Stream Reach Specific Watershed Data: Threats to Aquatic Ecosystem Integrity

Final Report

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Missouri Resource Assessment Partnership (MoRAP)
School of Natural Resources
University of Missouri

Project Name: Developing Reach Specific Watershed Data on Nonpoint Pollution Sources
Project #: G07-NPS-14

Missouri Department of Natural Resources

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Executive Summary

There has been a tremendous amount of geospatial data developed over the last decade, much of which represents anthropogenic features on the landscape than have the potential to threaten the ecological integrity of streams. What has been lacking is a means of assembling, organizing, and quantifying this data in a fashion that will provide information relevant to each stream segment.

To help address this information gap the primary purpose of this project was to gather and quantify geospatial data layers pertaining to anthropogenic features on that landscape that threaten the ecological integrity of Missouri's streams. As such the scope of this project was largely that of data development in which we quantified threats in the drainage area above each stream segment in Missouri using a modified version of the 1:100,000 National Hydrography Dataset (NHD).

Approximately 40 geospatial data layers were identified through the help of a regional oversight committee that was brought together to provide guidance for this project and another related project that is being conducted throughout EPA Region 7. This committee consisted of individuals from each of the states comprising EPA Region 7 (Iowa, Kansas, Missouri, and Nebraska). A large thrust of this project was to collect and assemble data layers that were seamless across state boundaries. These seamless data layers allow information for watersheds that straddle state boundaries to have information quantified accurately for the drainage area above each stream segment.

A total of three training workshops were hosted as part of the project. These sessions were intended to provide end users with an overview of the data as well as allow them to work with the data in a hands-on GIS environment. A special training manual with student exercises and data CD were developed especially for these training sessions.

Building on the idea that accurate inventories can lead to better understanding and better understanding in turn leads to better decision making, it is our hope that the information assembled as part of this project will provide aquatic resource managers with the information they need to make more informed and objective decisions about Missouri's riverine ecosystems.

Project Funding

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.

Additional funding provided by a separate project/grant throughout EPA Region 7 will utilize this data along with similar data quantified over the other states of EPA Region 7 (Iowa, Kansas, and Nebraska) to produce a human threat index (HTI) for every stream segment. This index will ultimately provide information about the potential threats to any given stream segment relative to all streams throughout EPA Region 7.

Introduction

The first step to effective resource management is having an accurate inventory of the, a) resources you intend to manage and b) factors that influence those resources (Fajen 1981). The use of geographic information systems (GIS) has certainly enhanced our ability to generate basic inventory statistics on Missouri's natural resources and factors that might negatively influence these resources. Numerous geospatial datasets have been developed (e.g., geology, soils, land cover, streams, dams, mines) and these datasets have given resource managers the ability to develop inventories and conduct assessments that help guide the allocation of limited human and financial resources to those locations most in need of restoration or conservation.

Despite these advances in GIS and the increased availability of geospatial data there still exists a tremendous data gap with regard to freshwater resources. This data gap pertains to the fact that the physicochemical and biological character of a lake or particular stream reach is largely influenced by natural and land-use conditions within the watershed. While the United States Geological Survey (USGS)/Natural Resource Conservation Service (NRCS) Hydrologic Unit (HU) layers have somewhat helped with this problem, they do not provide a comprehensive picture of watershed conditions within the state since inventory data compiled for these HUs, only accurately characterize watershed conditions of the stream reach at the outlet of each HU. Even with the most detailed 12-digit HU coverage we can only accurately characterize the watersheds of approximately 1,400 stream reaches in the state. This represents less than 2% of the more than 100,000 individual stream reaches contained in the 1:100,000 National Hydrography Dataset (NHD) within Missouri.

As part of the Missouri Aquatic GAP Project, MoRAP developed a GIS methodology that can be used to quantify watershed and upstream riparian conditions for every single stream reach (between consecutive tributaries) within the 1:100,000 NHD. These data provide a powerful tool for developing comprehensive inventories and conducting detailed assessments for the freshwater resources within Missouri. The reach-specific precision of these data allow inventories and assessments to move from a fixed unit state (i.e., HUs) to a continuum of data that provides the necessary flexibility to meet a wide range of research and management applications. For instance, we can now generate maps and linear statistics to display and quantify the number or percent of stream miles in Missouri that have greater than 10% (or any desired percentage) of their watershed draining urban lands, row crop agriculture, forest land, and other land uses.

When we consider natural resources management and think about what resource managers really do, we find that they don't necessarily manage the resource itself, but often manage human activities that impact resource quality. Some common questions of resource managers include: What factors threaten the ecological integrity of a stream of interest? What threat is most pervasive? Where are these threats within the network or watershed? Answering these questions and others like them can help resource managers target specific threats at specific locations. Finally for a decision to be objective, it must be driven by data/information. More specifically, nearly all natural resource management decisions must be driven by spatially-explicit (i.e., map-based) data/information.

In order to make effective decisions aquatic resource managers must have an understanding of the threats to aquatic ecosystem integrity. These threats may be local, residing at the stream reach of interest, or may be some distance upstream. The data developed as part of this project will help identify and quantify many of these threats in a high resolution spatially-explicit manner.

The primary objectives of this project were to:

1. Generate reach-specific watershed data for stream reaches within the 1:100,000 NHD;
    a. Quantify the number, density, aerial extent, and percentages for a variety of human land-use factors associated with nonpoint source pollution (e.g., roads, mines, dams, land cover, confined animal feeding operations).
2. Provide training on the data use.

In addition, we wanted to quantify potential human threats for the drainage area above each 1:100,000 NHD stream segment in Missouri and include human land-use factors for both nonpoint and point source pollution using existing data sets. In addressing these objectives we sought to create an aquatic 'threat assessment tool' that would be useful for on-the-ground planning and management. We wanted to utilize as many threat datasets as possible, consider the drainage area above each stream segment, incorporate riparian landcover, and account for distance to upstream threats. Finally, we wanted the resulting data sets to be seamless across state borders.

To help us get started we utilized the expertise of members of a project oversight committee that was brought together to provide insights and guidance both for this project and another separate but related MoRAP project covering all of EPA Region 7. This committee consisted of approximately twelve active participants with representatives from state or federal agencies across the four states comprising EPA Region 7 (See Appendix A). Committee meetings were held approximately twice a year.

A total of 35 individual threat attributes were quantified and are seamless across state borders. We also quantified distance to threat information for 15 of these data sets. An additional five threat attributes were quantified that are specific to Missouri only.

The resulting data sets developed for this project <u>will</u> help answer questions like: What threats are upstream? How much or how many threats are upstream? Where or how far are these threats upstream? The resulting data sets developed for this project <u>will not</u> answer questions like: What is the impact of a given threat upstream? Of the many threats upstream, which is worse? How exactly do these threats alter the physical/chemical character of the stream? Is there a threshold for possible impacts? What can be done to mitigate these potential problems? To help answer these questions resource managers will need to rely on addition information and their own areas of expertise.

The remainder of this report will describe the data layers we used, our methodologies, and project components in more detail.

Threat Data

We sought to utilize as many different threat data sets as possible. A caveat was that we wanted the data to be consistent and useful across state lines so that the entire drainage area could be considered for streams beginning in one state and flowing into another. To help identify all possible threats we relied on our regional oversight committee to help us generate a list of possible threats. From this list we identified those that were available digitally and those that we could create within the time and money constraints for the project (Figure 1). Table 1 presents a list of all threats that were quantified as part of this project including sources and dates. It should be noted that some threats are represented by multiple components; for instance roads are represented as both 1) length of road and 2) road-stream crossings. Many of the threats that were mapped as points had distance-to-threat information computed. Each of these individual threat datasets has its own limitations with regard to data quality, completeness, resolution, and date of mapping.

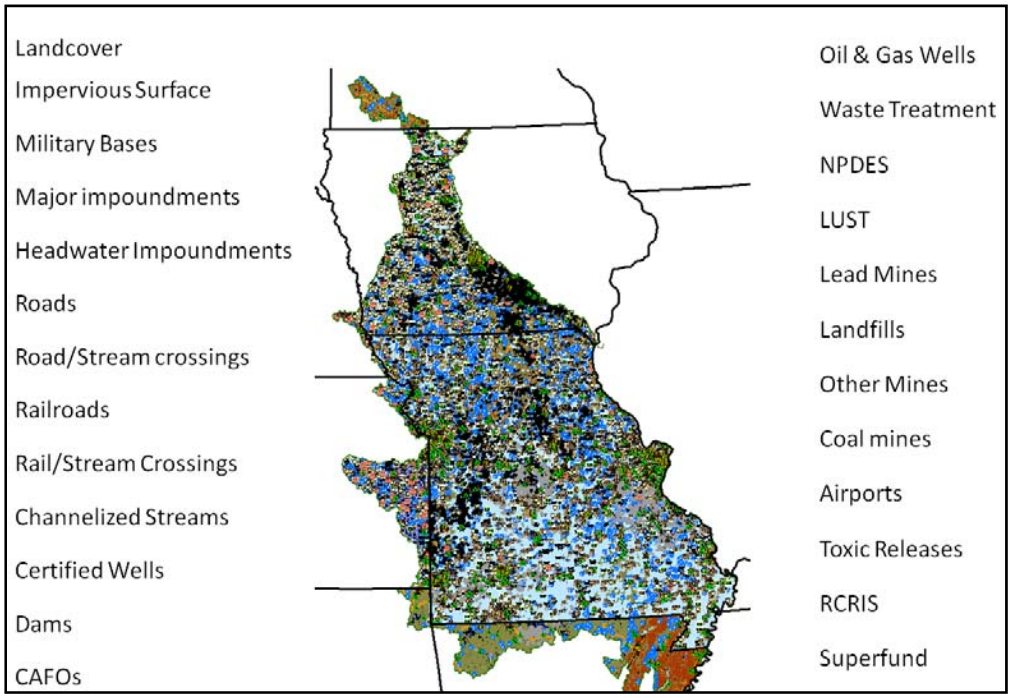

Figure 1. Selected potential human threats to aquatic ecological integrity.

A substantial portion of project time was spent looking for, acquiring, and cleaning geospatial data representing these anthropogenic threats to aquatic ecosystems. It is important to note that many of the data layers acquired for this project had very minimalistic metadata available. Appendix B contains brief reports for each input data set utilized for this project.

Table 1. The primary threat data layers utilized for this project with source and data set date.

File Name	File Definition	Source(s)	Source Date
Airports.shp	Airports	Acquired from EPA. EPA cites: GDT Dynamap 2000	2000
CAFOS.shp	Confined Animal Feeding Operation	Acquired from EPA. EPA cites: Dunn & Bradstreet 2003	2003
Mines.shp	Mines, except coal and lead	USGS	2005
Coal_Mines.shp	Coal mines	EPA BASINS	2001
		University of Nebraska - Lincoln	1996
		Iowa DNR	2003
Lead_Mines.shp	Lead mines	EPA BASINS	2001
Oil_Gas_Wells.shp	Active oil and gas wells	Conservation and Survey Division, University of Nebraska – Lincoln	1996
		Kansas Geological Survey	Varies
		MoDNR	Provisional
IA_wells.shp	Iowa certified water wells	Iowa DNR	1995
KS_wells.shp	Kansas certified water wells	Kansas Geological Survey	Varies
MO_wells.shp	Missouri certified water wells	MoDNR	2006
NE_wells.shp	Nebraska certified water wells	Nebraska DNR	2006
Roads.shp	Roads	TIGER census	1999
Road_Stream_Crossings.shp	Road and stream intersections	MoRAP	2007
Railroads.shp	Railroads	TIGER census	1999
Rail_Stream_Crossings.shp	Railroad and stream intersections	MoRAP	2007
RCRIS.shp	Resource conservation recovery information system sites	EPA	2007
Superfund.shp	Superfund sites	EPA	2007
Toxic_Releases.shp	Toxic release sites	EPA	2007
NPDES.shp	National pollutant discharge elimination system sites	EPA	Unknown Acquired 2007
WWTF.shp	Waste water treatment facilities	EPA	Unknown Acquired 2007
Landfills.shp	Landfills	EPA BASINS	2001
LUST.shp	Leaking underground storage tanks	MoDNR	2004
EPA_R7_Channelized_Streams.shp	Channelized or ditched streams	Kansas Dept of Health and Environment	unknown
		Iowa DNR	2003
		Nebraska DEQ	Unknown
		Created by MoRAP using: 24K NHD, 100K NHD, and NWI	2008
Major_Impoundments.shp	Major impoundments	Created by MoRAP using: NHD and NWI	2008
EPA_R7_Headwater_Impoundments.shp	Headwater impoundments	Created by MoRAP using: NWI and 2001 NLCD	2008
Dams.shp	Dams	U.S. Army Corps of Engineers	1996
Military_Bases.shp	Military bases	Bureau of Transportation	2001
Crop_Pest (ESRI grid)	Estimated crop pesticide application	Created by MoRAP using various inputs including 2001 NLCD	2007
Impervious (ESRI grid)	Impervious surface areas	Created by MoRAP using: 2001 NLCD	2006
NLCD_2001 (ESRI grid)	2001 national landcover dataset	USGS/MRLC	2006
1990 Population (geodatabase)	1990 block population	Census Bureau	1990
2000 Population (geodatabase)	2000 block population	Census Bureau	2000
Airports.shp	Airports	Acquired from EPA. EPA cites: GDT Dynamap 2000	2000

Missouri Specific Data

A few additional data sets specific to Missouri were acquired and utilized in addition to the seamless data between states (Table 2). These data sets are intended to supplement the rest of the project source data. It is important to note that these Missouri specific data sets stop at the state border and are best suited to watersheds completely contained within Missouri.

Table 2. Missouri specific data layers with source and data set date.

File Name	File Definition	Source(s)	Source Date
MO_CAFOS.shp	Missouri confined animal feeding operations	MoDNR	2006
MO_Haz_Generator.shp	Missouri hazardous waste generators	MoDNR	2008
MO_Haz_Waste_Permits.shp	Missouri hazardous waste permits	MoDNR	2004
MO_NPDES.shp	Missouri national pollutant discharge elimination system sites	MoDNR	2006
MO_UST.shp	Missouri underground storage tanks	MoDNR	2004

Special Data Sets Created for this Project

Although the intent for this project was to use existing geospatial data sets of potential threats to aquatic ecosystem integrity, our regional oversight committee identified several threats that were deemed particularly important, but for which no existing data set was available. On advice from the regional oversight committee we undertook to create these data sets. These data sets include:

1. Fragmentation of stream networks from major impoundments
2. Headwater impoundments
3. Ditched or channelized streams
4. Population change in the drainage area above every stream segment
5. Estimated crop pesticide use (MoRAP recreated an existing data set at a finer resolution using newer data)
6. Modified impervious surface from 2001 NLCD (MoRAP altered the impervious surface from the 2001 NLCD)

Stream Fragmentation

A data set that deserves special mention is one representing stream fragmentation that was developed specifically for this project. We sought to determine how fragmented the stream networks were from impoundments. We wanted to answer questions like; What is the total length of interconnected stream in any given “network fragment”? In other words, how many miles of stream does a fish have access to without having to swim through an impoundment?

Any stream barrier intersecting Small or Large Rivers was used to cut up the stream network. Any segments intersecting or inundated by an impoundment were given a distinct code to temporarily remove them from the network. All remaining interconnecting stream segments were given a “Group_id” and their total length was summed. This information yields the total length of all stream network in any given network fragment (Figure 2).

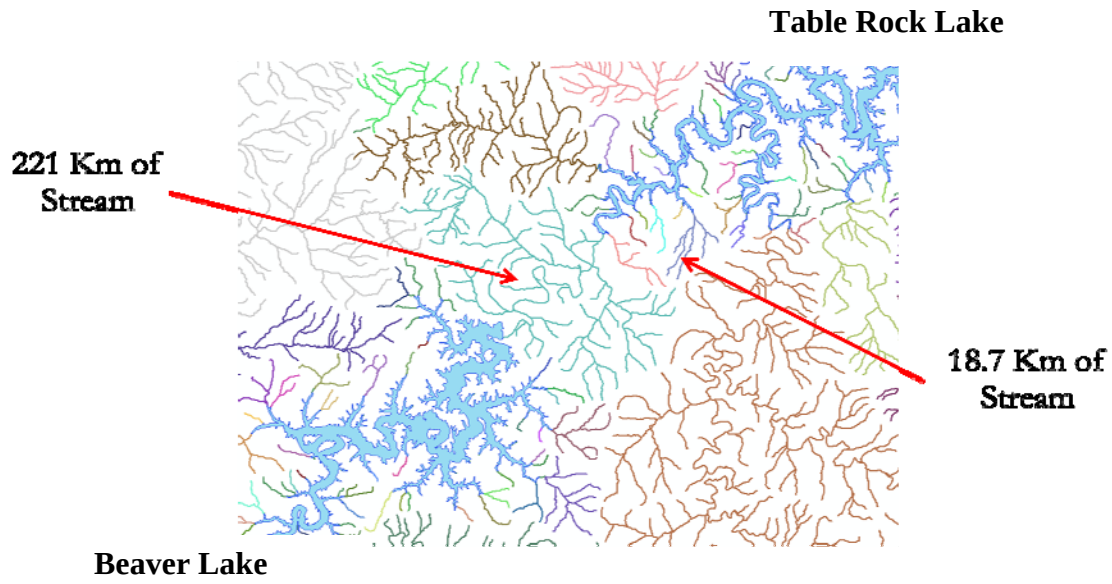

Figure 2. Representation of the length of interconnected stream by stream fragment. In this example the stream networks are fragmented by Table Rock and Beaver Lakes. Thought of a different way, a fish living in the green fragment between lakes would have access to 221 kilometers of stream without having to swim through impounded water, while a fish living in the smaller purple headwater fragment would have access to only 18.7 kilometers of stream without having to swim through an impoundment.

Headwater Impoundments

Headwater impoundments were identified as an important threat for this project. We wanted to determine an approximate number of headwater impoundments in EPA Region 7. First we extracted waterbodies from the National Wetlands Inventory (NWI) and National Land Cover Dataset (NLCD) and combined into one layer. Then we used a DEM to create a very dense stream network representing small headwater streams. Any waterbodies that intersected these small headwater streams were extracted for analysis. We then compared the result to various other sources to ensure we only had manmade headwater impoundments. See Appendix B or the headwater impoundment layer's metadata for more information.

Channelized Streams

We attributed our base stream layer (1:100,000 modified NHD) with an attribute indicating whether each stream segment was channelized or ditched. This was accomplished by creating a new layer of channelized or ditched stream segments using attribution from the 1:24,000 NHD, attribution from the NWI, and manual assessment of stream segments. This new layer of ditched stream segments was used to attribute our base assessment units (1:100,000 modified NHD). The resulting attribution approximates channelized or ditched stream segments in the 1:100,000 modified NHD. See Appendix B or the channelized stream layer's metadata for more information.

Population Change

To quantify population change in the watershed above every stream segment we used the 1990 and 2000 census block information for EPA Region 7 and assigned the population from each census block to our assessment catchment polygons based on the percentage of block area located within each catchment. This process yielded a population from 1990 and 2000 attached to each catchment polygon. Once complete we were able to quantify the population from each census year for the drainage area above each stream segment. Subtracting these two values resulted in population change. See Appendix B for more information.

Estimated Crop Pesticide Use

We created a grid of estimated crop pesticide use using methods developed by the United States Geological Survey (USGS) (Gianessi and Thelin 2000; Nakagaki 2007). We used the 1997 agriculture census data's pesticide sales by county for the 43 most used crop pesticides. The amount of pesticide sold by county was partitioned evenly to pixels of cropland in a given county using the 2001 NLCD. The resulting grid displays the approximated amount of pesticide used on each 30 meter grid cell. See Appendix B or the crop pesticide grid's metadata for more information.

Modified Impervious Surface

We modified the "developed" classifications from the 2001 NLCD by removing most rural roads from the impervious class. This was done because a 30 meter pixel is often too large to represent most rural roads and overestimates impervious surface in these areas (Figure 3).
A shrink and expand process was used to remove rural roads, but maintain urban impervious.
See Appendix B or the impervious surface grid's metadata for more information.

Figure 3. Figure depicting impervious surface grid cells (red pixels) draped over a National Agricultural Imagery Program (NAIP) image. This figure highlights the overestimation of impervious surface from the 2001 NLCD.

Assessment Units

The primary assessment units consist of catchment polygons for all of the primary channel stream segments from a modified version of the 1:100,000 National Hydrography Dataset (NHD) (Sowa et al. 2007). These catchment polygons were created by using a 30-meter digital elevation model (DEM) and the stream network (Figure 4). These input data sets were put into an automated process in ArcMap to create the catchment polygons. Although quite variable, the average size of a catchment polygon assessment unit is 2-3 square kilometers. This small size allows for very fine assessments. The resulting polygons carve Missouri into approximately 100,000 individual hydrologic pieces.

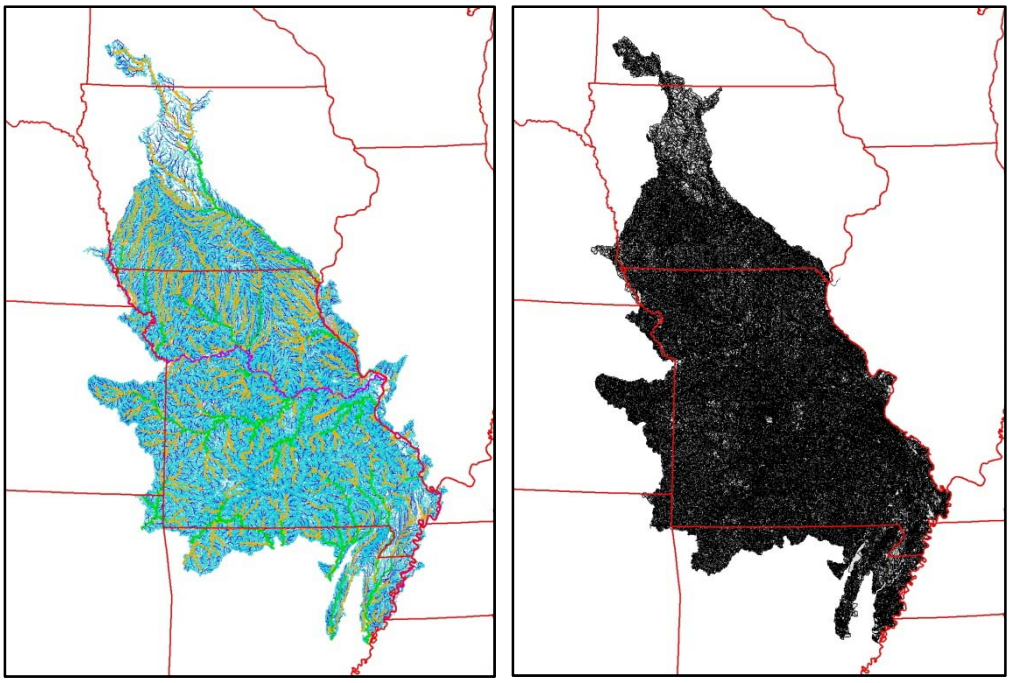

Figure 4. 150,000 primary channel stream segments (left) and corresponding catchment polygons (right).

The utility of the catchment polygons resides in the fact that there is a one-to-one relationship between the catchment polygons and the stream segments (Figure 5). This allowed the transfer of data from the polygons to the stream networks and downstream accumulations to be computed. The common identifier "Seg_id" allows table relations to be performed between the two files. Statistics such as total drainage area, point sources, landcover, etc. can then be attributed to the streams and their values can be converted to a proportion of the drainage area.

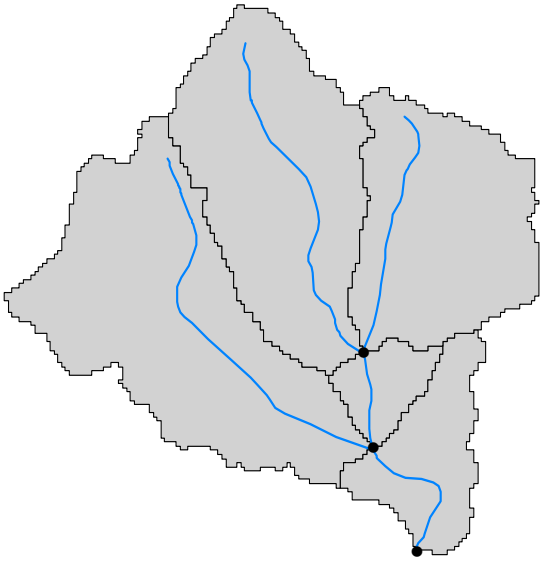

Figure 5. Zoom-in of five catchment polygons illustrating one catchment polygon for each stream segment (blue lines).

A secondary assessment units layer consists of stream buffers for each of the primary channel stream segments in the modified 1:100,000 NHD. Headwaters and Creek stream size classes were buffered by 45 meters on a side, while Small and Large Rivers were buffered by 110 meters on a side. The Missouri and Mississippi Rivers were buffered by 110 meters from the stream bank. These buffers were used to quantify riparian land cover.

Quantifying the Data

Each individual threat data layer was quantified by first tabulating locally to get an amount in each catchment polygon. The next step involved bringing the local information over to the stream network. Then programs were run to quantify everything in the drainage area above every stream segment. This basic idea is depicted in Figure 6. The same basic process was used to quantify continuous data (land cover), point data (CAFOs), and linear data (roads).

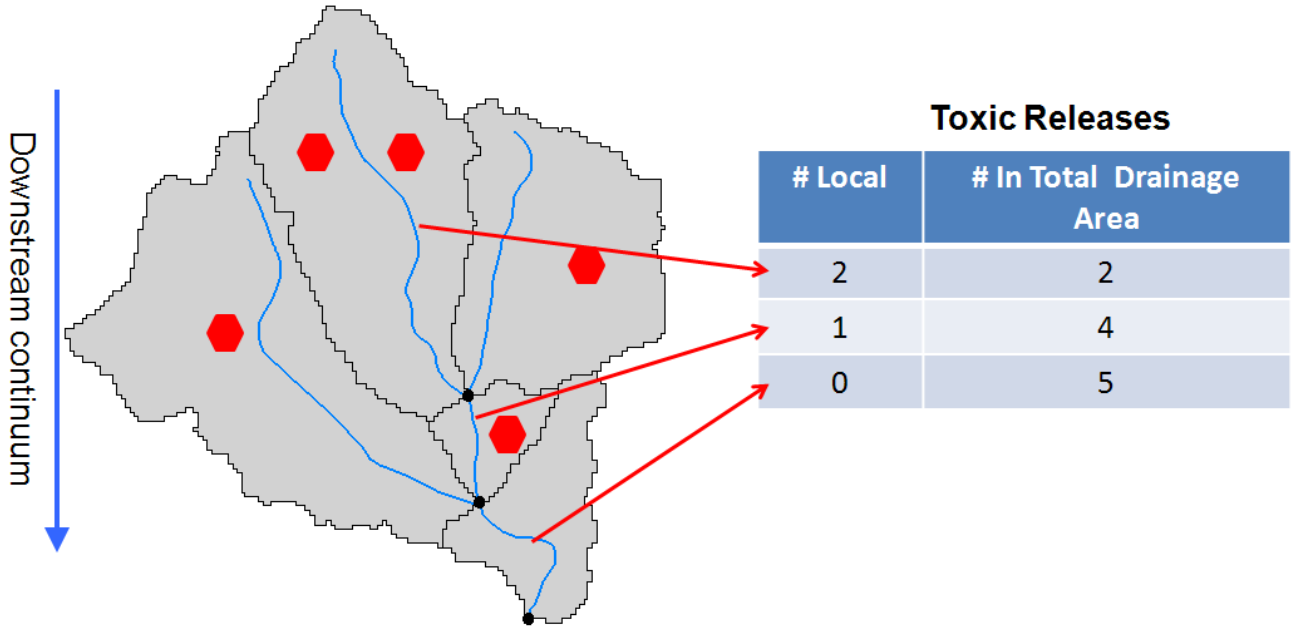

Figure 6. Example depicting the quantification of point sources upstream of each stream segment. Blue lines represent stream segments and grey polygons represent the catchment polygons.

The quantified data consists of local amount and the amount in the total drainage area for each individual stream segment. Finally, depending on the type of data that was quantified, there is a field that presents the data as amount per unit area (percent of the watershed, number per square kilometer, or length per square kilometer. All of this information resides in tables that relate to the stream and catchment layers via the identifier "Seg_id". Figures 7 and 8 depict CAFOs and cropland quantified for each stream segment's drainage area.

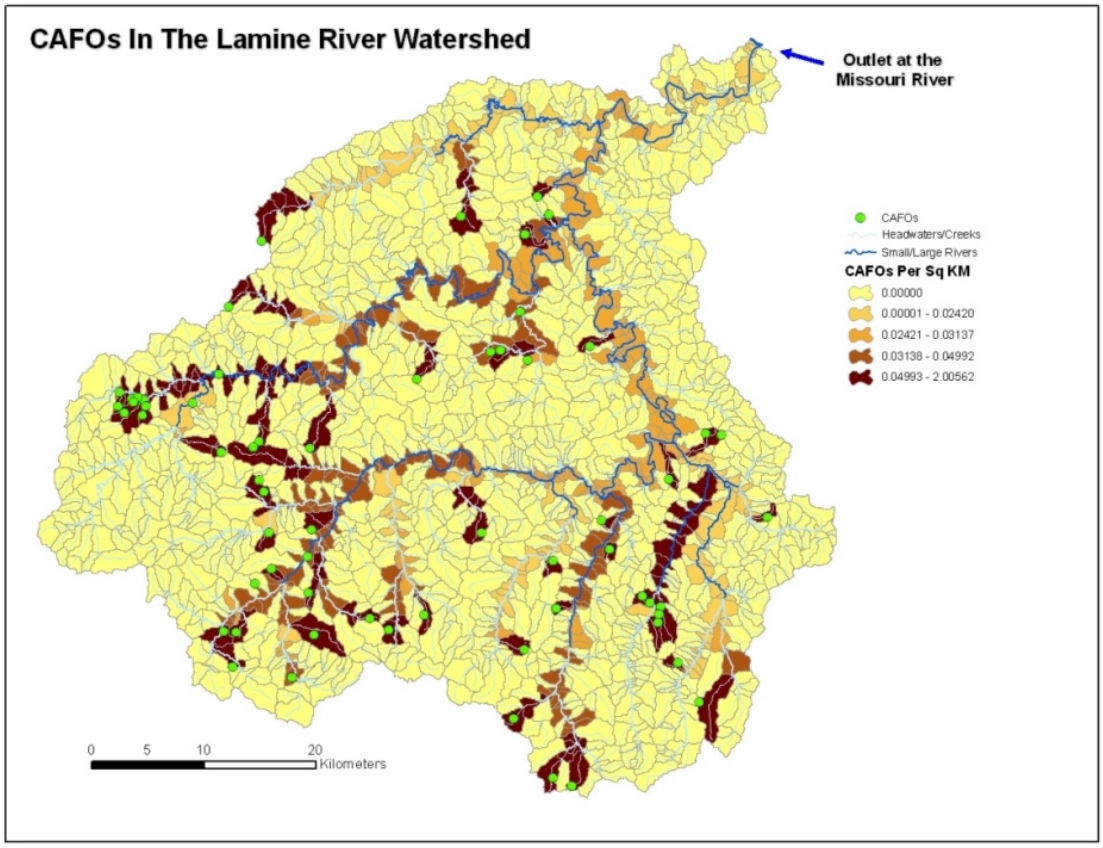

Figure 7. Number of CAFOs per square kilometer in the drainage area above <u>each</u> stream segment within the Lamine River watershed.

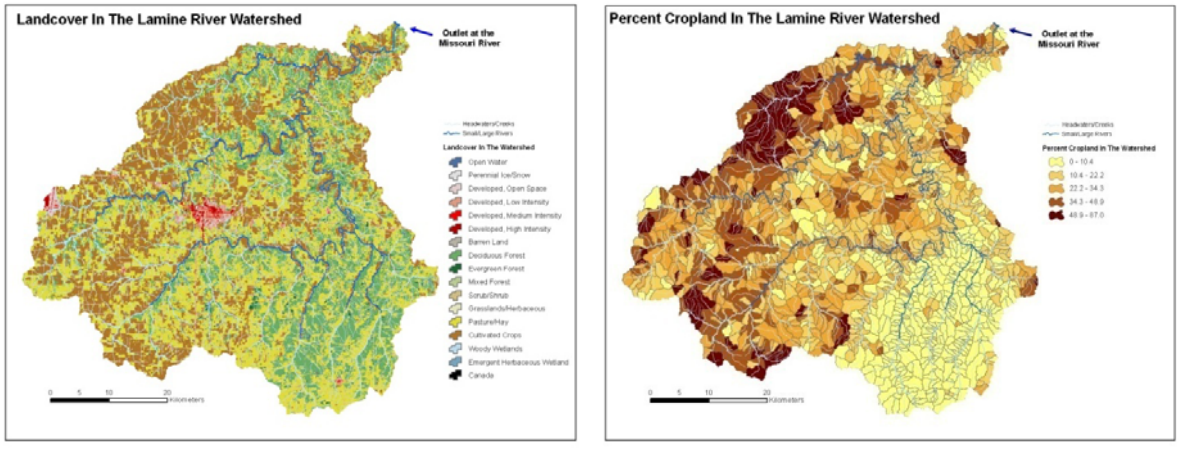

Figure 8. Land cover from the NLCD in the Lamine River Watershed (left map) and percent of drainage area in cropland above <u>each</u> stream segment (right map).

Accounting for Distance

Beyond simply quantifying how much or how many of a given threat is upstream we also wanted to consider the spatial distribution when possible (Figure 9). Because nearby threats have a different potential impact on ecological integrity than the same threat further away we computed both minimum and mean distance to threat for threats represented as points on the landscape. Minimum distance to a threat is represented as the in-stream distance to the closest threat upstream. Mean distance is represented as the mean in-stream distance to all threats of a given class (e.g. CAFOs, coal mines, and others) upstream (Figure 10).

For instance, in a given watershed ten coal mines located immediately upstream of the outlet would have a different potential threat to the outlet stream segment than would ten coal mines located 200 miles upstream even though the density of coal mines in these two scenarios would be identical.

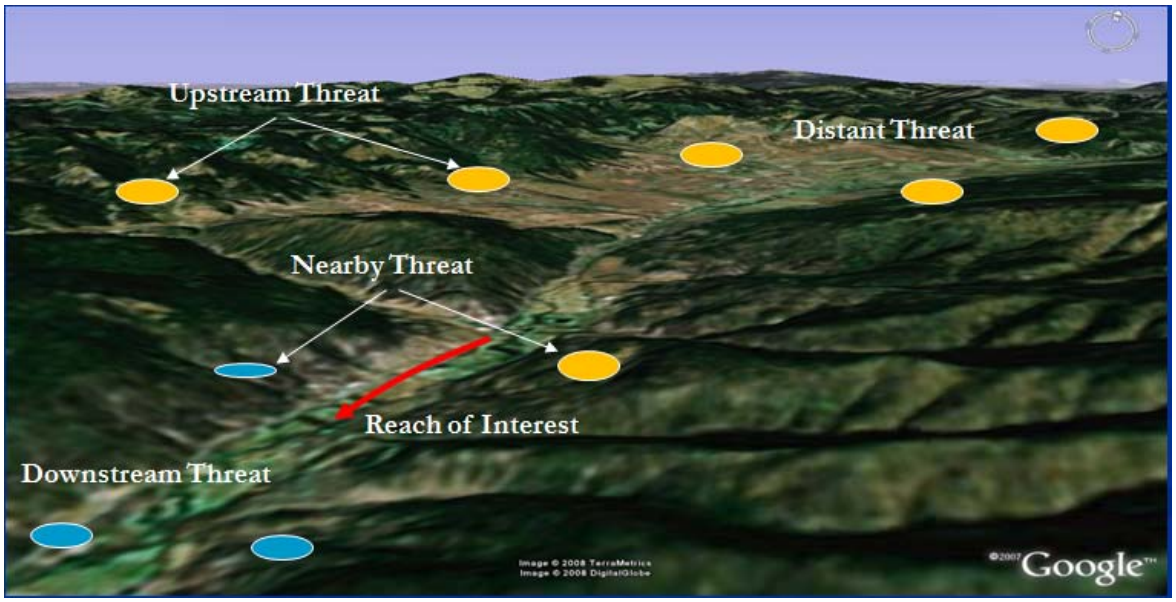

Figure 9. Ecological integrity of riverine ecosystems is dependent on the integrity of the entire watershed.

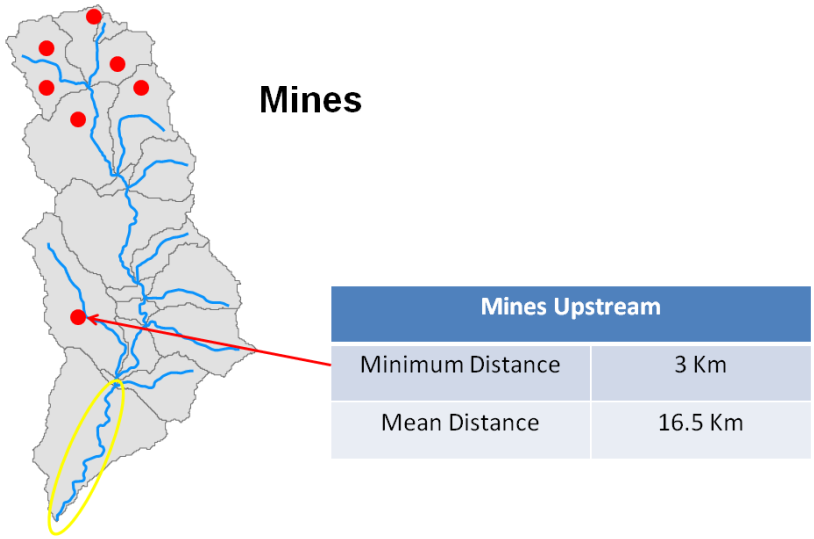

Figure 10. Figure depicting both minimum and mean distance to mines in a watershed. Both of these pieces of information have been quantified and are available in the data package.

Data Gaps and Limitations

It is important to address the limitations of the data compiled and quantified as part of this project. The data quantified as part of this project in no way represents every possible threat to aquatic ecosystem integrity. In reality it is a reflection of data that were identified as being a potential threat and, as importantly, data that were available for use across a large geographic area. All data utilized represents the best available source data at the time of the project given the constraints of requiring data that is seamless across state borders.

The metrics quantified as part of this project relied on numerous existing datasets each with its own inherent limitations and inaccuracies. Each individual input data set has its own date of creation, resolution, standards, and level of completeness. Point data sets tend to imply an absolute location on the landscape, however, we learned that this is very often not the case.

There were three basic issues encountered with source data; 1) location or horizontal positioning on the landscape, 2) incompleteness, and 3) having multiple sources of the "same" data. As mentioned previously, many of the datasets depicting features on the landscape using points suffered from poor point positioning. An example of this is the National Pollution Discharge Elimination System (NPDES) layer acquired from the Environmental Protection Agency (EPA). Ideally each point in this data layer would be located at the "end of pipe", however features are located by a variety of means including but not limited to facility address match, nearest intersection, owner's address, map interpolation, or centroid of census block. Figure 11 gives an example of CAFOs taken from the NPDES data layer that represent owner address as opposed to facility location.

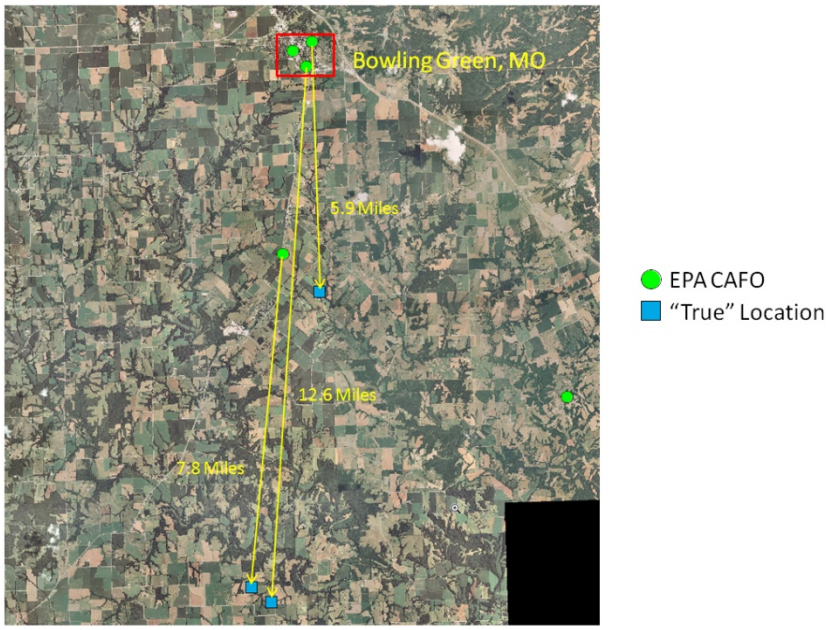

Figure 11. Figure depicting facilities mapped by owner's address as opposed to facility location.

As might be expected, most data sets had some limitations with regard to incompleteness resulting from file date or mapping protocol where all features from ground reality are not represented in the data layer.

The final data issue we encountered was with regard to having several data sets representing the same threat, but with clear differences (Figure 12). When this occurred we talked to the originators of each data set when possible and made our best professional judgment on which data layer was best to use.

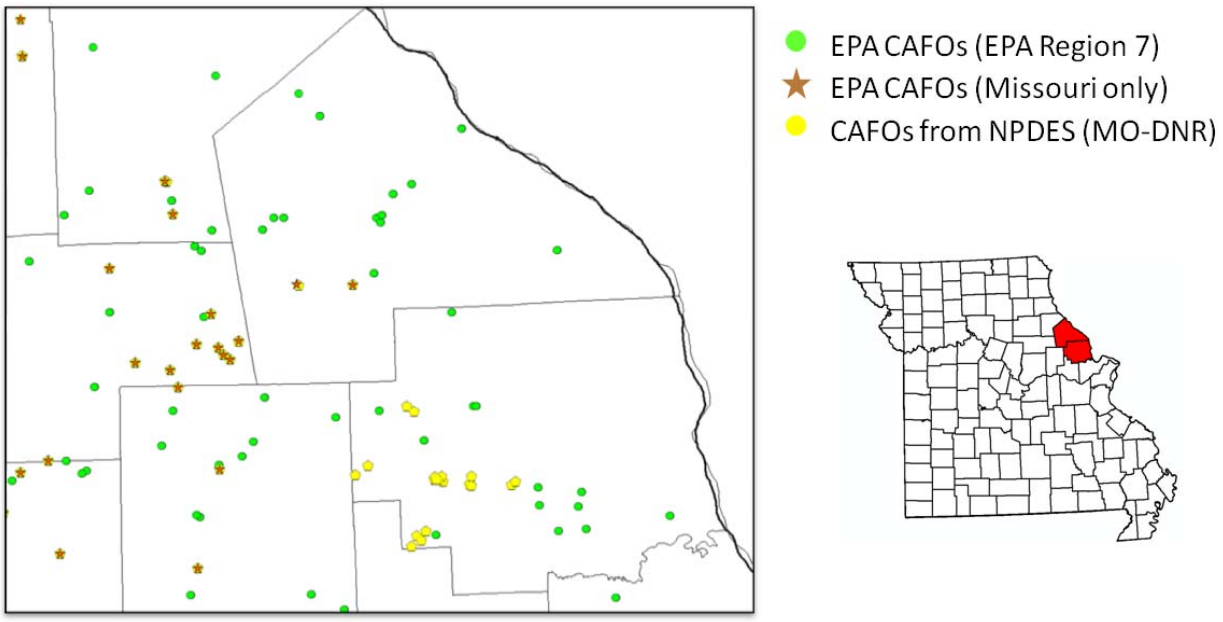

Figure 12. Three data layers representing confined animal feeding operations (CAFOs) in Missouri.

Resulting Data Products

A number of products were produced and delivered to the Missouri Department of Natural Resources as a result of this project and include data, a data suite training manual, and the final report (Figure 13). The data package consists of raw input threat data layers, the assessment units used for quantifying the threats, related dbf tables containing the quantified threat data, and some supplemental data that was also quantified and intended to supplement the quantified threats. The supplemental data consists of quantified soils, landcover, and relief information about the drainage area above each stream segment. This supplemental data is useful for identifying streams and watershed with similar physical character and can be used in conjunction with the quantified threats. A folder containing administrative data that includes state boundaries, county boundaries, cities, and road networks is included to help orient the user with respect to political boundaries and road networks.

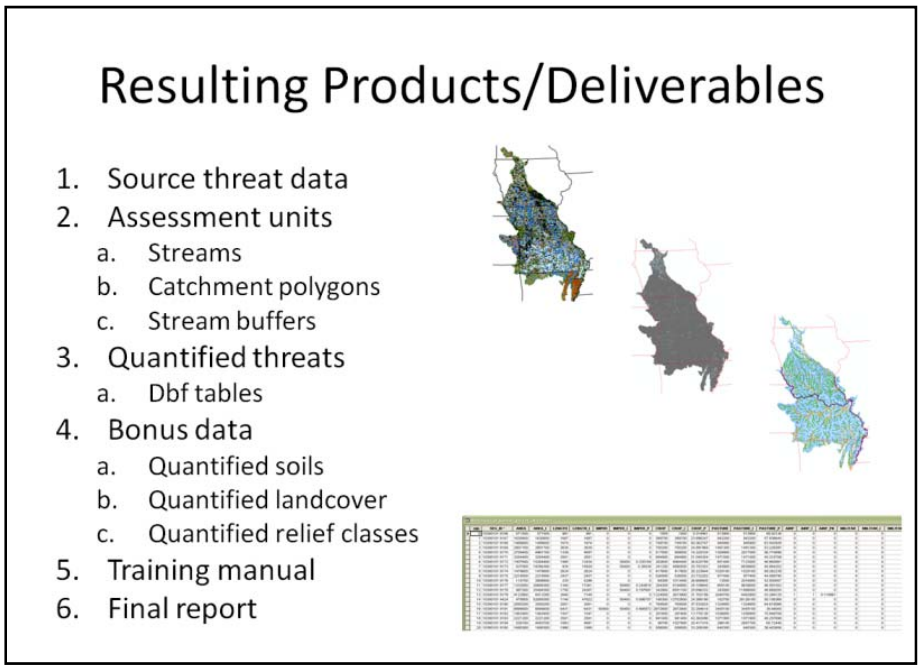

Figure 13. The basic products and deliverables.

The resulting data suite is organized into a package consisting of four main components; data for orientation (administrative data), assessment units, quantified threats, and natural data (Figure 14).

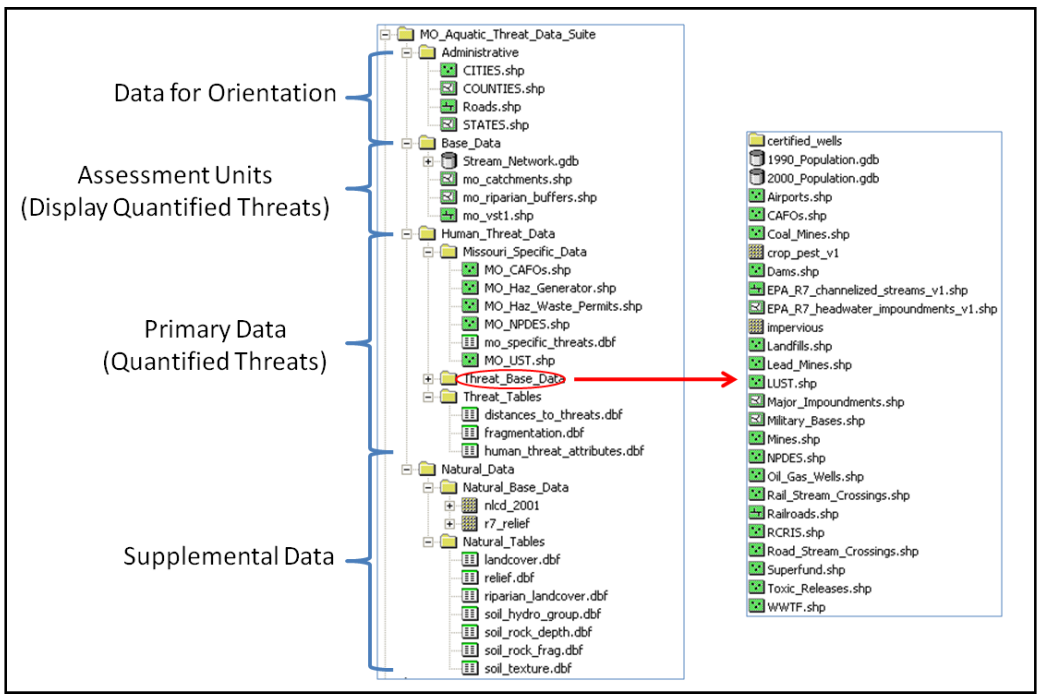

Figure 14. The data hierarchy and organization.

The data quantified as part of this project resides in three principal dbf tables. A forth table contains additional information that was quantified for threat data layers that stop at the state boundary.

1. Human_threat_attributes.dbf
2. Distance_to_threats.dbf
3. Fragmentation.dbf
4. Missouri_specific_threats.dbf

Seven additional dbf tables contain information about the physical and vegetative character of each stream segment's drainage area.

1. Landcover.dbf
2. Relief.dbf
3. Riparian_landcover.dbf
4. Soil_hydro_group.dbf
5. Soil_rock_depth.dbf
6. Soil_rock_frag.dbf
7. Soil_texture.dbf

Tables 3, 4, 5, and 6 provide lists of all of the data quantified as part of this project. All of these quantified threats reside in the aforementioned dbf tables that can be related to any of the GIS layer assessment units for query or display.

Table 3. The primary quantified data. All of this data is seamless across state boundaries.

Quantified Data (Seamless State to State)			
1.	Impervious surface	21.	Railroad and stream intersections
2.	Cropland	22.	Waste water treatment facilities
3.	Pasture	23.	Toxic release inventory sites
4.	Airports	24.	Resource conservation recovery information system
5.	Military bases	25.	Estimated kilograms of crop pesticide
6.	Lead mines	26.	Landfills
7.	Coal mines	27.	Headwater impoundments
8.	Dams	28.	Confined animal feeding operations
9.	Road and stream intersections	29.	Dollar amount of livestock sales
10.	Certified water wells	30.	National pollution discharge elimination system sites
11.	Superfund sites	31.	Length of channelized or ditched streams
12.	Major impoundments	32.	Population from the 1990 census
13.	Length of roads	33.	Population from the 2000 census
14.	Oil and gas wells	34.	Population change between 1990 and 2000 census
15.	Mines excluding coal and lead mines	35.	Stream fragmentation
16.	Leaking underground storage tanks		
17.	Pipelines (crude oil)		
18.	Pipelines (refined products/fuels)		
19.	Pipelines (natural gas, propane, etc)		
20.	Length of railroads		

Table 4. Data sets for which distance to threat was computed (minimum, maximum, and mean). All of this data is seamless across state boundaries.

Distance to Threats (Seamless State to State)			
1.	Airports	9.	Superfund sites
2.	Dams	10.	Toxic release inventory sites
3.	Military bases	11.	Waste water treatment facilities
4.	Coal mines	12.	Confined animal feeding operations
5.	Lead mines	13.	Landfills
6.	Other mines	14.	National pollution discharge elimination system sites
7.	Oil and gas wells	15.	Resource conservation recovery information system
8.	Leaking underground storage tanks		

Table 5. Missouri specific threats. This data stops at Missouri's border and is best suited for use with watersheds completely contained in Missouri. No distance to threat information was computed for these data layers.

Missouri Specific Datasets	
1.	National pollution discharge elimination system sites
2.	Confined animal feeding operations
3.	Underground storage tanks
4.	Hazardous waste generators
5.	Hazardous waste permits

Table 6. Additional supplemental quantified data. This information was provided to help characterize streams and watershed according to physical character. Some components of the riparian landcover (crop and pasture) are considered potential threats.

Supplemental Data	
1.	2001 National Landcover Dataset (16 class)
2.	Riparian Landcover (16 class)
3.	Soil Texture (12 classes)
4.	Soil Hydrological Group (8 classes)
5.	Soil Rock Fragment Volume (6 classes)
6.	Soil Depth to Bedrock (7 classes)
7.	Relief Classes (8 classes)

We made an effort to keep all dbf table field names as simple and intuitive as possible. Generally, there are three fields associated with each quantified threat; an amount for the local catchment polygon, an amount for the entire drainage area above each stream segment, and an amount per unit area. For example, quantified coal mines are represented by the field names "Coal", Coal_i", and "Coal_pk". It should be noted that each of these fields has the same prefix 'coal' followed by a different suffix. No suffix indicates that the information in that data field represents the local catchment amount, the suffix '_i' indicates the amount in the inclusive drainage area for the stream segment, and the suffix '_pk' is the number of coal mines per square kilometer in the drainage above the stream segment. Area features like landcover classes have a

similar naming convention. A prefix like "crop" without a suffix indicates the information in that data field represents the amount of cropland in the local catchment, the suffix "_i" indicates the amount of cropland in the inclusive drainage area for the stream segment, and the suffix "_p" represents the percent of the drainage area in cropland. Features for which a distance to threat was computed are represented with three fields. Again, a standard prefix (i.e. coal, cafo, lead, etc.) is followed by one of three suffixes. For example the field "Cafo_min" represents the minimum distance to the nearest confined animal feeding operation (CAFO) upstream, "Cafo_max" represents the distance to the furthest CAFO upstream, and "Cafo_ave" represents the average or mean distance to all CAFOs collectively upstream. All distances are measured through the stream channel.

Data Use

The resulting data suite is designed to be very user friendly for individuals with basic GIS skills. All assessment unit layers (streams, catchments, and stream buffers) contain an identifier for each stream segment called "Seg_id". In addition, each dbf table of quantified threats also contains the field "Seg_id". As such, "Seg_id" serves as the common identifier to relate the dbf tables to any of the assessment unit layers and vice versa. All table relations are one-to-one. The key points to using the data are: 1) know what data is available, 2) look at the available metadata, 3) understand the common identifiers, 4) learn by use and start exploring the data suite.

Natural resource professionals will find a number of potential uses for the data developed as part of this project. The data suite is well suited for data inventories and assessments, experimental design, identifying streams with similar threats and similar physical character, permit review and compliance, identifying information needs, and education and outreach.

A tremendous amount of data was quantified for each 1:100,000 stream reach that is "on the shelf" and ready for use in a geographic information system (GIS). The data can be used to generate maps displaying quantified individual threats for the drainage above each stream segment (i.e. distance to nearest upstream coal mine, percent cropland, length of road) (Figure 15 A). By combining multiple tables complex queries of the data can be performed to isolate distinct stream segments with specific criteria (Figure 15 B). The resulting data suite provides a large amount of data that can facilitate gathering statistics for reporting. Finally, the data suite as a whole serves as a 'decision support system' for natural resource management.

When combined with other data sets and professional knowledge this data suite should provide a valuable component to the natural resource professional's "tool kit" to help improve understanding and foster more informed decision making.

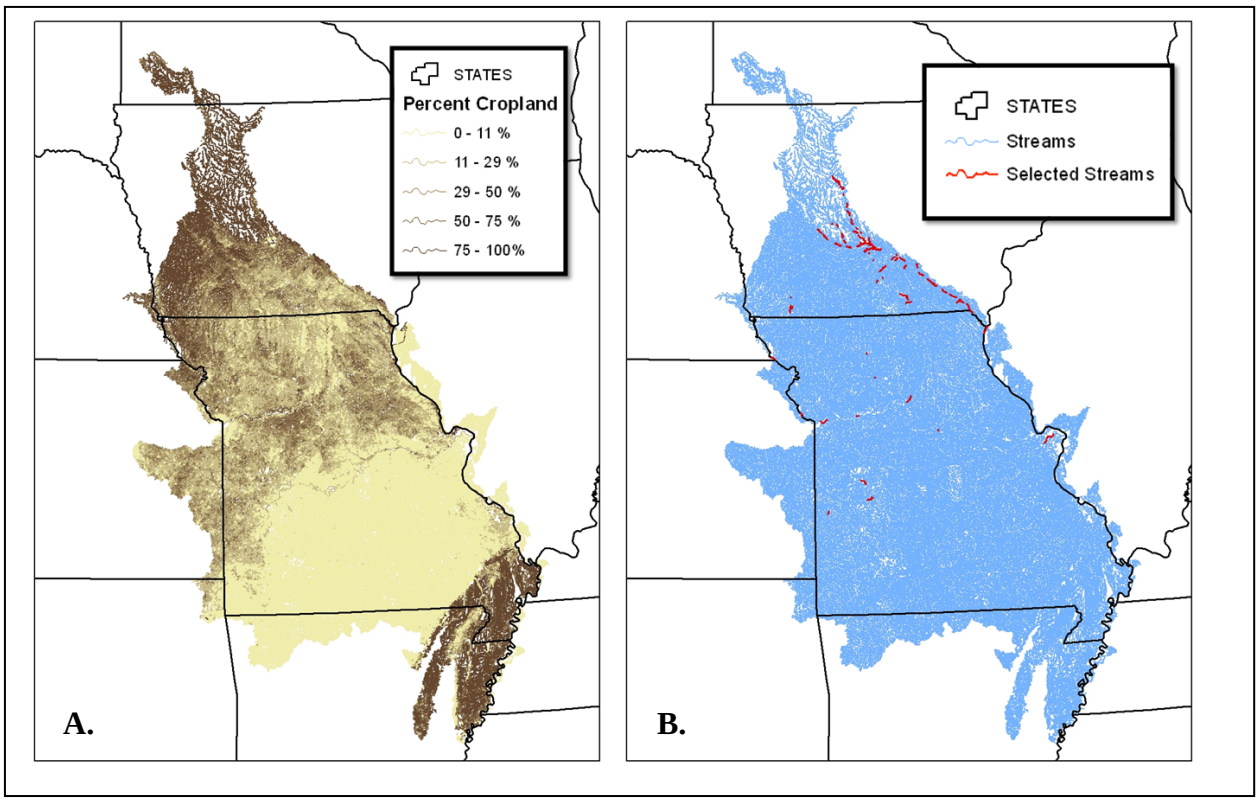

Figure 15. Map A: Percentage of cropland in the drainage area above each stream segment.
Map B: Stream segments with at least 10 coal mines and 10 leaking tanks upstream and with both a coal mine and leaking tank within 10 kilometers upstream.

Data Suite Training

A total of three training session were conducted as part of this project. These sessions were intended to ensure that potential end-users of the data knew what was available and how to use it. The first of the three training sessions consisted of a PowerPoint presentation and live demonstration of the data. There were approximately 60 participants at this initial session (Figure 16). The two subsequent sessions were hands-on training at which participants were able to work with the data at computers using ESRI's ArcMap software (Figures 17 and 18). There were 36 participants between the two sessions. Available seats for the hands on sessions filled within two days of the announcement going out. A special training manual with hands-on exercises and a data CD were developed specifically for these hands-on sessions.

Figure 16. Photo from the initial data overview and live demonstration session held on March 19, 2009.

Figure 17. Photo from the April 24, 2009 hands-on training session.

Figure 18. Photo from the May 15, 2009 hands-on training session.

Applying Project Results to EPA Region 7

The data that was developed for this project will be incorporated into a broader project covering all of EPA Region 7. The same threat data sets developed for Missouri are being developed for Iowa, Kansas, and Nebraska. The Missouri data will be integrated with the data from these other three states, and, once combined an overall human threat index (HTI) will be developed for each stream segment throughout EPA Region 7. The HTI will be consistent over all of Region 7 and will provide information about the degree of cumulative threat any given stream reach is experiencing in relation to all others (Figure 19).

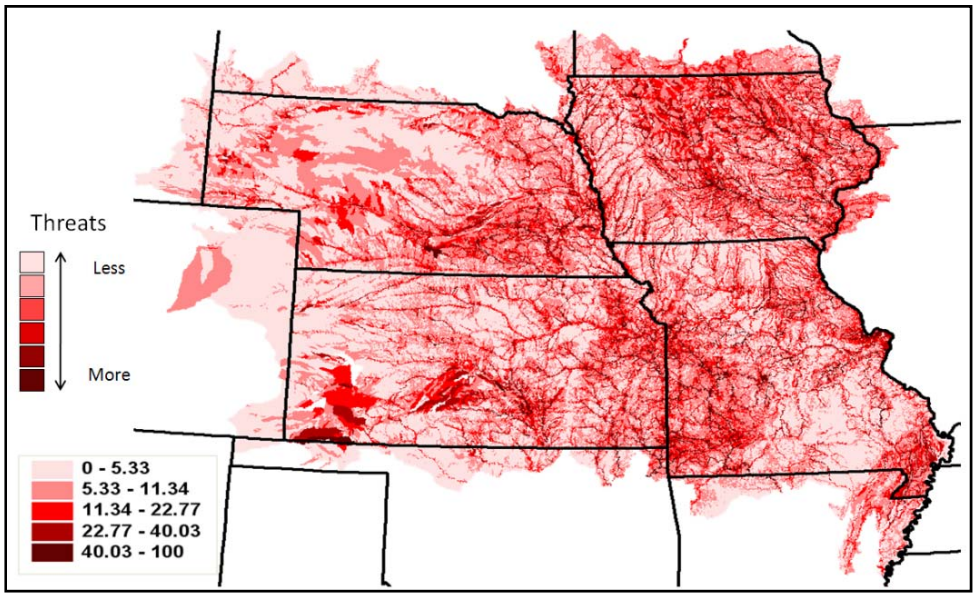

Figure 19. Draft human threat index (HTI) for EPA Region 7.

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Fajen, O. F. 1981. Warmwater stream management with emphasis on bass streams in Missouri. Pages 252-265 *In* L. A. Krumholz, ed., *Warmwater Streams Symposium*. American Fisheries Society, Bethesda, MD.

Gianessi, L.P. and Thelin, G.P., 2000, Method for Estimating Pesticide Use for County Areas of the Conterminous United States: U.S. Geological Survey, Open File Report 00-250, 67 p.

Nakagaki, N., 2007, Grids of agricultural pesticide use in the conterminous United States, 1997: U.S. Geological Survey, Metadata File, 23 p.

Sowa, S.P., G. Annis, M. Morey, and D. Diamond. 2007. A Gap Analysis and Comprehensive Conservation Strategy for Riverine Ecosystems of Missouri. Ecological Monographs 77(3):301-334.

Appendix A

Regional Oversight Committee and Other Participants

Gust Annis	Missouri Resource Assessment Partnership
Scott Sowa	Missouri Resource Assessment Partnership
Aaron Garringer	Missouri Resource Assessment Partnership
Cody Wheeler	Corps of Engineers
Benita Hamilton	Environmental Protection Agency (Region 7)
Cathy Wooster-Brown	Environmental Protection Agency (Region 7)
Eliodora Chamberlain	Environmental Protection Agency (Region 7)
Holly Mehl	Environmental Protection Agency (Region 7)
Jennifer Ousley	Environmental Protection Agency (Region 7)
Walt Foster	Environmental Protection Agency (Region 7)
Clay Pierce	Iowa Coop Fish & Wildlife Research Unit
Tom Wilton	Iowa Department of Natural Resources
Tom Isenhart	Iowa State University
Mark Van Scoyoc	Kansas Department of Wildlife and Parks
Ryan Waters	Kansas Department of Wildlife and Parks
Deb Baker	Kansas Water Office
Matt Combes	Missouri Department of Conservation
Matt Engel	Missouri Department of Conservation
Mike McKee	Missouri Department of Conservation
Tory Mason	Missouri Department of Conservation
Mohsen Dkhili	Missouri Department of Natural Resources
Randy Sarver	Missouri Department of Natural Resources
Stacia Bax	Missouri Department of Natural Resources
Stuart Harlan	Missouri Department of Natural Resources
Dave Schumacher	Nebraska Department of Environmental Quality
Ken Bazata	Nebraska Department of Environmental Quality
Steve Schainost	Nebraska Game and Parks Commission
Vernon Tabor	U.S. Fish and Wildlife Service
Chris Schmitt	U.S. Geological Survey
Jo Ellen Hink	U.S. Geological Survey
Kathy Doisy	University of Missouri
Alan Kolok	University of Nebraska, Omaha
Rick Stasiak	University of Nebraska, Omaha
Kyle Hoagland	Water Center, University of Nebraska, Lincoln

Appendix B

Input Dataset Reports

Streams (mo_vst1)

Description

- This data set covers all watersheds draining into Missouri, except the Missouri and Mississippi Rivers outside of Missouri. This includes the states of Iowa, Kansas, and Missouri. The original stream network was created for all of EPA Region 7, however for our purposes it was clipped to Missouri drainages. This shapefile consists of consolidated and modified stream shapefiles that were prepared as part of individual Aquatic Gap Analysis Projects for the states of Iowa, Missouri, and Kansas. Individuals from Kansas and Iowa along with staff at the Missouri Resource Assessment Partnership worked cooperatively on these state specific data sets. Generally, this coverage contains selected arcs from the 1:100,000 National Hydrography Dataset (NHD) that was developed by the USGS and EPA. The selected arcs represent the centerlines of wide streams, impoundments, reservoirs, and wetlands as well as the segments of single line streams.

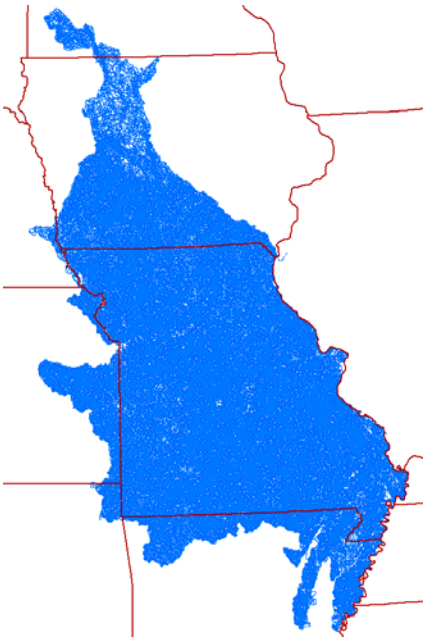
Observations

- Contains all of the information from the EPA Region 7 file.
- This is one of the main datasets used in the analysis for this project.

Source(s)

1. EPA Region 7 Modified Stream Network
   - Who created the data: Missouri Resource Assessment Partnership (MoRAP)
   - Publication date and time: 2006
   - Publisher and place: MoRAP, Columbia Missouri
   - Acquired from: MoRAP
   - Acquisition Date: 2006

Stream Catchments (mo_catchments)



Description

- This dataset is a shapefile representing the catchments for every stream segment in our study area. This dataset was created using the National Hydrography Dataset Plus (NHD Plus) DEM data.

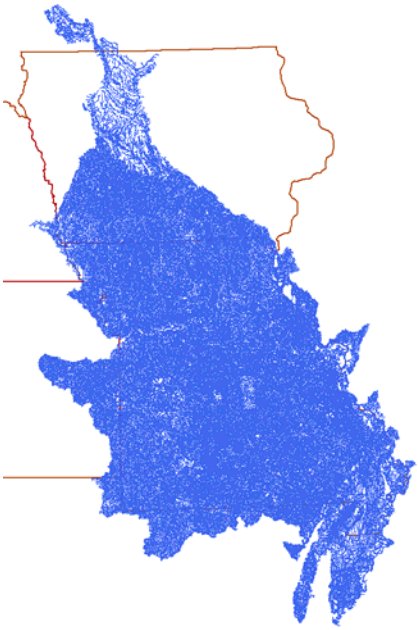
Observations

- None.

Source(s)

1. EPA Region 7 Modified Stream Network
   - Who created the data: Missouri Resource Assessment Partnership (MoRAP)
   - Publication date and time: 2006
   - Publisher and place: MoRAP, Columbia Missouri
   - Acquired from: MoRAP
   - Acquisition Date: 2006

Stream Riparian Buffers



Description

- This dataset is a shapefile representing stream buffers for every primary channel stream segment in our study area (most streams draining into Missouri). This dataset was created using the mo_vst1 stream shapefile. This data layer was created to quantify landcover within riparian areas.

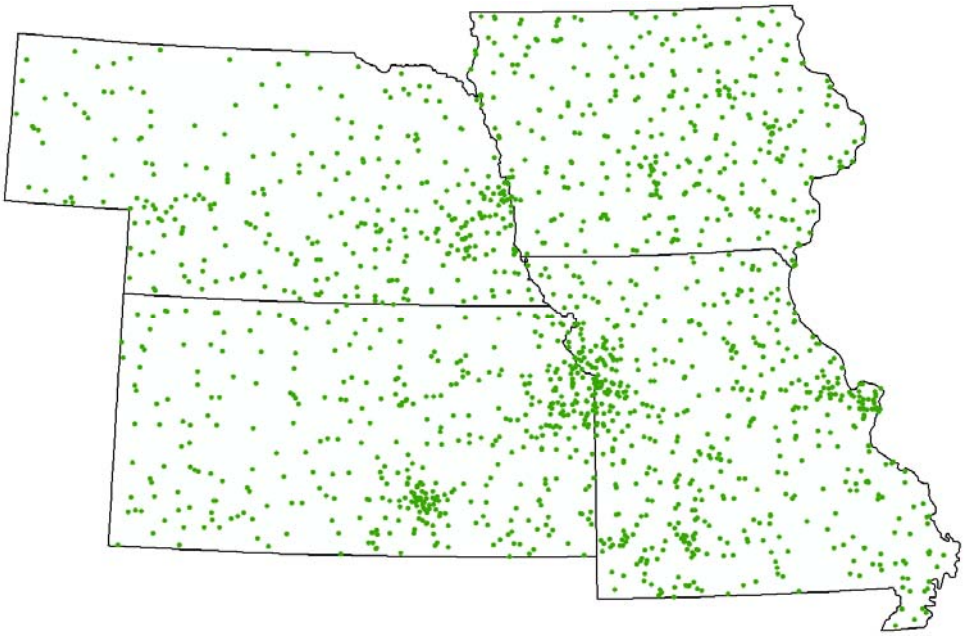
Observations

- Headwaters and creeks were buffered by 45 meters on a side.
- Small and Large Rivers were buffered by 105 meters on a side.
    - Great Rivers (Missouri and Mississippi Rivers) were buffered by 105 meters from the stream bank.

Source(s)

1. EPA Region 7 Modified Stream Network
    - Who created the data: Missouri Resource Assessment Partnership (MoRAP)
    - Publication date and time: 2006
    - Publisher and place: MoRAP, Columbia Missouri
    - Acquired from: MoRAP
    - Acquisition Date: 2006

Airports



Description

- Airport locations from GDT Dynamap/2000.

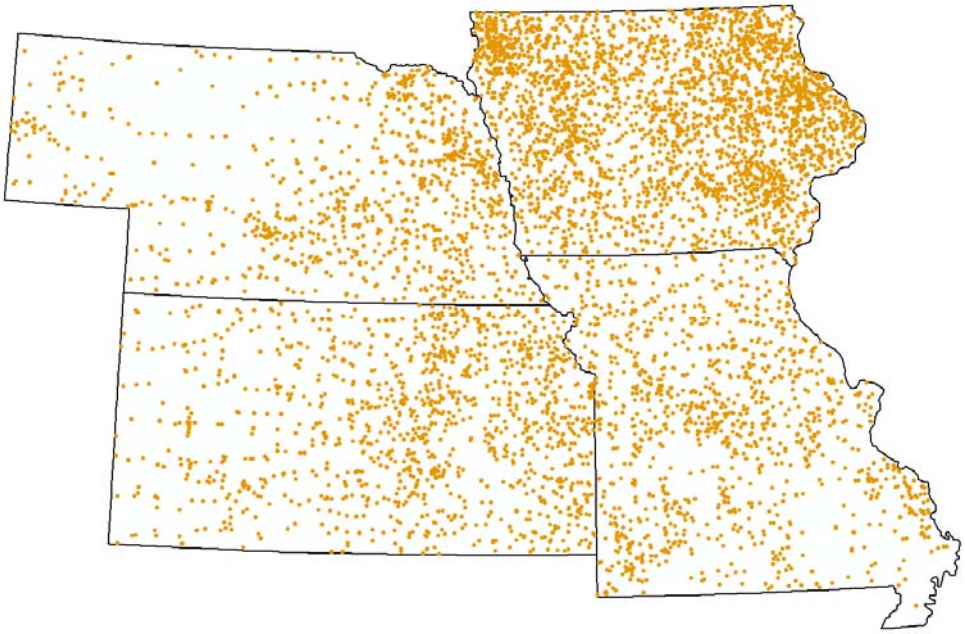
Observations

- Data was provided by the EPA and is consistent for all of EPA Region 7.
- This dataset includes private and public airports of all sizes.

Source(s)

1. EPA Region 7 Airports
   - Who created the data: Dynamap
   - Publication date and time: 2004
   - Publisher and place: U.S. Environmental Protection Agency, Region 7, Kansas City, KS
   - Acquired from: EPA Region 7
   - Acquisition Date: 2007

Confined Animal Feeding Operations



Description

- This data was selected from Dunn & Bradstreet data (2003) by SIC code to try to capture animal feedlots in the Region 7 area.

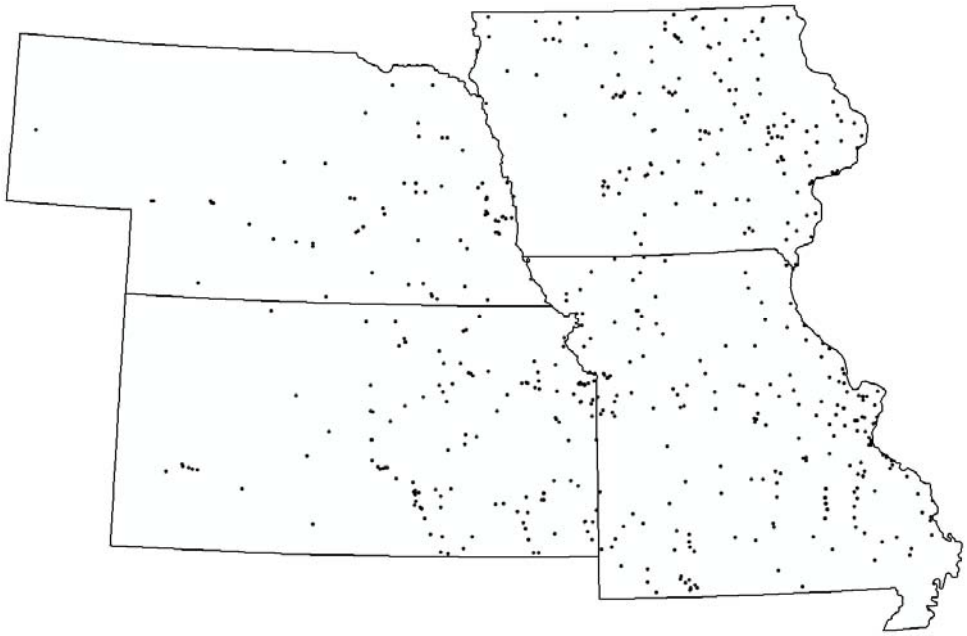
Observations

- One limitation to this dataset is that points representing CAFOs were recorded using one of many methods including: geo-coding facility address, geo-coding owner address, GPS, zip code centroids, etc...

Source(s)

1. EPA Region 7 Airports
   - Who created the data: Dunn 7 Bradstreet
   - Publication date and time: 2003
   - Publisher and place: U.S. Environmental Protection Agency, Region 7, Kansas City, KS
   - Acquired from: EPA Region 7
   - Acquisition Date: 2006

Mines_Sub



Description

- This dataset is a subset from the USGS mines dataset created by the Minerals Information Team. It is important to note that we removed both coal and lead mines from the original source data. Coal and lead mines were quantified as separate layers.

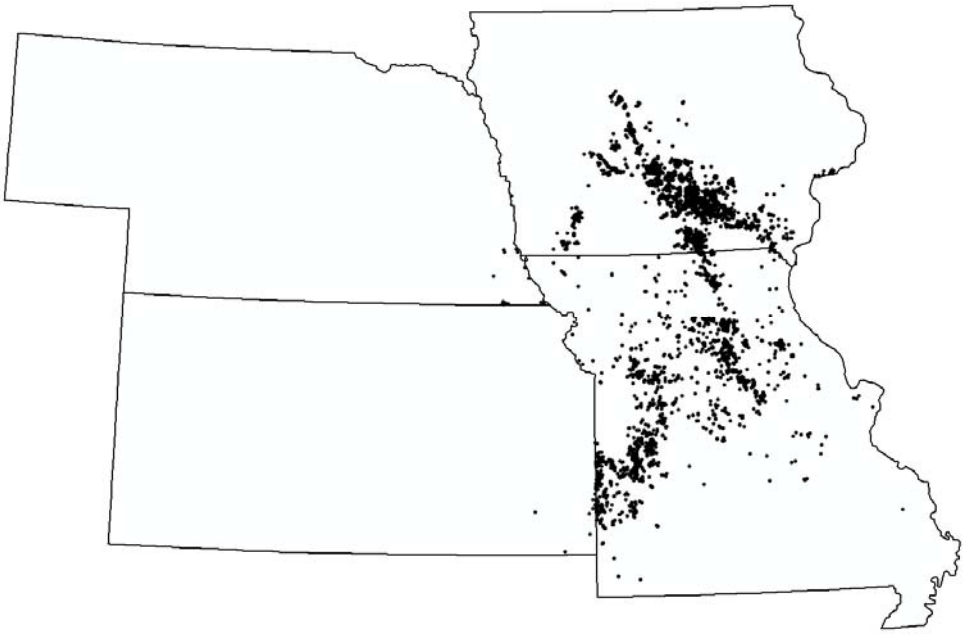
Observations

- The completeness of this dataset is unknown.

Source(s)

1. USGS Mines
   - Who created the data: U.S. Department of the Interior United States Geological Survey (USGS)
   - Publication date and time: 2005
   - Publisher and place: USGS Reston, Virginia
   - Acquired from: USGS Minerals Information Team
   - Acquisition Date: 2007

Coal Mines



Description

- This dataset consists of all coal mines that could be identified using three input datasets; namely the mines datasets provided by the EPA's Better Assessment Science Integrating point & Non-point Sources (BASINS) 2001 data, the Conservation & Survey Division (CSD) University of Nebraska and the Coal Mines of Iowa from the Iowa Department of Natural Resources. We used existing attribution from the aforementioned files to identify coal mines.

Observations

- This dataset is comprised of coal mines that were obtained with the best available data at the time.
- The dataset contains active and abandoned coal mines.

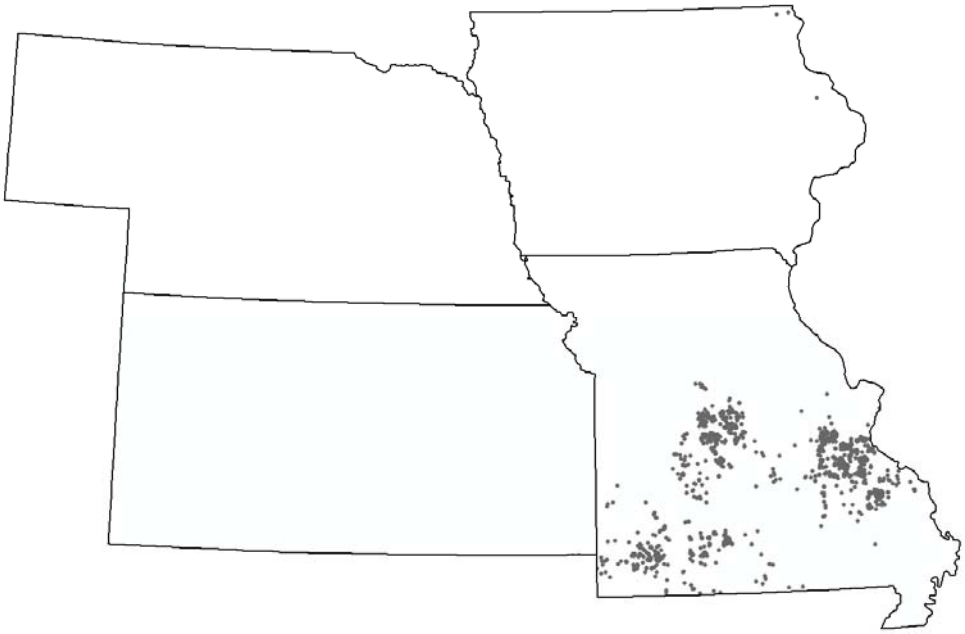
Source(s)

1. EPA Region 7 BASINS Coal Mines
   - Who created the data: Environmental Protection Agency
   - Publication date and time: 2001
   - Publisher and place: U.S. Environmental Protection Agency
   - Acquired from: BASINS Version 3.0 Region 7 CD's
   - Acquisition Date: Unknown

2. Coal Mines of Iowa
    - Who created the data: Mary R. Howes, Iowa Department of Natural Resources
    - Publication date and time: 8/27/2003
    - Publisher and place: Iowa Department of Natural Resources
    - Acquired from: Iowa GIS Library
    - Acquisition Date: 2006

3. Nebraska Coal Mines
    - Who created the data: Conservation & Survey Division, University of Nebraska - Lincoln (CSD)
    - Publication date and time: 1996
    - Publisher and place: Conservation and Survey Division, University of Nebraska - Lincoln
    - Acquired from: University of Nebraska – Lincoln (CSD)
    - Acquisition Date: Unknown

Lead Mines



Description

- This dataset is a subset from EPA's mines dataset obtained from the EPA's Better Assessment Science Integrating point & Non-point Sources (BASINS) 2001 data. All features that were classified as lead mines were extracted to create this shapefile.

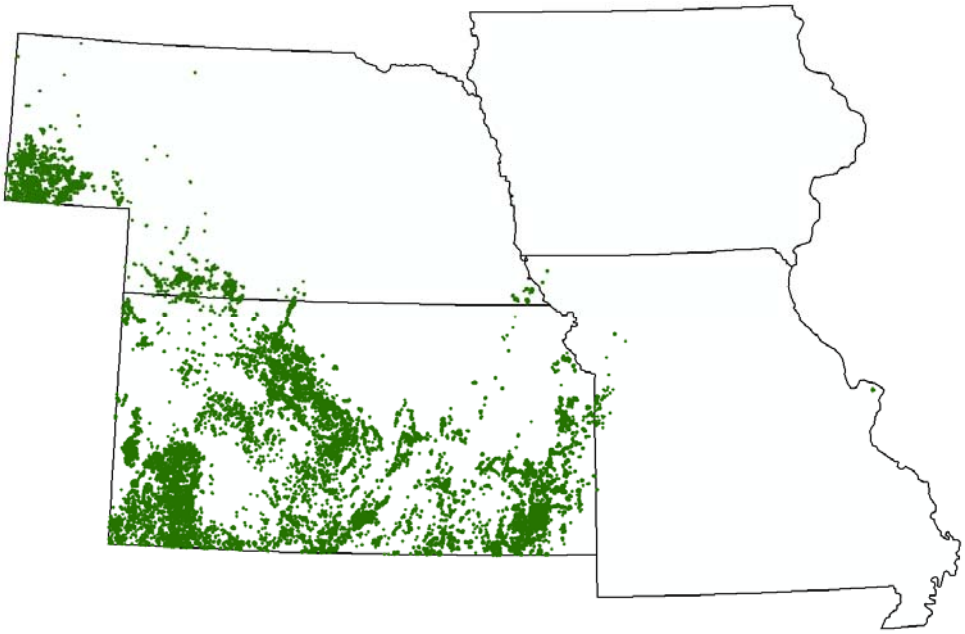
Observations

- This dataset was extracted from the mines dataset from the EPA's Better Assessment Science Integrating point & Non-point Sources (BASINS) 2001 data.
- The data contains both active and abandoned mines.

Source(s)

1. EPA Region 7 BASINS Mines
   - Who created the data: Environmental Protection Agency
   - Publication date and time: 2001
   - Publisher and place: U.S. Environmental Protection Agency
   - Acquired from: BASINS Version 3.0 Region 7 CD’s
   - Acquisition Date: Unknown

Oil and Gas Wells



Description

- This dataset consists of all oil and gas wells that could be identified using three input datasets; namely oil and gas well datasets provided by the state agencies of Kansas, Nebraska and Missouri; the state of Iowa did not contain any active oil or gas wells. We used existing attribution from the aforementioned files to identify oil and gas wells that were active and appended the files into one layer.

Observations

- Presently Iowa does not have any active producing oil or gas wells.
- The Missouri file consisted of active oil and gas wells only.
- The Kansas and Nebraska contained all wells that were drilled, plugged, abandoned or active. We restricted this to active wells only.

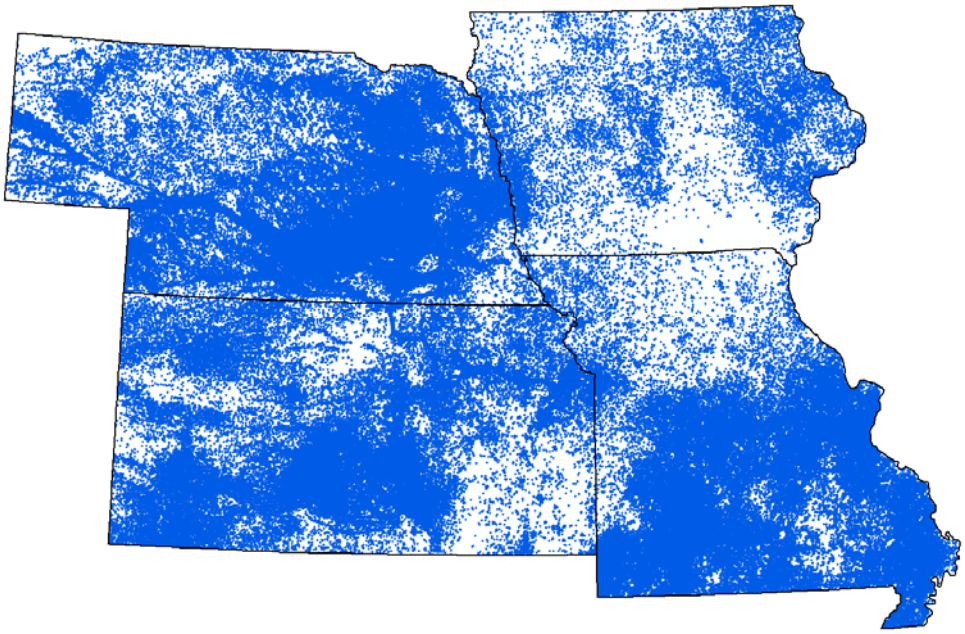
Source(s)

1. Nebraska Oil and Gas Wells
   - Who created the data: Conservation & Survey Division, University of Nebraska - Lincoln (CSD)
   - Publication date and time: 1996
   - Publisher and place: Conservation and Survey Division, University of Nebraska – Lincoln, Lincoln, Nebraska
   - Acquired from: Conservation and Survey Division, University of Nebraska – Lincoln
   - Acquisition Date: 2006

2. Kansas Oil and Gas Wells
    - Who created the data: Kansas Geological Survey
    - Publication date and time: Varies
    - Publisher and place: Unknown
    - Acquired from: Kansas Geological Survey
    - Acquisition Date: 2006

3. Missouri Oil and Gas Wells (Provisional Data)
    - Who created the data: Scott Kaden - Missouri Department of Natural Resources
    - Publication date and time: Unknown
    - Publisher and place: MoDNR, Provisional Data
    - Acquired from: Scott Kaden - MoDNR (Data CD)
    - Acquisition Date: 2007

Certified Wells



Description

- This data set provides information about water wells that are certified by each state in EPA Region 7. Most of the information in these datasets was provided by the well drillers within each state.

Observations

- The well data is made up of four different state datasets.
- Most of the data was created based on township and range legal descriptions.

Source(s)

1. Iowa Certified Wells
   - Who created the data: Mary R. Howes; Iowa DNR
   - Publication date and time: 12/21/1995
   - Publisher and place: Iowa Department of Natural Resources, None
   - Acquired from: Iowa GIS Library
   - Acquisition Date: 2006

2. Kansas Certified Wells
   - Who created the data: Kansas Geological Survey
   - Publication date and time: Varies
   - Publisher and place: Unknown
   - Acquired from: Kansas Geological Survey
   - Acquisition Date: 2006

3. Nebraska Certified Wells
    - Who created the data: Nebraska Department of Natural Resources
    - Publication date and time: 1957-Present at time 060000
    - Publisher and place: Nebraska Department of Natural Resources, Lincoln, Nebraska, United States
    - Acquired from: Nebraska Department of Natural Resources
    - Acquisition Date: 2006

4. Missouri Certified Wells
    - Who created the data: Missouri Department of Natural Resources (MoDNR), Division of Environmental Quality (DEQ), Wellhead Protection Section (WPS)
    - Publication date and time: 1/1/2006
    - Publisher and place: Bob Archer, Geologist, MoDNR
    - Acquired from: Missouri Spatial Data Information Service (MSDIS)
    - Acquisition Date: 2006

Pipelines

(Picture not Available)

Description

- The data for pipelines is sensitive data; EPA Region 7 had the data and ran the analysis on it for MoRAP.

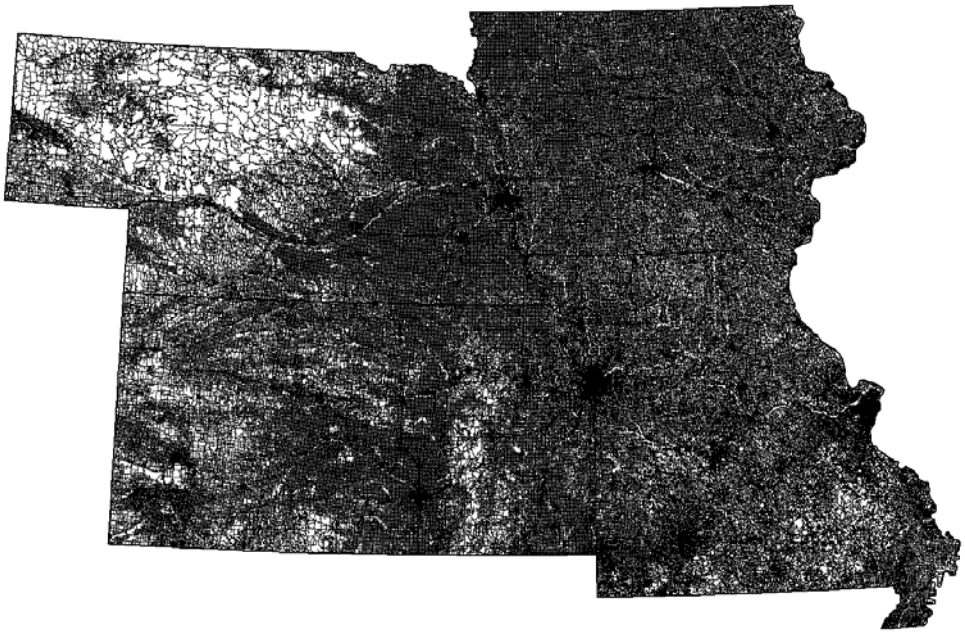
Observations

- The types of files have been split into three different datasets to run the analysis on.
    - The first is “pipeline1” and has the types CRD and crude oil.
    - The second is “pipeline2” and has types diesel and gas, jet fuel, petroleum products, PRD, product, and refined products systems.
    - The third dataset is “pipeline3” and has types HVL products, natural gas, NGL, propane, and propane and ethanol.

Source(s)

1. EPA Region 7 Pipelines (Sensitive Data)
    - Who created the data: Unknown
    - Publication date and time: Unknown
    - Publisher and place: Unknown
    - Acquired from: EPA Region 7
    - Acquisition Date: Never Acquired

Roads



Description

- Roads layer from the 1999 TIGER line file dataset.

Observations

- None

Source(s)

1. EPA Region 7 Roads
   - Who created the data: U.S. Department of Commerce U.S. Census Bureau Geography Division, TIGER/Lines
   - Publication date and time: 2000
   - Publisher and place: U.S. Department of Commerce U.S. TIGER/Line Geography Division, Washington, DC
   - Acquired from: ESRI Website
   - Acquisition Date: 2006

Road/Stream Crossings

Description

- This dataset consists of points where roads cross streams. These locations were identified by intersecting the TIGER/line road file with a modified version of the 1:100,000 National Hydrography Dataset (NHD).

Observations

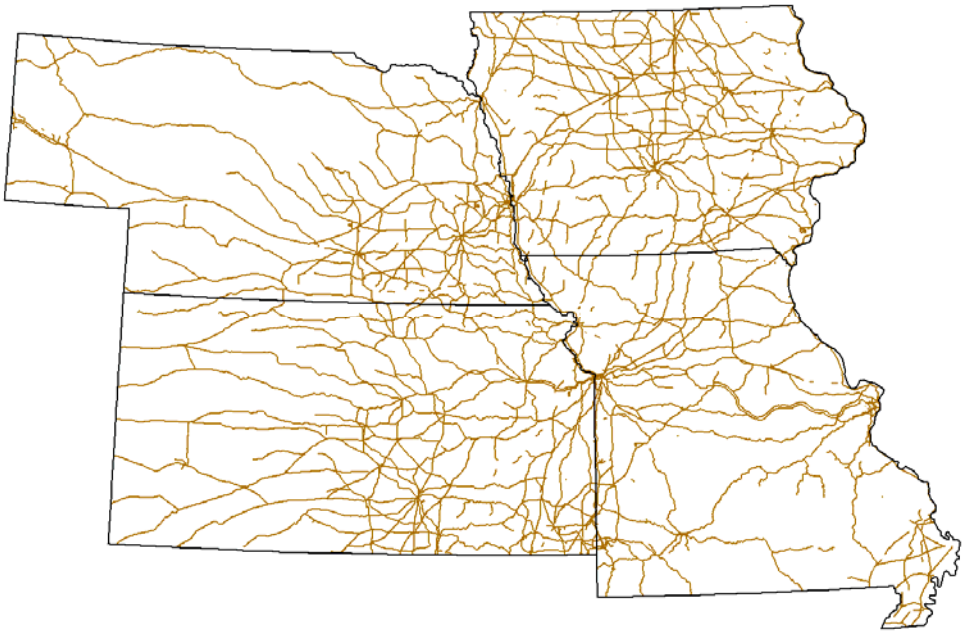
- None

Source(s)

1. EPA Region 7 Roads
   - Who created the data: U.S. Department of Commerce U.S. Census Bureau Geography Division, TIGER/Lines
   - Publication date and time: 2000
   - Publisher and place: U.S. Department of Commerce U.S. TIGER/Line Geography Division, Washington, DC
   - Acquired from: ESRI Website
   - Acquisition Date: 2006

2. EPA Region 7 Modified Stream Network
   - Who created the data: Missouri Resource Assessment Partnership (MoRAP)
   - Publication date and time: 2006
   - Publisher and place: MoRAP, Columbia Missouri
   - Acquired from: MoRAP
   - Acquisition Date: 2006

Railroads



Description

- Railroads layer from the 1999 TIGER line file dataset.

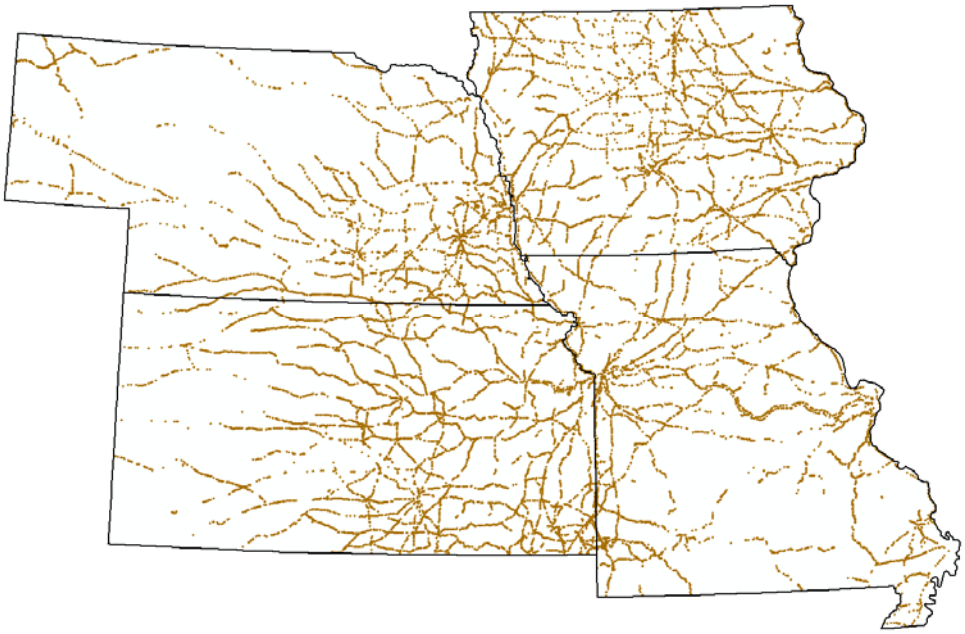
Observations

- None

Source(s)

1. EPA Region 7 Railroads
   - Who created the data: U.S. Department of Commerce U.S. Census Bureau Geography Division, TIGER/Lines
   - Publication date and time: 2000
   - Publisher and place: U.S. Department of Commerce U.S. TIGER/Line Geography Division, Washington, DC
   - Acquired from: ESRI Website
   - Acquisition Date: 2006

Railroad/Stream Crossings



Description

- This dataset consists of points where railroads cross streams. These locations were identified by intersecting the TIGER/line railroad file with a modified version of the 1:100,000 National Hydrography Dataset (NHD).

Observations

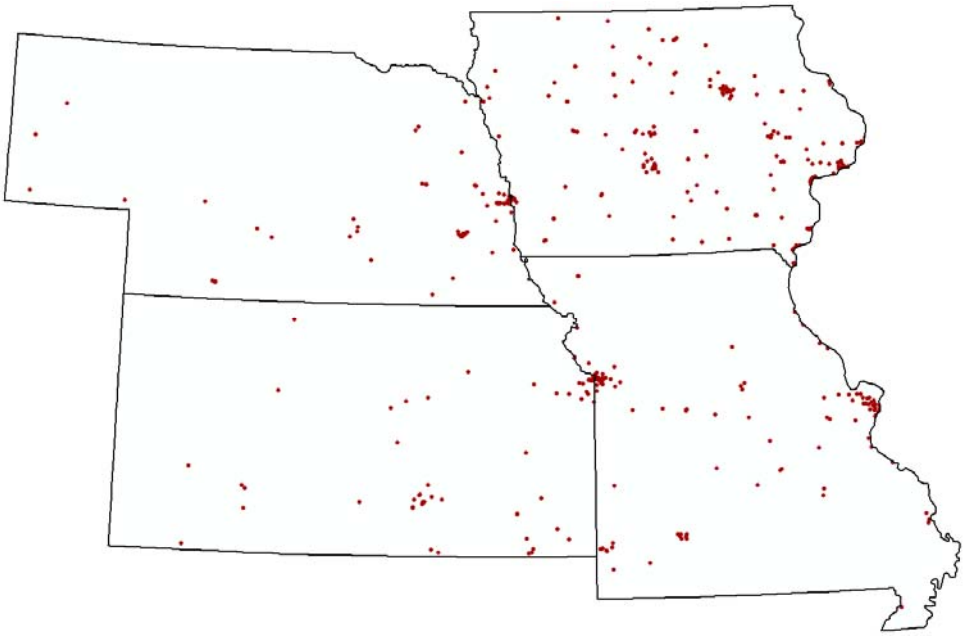
- None

Source(s)

1. EPA Region 7 Railroads
   - Who created the data: U.S. Department of Commerce U.S. Census Bureau Geography Division, TIGER/Lines
   - Publication date and time: 2000
   - Publisher and place: U.S. Department of Commerce U.S. TIGER/Line Geography Division, Washington, DC
   - Acquired from: ESRI Website
   - Acquisition Date: 2006

2. EPA Region 7 Modified Stream Network
   - Who created the data: Missouri Resource Assessment Partnership (MoRAP)
   - Publication date and time: 2006
   - Publisher and place: MoRAP, Columbia Missouri
   - Acquired from: MoRAP
   - Acquisition Date: 2006

RCRIS_Sub



Description

- This dataset contains all Resource Conservation Recovery Act (RCRA/RCRIS) sites in EPA Region 7 excluding those classed as Superfund or Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) sites.

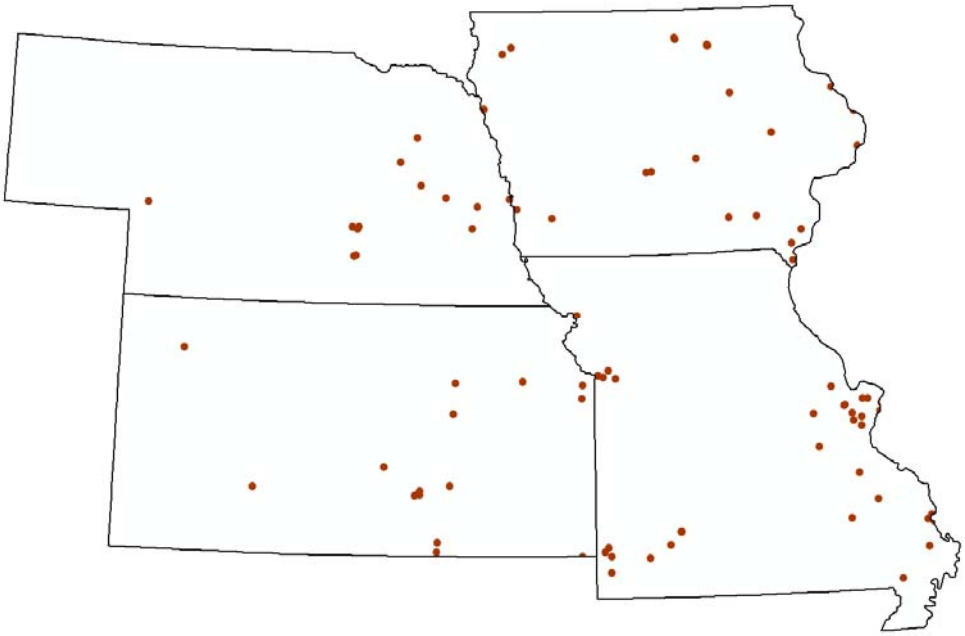
Observations

- This is not the complete RCRIS dataset. Any RCRIS sites listed as Superfund sites were removed and quantified separately.

Source(s)

1. EPA Region 7 RCRA sites
   - Who created the data: The Environmental Protection Agency (EPA) Envirofacts
   - Publication date and time: 5/2007
   - Publisher and place: Environmental Protection Agency, Headquarters, Washington, DC
   - Acquired from: EPA Envirofacts Website
   - Acquisition Date: 2007

Superfund



Description

- This dataset is a subset from EPA's Geodata dataset obtained from the EPA Envirofacts website. Features attributed as Comprehensive Environmental Response, Compensation, and Liability Information System sites (Superfund\CERCLIS) were extracted to create this shapefile.

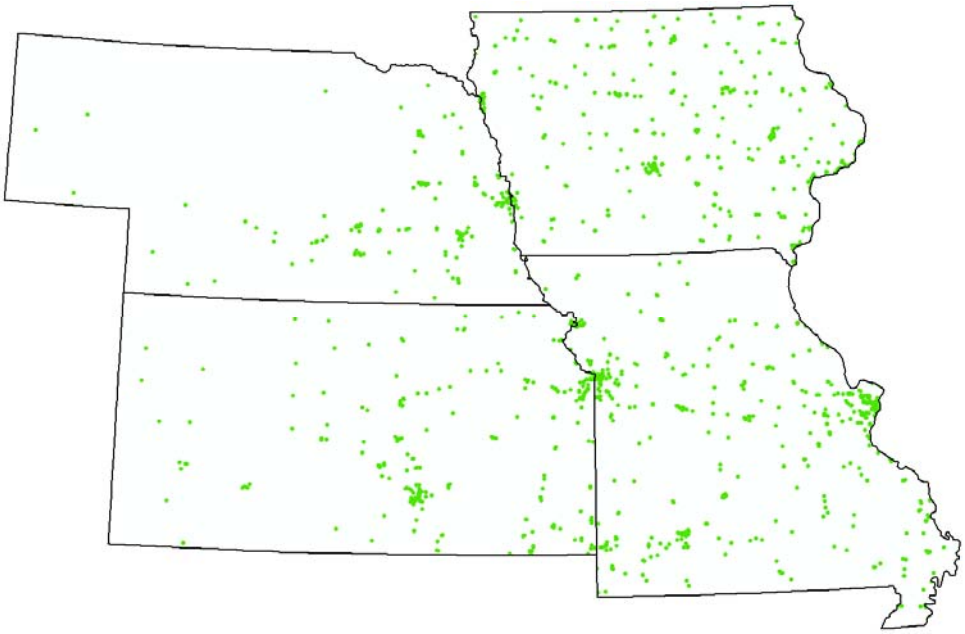
Observations

- The extraction was based on if the CERCLIS field had any attribution.

Source(s)

1. EPA Region 7 Superfund sites
   - Who created the data: The Environmental Protection Agency (EPA) Envirofacts
   - Publication date and time: 5/2007
   - Publisher and place: Environmental Protection Agency, Headquarters, Washington, DC
   - Acquired from: EPA Envirofacts Website
   - Acquisition Date: 2007

Toxic Releases (TRI)



Description

- This dataset is a subset from EPA's Geodata dataset obtained from the EPA Envirofacts website. From the original dataset all features that were classified as Toxic Release sites in the TRI fields were removed for this shapefile. This dataset contains all Toxic Release sites (TRI) excepting those classed as Resource Conservation Recovery Act (RCRA) or Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) sites.

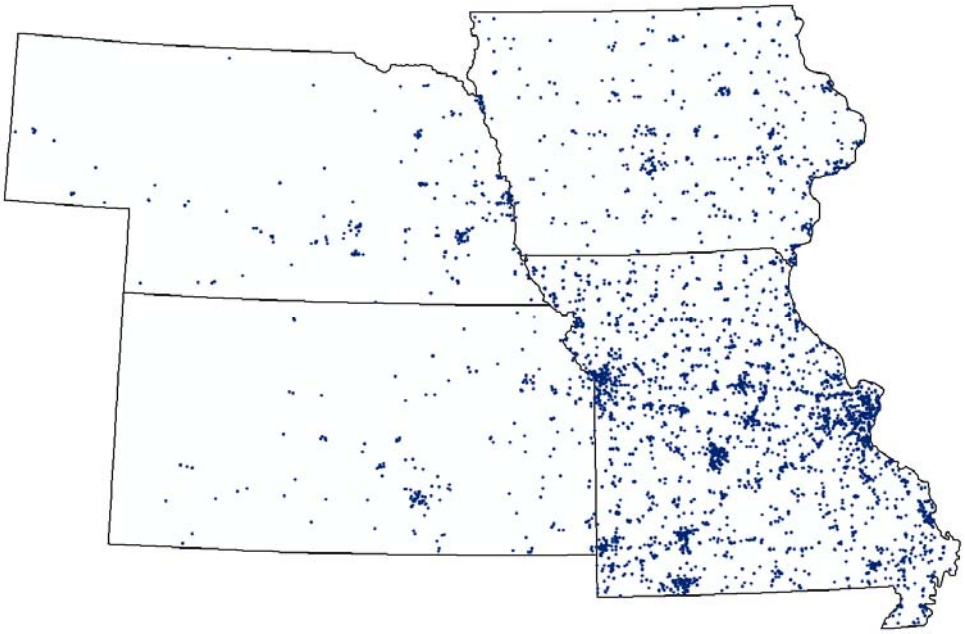
Observations

- None

Source(s)

1. EPA Region 7 TRI sites
   - Who created the data: The Environmental Protection Agency (EPA) Envirofacts
   - Publication date and time: 5/2007
   - Publisher and place: Environmental Protection Agency, Headquarters, Washington, DC
   - Acquired from: EPA Envirofacts Website
   - Acquisition Date: 2007

NPDES_Sub



Description

- This dataset is a subset from EPA's NPDES/PCS dataset obtained from the EPA. Since we were also classifying various other threats included in the NPDES data for this project we did not want to count the sites multiple times. It is important to note that we removed all features that had a SIC code corresponding to Waste Water Treatment Facilities (WWTF), Landfills, Temporary Permits, Mines, Confined Animal Operations (CAFOs), RCRA sites, Superfund Sites or Toxic Release sites (TRI) from the original source data. The removed datasets were quantified as separate layers.

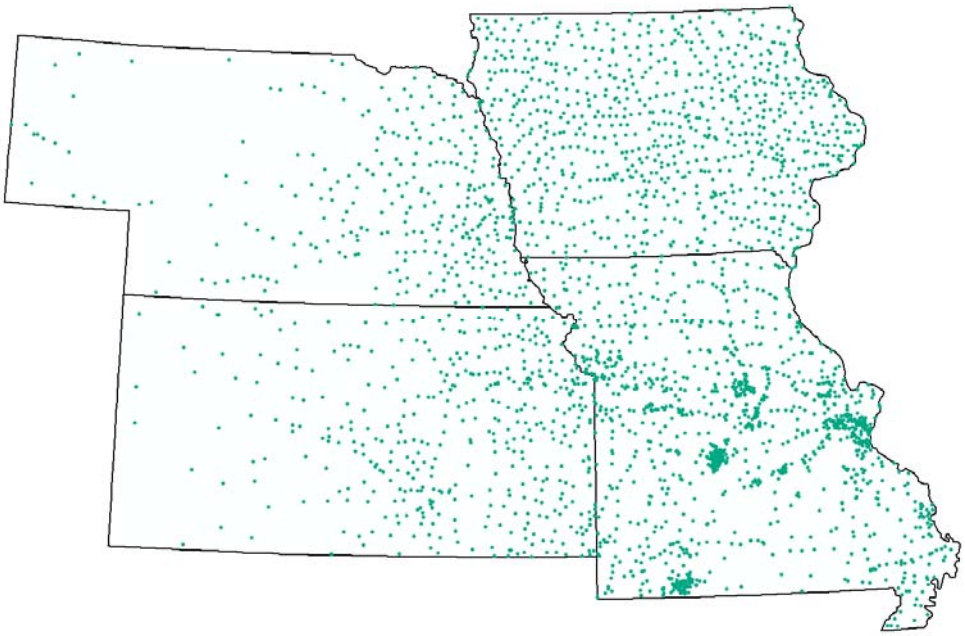
Observations

- Some points were also removed if they were time limited such as temporary building permits, these points were things such as construction sites of houses and businesses or road work.

Source(s)

1. EPA Region 7 NPDES
   - Who created the data: The Environmental Protection Agency (EPA)
   - Publication date and time: Unknown
   - Publisher and place: Unknown
   - Acquired from: EPA Region 7, Kansas City, Missouri
   - Acquisition Date: 2007

Waste Treatment Plants



Description

- This dataset is a subset from EPA's NPDES/PCS dataset obtained from the EPA on a data CD. All features attributed as Waste Treatment Facilities based on various SIC codes were extracted to create this data layer.

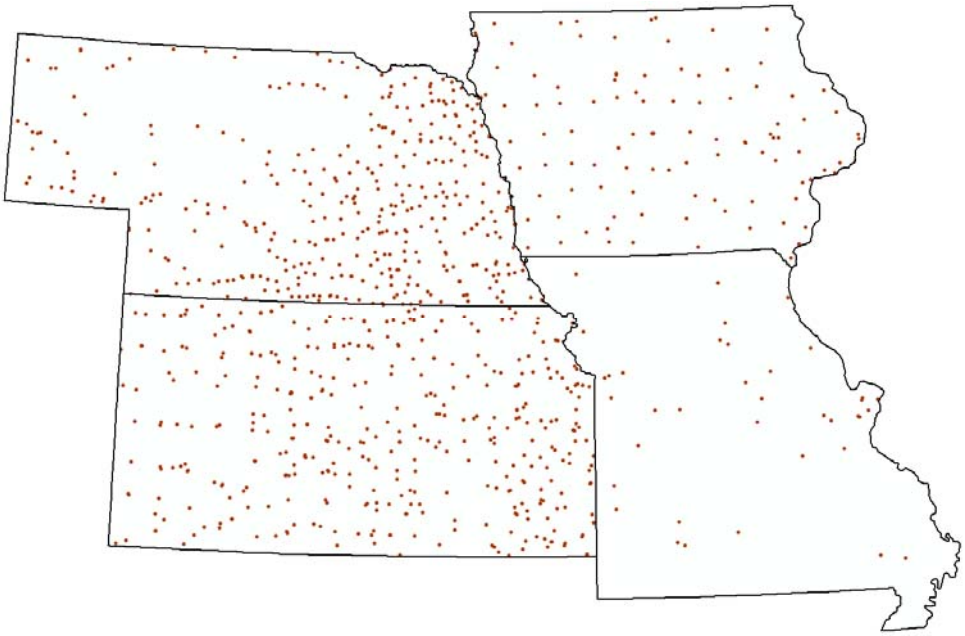
Observations

- None

Source(s)

1. EPA Region 7 NPDES
   - Who created the data: The Environmental Protection Agency (EPA)
   - Publication date and time: Unknown
   - Publisher and place: Unknown
   - Acquired from: EPA Region 7, Kansas City, Missouri
   - Acquisition Date: 2007

Landfills



Description

- We used EPA's BASINS 2001 landfill data for Iowa, Kansas, and Nebraska. The BASINS dataset did not include data for Missouri. A Missouri specific landfill dataset was converted from polygons to points and appended to the EPA BASINS dataset for analysis.

Observations

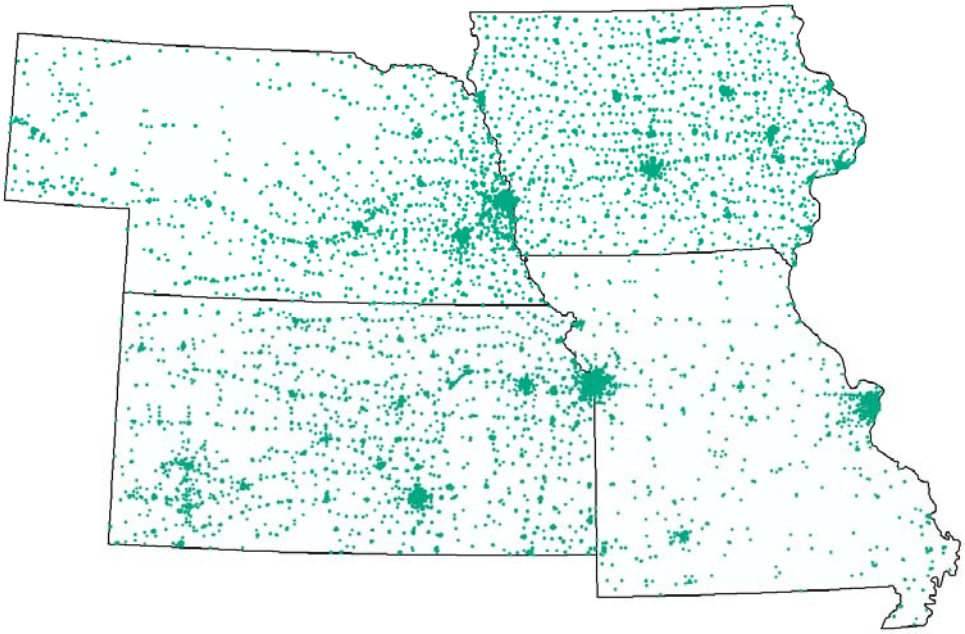
- **None**

Source(s)

1. EPA Region 7 BASINS Landfills
   - Who created the data: Environmental Protection Agency
   - Publication date and time: 2001
   - Publisher and place: U.S. Environmental Protection Agency
   - Acquired from: BASINS Version 3.0 Region 7 CD's
   - Acquisition Date: Unknown

2. Missouri Landfills
   - Who created the data: Missouri Department of Natural Resources, Air and Land Protection Division, Solid Waste Management Program
   - Publication date and time: 2004
   - Publisher and place: MoDNR
   - Acquired from: Missouri Spatial Data information Service
   - Acquisition Date: 2006

Leaking Underground Storage Tanks (LUST)



Description

- This dataset consists of all leaking underground storage tanks (LUST) that could be identified using four input datasets; namely leaking underground storage tank datasets provided by the state agencies of Kansas, Iowa and Missouri; the state of Nebraska did not have a shapefile of LUST sites, but they did have a list with addresses that we were able to geocode. We used existing attribution from the aforementioned files to identify active LUST sites.

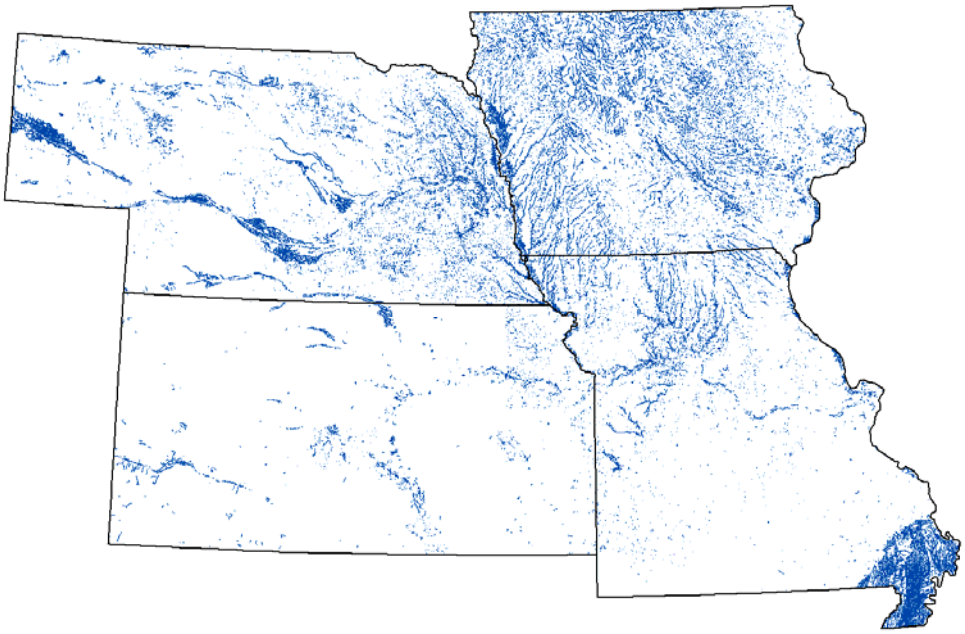
Observations

- Various methods for creating the source data include: GPS, zip code centroids, address matching, topographic maps and aerial imagery digitizing, and others.

Source(s)

1. Missouri Leaking Tanks
   - Who created the data: Missouri Department of Natural Resources, Air and Land Protection Division, Hazardous Waste Program, Tanks Section
   - Publication date and time: 7/15/2004
   - Publisher and place: MoDNR, Jefferson City, MO
   - Acquired from: Missouri Spatial Data information Service
   - Acquisition Date: 2006

Channelized and Ditched Streams



Description

- This dataset consists of all ditches or channelized pieces of stream that could be identified using three input datasets; namely the 1:24,000 National Hydrography Dataset (NHD), the National Wetlands Inventory (NWI), and a modified version of the 1:100,000 National Hydrography Dataset (NHD). We used existing attribution from the aforementioned files to identify stream segments that were channelized or ditched. In addition we identified additional stream segments by visually searching for segments that appeared straightened based on professional judgment.

Observations

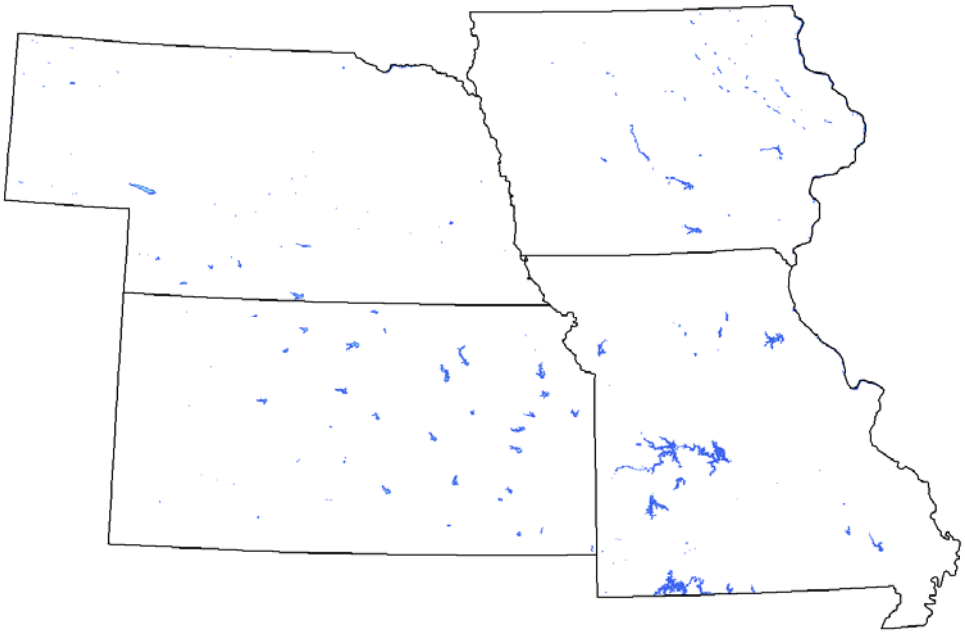
- In certain areas where we did have overlap, most of the overlap between the files was removed, however a small percentage of overlap remained because of the distance between the same features of different files.
- Some areas only have NWI data and others only have NHD data, while some areas consist of a combination of these two sources.

Source(s)

1. National Wetlands Inventory
   - Who created the data: U.S. Department of the Interior United States Geological Survey (USGS) Wetland Mapper Team
   - Publication date and time: Unknown
   - Publisher and place: U.S. Department of the Interior United States Geological Survey (USGS) Wetlands Mapper Team
   - Acquired from: USGS Wetlands Mapper Team
   - Acquisition Date: 2007

2. 1:24,000 National Hydrography Dataset
    - Who created the data: U.S. Department of the Interior United States Geological Survey (USGS)
    - Publication date and time: Unknown
    - Publisher and place: USGS
    - Acquired from: USGS ftp site
    - Acquisition Date: 2007

Major Impoundments



Description

- This dataset consists of all impoundments that intersected a Small River or larger based on stream size attribution from the modified version of the NHD stream layer used in this project. The sources of the impoundments were the1:100,000 National Hydrography Dataset Plus (NHDPlus) and the 1:24,000 National Wetlands Inventory (NWI). We used existing attribution from the aforementioned files to identify waterbodies that were impounded. We also identified additional impoundments by visually searching for waterbodies that appeared impounded based on professional judgment.

Observations

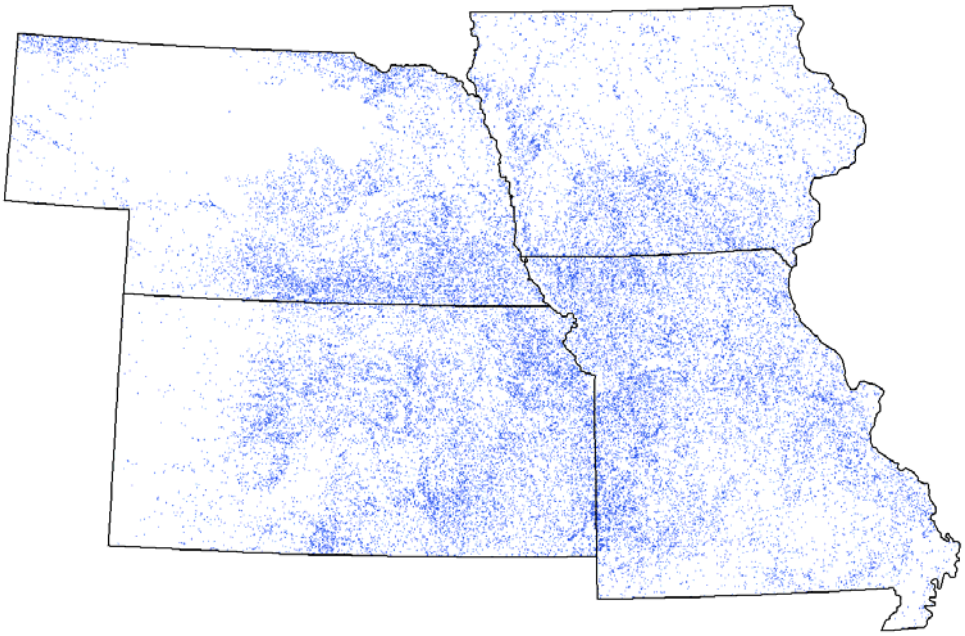
- This dataset was created using the NHD Plus and NWI to extract the water bodies for EPA Region 7.
- The impoundments were then manually compared to aerial imagery to determine if they were in fact an impoundment.

Source(s)

1. National Wetlands Inventory
   - Who created the data: U.S. Department of the Interior United States Geological Survey (USGS) Wetland Mapper Team
   - Publication date and time: Unknown
   - Publisher and place: U.S. Department of the Interior United States Geological Survey (USGS) Wetlands Mapper Team
   - Acquired from: USGS Wetlands Mapper Team
   - Acquisition Date: 2007

2. 1:100,000 National Hydrography Dataset
    - Who created the data: U.S. Department of the Interior United States Geological Survey (USGS)
    - Publication date and time: Unknown
    - Publisher and place: USGS
    - Acquired from: USGS horizon systems website
    - Acquisition Date: 2007

Headwater Impoundments



Description

- This dataset consists of all headwater impoundments that could be identified using four input datasets; namely the Elevation Derivatives for National Applications (EDNA), the National Land Cover Database (NLCD), the National Wetlands Inventory (NWI), and a modified version of the 1:100,000 National Hydrography Dataset (NHD). We used existing attribution from the aforementioned files to identify waterbodies that were impounded. We identified additional headwater impoundments by visually searching for waterbodies that appeared impounded based on professional judgment.

Observations

- This dataset represents an estimation of headwater impoundments.
- An effort was made to exclude natural waterbodies from this dataset.

Source(s)

1. National Wetlands Inventory
   - Who created the data: U.S. Department of the Interior United States Geological Survey (USGS) Wetland Mapper Team
   - Publication date and time: Unknown
   - Publisher and place: USGS
   - Acquired from: USGS Wetland Mapper Team
   - Acquisition Date: 2007

2. 2001 NLCD
    - Who created the data: U.S. Geological Survey
    - Publication date and time: 11/13/2006
    - Publisher and place: U.S. Geological Survey, Sioux Falls, SD
    - Acquired from: MRLC Consortium - U.S. Department of the Interior United States Geological Survey (USGS)
    - Acquisition Date: 2007

3. Elevation Derivatives for National Applications (EDNA)
    - Who created the data: U.S. Department of the Interior United States Geological Survey (USGS) EROS Data Center
    - Publication date and time: Unknown
    - Publisher and place: U.S. Geological Survey
    - Acquired from: U.S. Department of the Interior United States Geological Survey (USGS) EROS Data Center
    - Acquisition Date: 2006

4. EPA Kansas Playa Lakes
    - Who created the data: University of Kansas - Geography Department
    - Publication date and time: Unknown
    - Publisher and place: Unknown
    - Acquired from: EPA Region 7
    - Acquisition Date: 2007

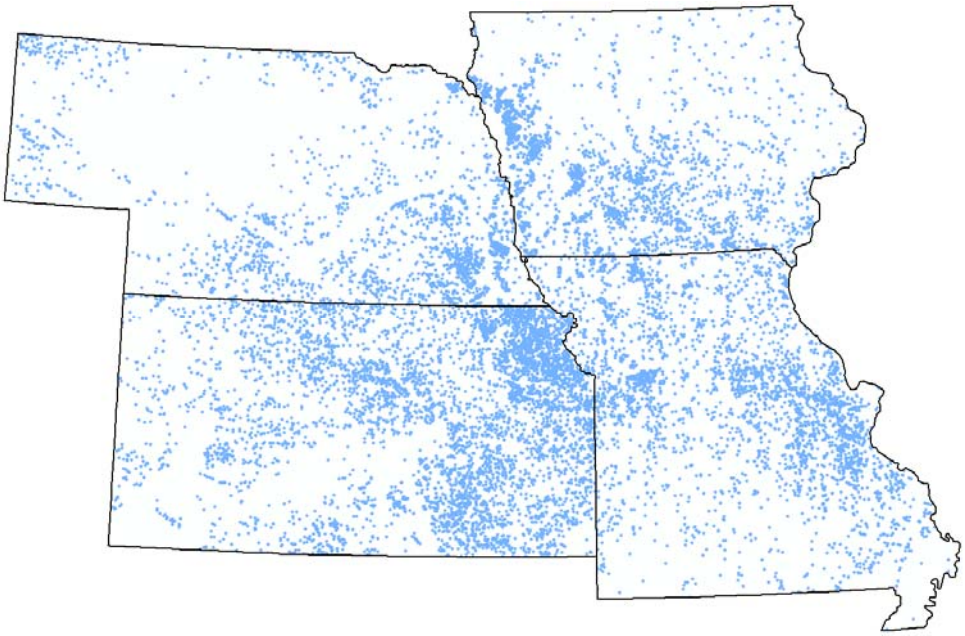
5. Iowa Designated Wetlands Setbacks
    - Who created the data: Iowa Department of Natural Resources
    - Publication date and time: 2003
    - Publisher and place: Iowa Department of Natural Resources
    - Acquired from: Iowa GIS Library
    - Acquisition Date: 2007

6. Ecoregions of the united States
    - Who created the data: United States Department of Agriculture - Forest Service ECOMAP Team
    - Publication date and time: 2005
    - Publisher and place: United States Department of Agriculture - Forest Service ECOMAP Team
    - Acquired from: Unknown
    - Acquisition Date: 2007

7. EPA Region 7 Dams
    - Who created the data: U.S. Army Corps of Engineers in cooperation with FEMA's National Dam Safety Program
    - Publication date and time: 1996
    - Publisher and place: Unknown
    - Acquired from: U.S. Army Corps of Engineers
    - Acquisition Date: 2006

8. Nebraska Dams Inventory
    - Who created the data: Nebraska Department of Natural Resources
    - National Dam Safety Program
    - Publication date and time: 1868 - present
    - Publisher and place: Nebraska Department of Natural Resources
    - Acquired from: Nebraska Department of Natural Resources
    - Acquisition Date: 2006

Dams



Description

- The National Inventory of Dams database contains information on 75,187 dams throughout the United States and its territories. The National Inventory of Dams is the Water Control Infrastructure, Inventory of Dams 1993-1994 report and CD-ROM. Significant changes were made to the inventory data, including the addition of new dam records and removal of breached dams, and duplicate dam records. This update was authorized under the Water Resources Development Act of 1986 (P.L. 99-662), as amended.

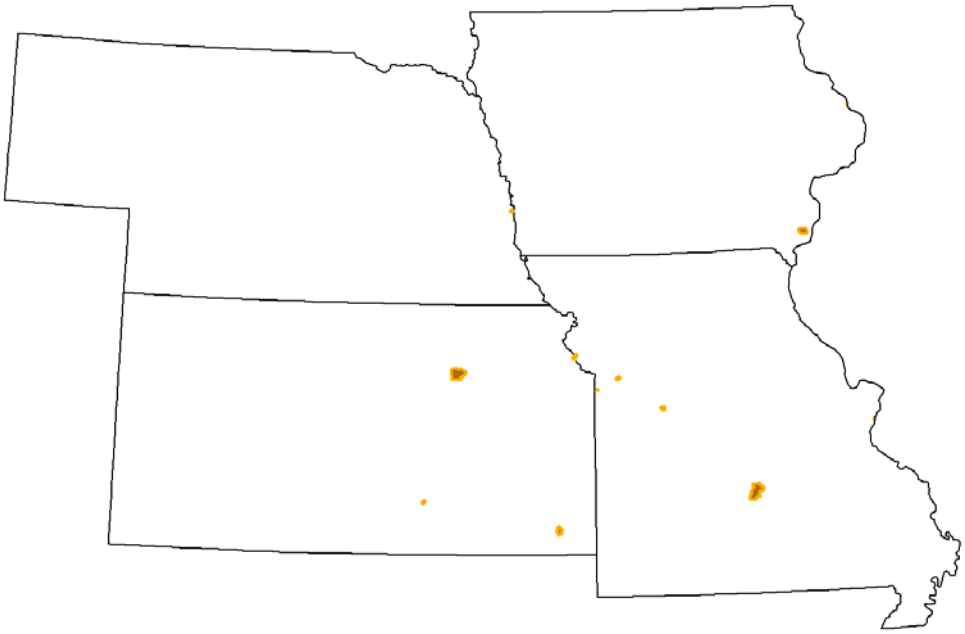
Observations

- None

Source(s)

1. EPA Region 7 Dams
   - Who created the data: U.S. Army Corps of Engineers in cooperation with FEMA's National Dam Safety Program
   - Publication date and time: 1996
   - Publisher and place: Unknown
   - Acquired from: U.S. Army Corps of Engineers
   - Acquisition Date: 2006

Military Sites



Description

- The United States Military Installations database contains the boundaries, location, and areal information for important military installations in the United States and Puerto Rico.

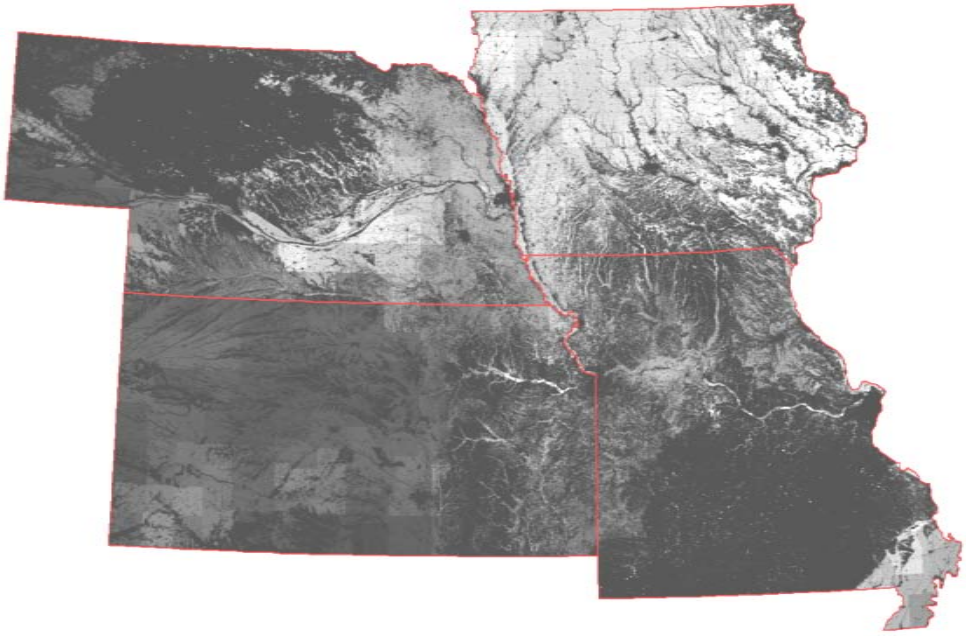
Observations

- The data is a polygon shapefile.

Source(s)

1. Military Bases
   - Who created the data: Bureau of Transportation Statistics
   - Publication date and time: 2001
   - Publisher and place: Unknown
   - Acquired from: Harvard Geospatial Library
   - Acquisition Date: 2006

Estimated Crop Pesticide Grid



Description

- The goal of creating this dataset was to try and establish an estimate of cropland pesticide use over all of EPA Region7.

Observations

- This dataset represents estimated crop pesticide use based on the 1997 Agricultural Census Data and methods developed by the USGS. The grid is a 30 meter cell grid based on the 2001 National Land Cover Dataset (NLCD) and was based on the 43 most used pesticides established by the USGS.

Source(s)

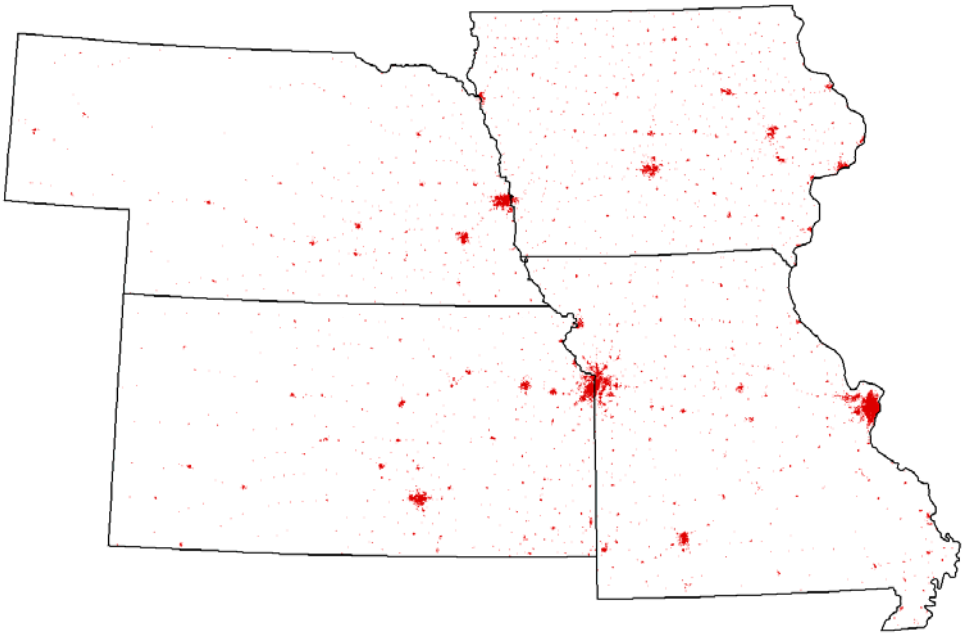
Grid created by MoRAP using the following sources:

1. 2001 NLCD
   - Who created the data: U.S. Geological Survey
   - Publication date and time: 11/13/2006
   - Publisher and place: U.S. Geological Survey, Sioux Falls, SD
   - Acquired from: MRLC Consortium - U.S. Department of the Interior United States Geological Survey (USGS)
   - Acquisition Date: 2007

2. Grids of agricultural pesticide use in the conterminous United States, 1997
   - Who created the data: U.S. Geological Survey, Naomi Nakagaki
   - Publication date and time: 1/2007
   - Publisher and place: U.S. Geological Survey, Sacramento, CA
   - Acquired from: U.S. Department of the Interior United States Geological Survey (USGS)
   - Acquisition Date: 2007

3. *Method for Estimating Pesticide Use for County Areas of the Conterminous United States*, Gail P. Thelin and Leonard P. Gianessi, 2000; U.S. Geological Survey Open-File Report 00-250

Impervious Surface



Description

- This dataset consists of all impervious surface areas excluding roads that could be identified using the 2001 National Land Cover Dataset. A 30-meter pixel often overestimates the amount of impervious surface from rural roads. As such, we decided to eliminate most roads outside of urban areas from the impervious classes in the NLCD. A shrink and expand process was used to remove roads, but maintain urban impervious.

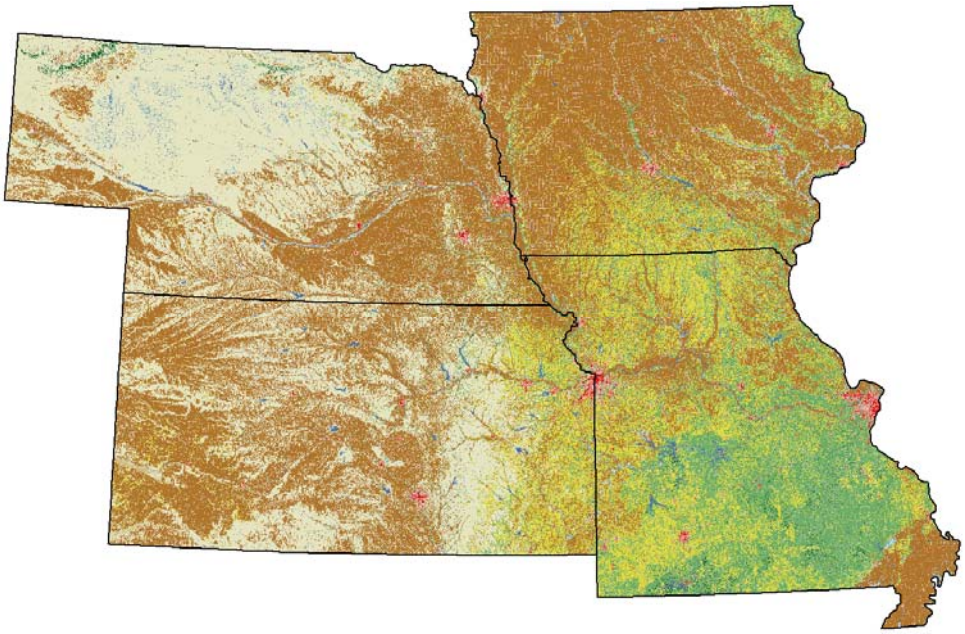
Observations

- The source data was separate from the 2001 NLCD data; it was part of the percent urban dataset.
- Due to the processing methods the depiction of impervious surface in urban areas was altered to a degree in some locations.

Source(s)

1. 2001 NLCD
   - Who created the data: U.S. Geological Survey
   - Publication date and time: 11/13/2006
   - Publisher and place: U.S. Geological Survey, Sioux Falls, SD
   - Acquired from: MRLC Consortium - U.S. Department of the Interior United States Geological Survey (USGS)
   - Acquisition Date: 2007

2001 National Landcover Dataset



Description

- The National Land Cover Database 2001 land cover layer was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. The MRLC Consortium is a partnership of federal agencies (www.mrlc.gov), consisting of the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), the U.S. Forest Service (USFS), the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM) and the USDA Natural Resources Conservation Service (NRCS). One of the primary goals of the project is to generate a current, consistent, seamless, and accurate National Land Cover Database (NLCD) circa 2001 for the United States at medium spatial resolution.

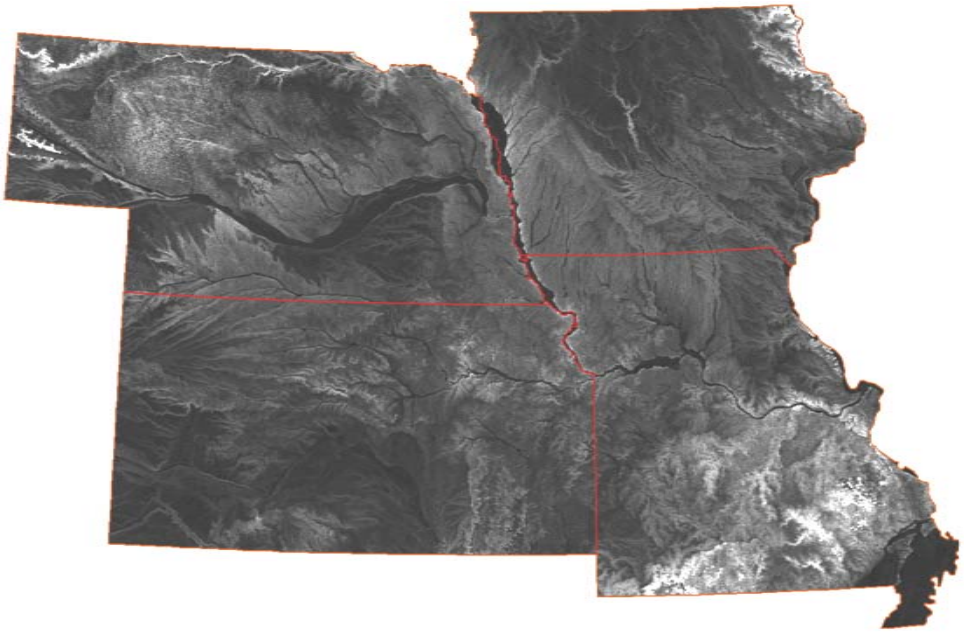
Observations

- Data was downloaded and combined into a single file for EPA Region 7.

Source(s)

1. 2001 NLCD
   - Who created the data: U.S. Geological Survey
   - Publication date and time: 11/13/2006
   - Publisher and place: U.S. Geological Survey, Sioux Falls, SD
   - Acquired from: MRLC Consortium - U.S. Department of the Interior United States Geological Survey (USGS)
   - Acquisition Date: 2007

Relief/Roughness Grid



Description

- This dataset is a grid representation of the relief or roughness of the surface of the landscape covering EPA Region 7. This dataset was created using the National Hydrography Dataset Plus (NHD Plus) DEM data.

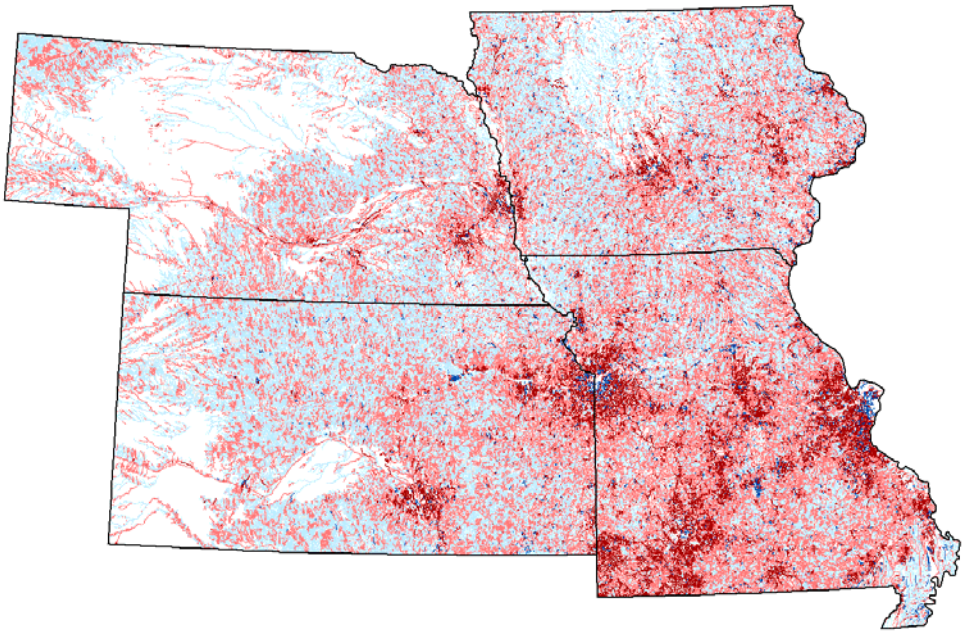
Observations

- We used the FocalRange command in ArcMap using the Raster Calculator to make a relief grid based on the difference in elevation within a 1 kilometer diameter circle on the DEM.

Source(s)

1. EPA Region 7 DEM's
   - Who created the data: Environmental Protection Agency & United States Geological Survey, NHD Plus
   - Publication date and time: 2006
   - Publisher and place: Unknown
   - Acquired from: NHD Plus Website
   - Acquisition Date: 2006

Population Data



Description

- In order for others to use the information in the Census TIGER database in a geographic information system (GIS) or for other geographic applications, the Census Bureau releases to the public extracts of the database in the form of TIGER/Line files. The various population datasets contain 1990 block population data as well as 2000 block population data for each state.

Observations

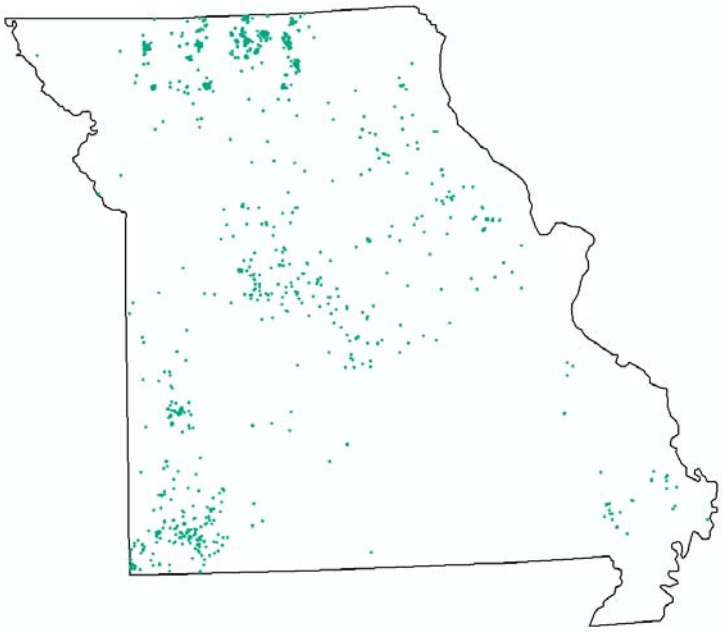
- Census block population data for both 1990 and 2000 were attached to the year 2000 census blocks to look at population changes between the two decades.

Source(s)

1. 1990 Census Block Data
   - Who created the data: U.S. Department of Commerce U.S. Census Bureau Geography Division
   - Publication date and time: 1993
   - Publisher and place: U.S. Department of Commerce U.S. Census Bureau Geography Division, Washington, DC
   - Acquired from: ESRI Website
   - Acquisition Date: 2007

2. 2000 Census Block Data
    - Who created the data: U.S. Department of Commerce U.S. Census Bureau Geography Division
    - Publication date and time: 2001
    - Publisher and place: U.S. Department of Commerce U.S. Census Bureau Geography Division, Washington, DC
    - Acquired from: ESRI Website
    - Acquisition Date: 2007

Missouri CAFOs



Description

- This dataset is a subset from a National Pollutant Discharge Elimination System dataset obtained from the Missouri Department of Natural Resources. From the original dataset all features that were classified as CAFO sites were removed for this shapefile. This data set covers the state of Missouri.

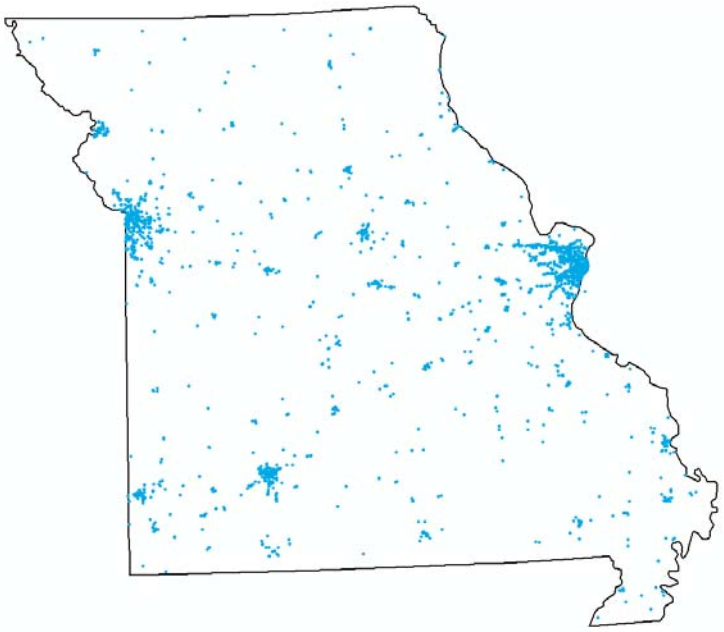
Observations

- The CAFOs were extracted from the Missouri NPDES layer if they had any SIC code indicating an animal feeding operation.

Source(s)

1. CAFOs from Missouri NPDES
   - Who created the data: Missouri Department of Natural Resources (MoDNR), Division of Environmental Quality (DEQ), Water Protection Program (WPP)
   - Publication date and time: 3/1/2006
   - Publisher and place: MoDNR, WPP, Jefferson City, Missouri
   - Acquired from: Missouri Spatial Data information Service
   - Acquisition Date: 2006

Missouri Hazardous Waste Generators



Description

- This data set depicts the locations of large and small quantity hazardous waste generators registered in Missouri.

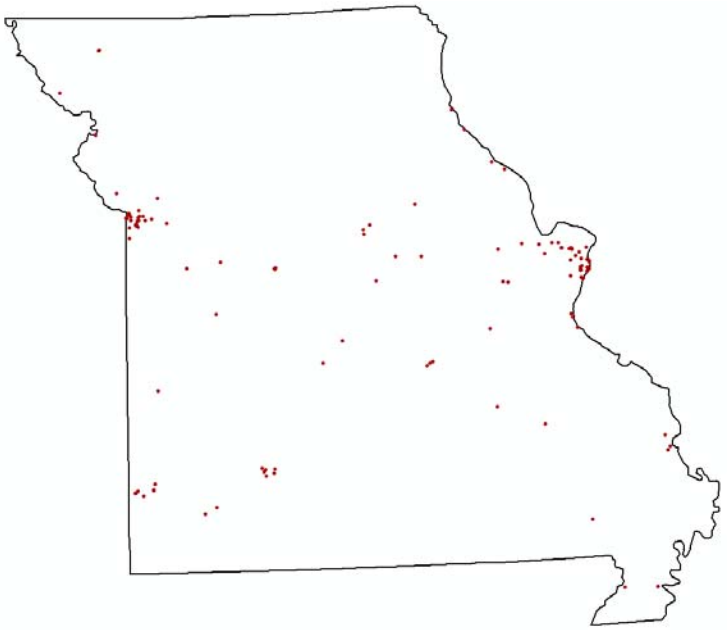
Observations

- None

Source(s)

1. Missouri Hazardous Waste Generators
   - Who created the data: Missouri Department of Natural Resources (MoDNR), Division of Environmental Quality (DEQ), Hazardous Waste Program (HWP)
   - Publication date and time: 4/30/2008
   - Publisher and place: MoDNR, Jefferson City, Missouri
   - Acquired from: Missouri Spatial Data information Service
   - Acquisition Date: 2008

Missouri Hazardous Waste Permits



Description

- This data set contains sites permitted to treat, store or dispose of hazardous waste and facilities that are certified for resource recovery. Some of the permitted sites have known or suspected hazardous contamination.

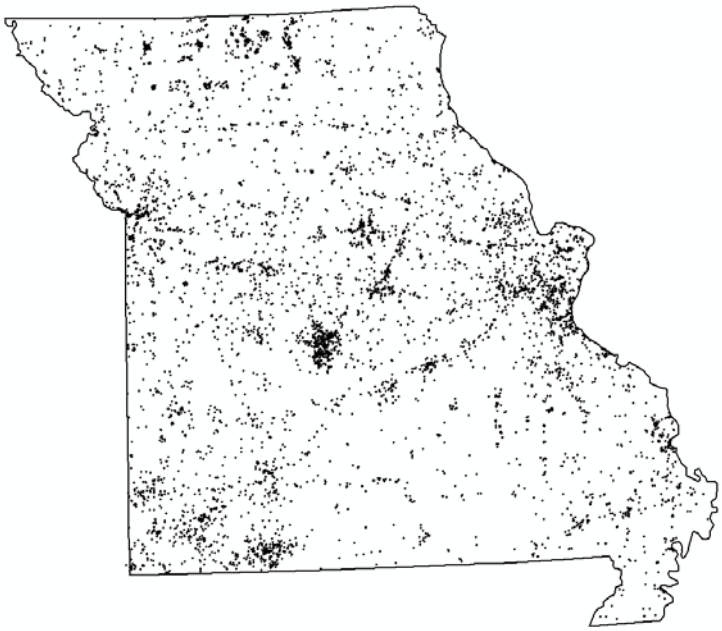
Observations

- None

Source(s)

1. Missouri Hazardous Waste Permits
   - Who created the data: Missouri Department of Natural Resources, Air and Land Protection Division, Hazardous Waste Program, Permits Section
   - Publication date and time: 2/4/2004
   - Publisher and place: MoDNR, Jefferson City, Missouri
   - Acquired from: Missouri Spatial Data information Service
   - Acquisition Date: 2008

Missouri National Pollutant Discharge Elimination System Facilities



Description

- This is a point data set depicting outfall locations of facilities with Missouri NPDES Operating Permits. The permittee through permit application provided attribute information. Locational data was obtained using a variety of methods, ranging from GPS real-time data collection to map interpolation using the legal description (Quarter, Quarter, Section, Township, Range).

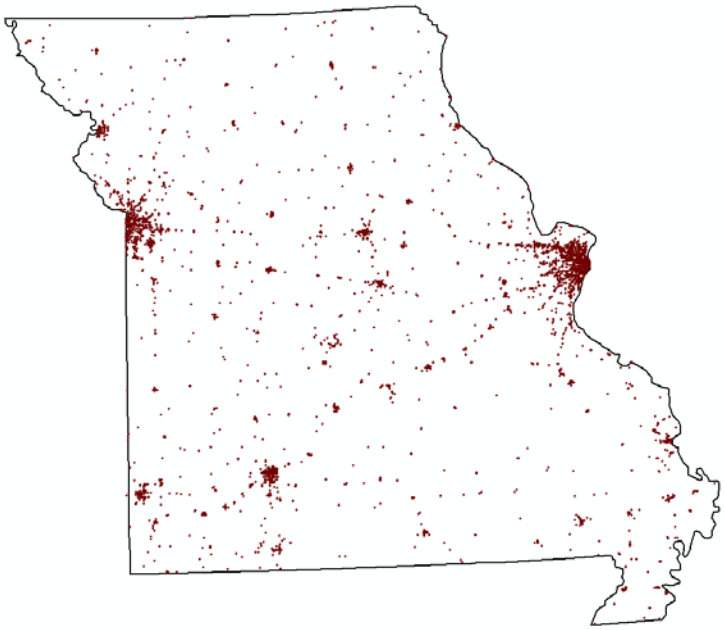
Observations

- None

Source(s)

1. Missouri NPDES
   - Who created the data: Missouri Department of Natural Resources (MoDNR), Division of Environmental Quality (DEQ), Water Protection Program (WPP)
   - Publication date and time: 3/1/2006
   - Publisher and place: MoDNR, WPP, Jefferson City, Missouri
   - Acquired from: Missouri Spatial Data information Service
   - Acquisition Date: 2008

Missouri Underground Storage Tanks (UST)



Description

- Locations of active underground storage tank (UST) facilities in Missouri. This data set contains all active sites for which the Missouri Department of Natural Resources tanks section has obtained locational data. This data set represents approximately 98% of the active UST facilities registered in Missouri. The 70 facilities included in this data set located by zip code centroid are considered incomplete. These coordinates will be replaced with Global Positioning System (GPS) coordinates as time permits and updated in future quarterly updates.

Observations

- None

Source(s)

1. Missouri UST's
   - Who created the data: Missouri Department of Natural Resources, Air and Land Protection Division, Hazardous Waste Program, Tanks Section
   - Publication date and time: 7/15/2004
   - Publisher and place: MoDNR, Jefferson City, Missouri
   - Acquired from: Missouri Spatial Data information Service
   - Acquisition Date: 2008

Appendix C

Data Structure and Descriptions

Level	Folder or File Name	Description
	MO_Aquatic_Threat_Data_Suite	**Folder containing all source data**
1.	**Base Data**	**Folder containing classification units**
2.	**Human Threat Data**	**Folder containing various threat datasets**
3.	**Natural Data**	**Folder containing natural features data**

1.	**Base Data**	**Folder containing classification units**
	Stream Network	Geodatabase containing geometric network
	Streams	Geometric stream network
	Lines	Feature dataset of stream lines
	Nodes	Feature dataset of stream nodes
	Streams Net	Feature dataset of geometric stream network
	Streams Net Junctions	Feature dataset of geometric junctions
	Mo_catchments.shp	Shapefile of catchment polygons of streams
	Mo_riparian_buffers.shp	Shapefile of riparian buffers of the streams
	Mo_vst1.shp	Shapefile of valley segment type streams

2.	**Human Threat Data**	**Folder containing various threat datasets**
	Missouri Specific Data	**Subfolder contain Missouri run only data**
	MO CAFOs.shp	Shapefile of Missouri confined animal facilities
	MO Haz Generator.shp	Shapefile of MO hazardous waste generators
	MO Haz Waste Permit.shp	Shapefile of Missouri hazardous waste permits
	MO NPDES.shp	Shapefile of Missouri NPDES permitted sites
	MO Specific Threats.dbf	Database of Missouri only threat statistics
	MO UST.shp	Shapefile of Missouri underground tanks
	Threat Base Data	**Subfolder containing threat datasets**
	Certified Wells	**Subfolder containing state well data**
	IA Wells.shp	Shapefile of Iowa certified water wells
	KS Wells.shp	Shapefile of Kansas certified water wells
	MO Wells.shp	Shapefile of Missouri certified water wells
	NE Wells.shp	Shapefile of Nebraska certified water wells
	1990 Population.gdb	Geodatabase containing 1990 census data
	Iowa 90	Dataset of 1990 Iowa block polygons
	Kansas 90	Dataset of 1990 Kansas block polygons
	Missouri 90	Dataset of 1990 Missouri block polygons
	Nebraska 90	Dataset of 1990 Nebraska block polygons
	2000 Population.gdb	Geodatabase containing 2000 census data
	Iowa 2000	Dataset of 2000 Iowa block polygons
	Kansas 2000	Dataset of 2000 Kansas block polygons
	Missouri 2000	Dataset of 2000 Missouri block polygons
	Nebraska 2000	Dataset of 2000 Nebraska block polygons
	Airports.shp	Shapefile of airports
	CAFOs.shp	Confined animal feeding operations
	Coal Mines.shp	Shapefile of coal mines

Level	Folder or File Name	Description
2.	**Human Threat Data**	**Folder containing various threat datasets**
	Crop_Pest_v1	Grid of estimated crop pesticide use
	Dams.shp	Shapefile of major dams
	EPA R7 Channelized Streams V1.shp	Shapefile of channelized or ditched streams
	EPA R7 Headwater Impoundments V1.shp	Shapefile of headwater impoundments
	Impervious	Grid of impervious surface
	Landfills.shp	Shapefile of landfills
	Lead Mines.shp	Shapefile of lead mines
	LUST.shp	Shapefile of leaking underground storage tanks
	Major impoundments.shp	Shapefile of major impoundments
	Military Bases.shp	Shapefile of military bases
	Mines.shp	Shapefile of active mines (excluding coal/lead)
	NPDES.shp	National pollution discharge elimination sites
	Oil Gas Wells.shp	Shapefile of active oil and gas wells
	Rail Stream Crossings.shp	Shapefile of railroad stream crossings
	Railroads.shp	Shapefile of railroads
	RCRIS.shp	Resource conservation recovery act sites
	Road Stream Crossings.shp	Shapefile of road stream crossings
	Roads.shp	Shapefile of roads
	Superfund.shp	Shapefile of superfund or cerclis sites
	Toxic Releases.shp	Shapefile of toxic release sites
	WWTF.shp	Shapefile of waste water treatment facilities
	Threat_Tables	**Related tables containing threat stats**
	Distances To Threats.dbf	Database of distances from stream to threats
	Fragmentation.dbf	Database of stream fragmentation
	Human Threat Attributes.dbf	Database of stream watershed threat statistics

3.	**Natural Data**	**Folder containing natural features data**
	Natural Base Data	**Subfolder containing natural data**
	NLCD 2001	Grid of national landcover database 2001
	R7 Relief	Grid of the relief in EPA region 7
	Natural Tables	**Related tables containing natural stats**
	Landcover.dbf	Database of landcover watershed stats
	Relief.dbf	Database of relief class watershed stats
	Riparian Landcover.dbf	Database of riparian landcover stats
	Soil Hydro Group.dbf	Database of soil hydrologic group stats
	Soil Rock Depth.dbf	Database of soil depth to bedrock stats
	Soil Rock Frag.dbf	Database of soil rock fragmentation stats
	Soil Texture.dbf	Database of soil surface texture stats