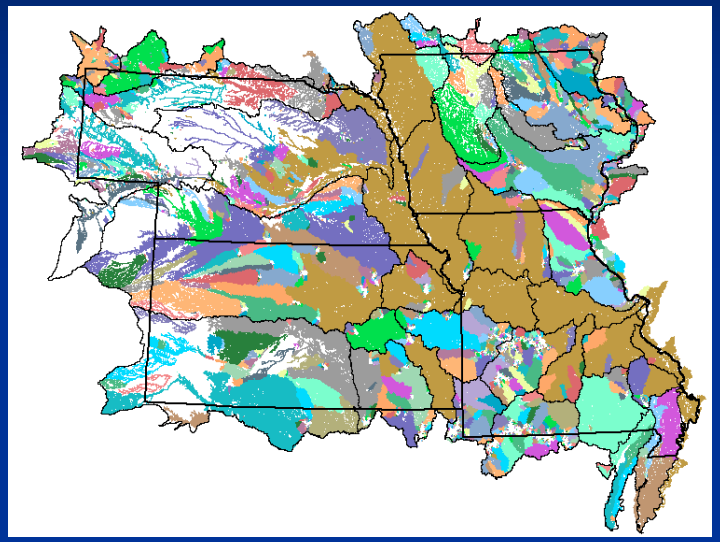


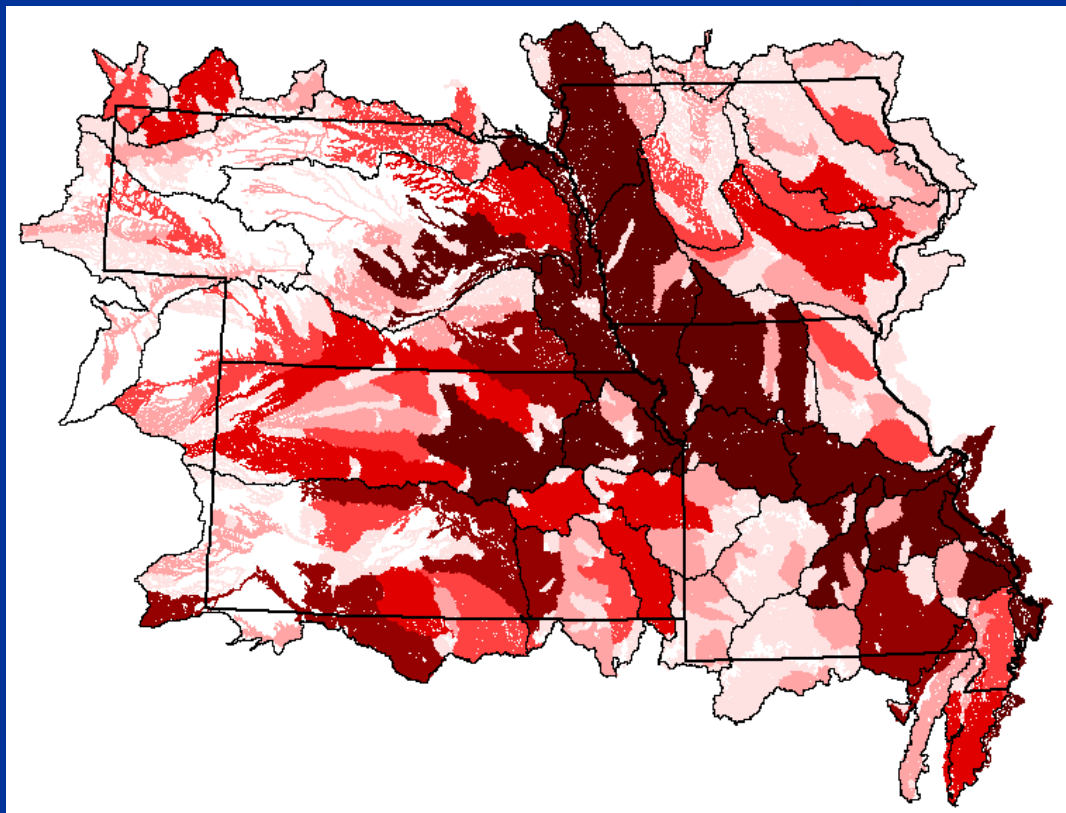
Connectivity / Fragmentation

- Groups of interconnected streams (between impoundments)
- Total length of interconnected stream
  - i.e. Miles of stream a fish has access to without going through a dam



Connectivity or Fragmentation of Streams in EPA Region 7





Interconnected Streams (km)

2 – 125
126 – 322
323 – 630
631 – 1094
1095 – 2400
> 2400

Population Change

1. What watersheds are gaining population
2. What watersheds are losing population
3. What watersheds are not changing

Data

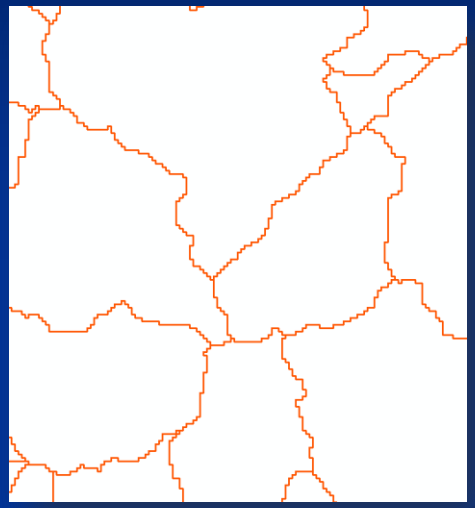
1. 1990 and 2000 census block data for EPA Region 7 (more than 1 million block polygons)
2. Performed a union with catchment polygons
3. proportional population assigned to each new polygon (more than 2 million new polygons)

Population Change

Census Blocks

+

Catchment Polys



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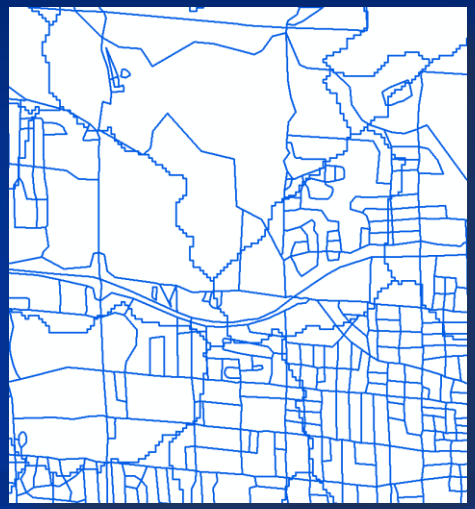
Union



Allowed us to partition block population to catchment polygons

Unique ID's Original Data New Data

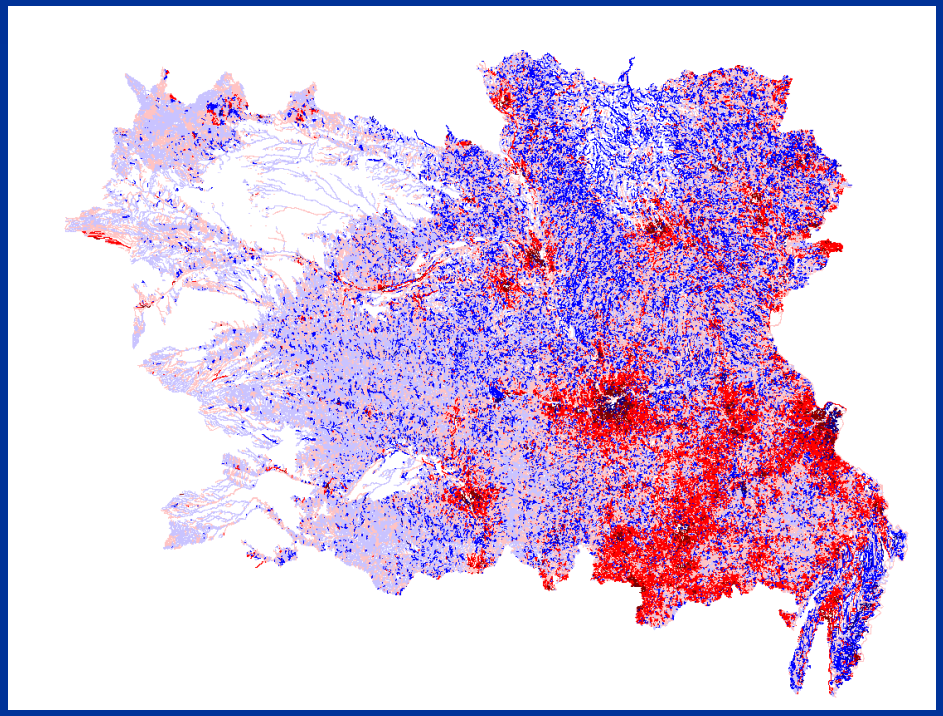
Selected Attributes of mo_cat_Intersect

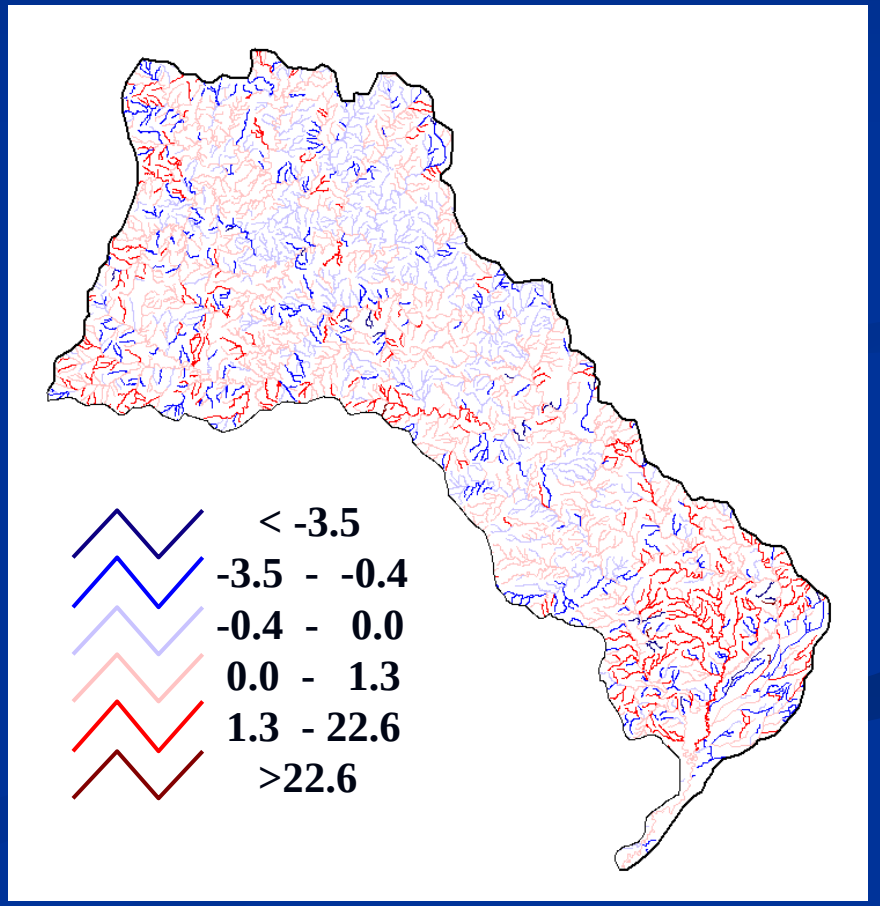
	SEG_ID	STBLKLINK	blk_area	pop90	Shape_Area	percent	new_pop_90
▶	10300102 1697	290190007001013	23509.268	40	13171.960108	0.560288	22.41152

Record: 1 Show: All Selected Records (1 out of 663655 Selected)

Quantifying Stressors Provides Critical Context

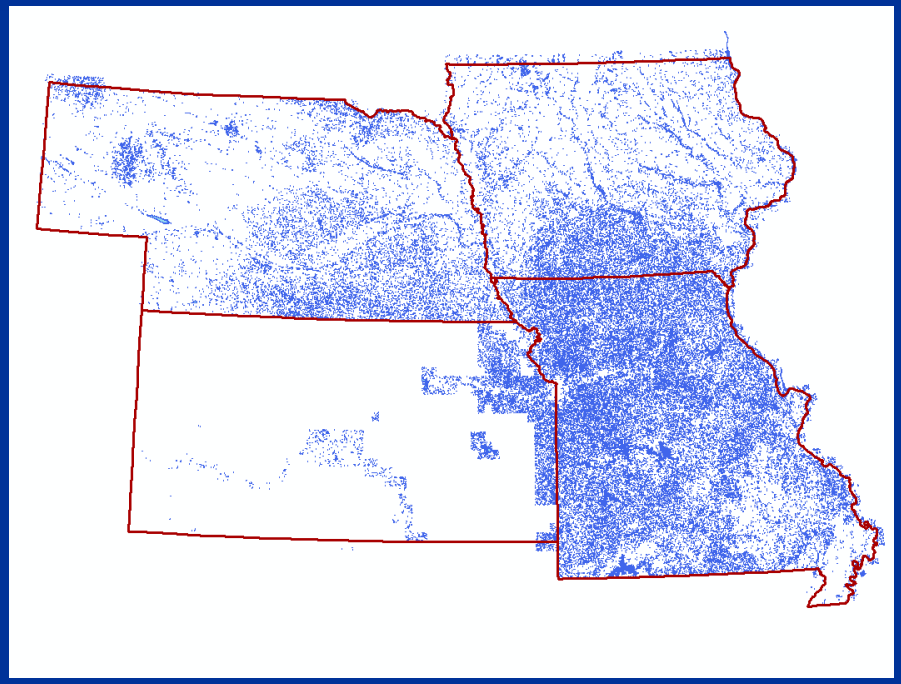
Population Change in Watershed (1990-2000) #/km^2



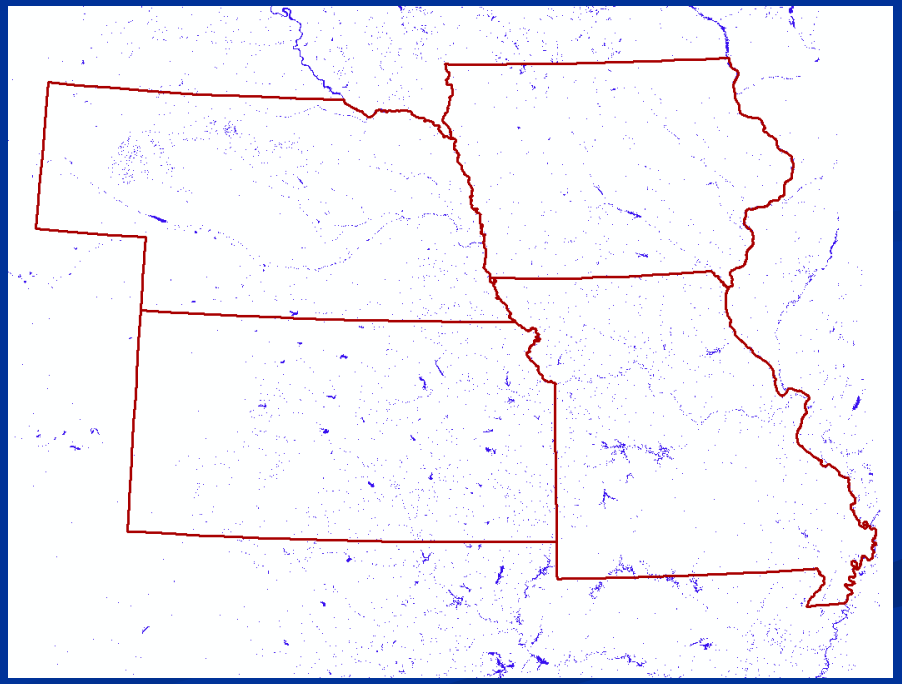


Present Work:
Identifying Headwater Impoundments

NWI

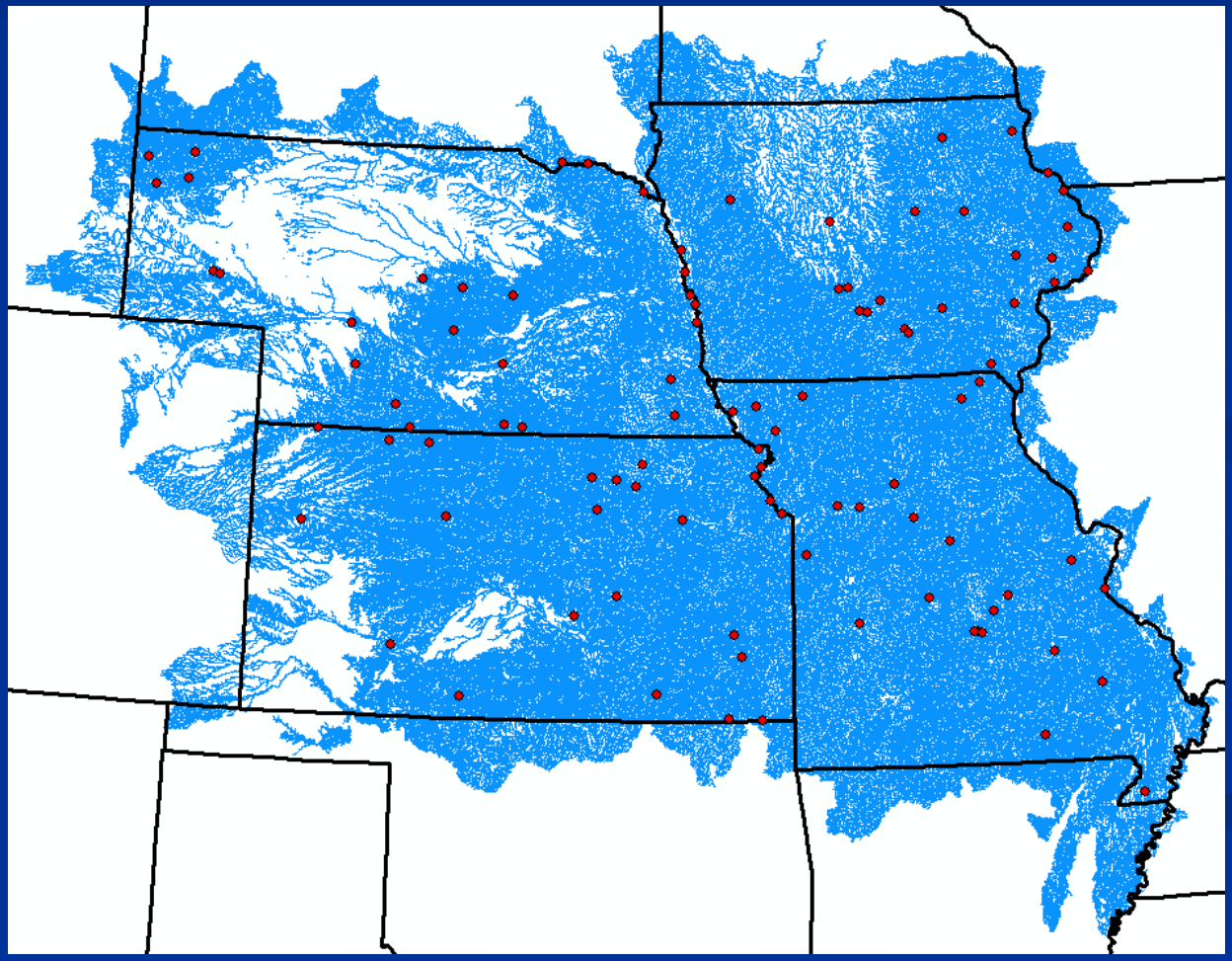


NLCD



Error Checking

100 Random Sites Selected for Review



Data Issues:
A General Overview

Data Issues: Three Basic Issues

1. Location
2. Completeness
3. Multiple sources of the “same” data

Location – Location – Location

- Unfortunately some point datasets lack the precision necessary for accurate assessments. For example:
  - Address locating
  - Zip code centroid
  - Census Block Centroid

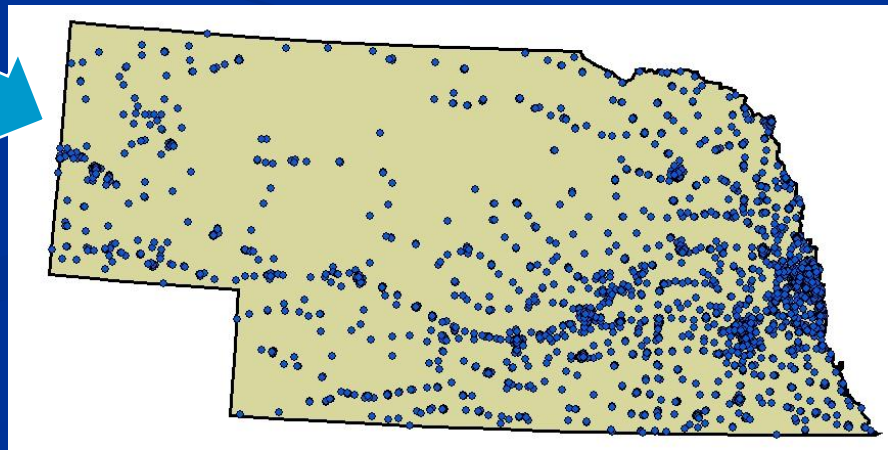
Address Locating - Geocoding

- Nebraska did not have a GIS layer of Leaking Underground Storage Tanks (LUST)
- The only spatial information available was a street address
- Geocoding from text file with street address to create points

SPILLFAC.CSV

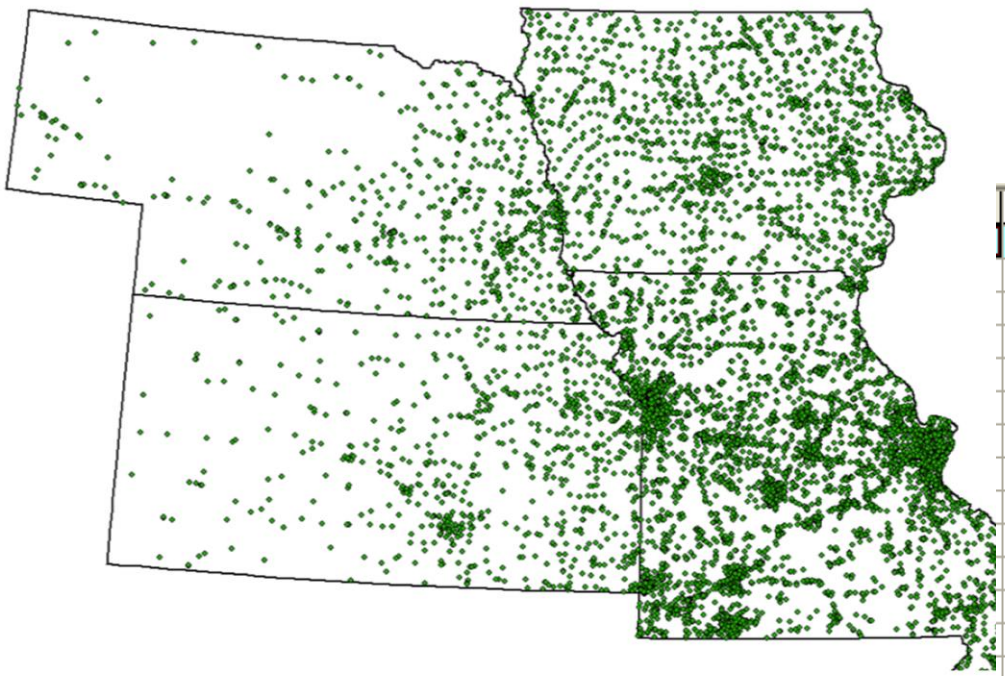
	C	D	E	F	G	H	I	J	K	L
1	OWNCO----------	OWNSTRE	OWNCITY	OS	OZIP	TY	DIDATE----	SPLOC----------	SPCITY----------	MATERIAL----
2	TESTING THIS	02 PGM	LINCOLN	NE	68123			AT PLANT SITE	SEWARD	BARSOL D-2(
3	TESTING	123 TEST	OMAHA	NE	68132			123 TEST ST	OMAHA	
4	TESTING AGAIN	123 TEST	OMAHA	NE	68054			123 TEST ST	OMAHA	
5	TESTING		BELLEVUI	NE	68123			124 TEST ST	BELLEVUE	
6	MADONNA	2200 S 52I	LINCOLN	NE	68506	14	10/12/1989	2200 S 52ND ST	LINCOLN	HEATING OIL
7	FARMERS MUTUAL INSURANCE	1220 LINC	LINCOLN	NE	68508	14	3/24/1993	1220 LINCOLN MALL	LINCOLN	HEATING OIL
8	BELLEVUE SCHOOL DIST #2	2009 FRAI	BELLEVUI	NE	68005	14	8/26/1991	2107 E AVERY RD	BELLEVUE	HEATING OIL
9	BELLEVUE PUBLIC SCHOOLS	2009 FRAI	BELLEVUI	NE	68005	14	7/24/1990	2202 WASHINGTON ST	BELLEVUE	HEATING OIL
10	GRAND ISLAND PUB. SCHOOLS	615 N ELM	GRAND IS	NE	68801	14	8/7/1992	602 W STOLLEY PARK RD	GRAND ISLAND	DIESEL/HEA
11	OMAHA PUBLIC SCHOOLS	4041 N 72I	OMAHA	NE	68134	14	11/27/1989	3520 MAPLEWOOD BLVD	OMAHA	#2 FUEL OIL
12	OMAHA PUBLIC SCHOOLS	3902 DAVI	OMAHA	NE	68131	14	7/21/1989	2758 ELLISON AVE	OMAHA	DIESEL
13	OMAHA PUBLIC SCHOOL	4041 N 72I	OMAHA	NE	68134	14	6/27/1990	3109 PEDERSON DR	OMAHA	
14	HAGERBAUMER BROTHERS INC	RR 1 BOX	ARLINGTC	NE	68025	14	10/4/1990	RR 1 BOX 152	ARLINGTON	GAS
15	LINCOLN PUBLIC SCHOOLS	5901 'O' S	LINCOLN	NE	68510	14	9/23/1992	7700 LEIGHTON AVE	LINCOLN	HEATING OIL
16	NORFOLK PUBLIC SCHOOLS	512 PHILIP	NORFOLK	NE	68701	14	7/28/1989	1703 PHILIP AVE	NORFOLK	HEATING OIL
17	HOOVER GROUP INC	700-710 S	BEATRICE	NE	68310	14	5/18/1989	700-710 S 7TH ST	BEATRICE	HEATING OIL
18	IBP, INC.	BOX 515	DAKOTA (	NE	68731	7	12/14/1987	HWY 275	WEST POINT	FUEL OIL
19	SCHUYLER CENTRAL HIGH SCH	401 ADAM	SCHUYLE	NE		14	12/13/1988	401 ADAMS STT	SCHUYLER	#2 FUEL OIL
20	CEDAR HOLLOW DIST 3	RR 2 BOX	GRAND IS	NE	68803	14	5/30/1991	RR 2 BOX 73A	GRAND ISLAND	HEATING OIL
21	ST PAULS LUTHERN CHURCH	1515 S HA	GRAND IS	NE	68801	14	12/12/1988	1515 S HARRISON	GRAND ISLAND	DIESEL
22	MUNICIPAL LIGHT AND WATER	4TH AND I	NORTH PL	NE	69101	7	3/30/1993	4TH AND PACIFIC NW CRNR	NORTH PLATTE	DIESEL
23	COLUMBUS CITY SCHOOLS	2200 26TH	COLUMBU	NE	68601	14		1610 9TH ST	COLUMBUS	HEATING OIL
24	COLUMBUS CITY SCHOOLS	2200 26TH	COLUMBU	NE	68601	14		2316 9TH ST	COLUMBUS	HEATING OIL
25	COLUMBUS CITY SCHOOLS	2200 26TH	COLUMBU	NE	68601	14	12/5/1989	4100 ADAMY ST	COLUMBUS	HE OIL
26	NE MILITARY DEPARTMENT	1300 MILIT	LINCOLN	NE	68508	14	6/14/1989	6929 MERCY RD	OMAHA	
27	CITY OF LOUP CITY	134 S 8TH	LOUP CIT	NE	68853	14	4/10/1991	626 N" ST"	LOUP CITY	
28	CHERRY CO COURTHOUSE	365 N MAI	VALENTIN	NE	69201	14	8/8/1990	365 N MAIN ST	VALENTINE	

SPILLFAC



Resulting GIS layer contains all attribute data attached to points

Point Placement (NPDES Dataset)



1. Address Match
2. Nearest Street Intersection
3. Centroid of Census Block
4. Centroid of Zip Code
5. Map Interpolation
6. Classical Survey
7. GPS
8. Unknown

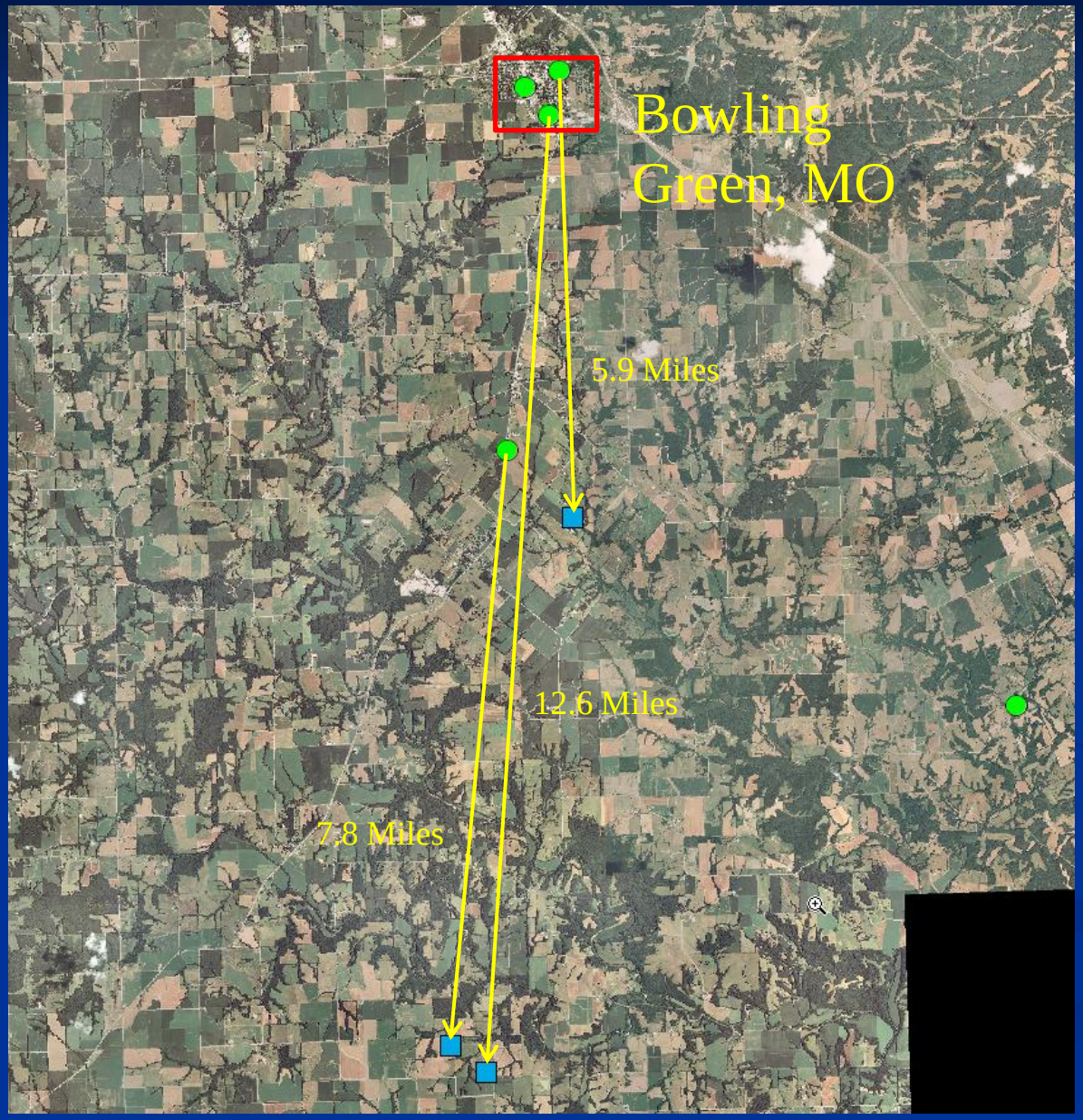
Methods of Point Placement

LL_COLLECT	Count_LL_COLLECT
	2425
ADDRESS MATCHING-BLOCK FACE	10
ADDRESS MATCHING-DIGITIZED	37
ADDRESS MATCHING-HOUSE NUMBER	2229
ADDRESS MATCHING-NEAREST INTERSECTION	19
ADDRESS MATCHING-OTHER	4
CENSUS BLOCK-1990-CENTROID	1
CENSUS BLOCK/GROUP-1990-CENTROID	2
CENSUS BLOCK/TRACT-1990-CENTROID	10
CENSUS-OTHER	8
CLASSICAL SURVEYING TECHNIQUES	3
GPS - UNSPECIFIED	815
GPS CARRIER PHASE STATIC RELATIVE POSITION	70
GPS CODE (PSEUDO RANGE) DIFFERENTIAL	192
GPS CODE (PSEUDO RANGE) STANDARD POSITION (SA OFF)	307
GPS CODE (PSEUDO RANGE) STANDARD POSITION (SA ON)	1
GPS CODE (PSUEDO RANGE) DIFFERENTIAL	224
GPS CODE (PSUEDO RANGE) STANDARD POSITION (SA OFF)	2
GPS-OTHER	3
INTERPOLATION - DIGITAL MAP SRCE (TIGER)	86
INTERPOLATION - SPOT	1
INTERPOLATION-MAP	2496
INTERPOLATION-PHOTO	1
INTERPOLATION-SATELLITE	2
MAP INTERPOLATION	87
PUBLIC LAND SURVEY - SIXTEENTH SECTION	1
PUBLIC LAND SURVEY-SECTION	559
UNKNOWN	18
ZIP CODE-CENTROID	346
ZIP+2 CENTROID	31
ZIP+4 CENTROID	19

Location – Location – Location

- Unfortunately many of the point datasets lack the precision necessary for accurate assessments. For example:
  - Address matching
  - Zip code centroid
  - Center of county
- The locations in many of the datasets are not consistent in what they represent
  - Owner Location
  - Activity Location

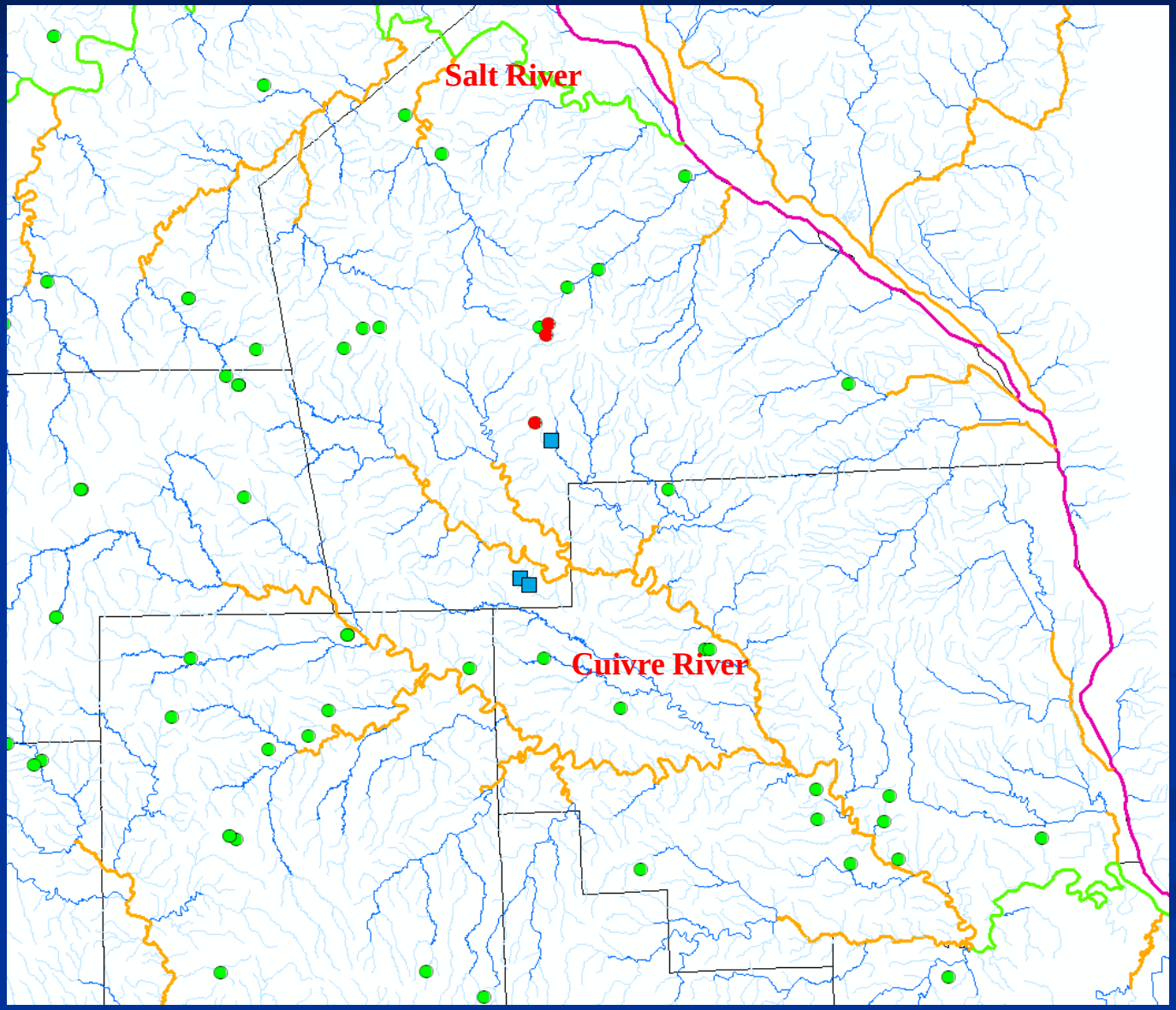
Location: Owner vs. Activity

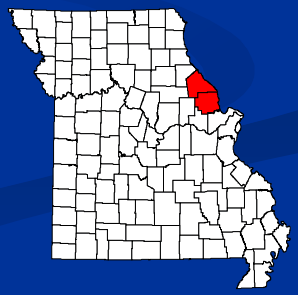


EPA CAFO
"True" Location

Bowling Green, MO

Poor Positioning Places Facilities (CAFOs) in Wrong Watershed

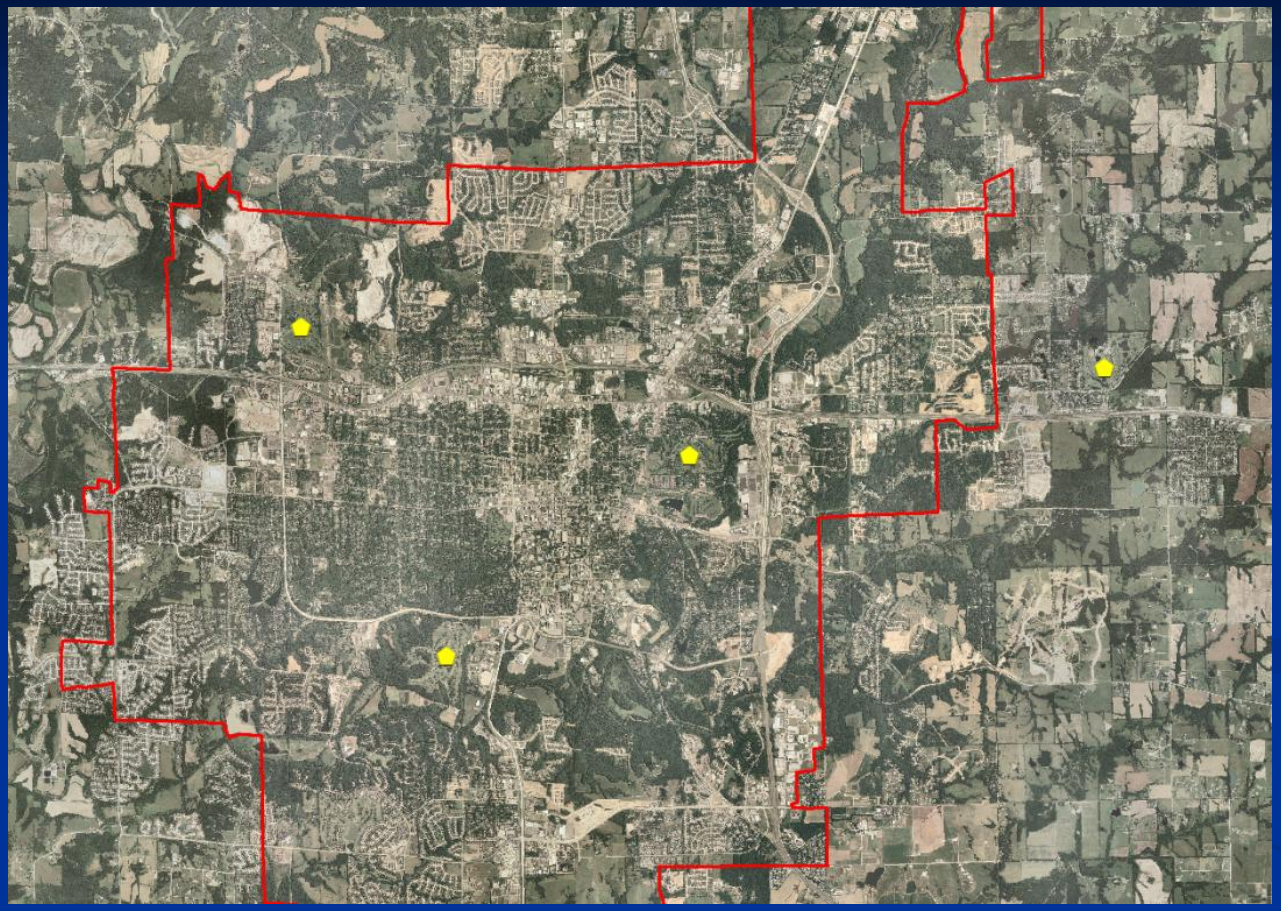


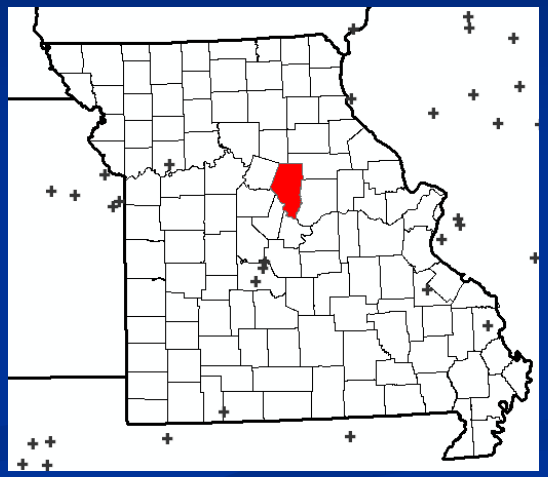


Completeness

- Often outdated
- Facilities missing
- Old non-applicable facilities/sites still in data
  - Sites with past construction permits still in data

Incomplete Data



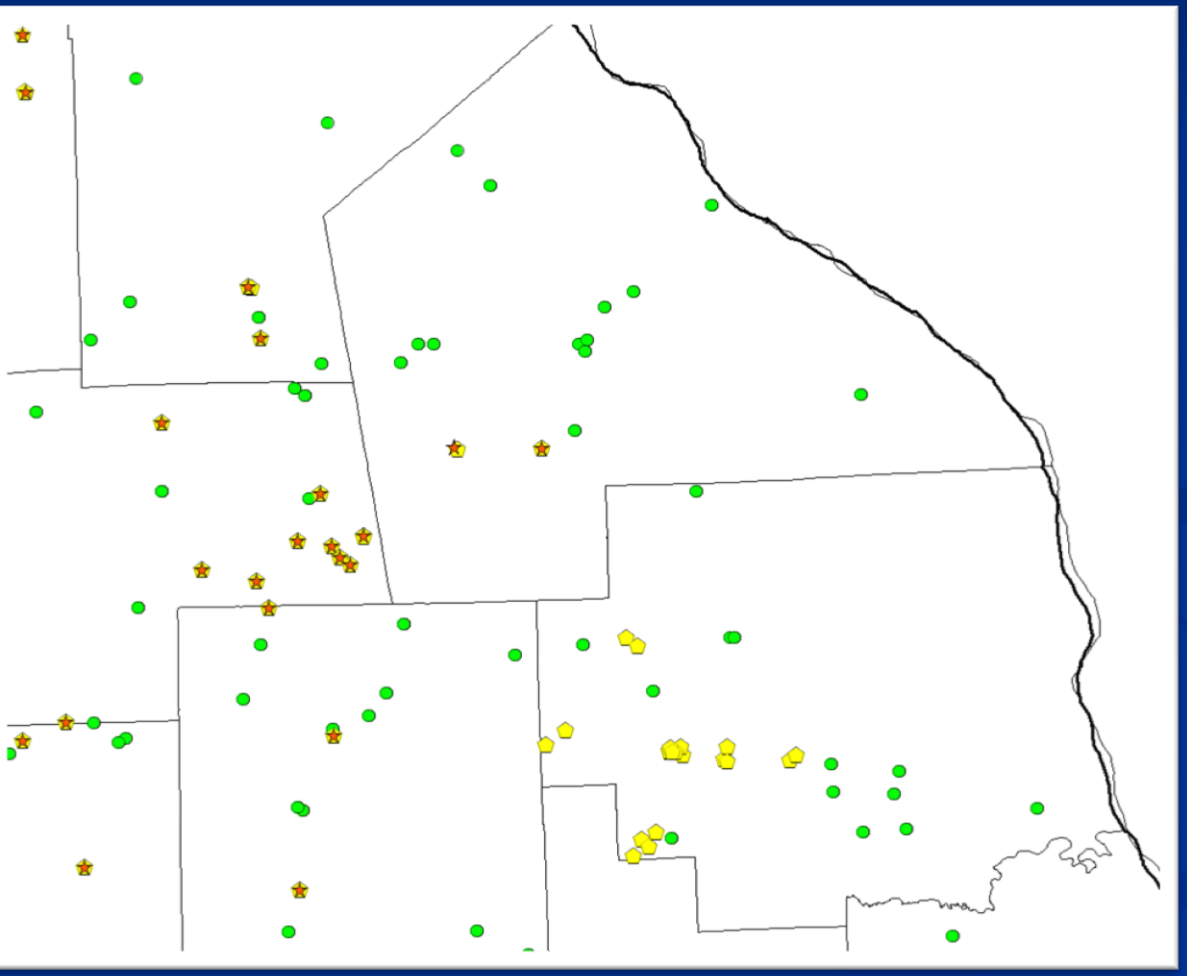


- A very generalized golf course data layer shows no courses located in Columbia, Missouri
- There are at least four golf courses located near Columbia

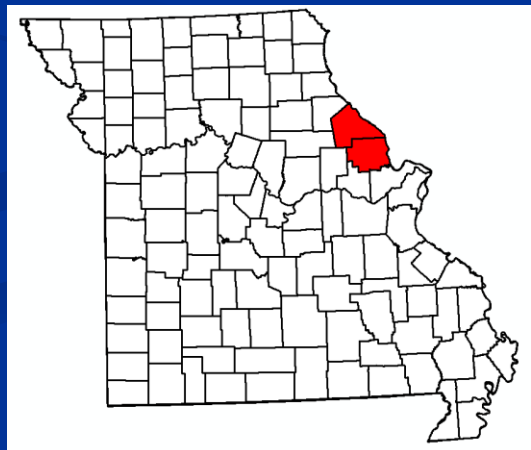
Differing Multiple Sources of the "Same" Data

- Sometimes 3 or 4 versions of the data
  - Not always a good crosswalk
- Partially overlapping datasets
  - i.e., two datasets with some overlap, but no way to determine exactly which features represent the same thing
- Some datasets as polygons some as points

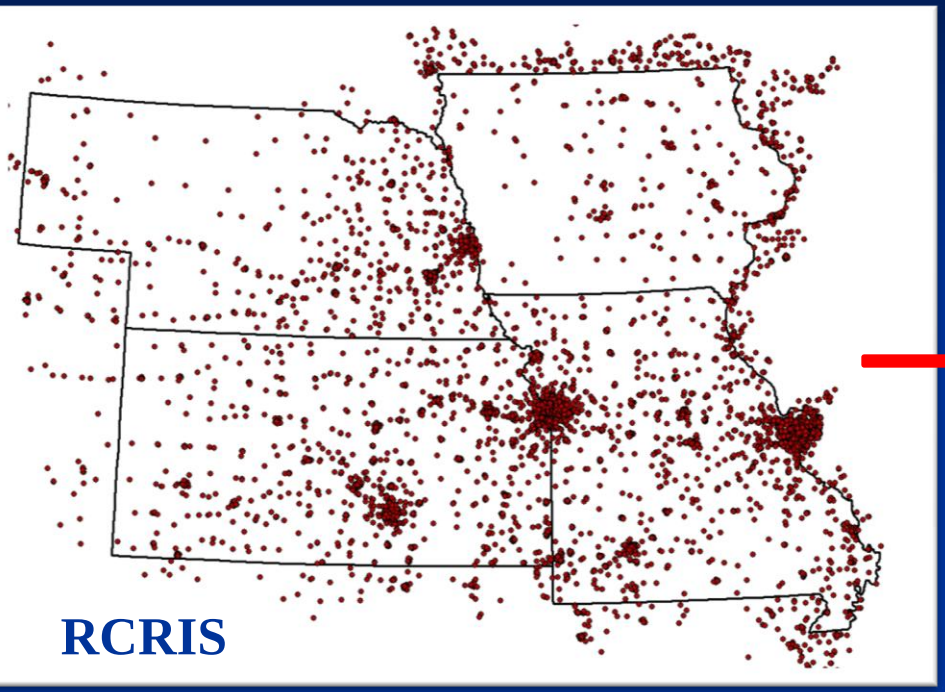
Three Datasets Representing CAFOs

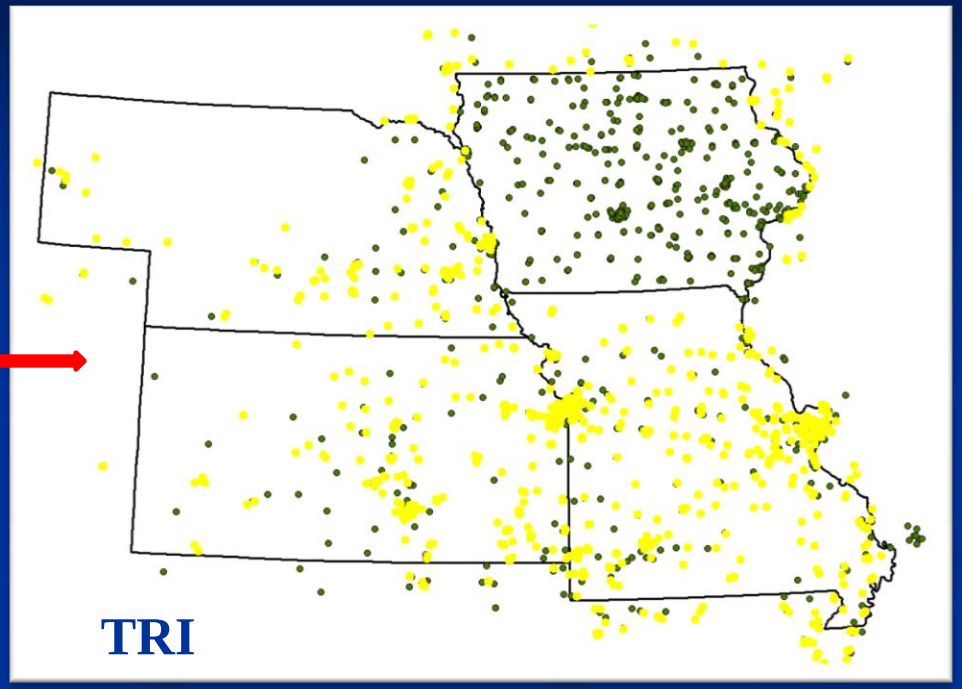


- EPA CAFOs (Region 7)
- EPA CAFOs (Missouri only)
- CAFOs from NPDES (MO-DNR

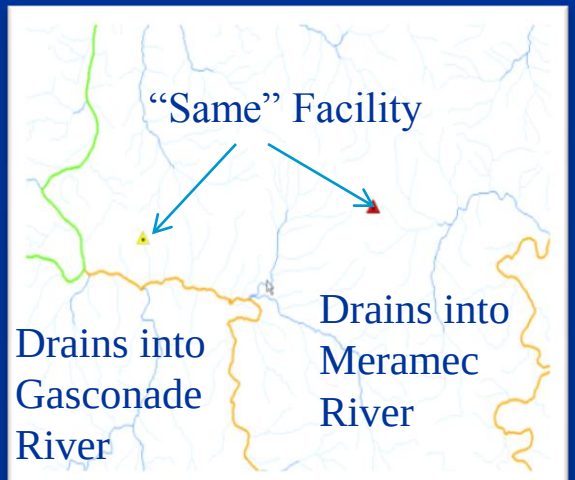


Comparing Datasets: RCRIS vs. TRI



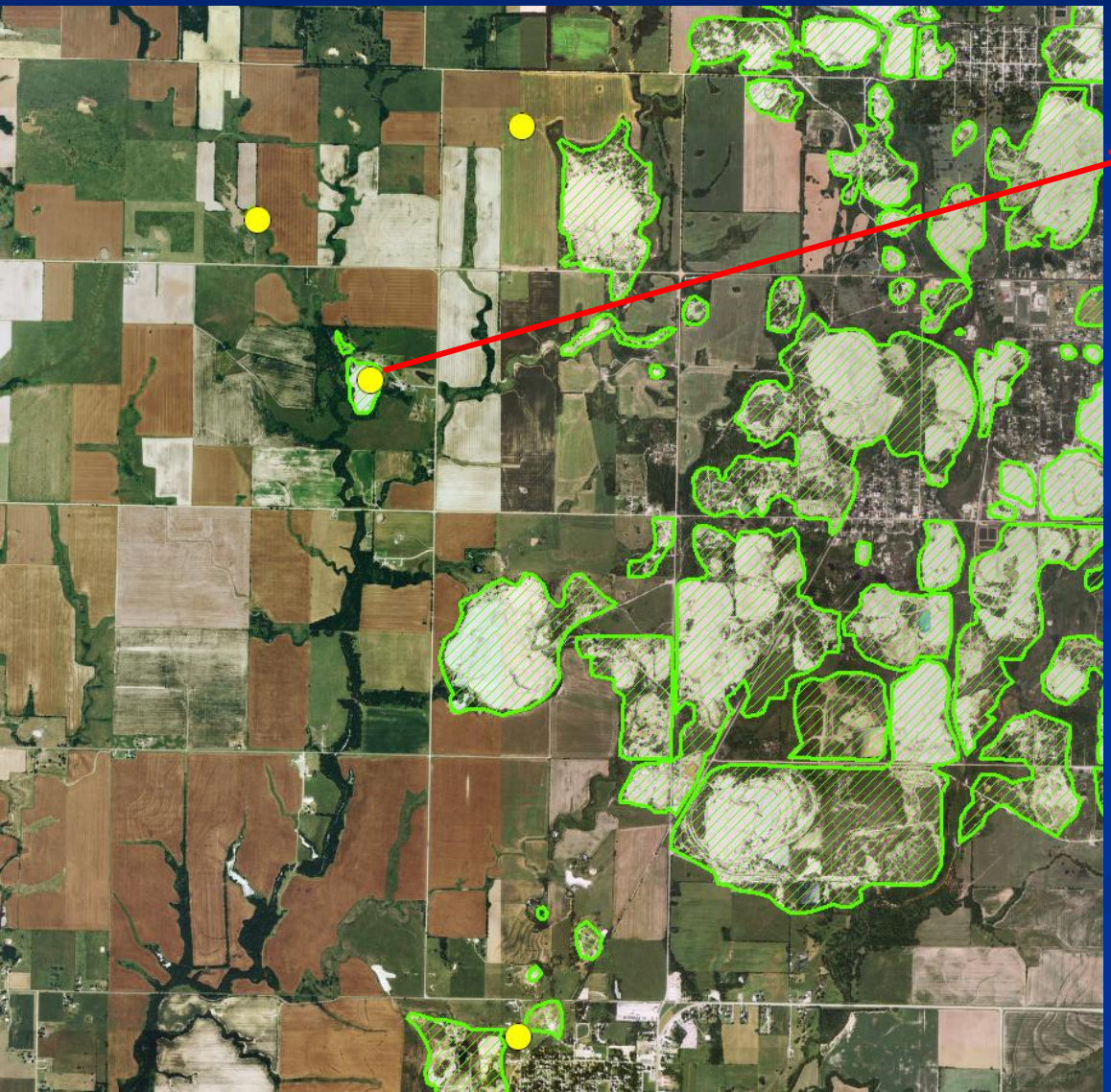


Yellow points are found in both datasets

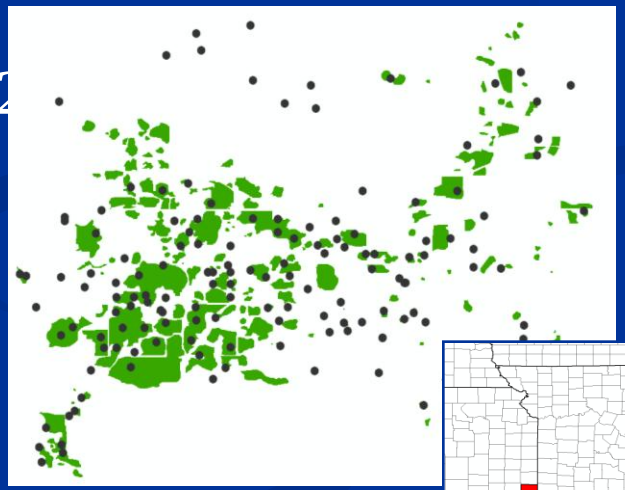


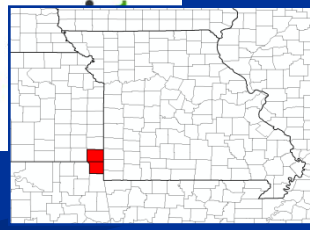
The same facility on different sides of a drainage divide

Mine Points and Polygons are Difficult to Integrate



1. Sometimes good correspondence between points and polygons

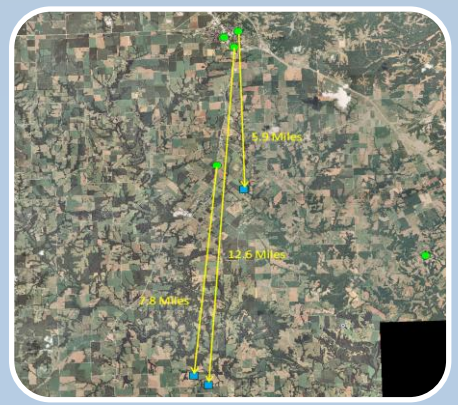


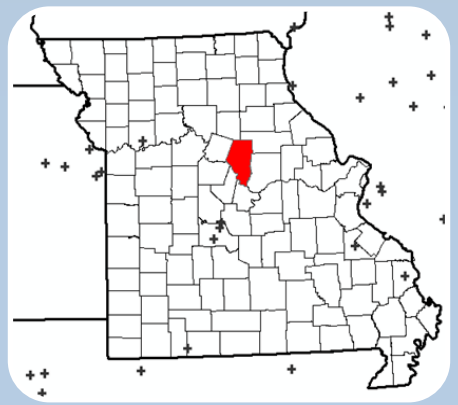


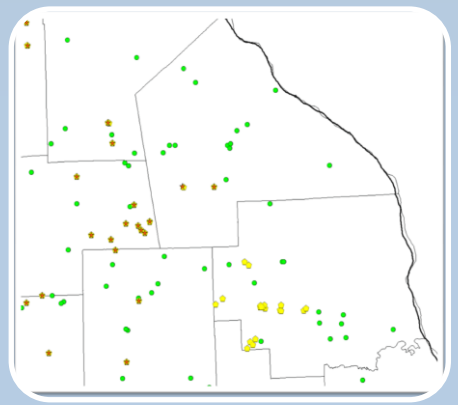
Mine as Point

Mine Waste Area

Problem Review







Location	Completeness	Multiple Sources of "Same" Data
Poor Placement	Incomplete Datasets	Which is Right?

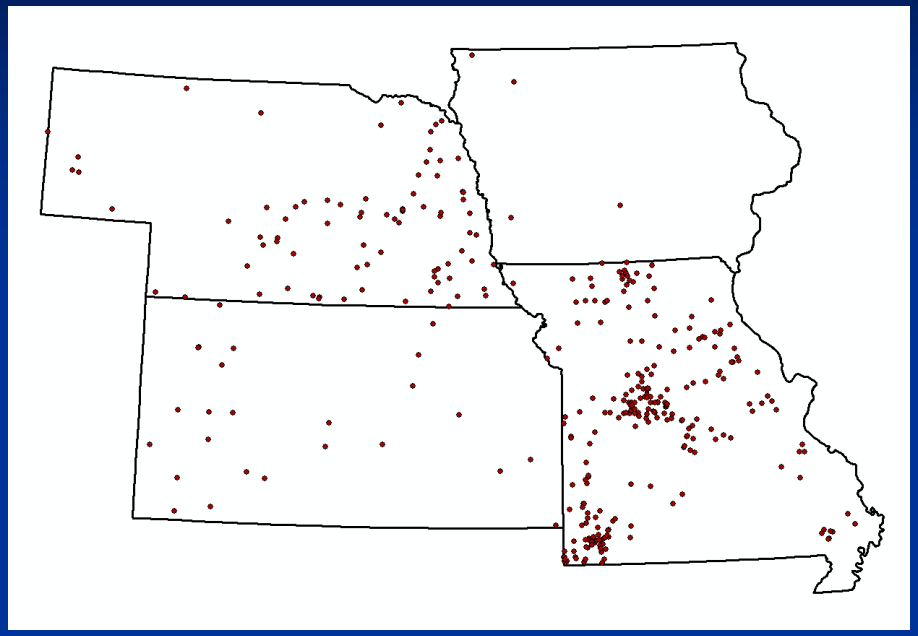
What Should be Done?

1. Improve spatial positioning
2. We need to "push" attribution of existing datasets
3. Fill in gaps and weed out defunct data entries
4. Develop standards in conjunction with adjacent states

Data Issues: Some Specific Questions

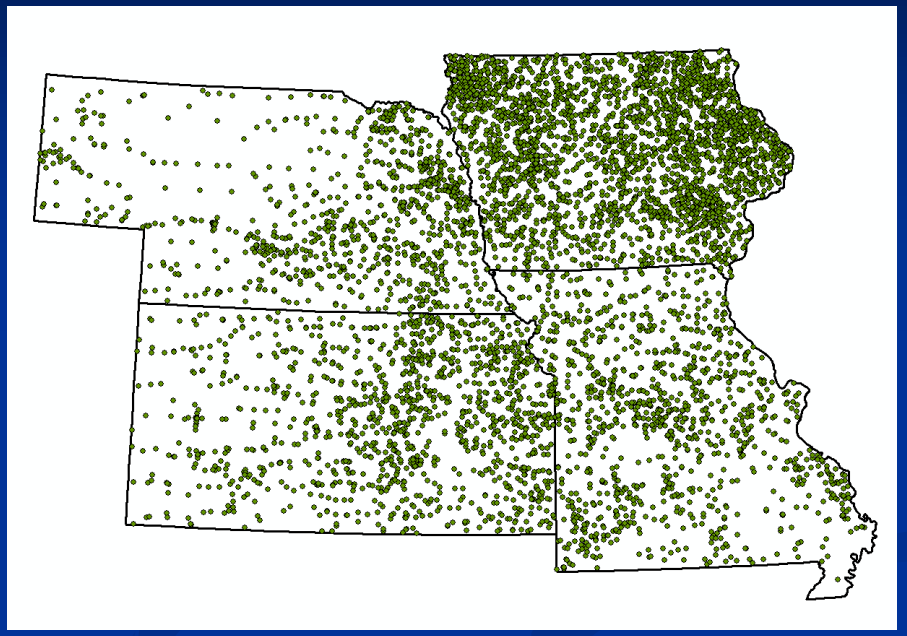
- CAFOs
- NPDES
- In-stream Mining
- Channelization
- Biological Data

Data Issues CAFOs



NPDES CAFO's

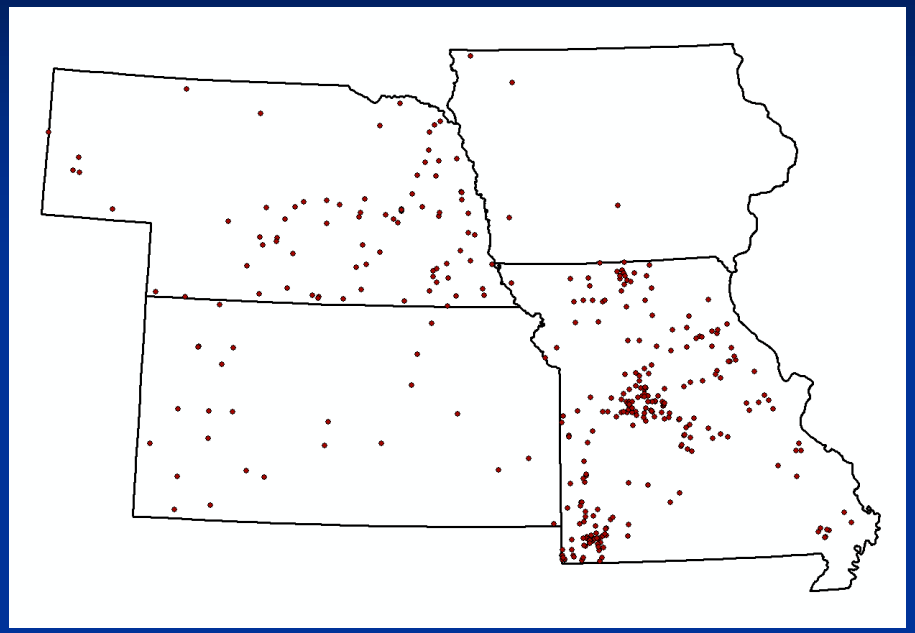
1. Data is not consistent across region
2. Some CAFO's are missing
3. Some of the facilities are generalized for the region (i.e. 1 point for many facilities)



EPA CAFO's

1. Data appears "consistent" across region
2. Often misses some of the larger facilities
3. Often poor locational accuracy

Data Issues: NPDES CAFOs Example



1. The data is not consistent for the entire study area (Iowa)
2. Some major CAFOs are included (Figure 1), but is missing some of the other facilities (Figure 2).
3. Some points are generalizations for the larger operations with many locations (Figure 3).

Figure 1

Figure 2

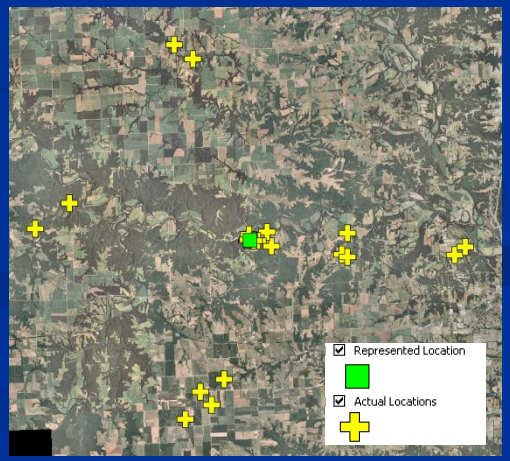
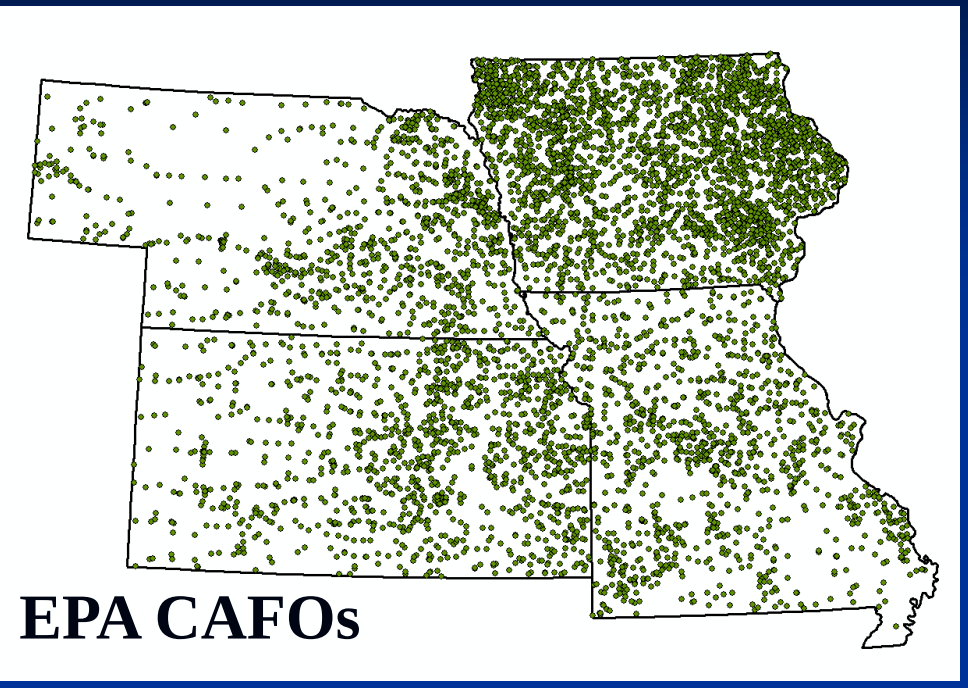


Figure 3

Data Issues: EPA CAFOs Example



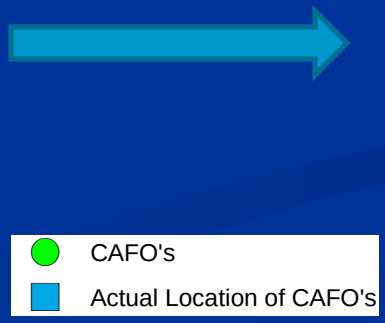
EPA CAFOs

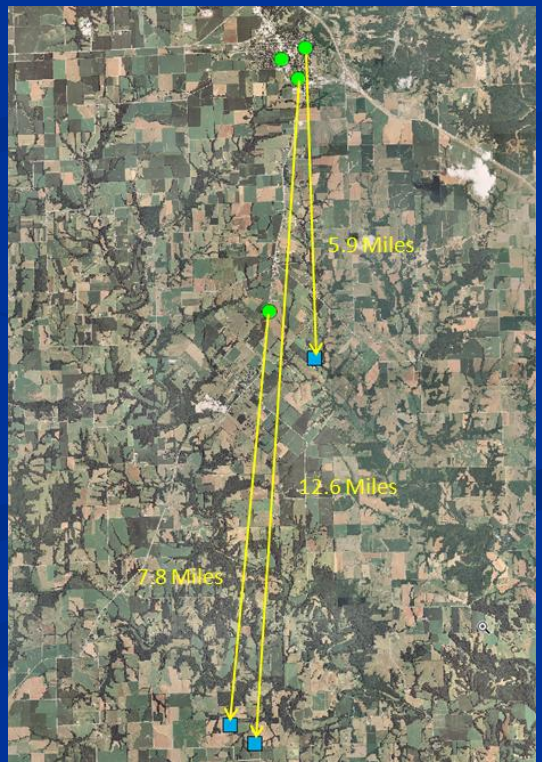
1. Data appears “consistent” across region
2. Often misses some of the larger facilities
3. Often poor locational accuracy

The actual locations should drain through the same stream segment 6 miles away, with 21 affected streams.

The depicted locations drain together 45 miles away with 203 affected streams (135 of which are incorrect)

Some points drain north to the Salt River Watershed and to the Mississippi River when they all should drain into the Cuivre River Watershed.



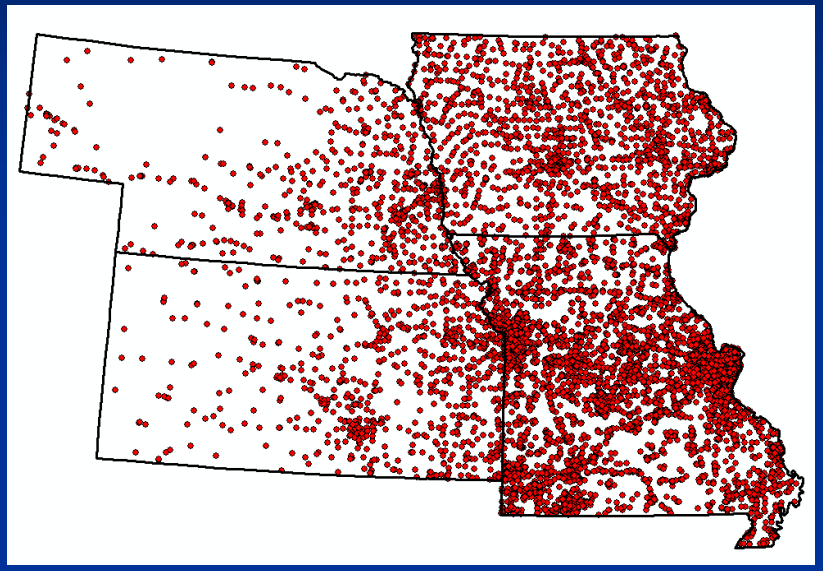


Data Issues: CAFOs

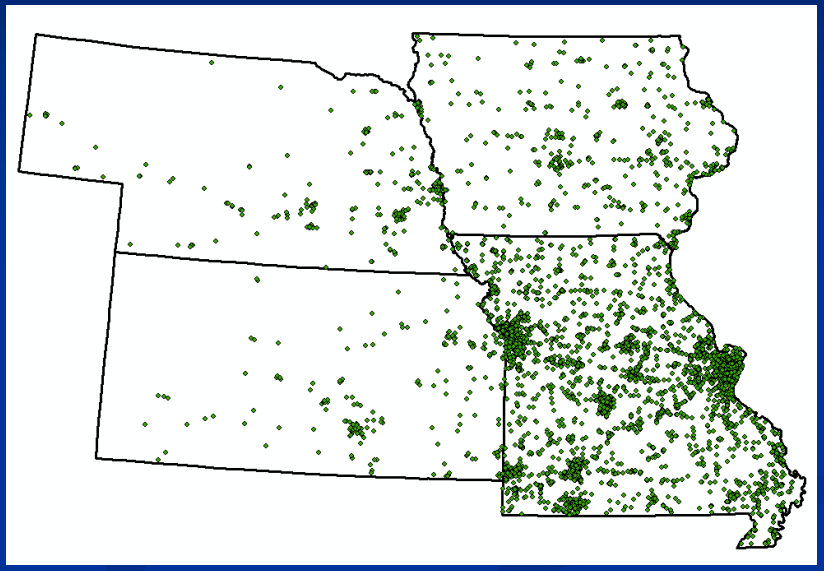
Suggestions?

Data Issues: NPDES

NPDES all data

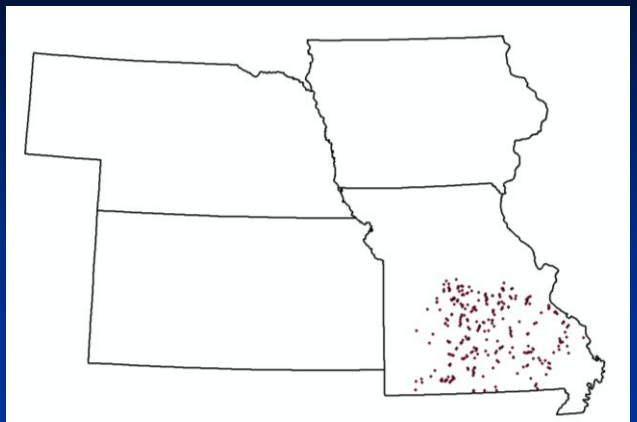


Overlap Removed



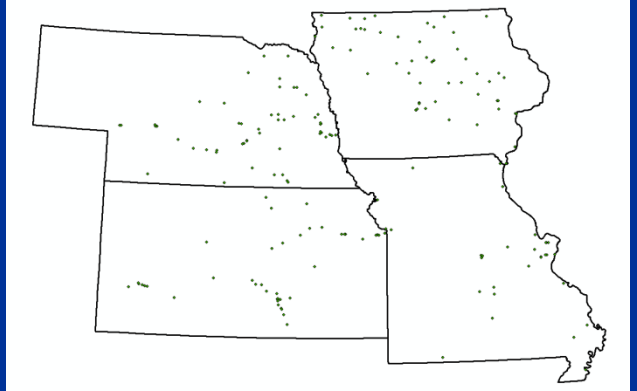
1. Should we utilize the remaining NPDES data?
2. Approximately half the data points remain after removing overlap, however most of this (66%) is in Missouri.
3. A large portion of the remaining points are due to construction site permits that are probably no longer there.
4. Other types of remaining points are service stations, farm supply stores and water supplies.

Data Issues: In-Stream Mines



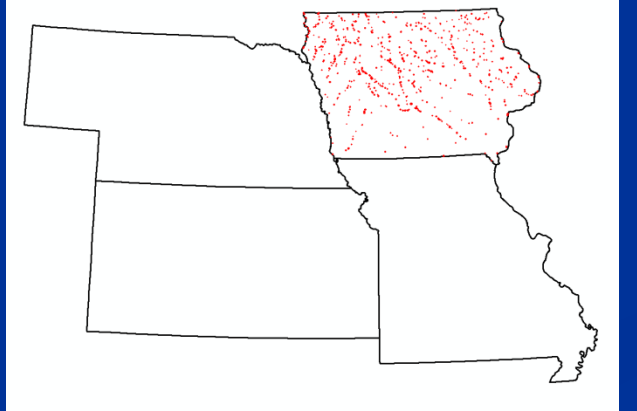
MO DNR - In stream mines

- Sand and gravel



Bureau of Mines Active Mines – Sand and gravel

- This data was extracted from the active mines data, it contains all sand and gravel mines.
- We understand that all sand and gravel mines should be in streams.

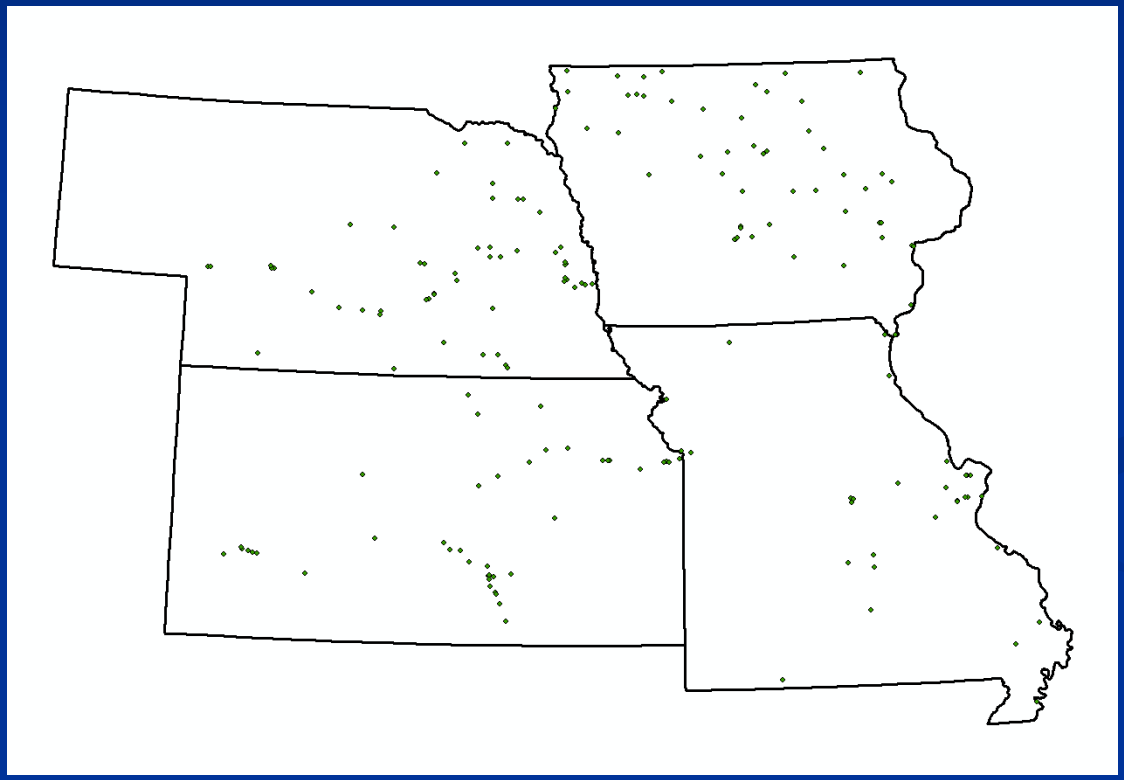


Iowa Mines 2000 – Sand and gravel

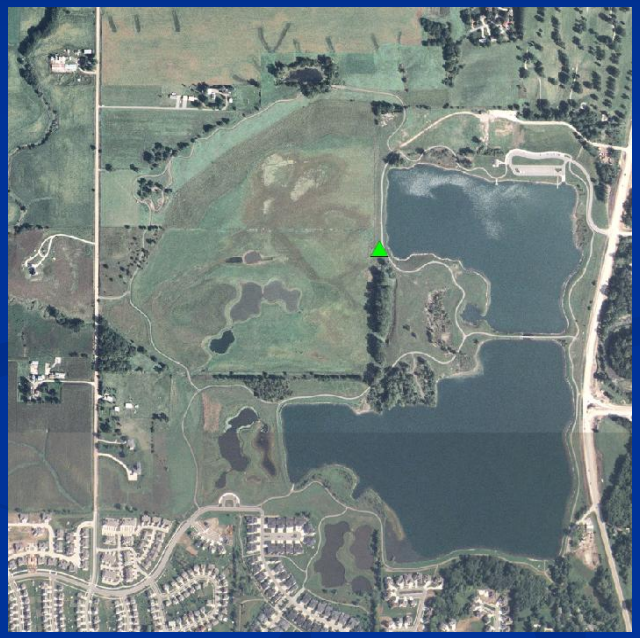
- This data was extracted from the Iowa Mines 2000 dataset, it contains only sand and gravel mines.
- We understand that all sand and gravel mines should be in streams.

Data Issues: In-Stream Mines

Bureau of Mines
Active Mines



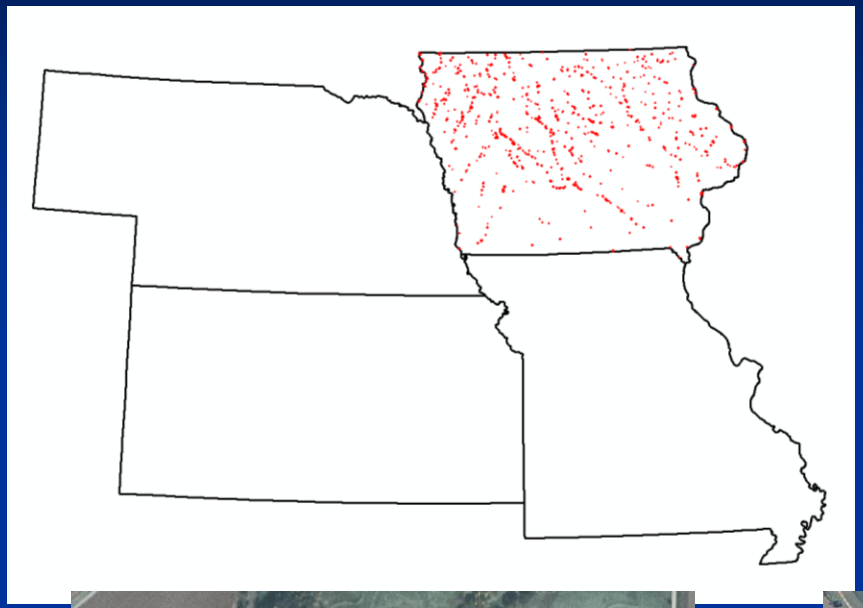
"In Stream" Mine?



The example to the right shows and in stream mining operation at a lake, the closest stream is about almost a mile to the east.

Data Issues: In-Stream Mines

Iowa Mines 2000



- Images show locations of sand/gravel mining operations
- However no visible evidence of any operation within the boundary of the mine.

Data Issues: In-Stream Mines

Suggestions?

1. Should we add the sand and gravel back into the active mines and run them as mines in general?

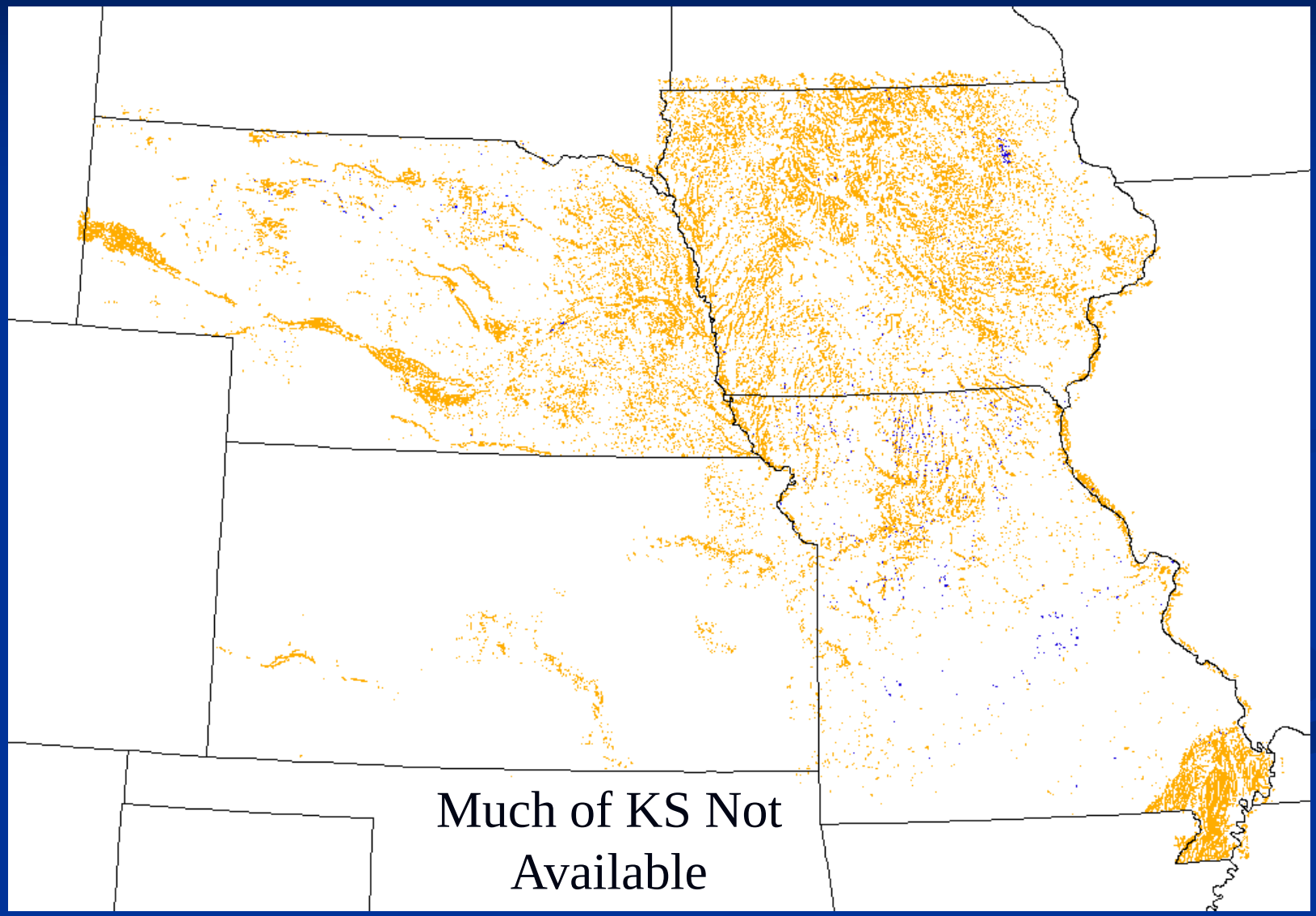
2. Should we use a buffer on the streams to select the sand and gravel mines that are within a certain distance of the streams?

3. What should we do with the Iowa polygon mines data, as it often represents property the mining company owns that may not have a mine?

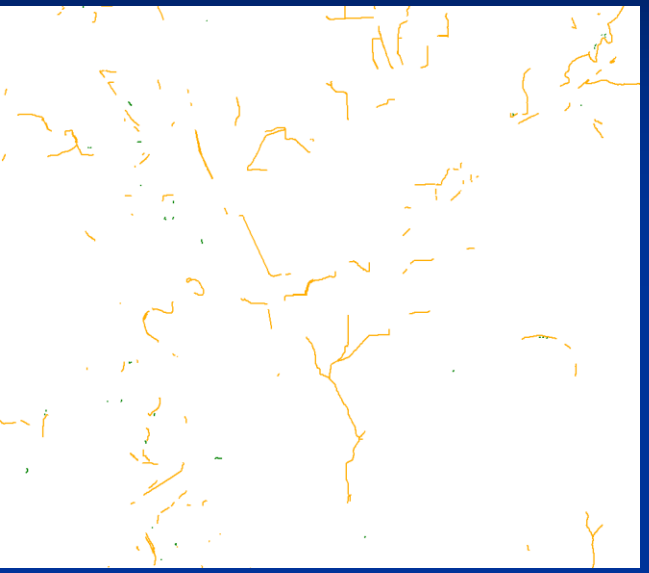
Data Issues: Channelization

- Sinuosity/straightness type programs
  - Introduce error
- Angle calculation
  - Introduce error
- NWI
  - Incomplete coverage for Region 7 (Kansas)
  - Misses some channelization/ditches
  - Different resolution lines
  - Attribution

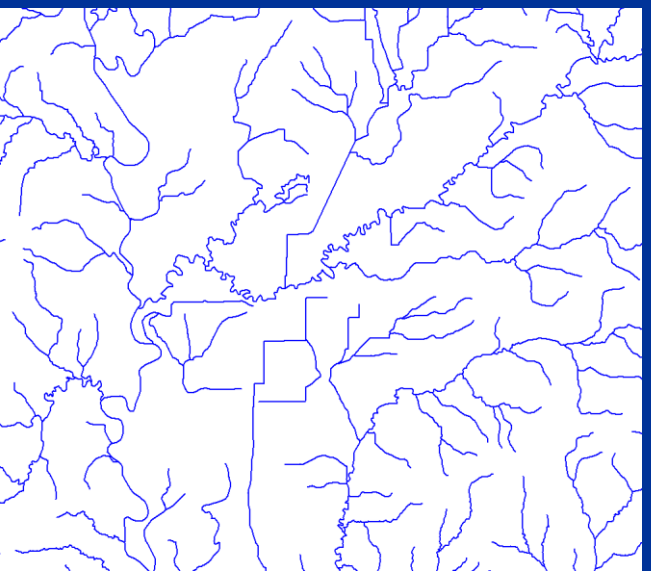
Data Issues: Channelization (NWI Example)



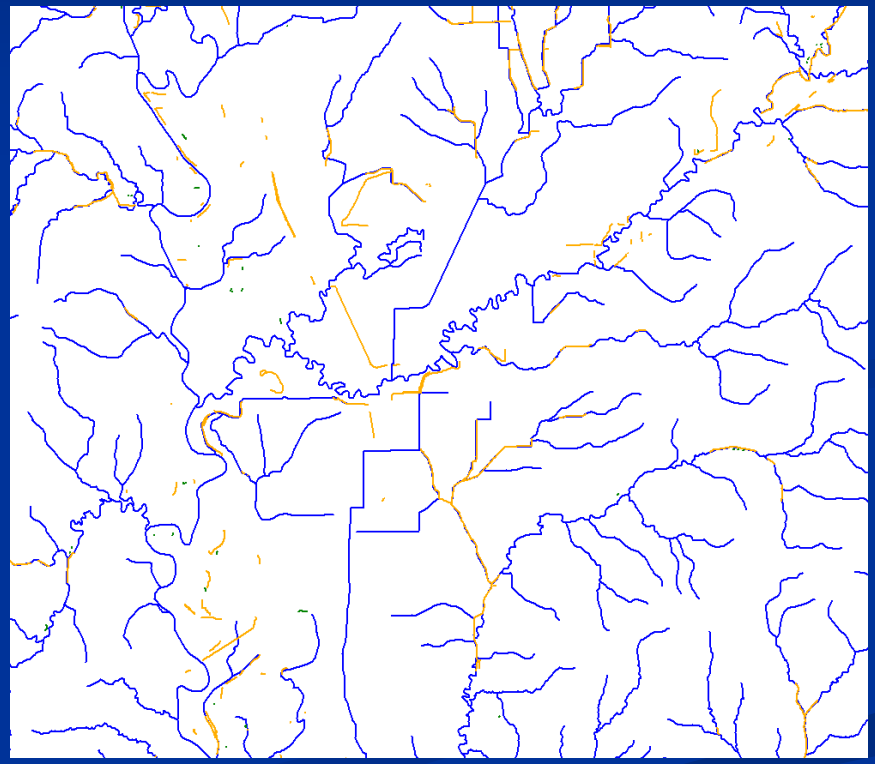
Data Issues: Channelization (NWI Example)



NWI



NHD



Combined

Data Issues: Channelization

Suggestions?

Data Issues: Biological Data

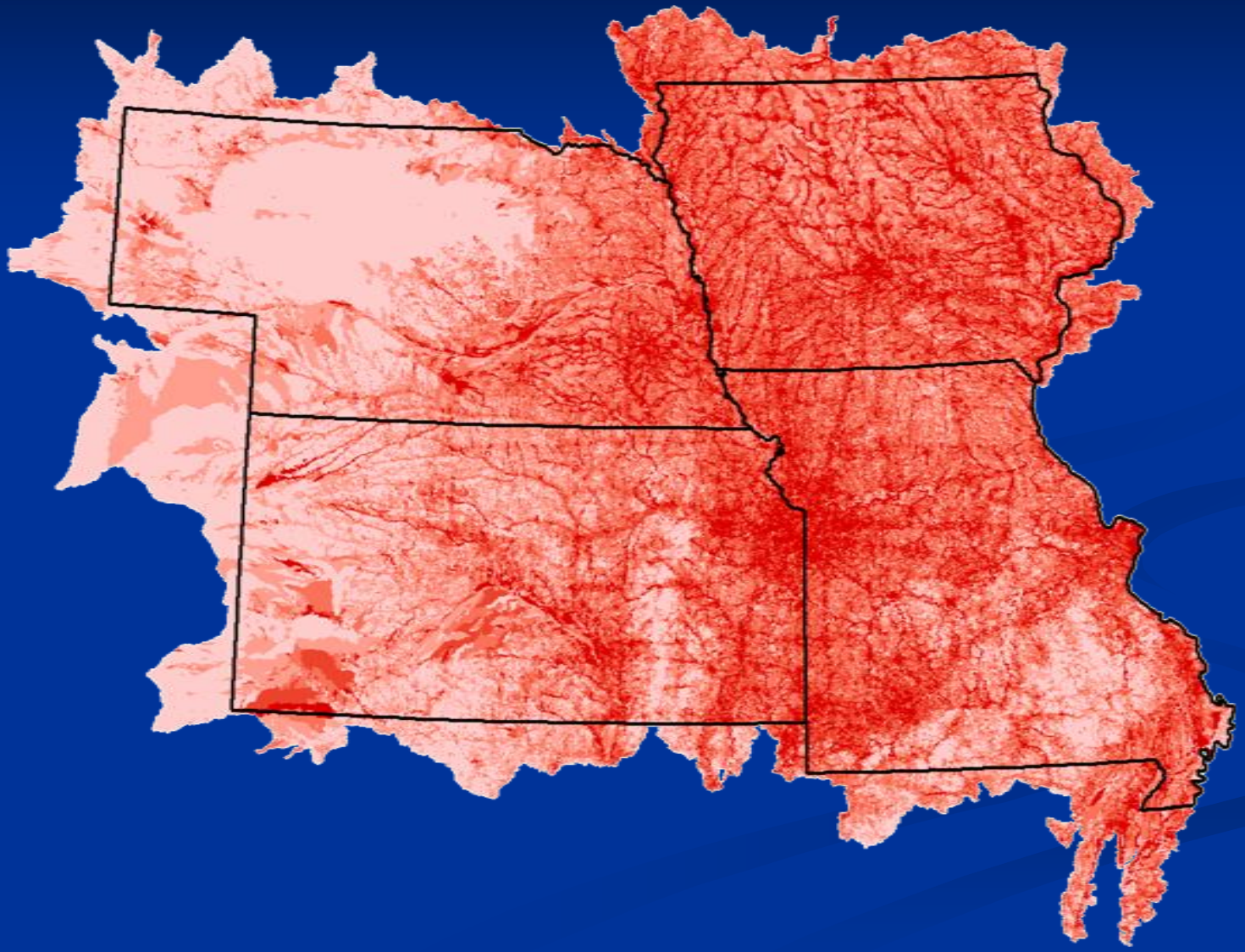
Look at databases

Suggestions?

What is next?

- Work on today's "decision" items
- Headwater impoundments
- Buffers/Riparian
- Error checking
- HTI
- Biological data

What we are shooting for . .



Project Funding

- Funding for this project was provided by a U.S. Environmental Protection Agency Region VII Wetland Program Development Grant;
- Additionally, the U.S. Environmental Protection Agency Region VII, through the Missouri Department of Natural Resources, has provided partial funding for this project Under Section 319 of the Clean Water Act.

MoRAP

Missouri Department of Natural Resources

United States Environmental Protection Agency