

Landscape and programmatic factors related to delisting impaired waterbodies, *and* applications to map water quality data

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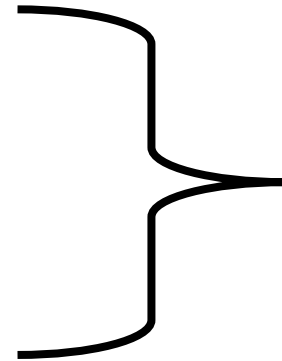
*For purposes of this presentation, delisting refers to waters no longer impaired by a particular cause due to restoration or reasons unknown and attaining water quality standards

What factors are correlated with assessed changes in water quality?

1) State 303(d)/305(b)

2) Landscape and programmatic

3) Montana Case Study



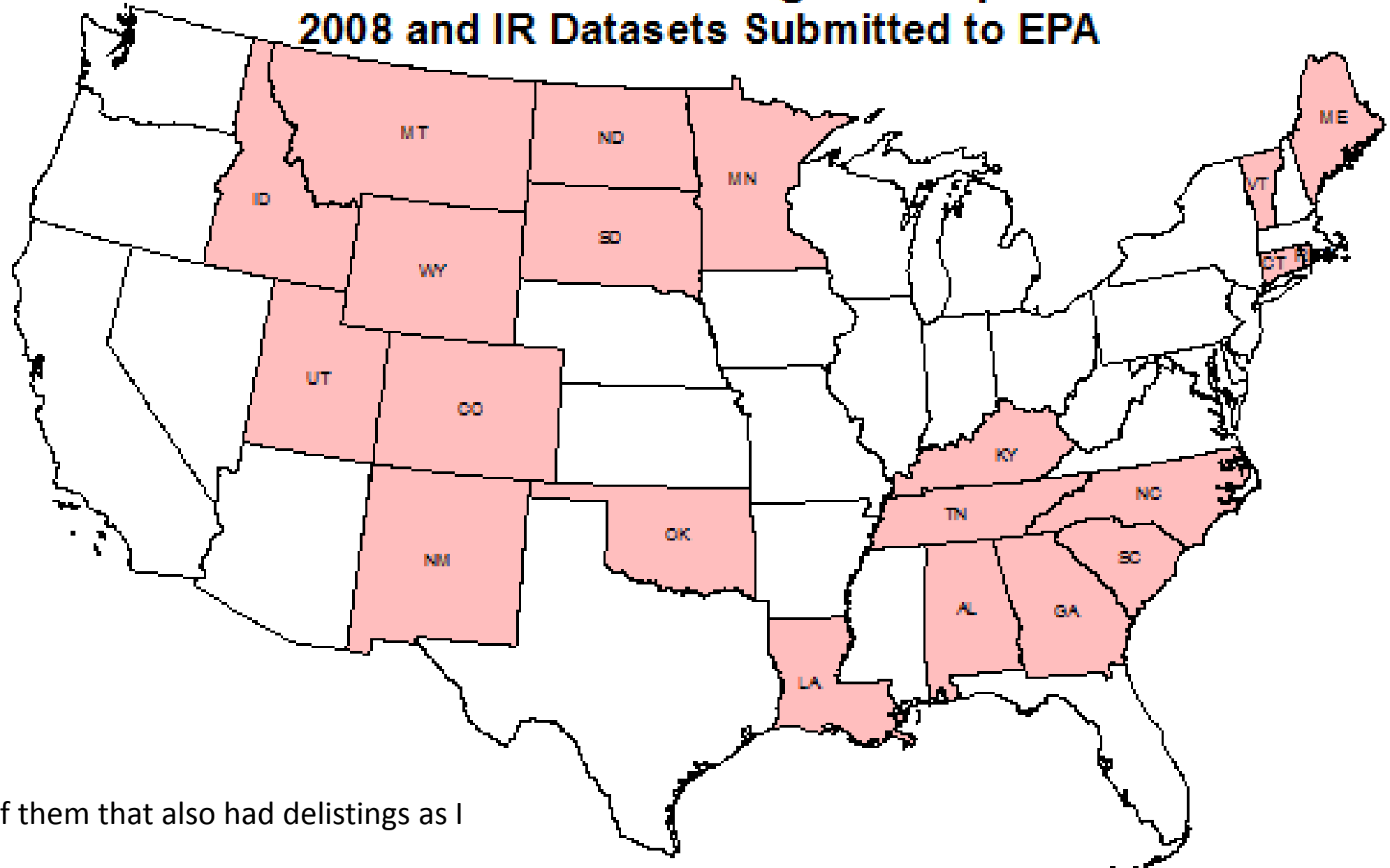
**Datasets to
explore this
question**

4) Interactive Mapping of Above Datasets

State 303(d)/305(b) data

States with at least Three Integrated Reports Since 2008 and IR Datasets Submitted to EPA

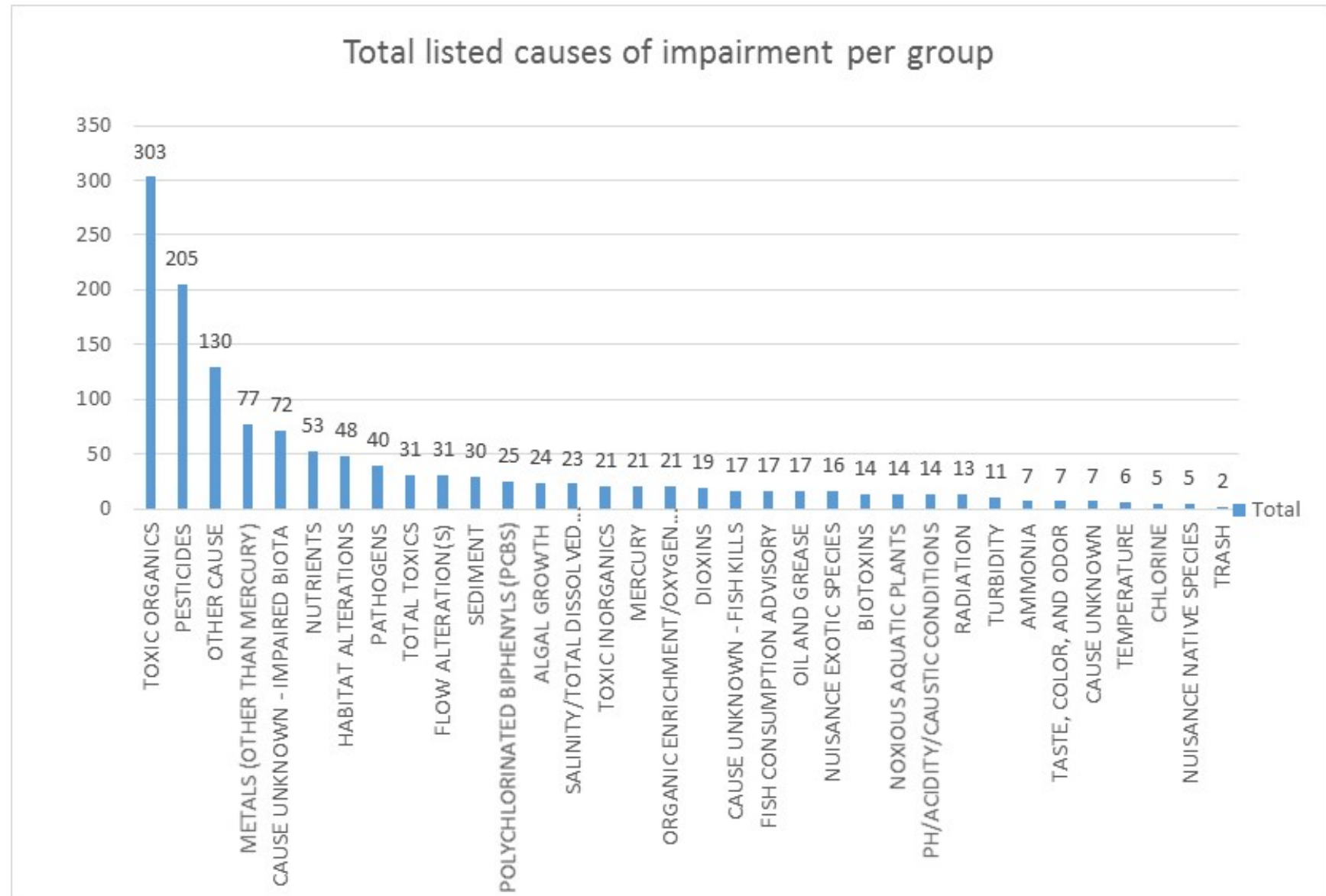
IR datasets allow tracking changes in Assessment Status



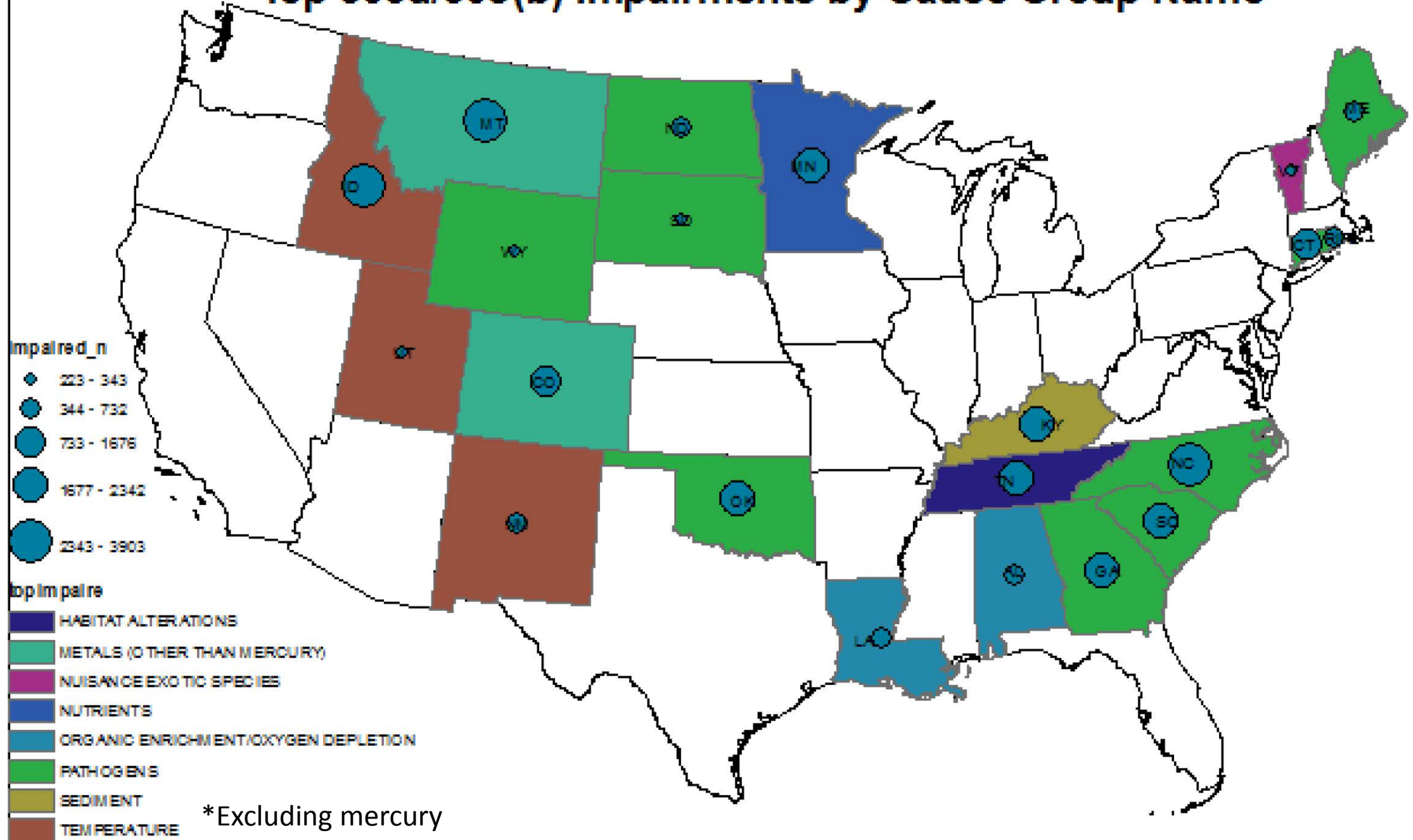
*Here just showing 20 of them that also had delistings as I define in next few slides

State 303(d)/305(b) data

- **1346 Causes**
- **34 cause group names**
- **Aggregating by group necessary to simplify analysis.**



Top 303d/305(b) Impairments by Cause Group Name



WQS_ATTAINMENT
_REASON=

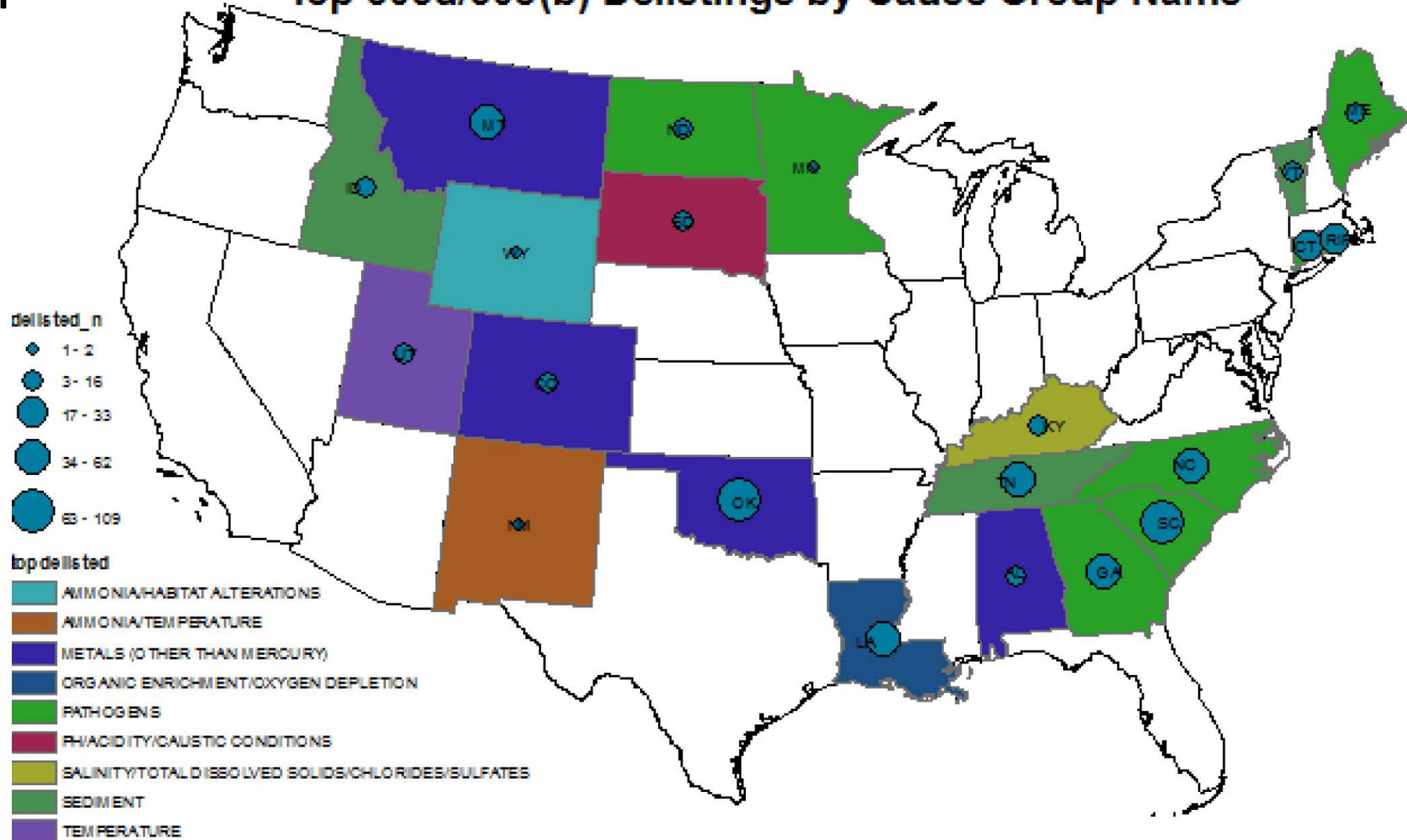
"Applicable WQS
attained, due to
restoration
activities."

Or
"Applicable WQS
attained; reason
for recovery
unspecified."

&

No impairment
next cycle

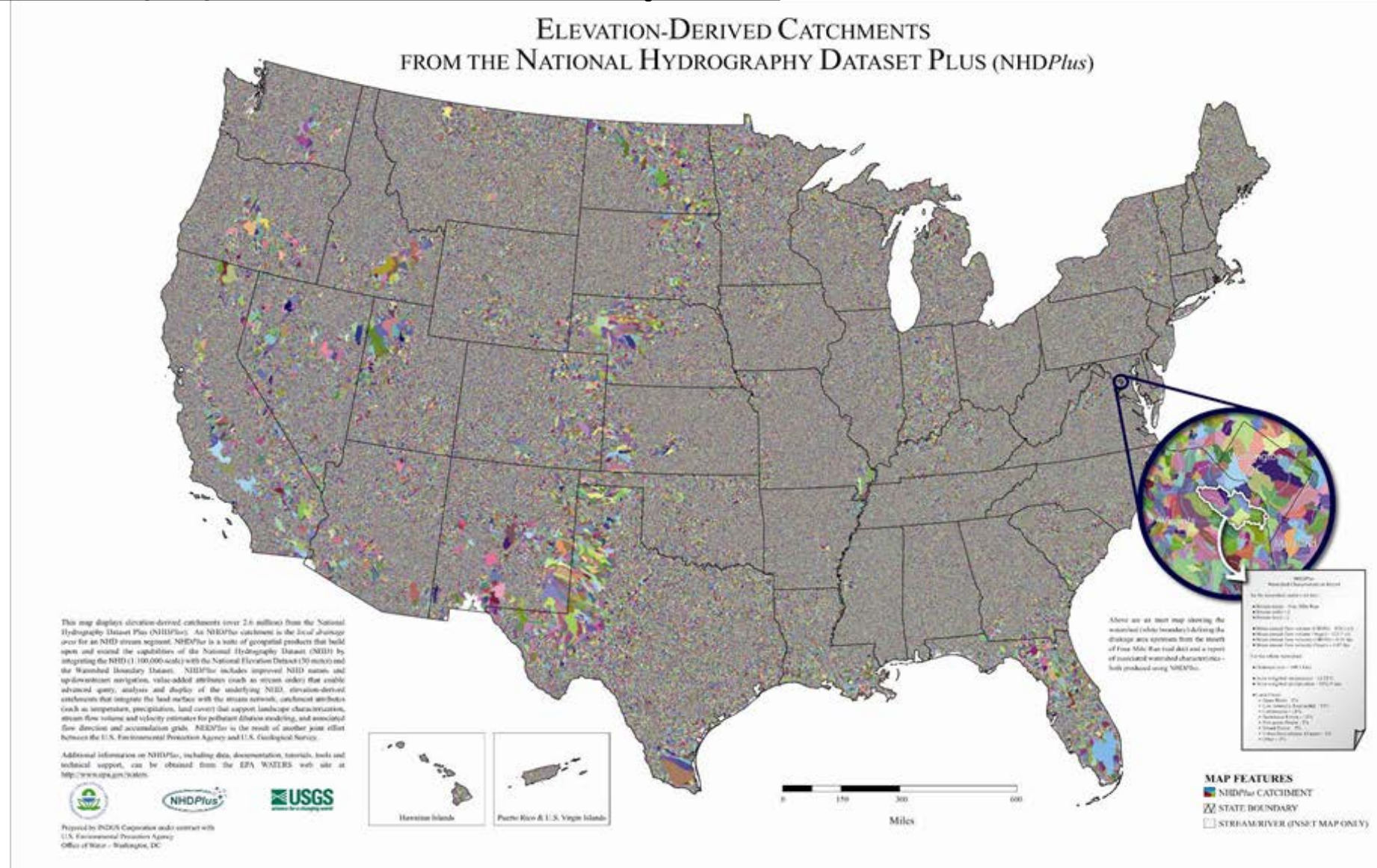
Top 303d/305(b) Delistings by Cause Group Name



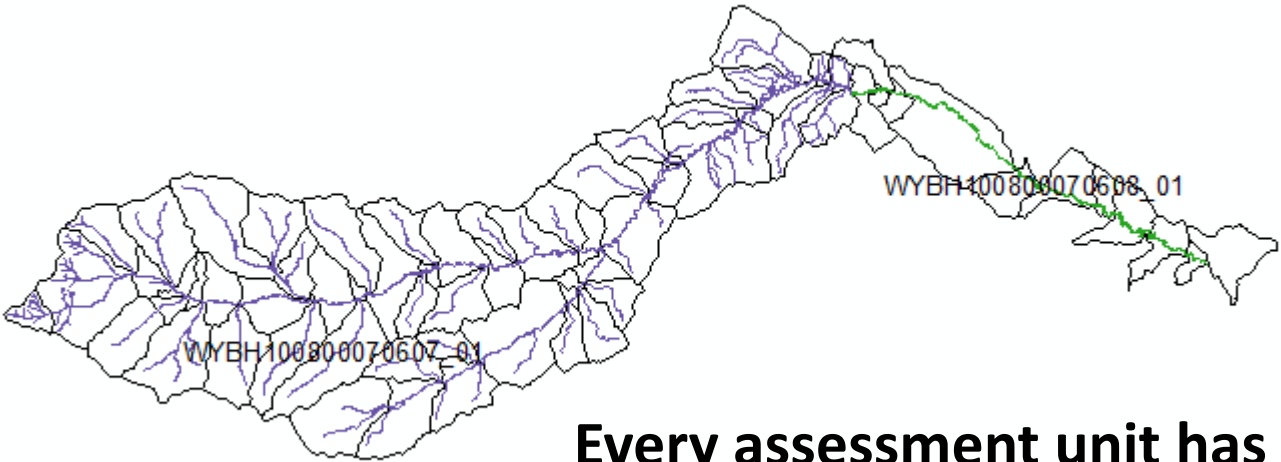
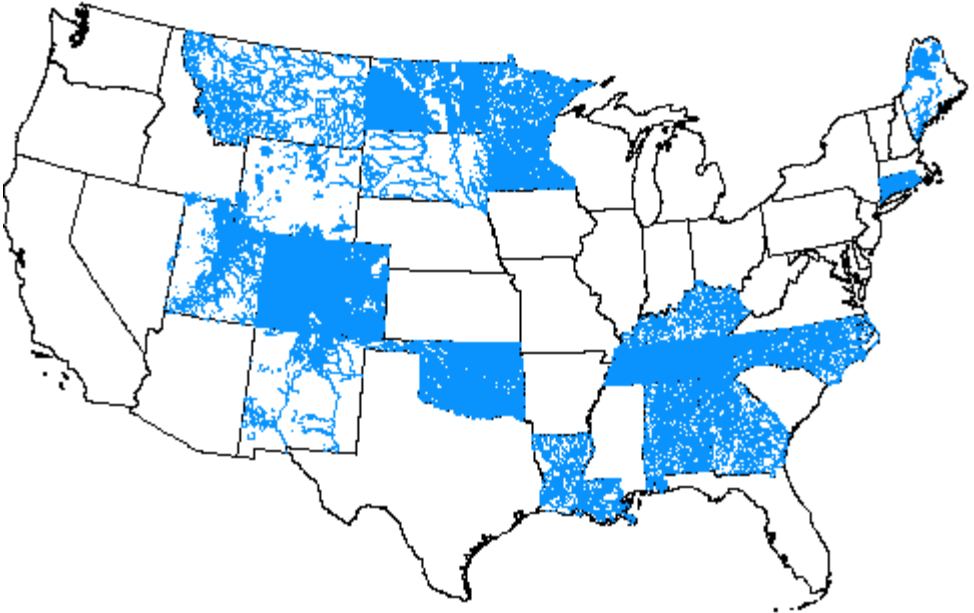
State 303(d)/305(b) data + NHDplus

NHDPlus is Hydrologic geofabric with rich attribute data for 2.6 million catchments in lower 48.

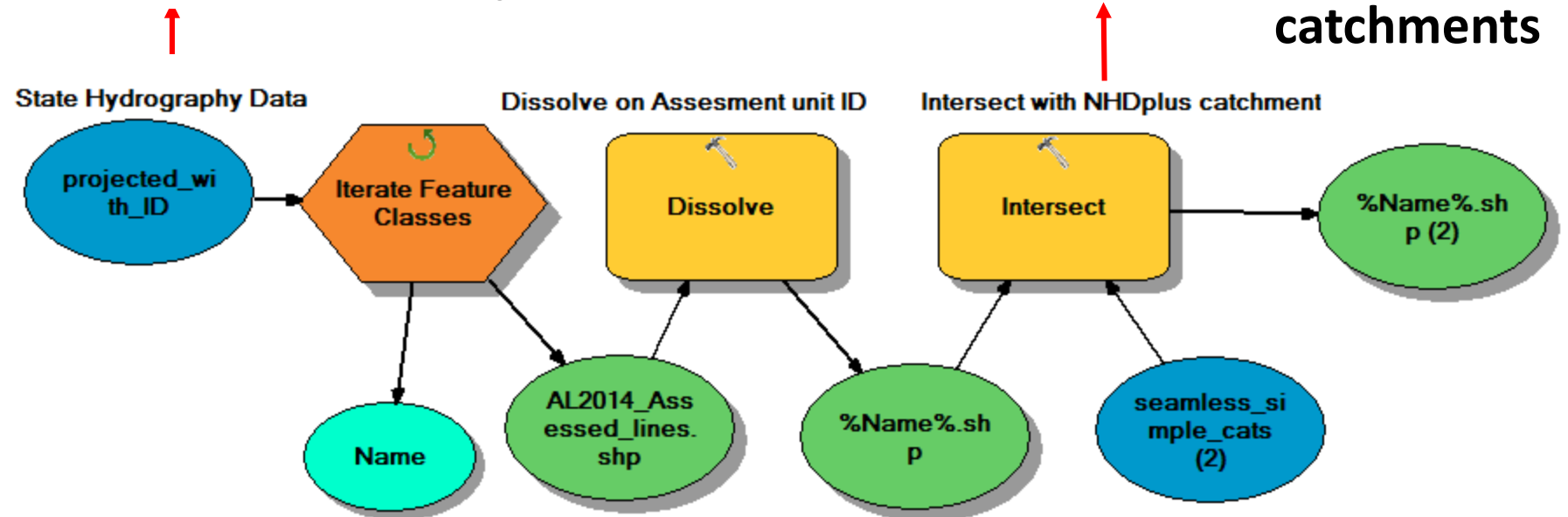
Excellent format to bring IR data into communication with other landscape features.



State WQ Assessment Data->NHDplus

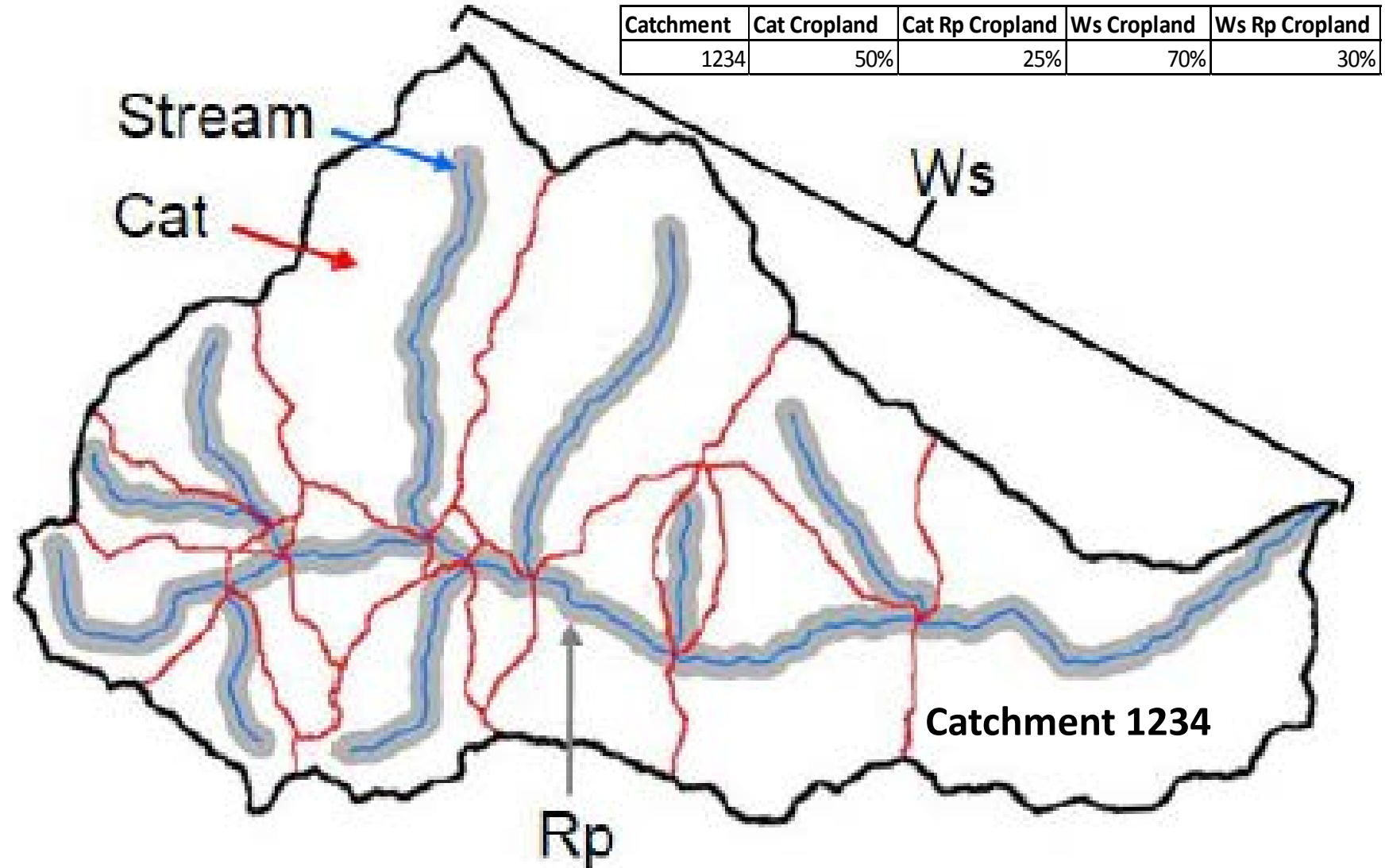


Every assessment unit has list of corresponding catchments



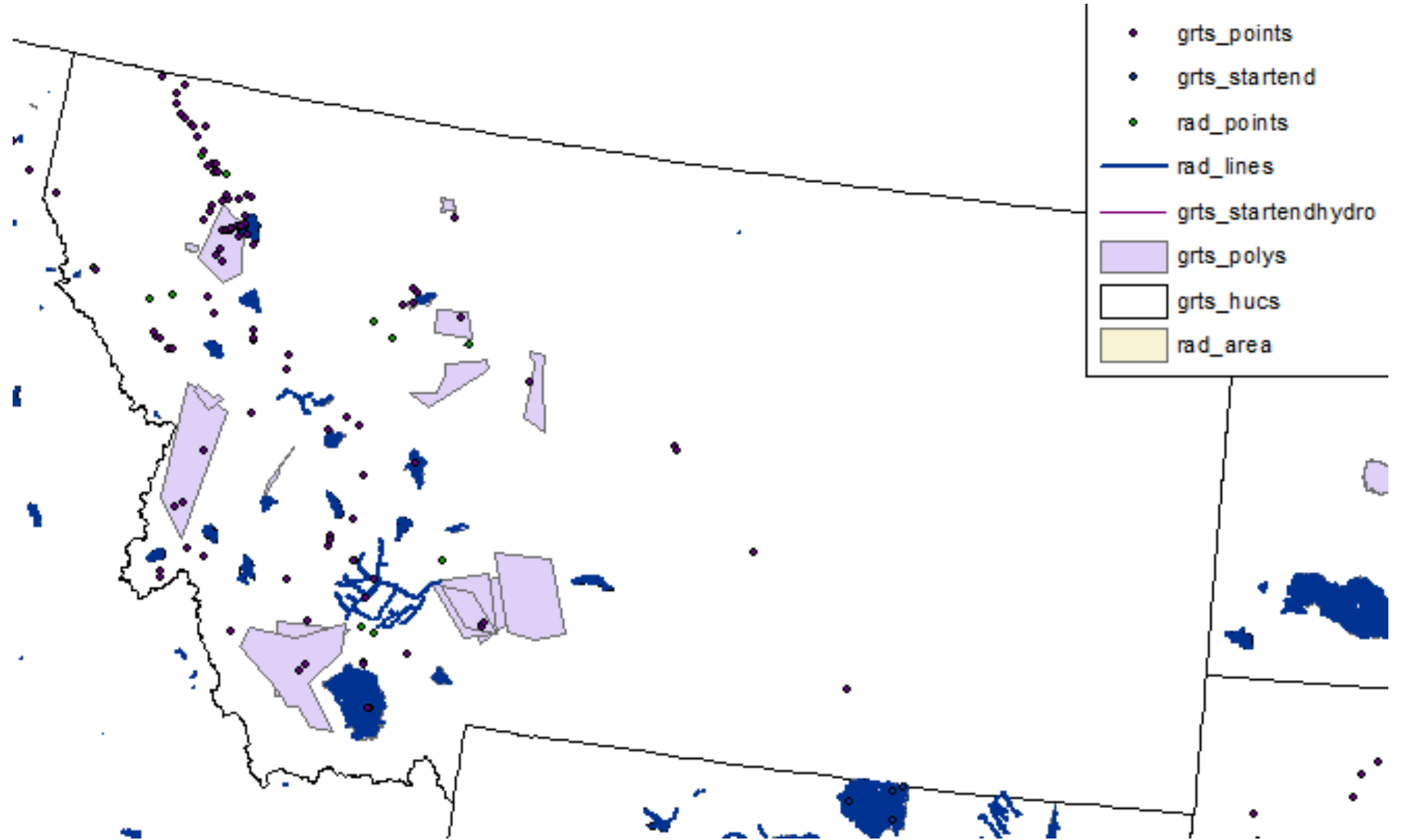
Landscape and Programmatic Data: Streamcat

Streamcat is dataset of anthropogenic and natural landscape attributes referenced to the NHD stream network at multiple scales.



Landscape and Programmatic Data: 319

- **1)Points->** representing impacted waterbodies, manually drawn project locations
- **2)Lines->** representing impacted reaches
- **3)Polygons->** representing impacted waterbodies, HUCs, and manually drawn project locations



*No start end hydro in MT

Example Case Study: Montana

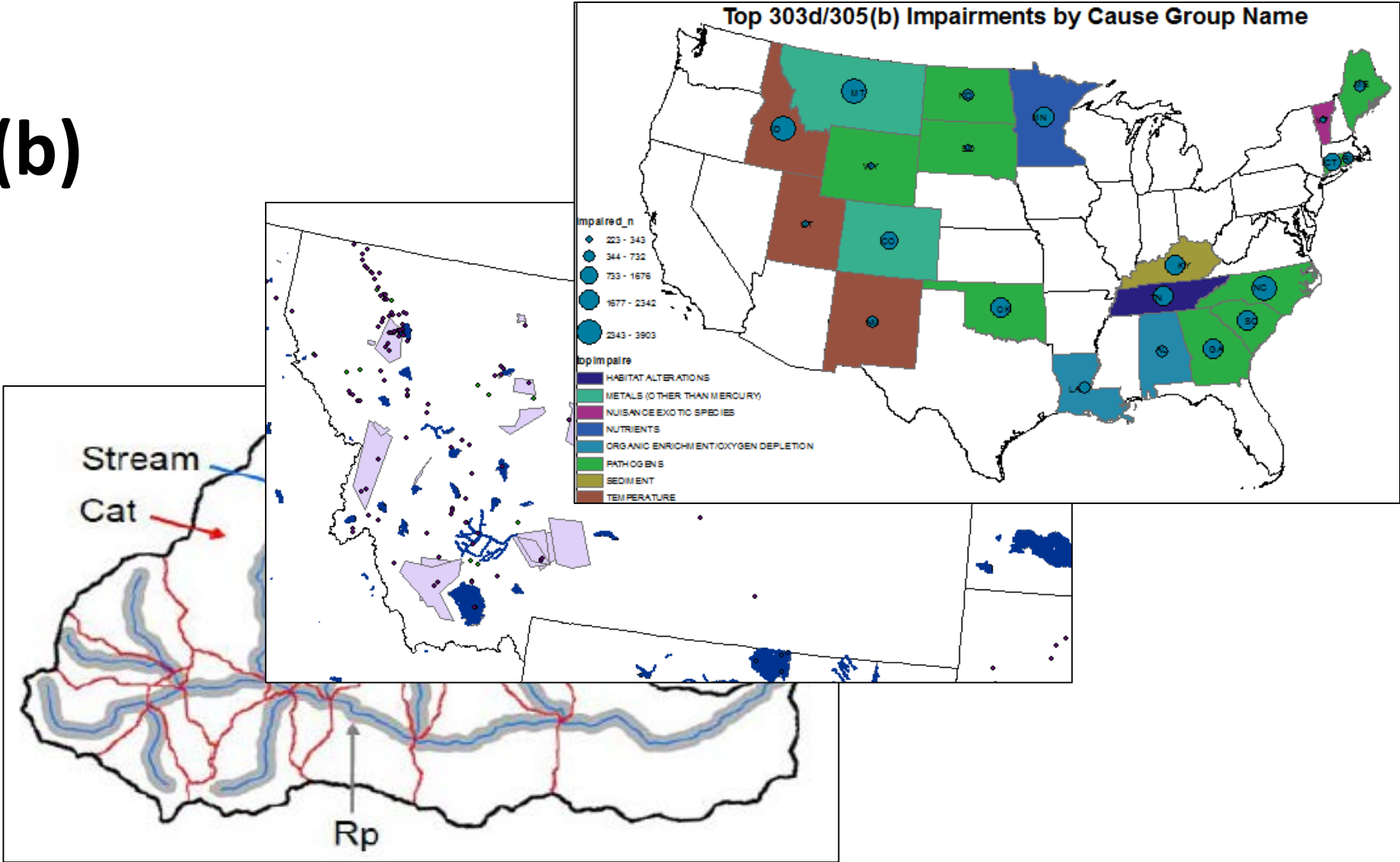
303(d)/305(b)

+

319

+

Streamcat



Montana Delistings 2008-2014

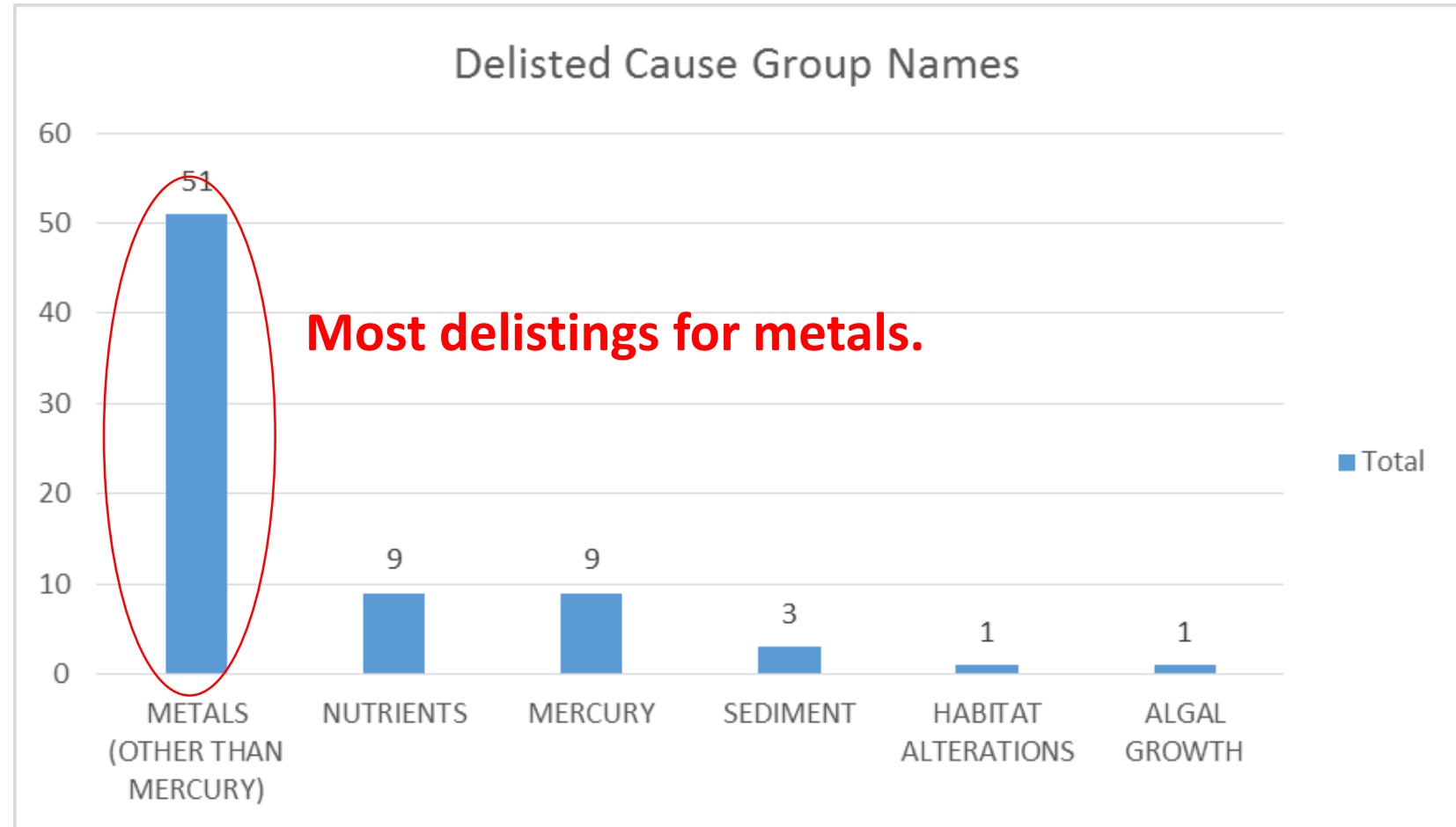
Examining causes of impairment in Montana which had

WQS_ATTAINMENT_REASON

"Applicable WQS attained, due to restoration activities."

Or

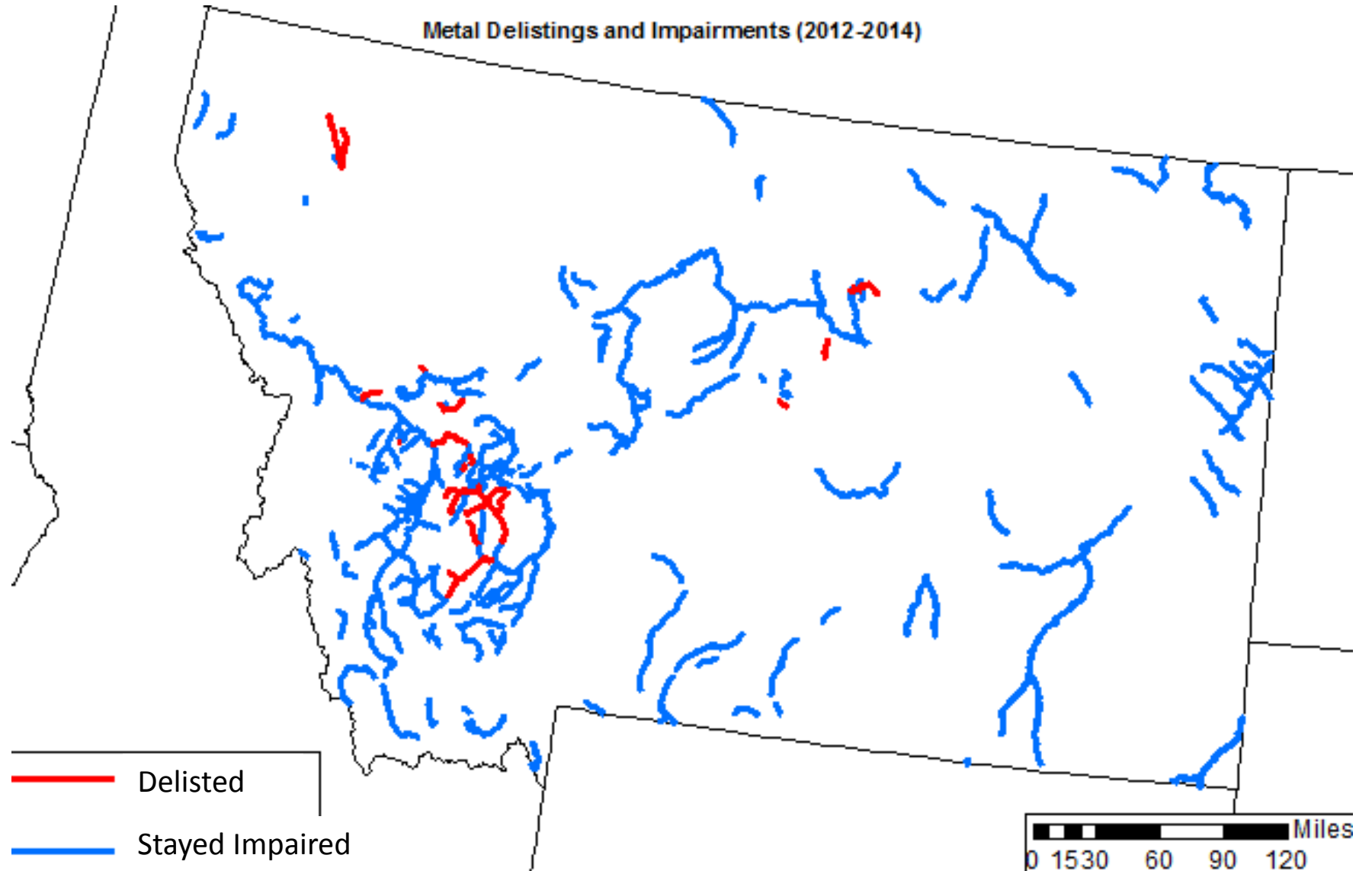
"Applicable WQS attained; reason for recovery unspecified."



Metal Impairments: 2012-2014

28 rivers/streams were delisted for metal impairment(s) in 2014.

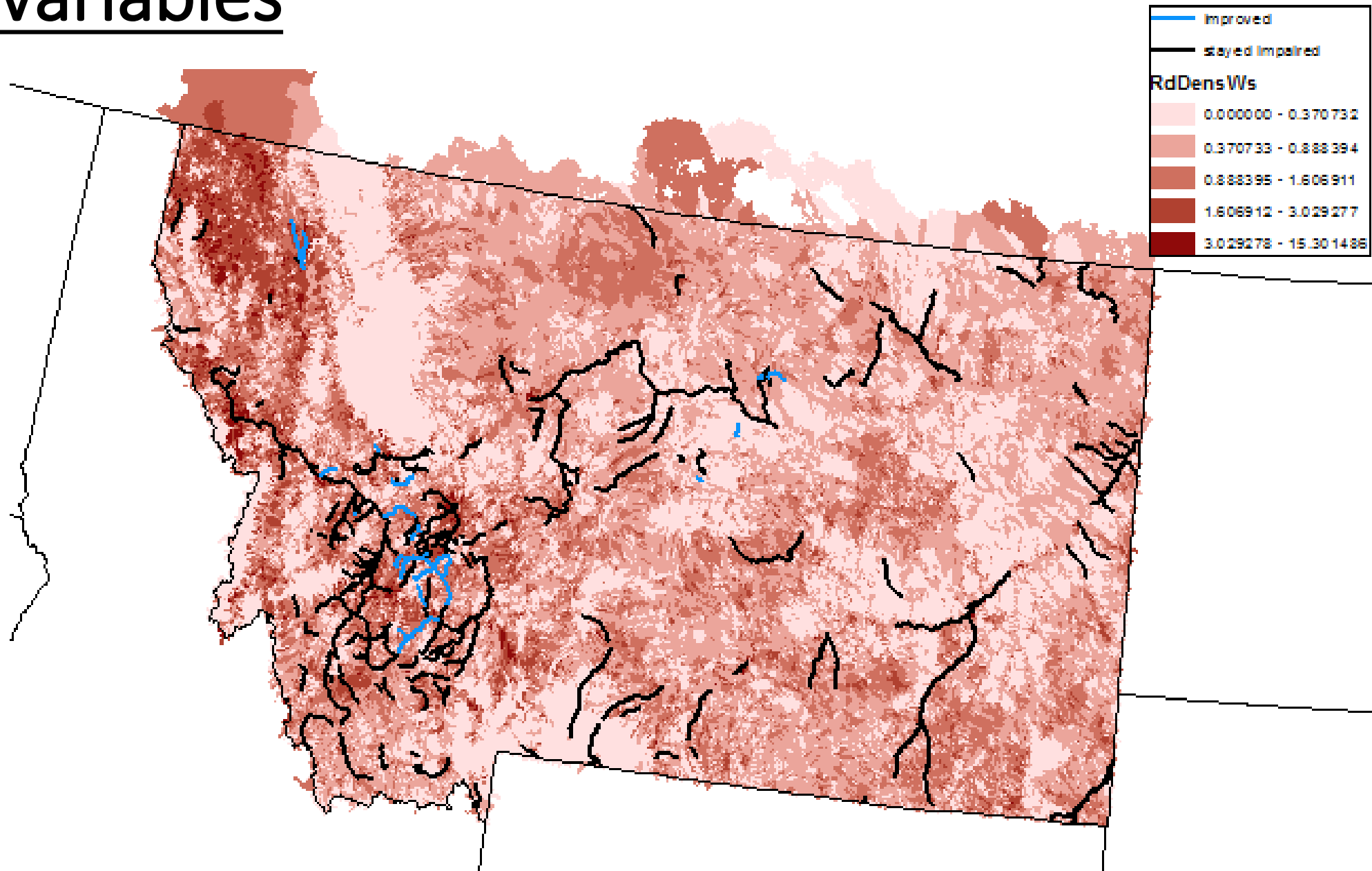
238 rivers/streams had metal impairment(s) in both 2012 and 2014 without a metal delisting.



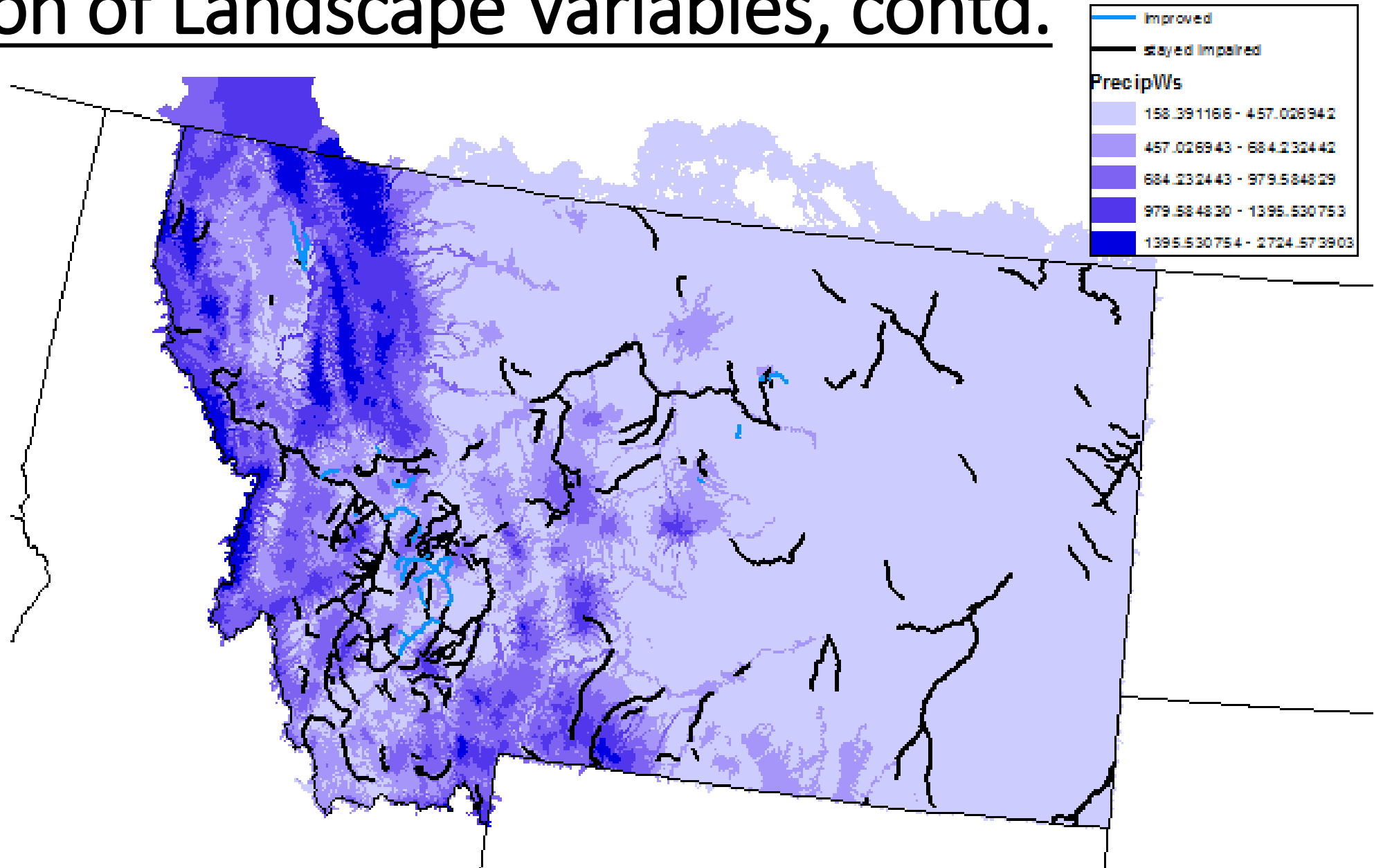
Visually Examine Distribution of Landscape Variables

Bringing in Streamcat data to visually examine potential patterns in landscape that may correlate to improvement vs lack of change.

These particular variables are just presented as examples.

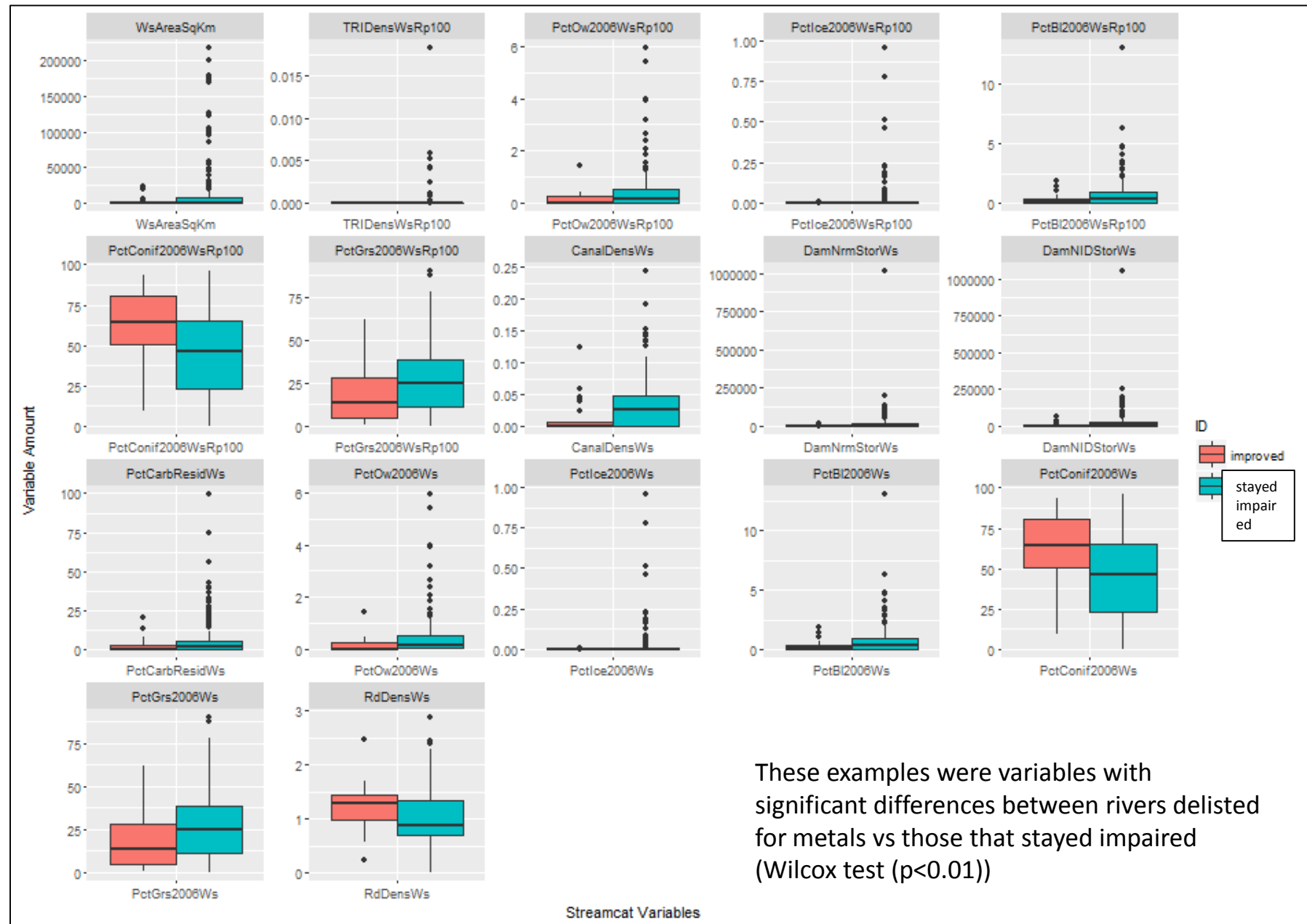


Distribution of Landscape Variables, contd.



Quantify land cover characteristics with Streamcat data

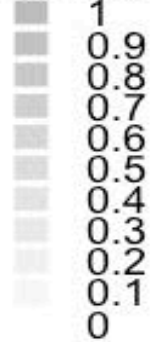
E.g. : Road density, watershed area, NLCD classes of land cover, dam density, superfund site density, etc.



Potential to Model Impairment Status or changes in Status

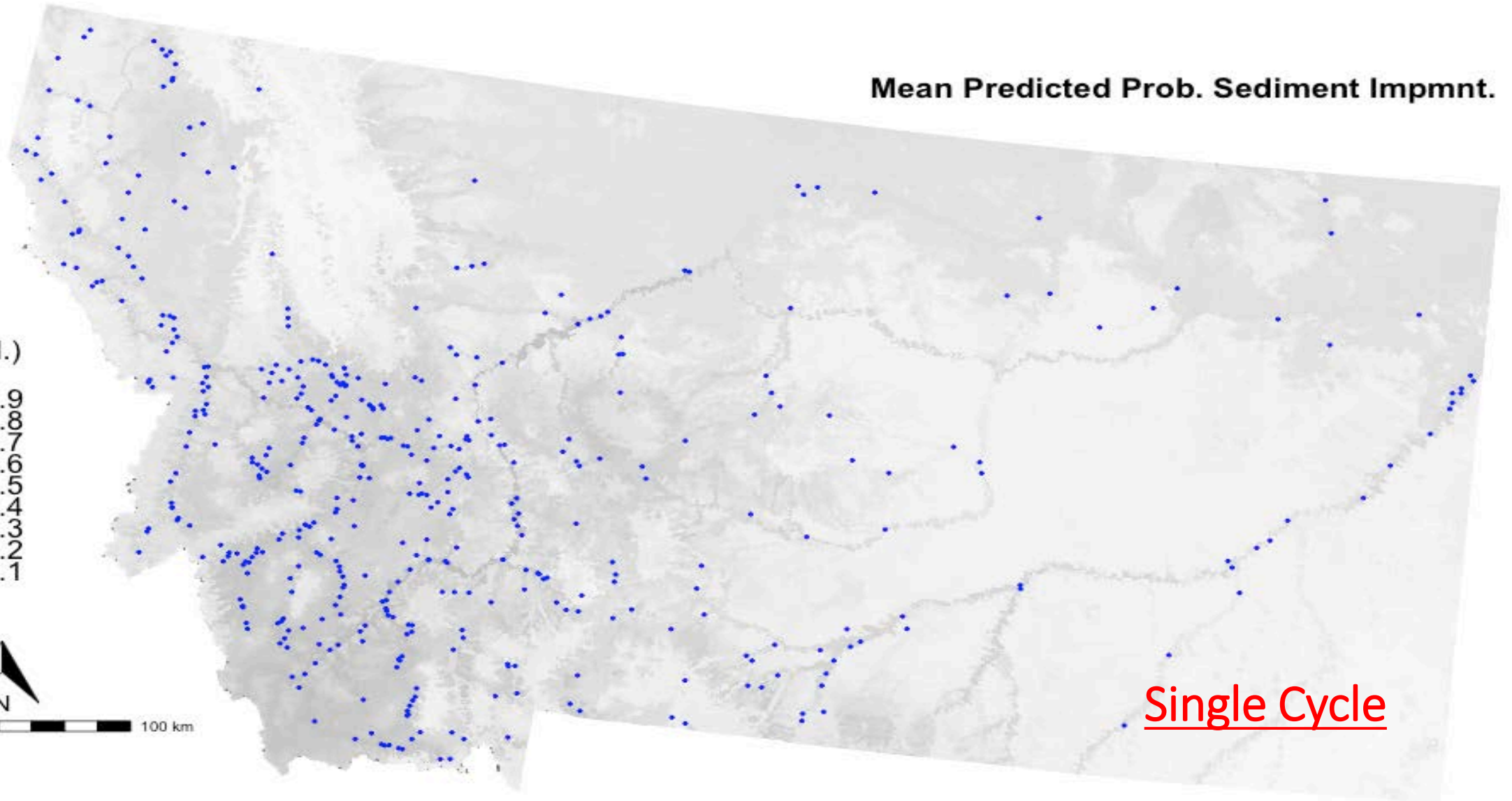
Mean Predicted Prob. Sediment Impmnt.

p(Sed.)



100 km

Single Cycle



Programmatic Data: 319 Metal Related Projects

Selected Columns

Double click on column names in the Subject Areas pane to add them to the analysis. Once added, drag-and-drop columns to reorder them. Edit a column's properties, formula and filters, or delete by clicking or hovering over the button next to its name.

Grant Information | Drainage Areas | Drainage Area Pollutants | General Information

State Name | Award Fiscal Year | PRJDRAR_SEQ | Pollutant Type | Project Title

Filters

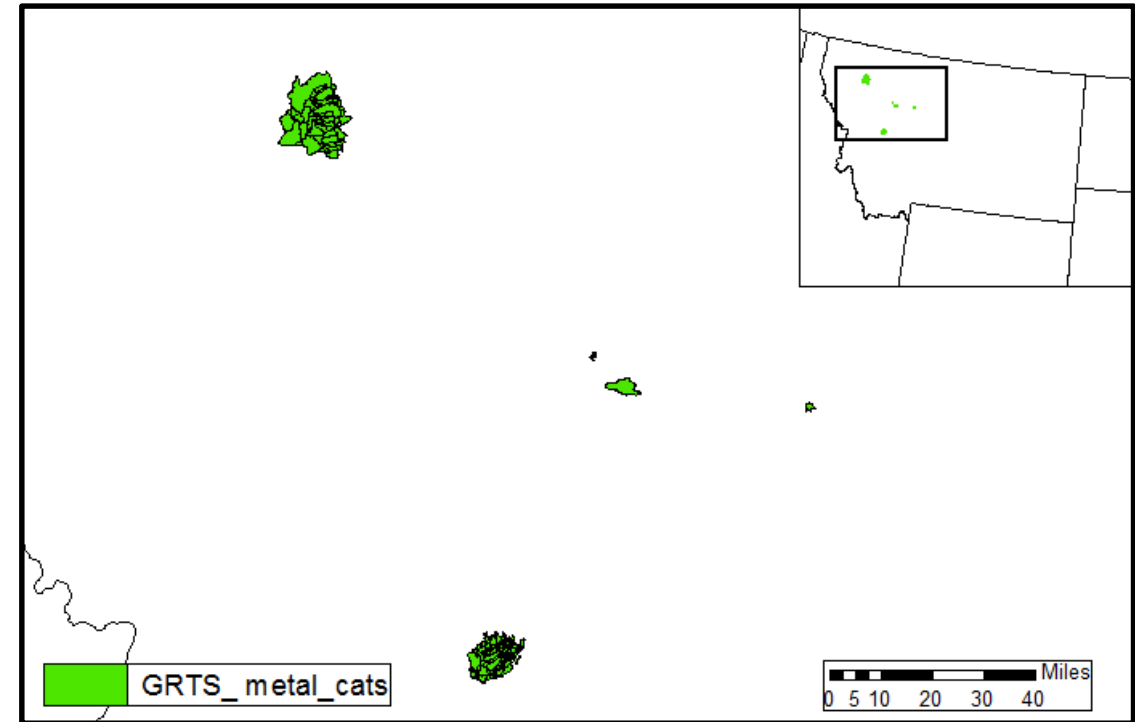
State Name is equal to / is in Montana

AND Pollutant Type is not null

AND Award Fiscal Year is less than 2010

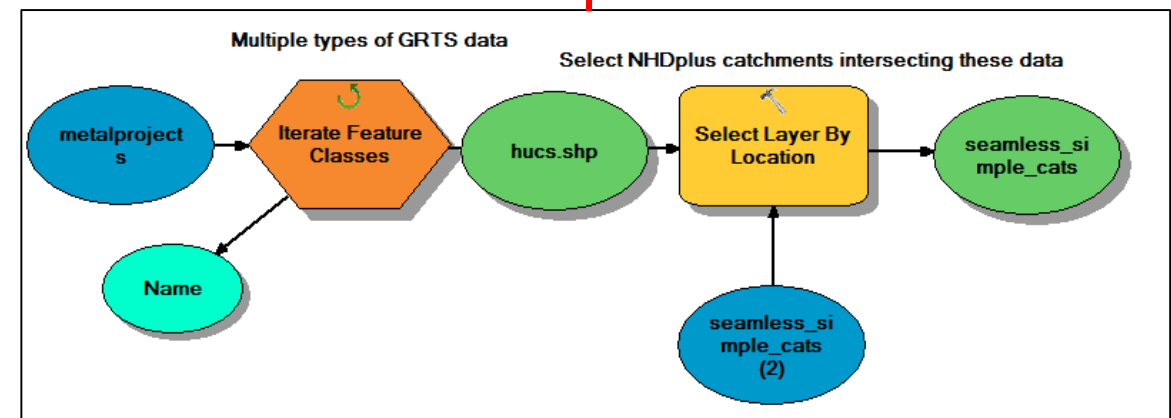
AND Pollutant Type is equal to / is in Acid Mine Drainage; Acidity; Metals (Aluminum); Metals (Arsenic); Metals (Cadmium); Metals (Chromium); Metals (Copper); Metals (Iron); Metals (Lead); Metals (Manganese); Metals (Other); Metals (Zinc); pH

| State Name | Award Fiscal Year | PRJDRAR_SEQ | Pollutant Type | Project Title |
|------------|-------------------|-------------|-----------------|--------------------------------------------------------------|
| Montana | 2002 | 19383 | Metals (Other) | Belt Creek Hydrocharacterization |
| Montana | 2005 | 19410 | Metals (Lead) | Middle and Lower Big Hole Watershed Restoration and Planning |
| Montana | 2005 | | Metals (Other) | Middle and Lower Big Hole Watershed Restoration and Planning |
| Montana | 2005 | 19413 | Metals (Other) | Blackfoot Headwaters TMDL Implementation |
| Montana | 2005 | 19418 | Metals (Other) | Middle Blackfoot/Nevada Creek/Lower Blackfoot TMDL Planning |
| Montana | 2005 | 19421 | Metals (Other) | Beaverhead Watershed TMDL |
| Montana | 2009 | 91563 | Metals (Copper) | Bigfork Storm Water Project |
| Montana | 2009 | | Metals (Zinc) | Bigfork Storm Water Project |



Corresponding Geometries in ArcGIS:
 "PRJDRAR_SEQ" IN
 ('19383','19410','19413','19418','19421','91563')

Intersecting
 NHDplus
 Catchments

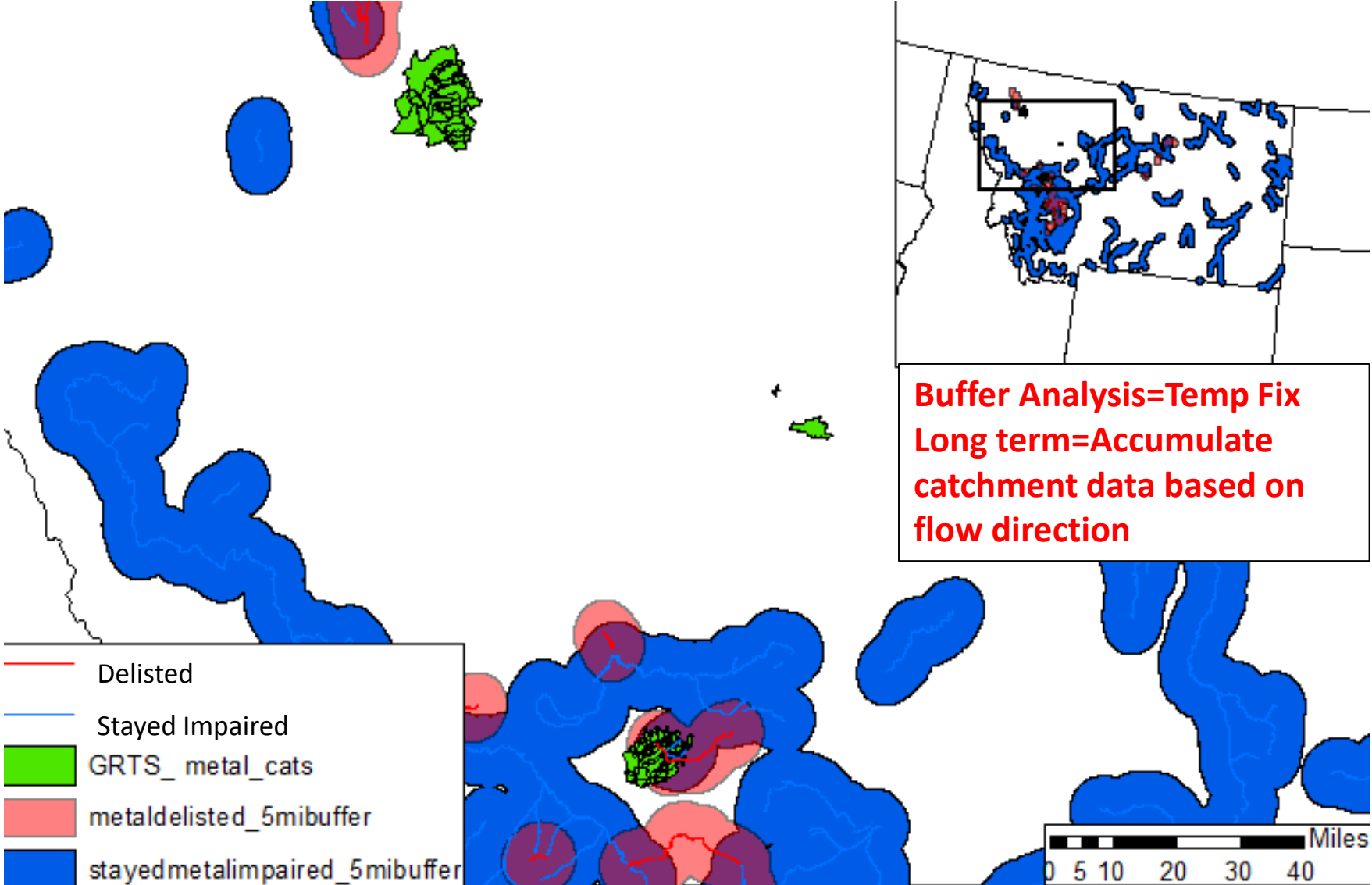


Metal Impairments + 319 Work?

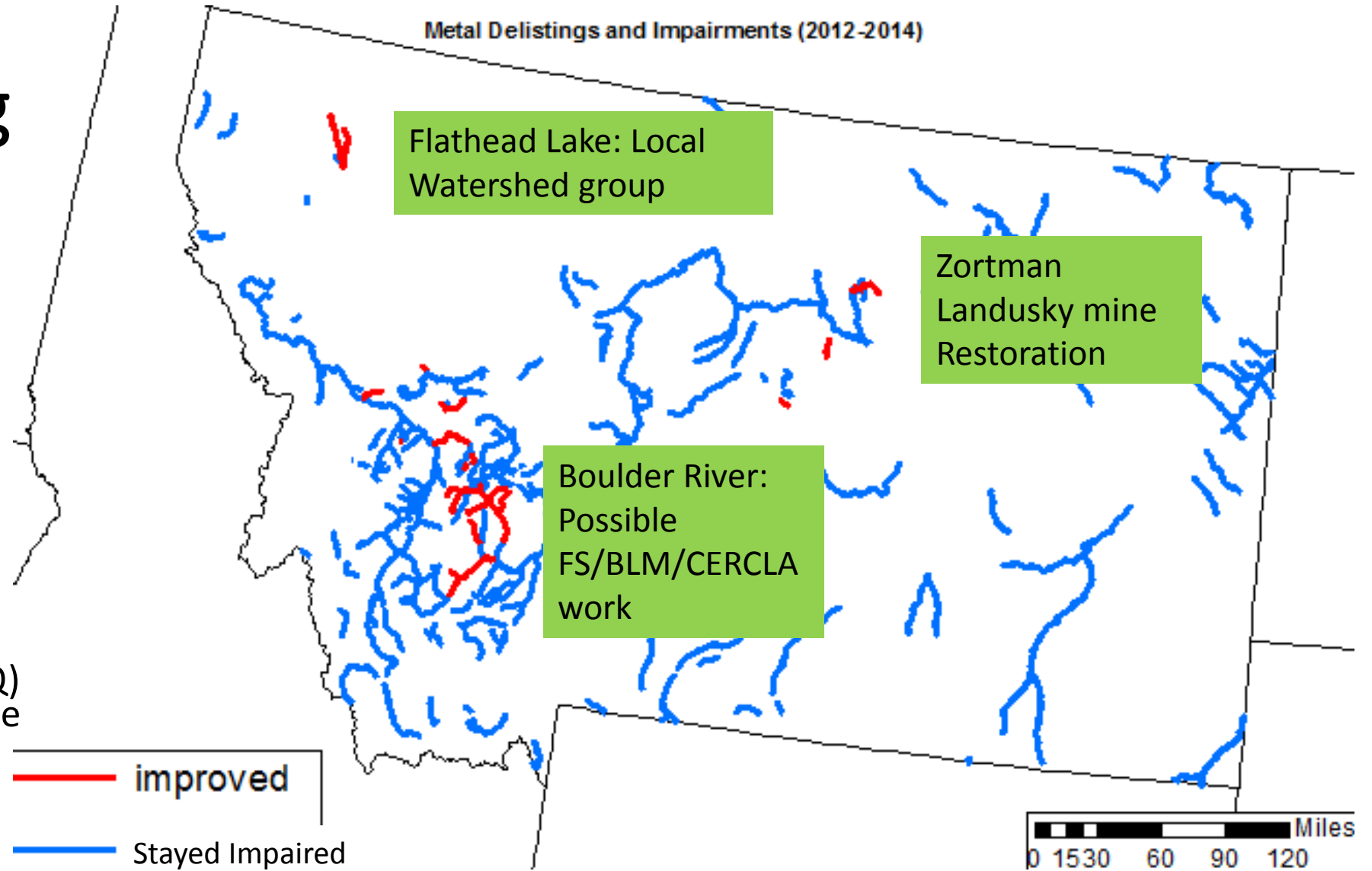
One delisted AU within five miles of GRTS drainage areas addressing metals.

Four AUs that remained impaired for metals in both cycles within five miles

Buffers to test whether GRTS catchments with metal remediation work are within certain distance of the selected rivers/streams →



Additional Contributing Restoration Work?



*Thank you to Autumn Coleman (Montana DEQ) for helping identify some of these restoration actions

Zortman Landusky mine Restoration

Active Treatment of
AMD

Copper, lead,
selenium, cadmium,
iron delistings

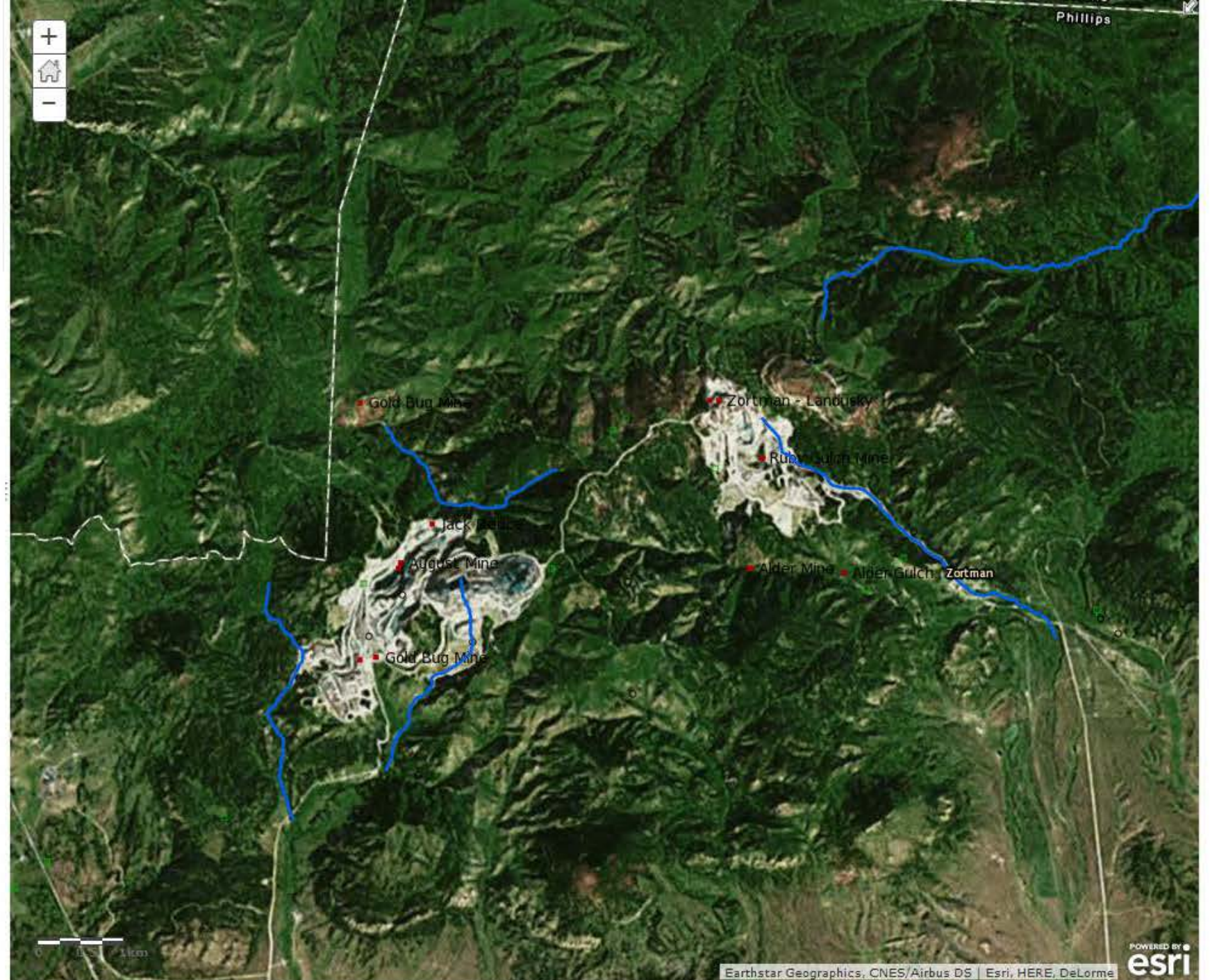
About Content Legend

Legend

Improved_Metals

MRDS

- Mine, past or present producer
- Prospect or occurrence
- Processing plant
- Unknown



Boulder River Area

Possible combination of BLM, FS, Superfund, and DEQ efforts

Cadmium, iron, zinc, silver, copper, lead, arsenic, selenium delistings

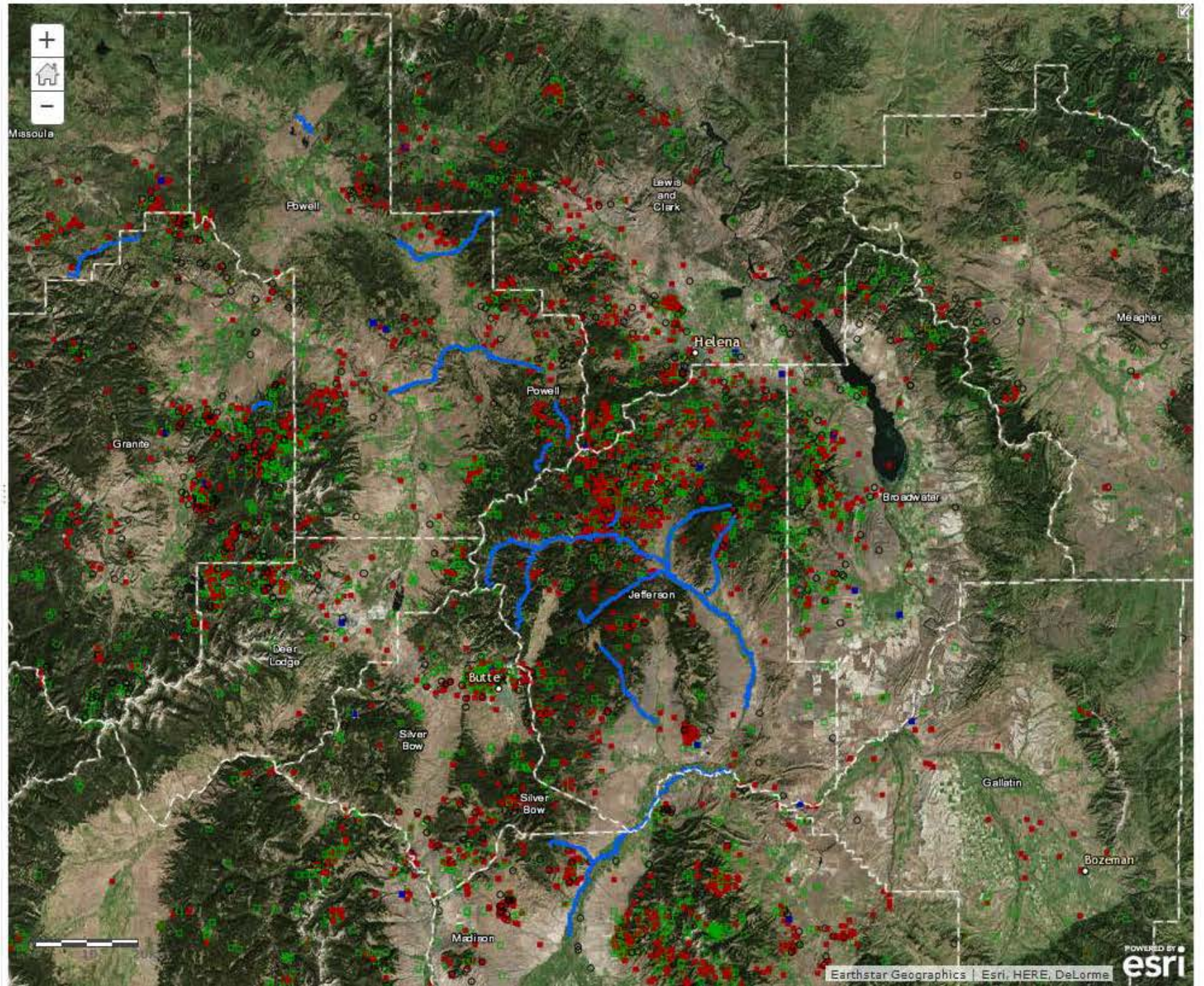
About Content Legend

Legend

Improved_Metals

MRDS

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- Prospect or occurrence
- Processing plant
- Unknown



Readily Available Datasets: 319 Geospatial Data

U.S. Environmental Protection Agency



GRTS HOME

- State Records
- Tribal Grants
- Pre-Award
- Watershed Plan Tracker
- Success Stories
- Polluted Runoff: Nonpoint Source Home
- Reports
- Load Reduction Models [Exit](#)
- XML Data Import
- [Shapefiles](#)
- Online Help
- Update My Profile
- Change Password
- Report an Issue
- Logout

Grants Reporting and Tracking System - GRTS

[EPA Home](#) > [GRTS Home](#)

Grant Reporting and Tracking System, Release 4.2

UPDATE (8/12/2016): *Anticipated Changes to GRTS, & the Impen*

Hello Team GRTS:

As many of you know, there have been long-standing plans to update the GRTS

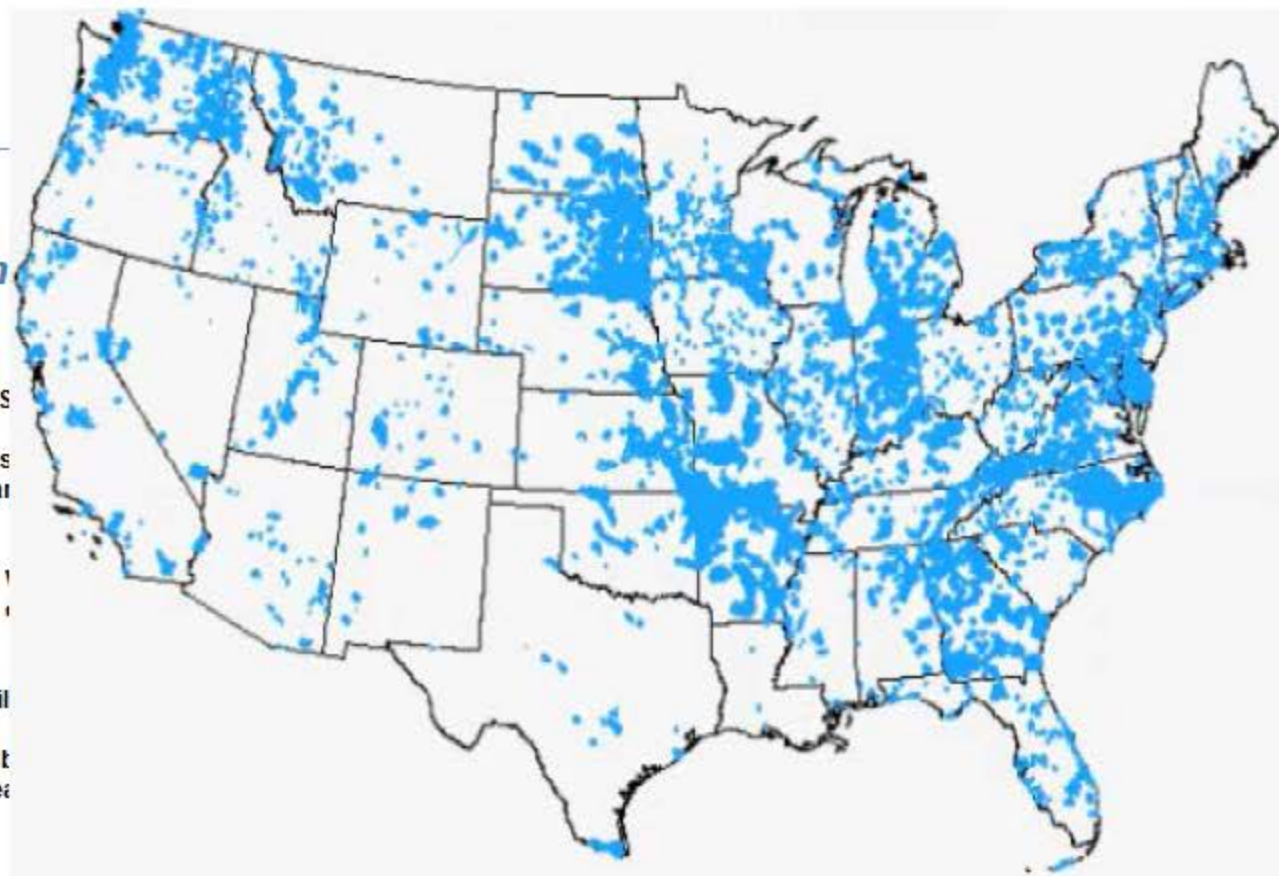
In recent months, EPA has been working with the contractor team to develop a much more user-friendly and modern GRTS. While most changes will appear to streamline and consolidate data resources and improve data quality.

Additionally, the impending shift from the Nonpoint Source Program Measure, housed in the GRTS environment and used to help build success stories in an on program successes using existing tools!

Supplemental training and guidance docs will be provided to assist users until

For both the updated GRTS system and the new SSDB, EPA Headquarters will be near future. If you are interested in participating in a pilot of either system, please contact Jorge.Adam@epa.gov.

Thank you again for your continued work.



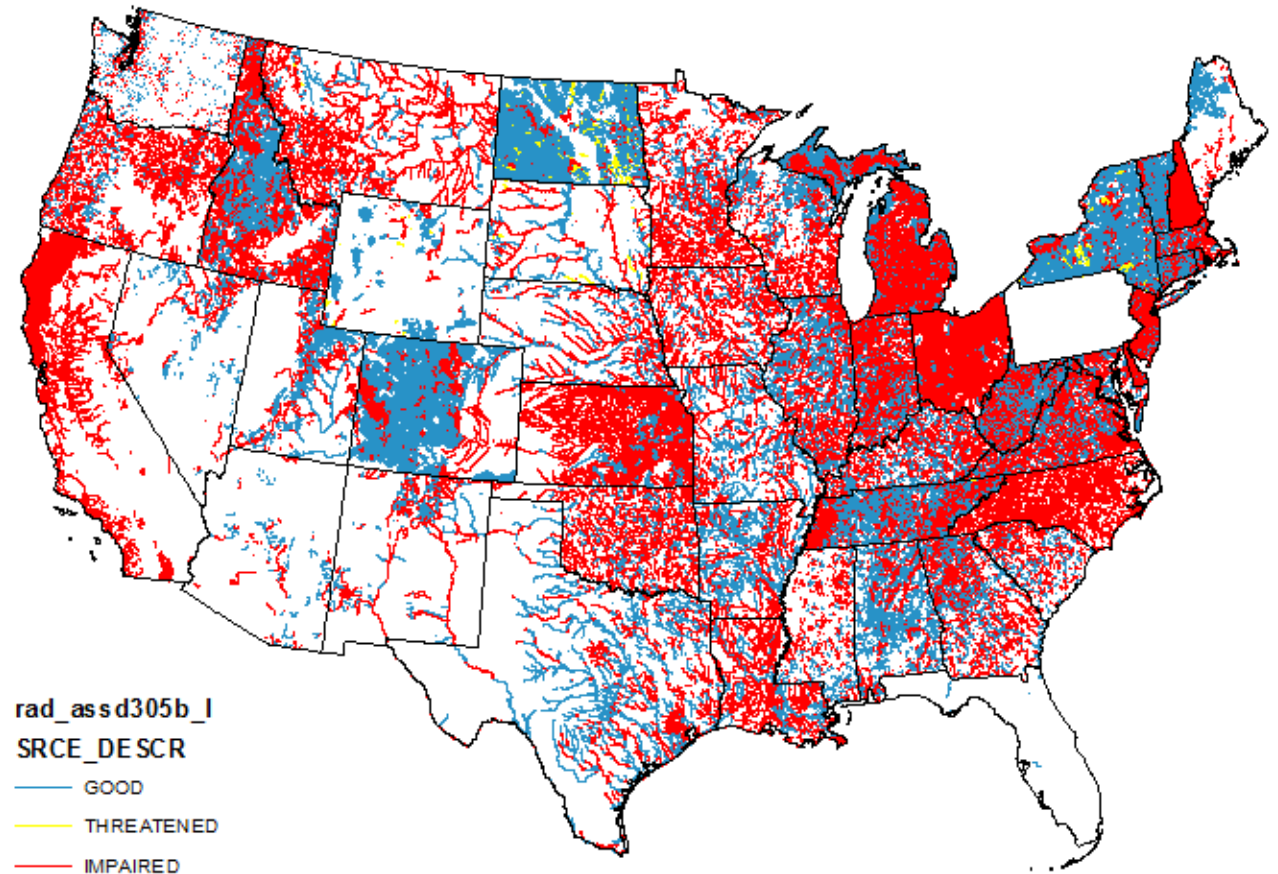
<https://iaspub.epa.gov/apex/waters/f?p=110:199>

Readily Available Datasets: 305(b) Geospatial Data

| 305(b) Waters As Assessed NHDPlus Indexed Dataset with Program Attributes | |
|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Download | Shapefiles (353 MB) OGC GeoPackage (406 MB) Extracted on June 18, 2015 Changelog (Excel)(24 K) ESRI 10.x File Geodatabase (240 MB) Attributes Only (Excel, 48 MB) |
| Metadata | Spatial and attribute metadata is located at the EPA Environmental Dataset Gateway . |
| Additional Information | For this dataset as of 2014, Reach Address Database events have been indexed to NHDPlus v2.1 hydrology (previous versions utilized NHDPlus v1.0 hydrology). Fact Sheet Coming Soon 305(b) Assessed Waters by Assessed Uses Field Descriptions (2 pp, 21 K) |
| Geospatial and Attribute Linkage Information | Use the provided ESRI_KEY for joining tables. Note that there is a many-to-many relationship between attributes and geospatial records. |

<https://www.epa.gov/waterdata/waters-geospatial-data-downloads>

Additional attributes can be downloaded from <https://iaspub.epa.gov/apex/waters/f?p=ASKWATERS:EXPERT:0>

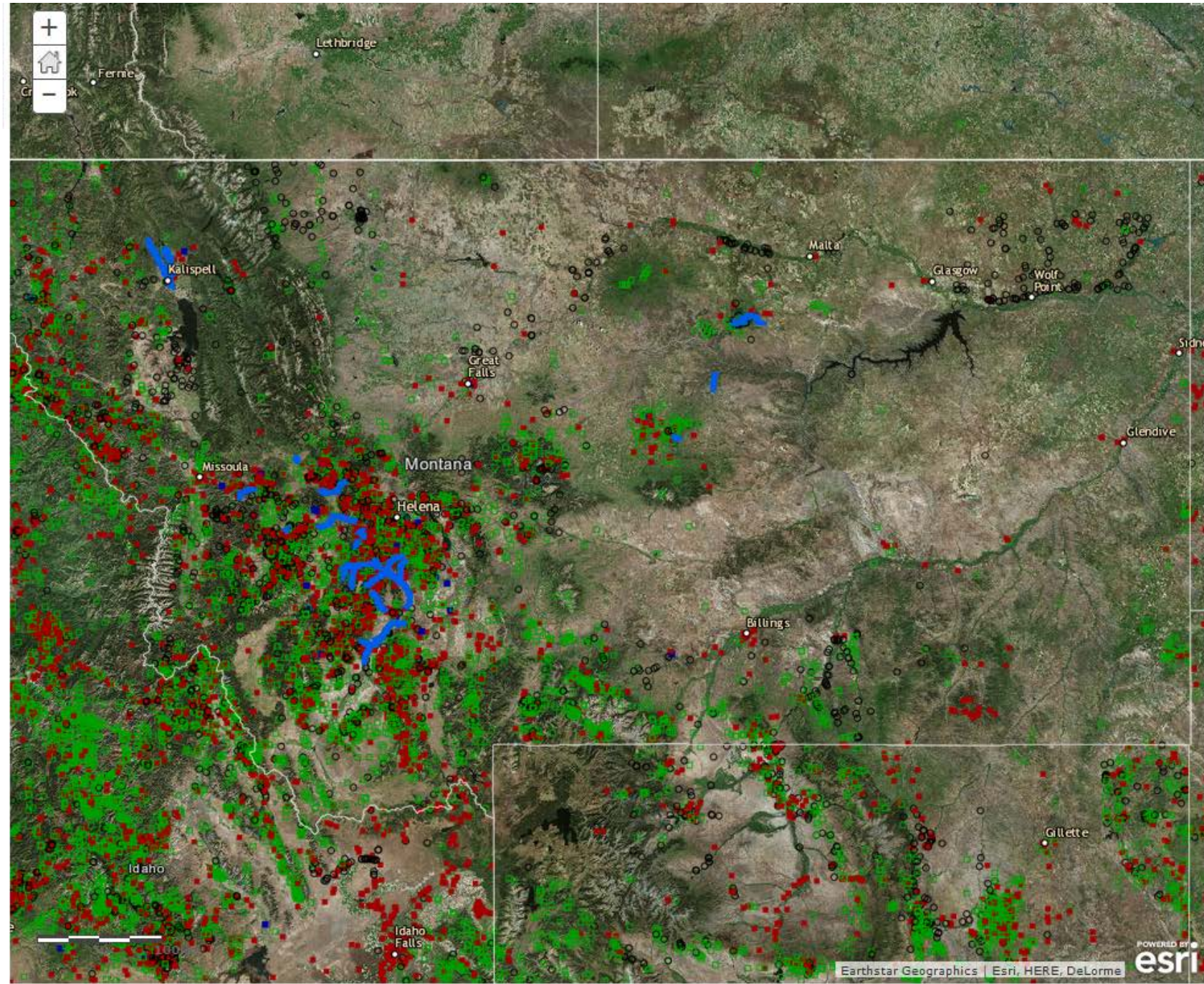


Take Away Questions/Comments

- Mapping the data and sharing this with colleagues, stakeholders, etc is very useful in NPS program implementation and data analysis.
- 303(d)/305(b) + NHDplus gives potential to examine factors associated with delistings or impairments within single cycle.
- Plan is to improve GRTS geospatial data entry by allowing users to actively edit which HUC12s are selected when they manually draw drainage areas.
- Next, a quick overview of several methods for interactive mapping of the above datasets

Lets get Mapping

- Mapping water quality and project data is an important first step in data analysis, stake holder engagement, and outreach.
- Many programs out there to facilitate interactive mapping



ArcGIS My Map New Map ari

Details Add Basemap Save Share Print Measure Bookmarks Find address or place

Make your own map

It's easy to make your own map. Just follow these steps:

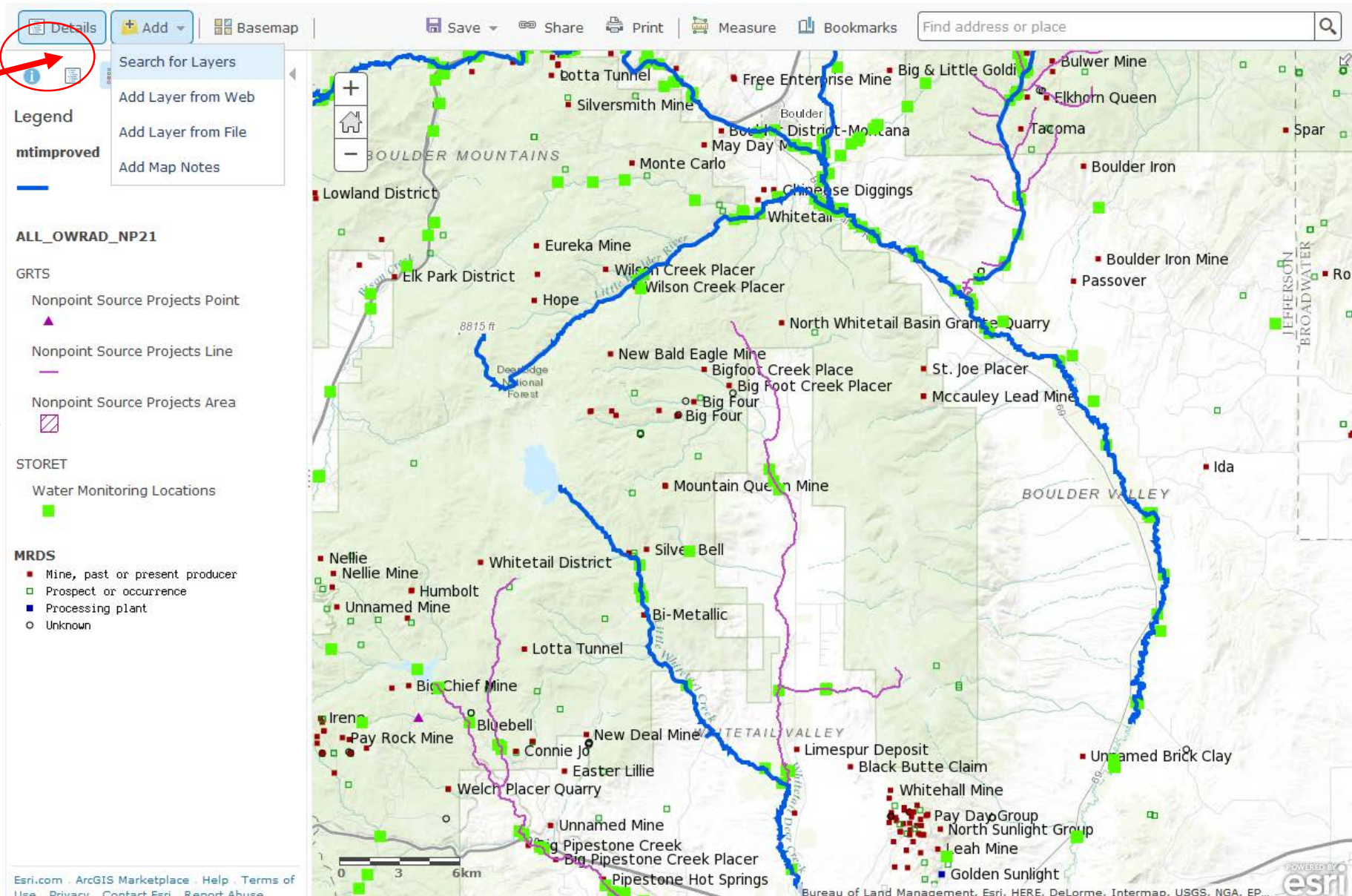
- 1. Choose an area.**
Pan and zoom the map to an area or search by its name or address.
- 2. Decide what to show.**
Choose a Basemap then Add layers on top of it.
- 3. Add more to your map.**
Add map notes to draw features on the map.

Display descriptive text, images, and charts for map features in a pop-up.
- 4. Save and share your map.**
Give your map a name and description then share it with other people.

Esri.com | ArcGIS Marketplace | Help | Terms of Use | Privacy | Contact Esri | Report Abuse

0 500 1000km

POWERED BY esri
Esri, HERE, DeLorme, FAO, NOAA, USGS, EPA



Search for online layers

Drag and drop EPA WATERS data (e.g. Storet, GRTS, 303(d) etc.)

Popups with Useful Summary data

Details Add Basemap Save Share Print Measure Bookmarks butte

About Content Legend

Legend

Improved_Metals

ALL_OW RAD_NP21

GRTS

- Nonpoint Source Projects Point
- Nonpoint Source Projects Line
- Nonpoint Source Projects Area

MRDS

- Mine, past or present producer
- Prospect or occurrence
- Processing plant
- Unknown

Map showing project locations and features. A popup window displays details for a specific project:

Project Information

Grant #: 99833610 Award Fiscal Year: 2010 Region: 08 State: MT

Project Number: 06 State Project Number: 210116 Statewide: No

Project Title: Upper Clark Fork Tributary Restoration

Project Manager: Mark Kelley Phone: 406-444-3508

State Project Manager: Robert Ray Phone: 406-444-5319

Will Have/Has Pollutant Load Data: Yes TMDL: Implementing a TMDL

Project Schedule

Project Start Date: Did Start On 07/01/2010 (MM/DD/YYYY)

Project End Date: Completed On 04/30/2013 (MM/DD/YYYY)

Comments:

Project Status

Project Budget

Grant Information

| | |
|--------------------------------------|-------------|
| Cumulative Award for Grant: | \$1,170,283 |
| Total 319(h) Funds for all Projects: | \$1,172,013 |
| Balance: | -\$1,730 |
| 319(h) Base Funds: | \$126,000 |
| * 319(h) Incremental Funds: | \$0 |
| Total 319(h) Funds: | \$126,000 |
| EPA Other: | \$0 |
| EPA Budget: | \$126,000 |
| Other Federal: | \$0 |
| State Funds: | \$41,840 |

(2 of 2)

Nonpoint Source Projects Line:
118253

PERMANENT_IDENTIFIER {

EVENTDATE F

REACHCODE 1

REACHSMDATE J

REACHRESOLUTION M

FEATURE_PERMANENT_IDENTIFIER M

SOURCE_ORIGINATOR M

Zoom to

Add
various
basemaps

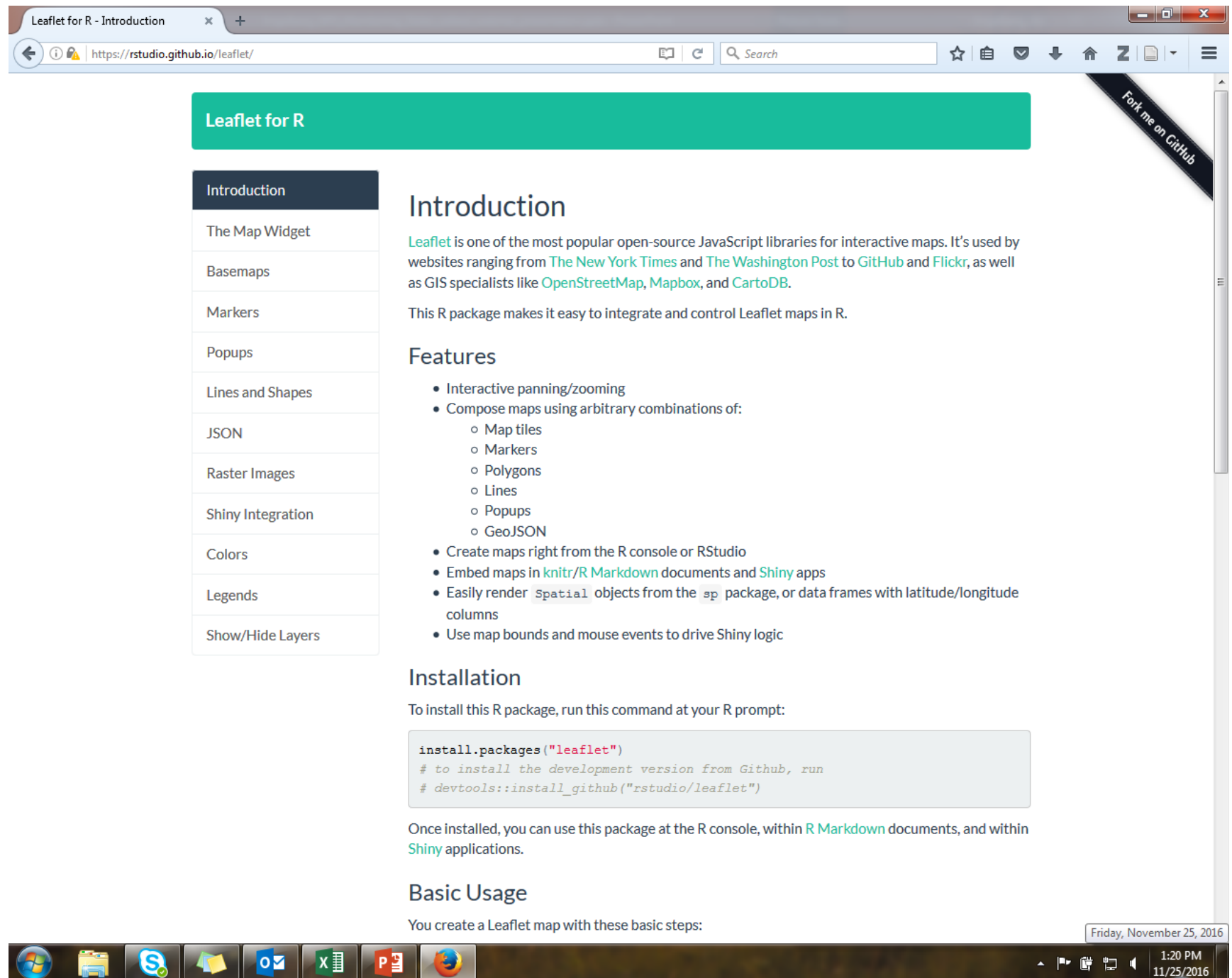
Share as url
or embed in
website

The screenshot displays an Esri web application interface. At the top, there are navigation options: 'Details' (selected), 'Basemap', 'Share', 'Print', and 'Measure'. A search bar at the top right contains the text 'butte montana' and shows a dropdown menu with search results. A red arrow points from the search bar to the dropdown menu. Another red arrow points from the 'Basemap' button to the legend on the left. The legend lists several layers: 'mtimproved' (blue line), 'ALL_OW RAD_NP21' (purple line), 'GRTS' (Nonpoint Source Projects Point, Line, Area), 'STORET' (Water Monitoring Locations), and 'MRDS' (Mine, past or present producer; Prospect or occurrence; Processing plant; Unknown). The map shows a topographic view of the Butte, Montana area, with various mines and districts labeled, such as 'Lotta Tunnel', 'Whitetail District', and 'Big Chief Mine'. A scale bar at the bottom indicates 0, 1.5, and 3 miles. The footer contains the text 'Esri.com · Help · Terms of Use · Privacy · Contact Esri · Report Abuse' and 'Bureau of Land Management, Esri, HERE, DeLorme, Intermap, USGS, NGA, EP...'.

Search by location

Leaflet for R:

R package which provides access to Leaflet javascript library for interactive mapping



The screenshot shows a web browser window displaying the "Leaflet for R - Introduction" page. The browser's address bar shows the URL "https://rstudio.github.io/leaflet/". The page has a green header with the title "Leaflet for R". On the right side, there is a diagonal banner that says "Fork me on GitHub". The main content is organized into sections: "Introduction", "Features", "Installation", and "Basic Usage". A left-hand navigation menu lists various topics like "The Map Widget", "Basemaps", "Markers", etc. The "Introduction" section explains that Leaflet is a popular JavaScript library for interactive maps, used by major news outlets and GIS specialists. The "Features" section lists capabilities like interactive panning, map composition, and integration with R and Shiny. The "Installation" section provides a code snippet for installing the R package. The "Basic Usage" section begins with the instruction to create a Leaflet map using basic steps. The Windows taskbar at the bottom shows the date as Friday, November 25, 2016, and the time as 1:20 PM.

Leaflet for R

Introduction

The Map Widget

Basemaps

Markers

Popups

Lines and Shapes

JSON

Raster Images

Shiny Integration

Colors

Legends

Show/Hide Layers

Introduction

Leaflet is one of the most popular open-source JavaScript libraries for interactive maps. It's used by websites ranging from [The New York Times](#) and [The Washington Post](#) to [GitHub](#) and [Flickr](#), as well as GIS specialists like [OpenStreetMap](#), [Mapbox](#), and [CartoDB](#).

This R package makes it easy to integrate and control Leaflet maps in R.

Features

- Interactive panning/zooming
- Compose maps using arbitrary combinations of:
 - Map tiles
 - Markers
 - Polygons
 - Lines
 - Popups
 - GeoJSON
- Create maps right from the R console or RStudio
- Embed maps in [knitr/R Markdown](#) documents and [Shiny](#) apps
- Easily render `spatial` objects from the `sp` package, or data frames with latitude/longitude columns
- Use map bounds and mouse events to drive Shiny logic

Installation

To install this R package, run this command at your R prompt:

```
install.packages("leaflet")  
# to install the development version from Github, run  
# devtools::install_github("rstudio/leaflet")
```

Once installed, you can use this package at the R console, within [R Markdown](#) documents, and within [Shiny](#) applications.

Basic Usage

You create a Leaflet map with these basic steps:

Friday, November 25, 2016 1:20 PM 11/25/2016

Bring datasets into R, write a few lines of code, and export as stand alone webpage

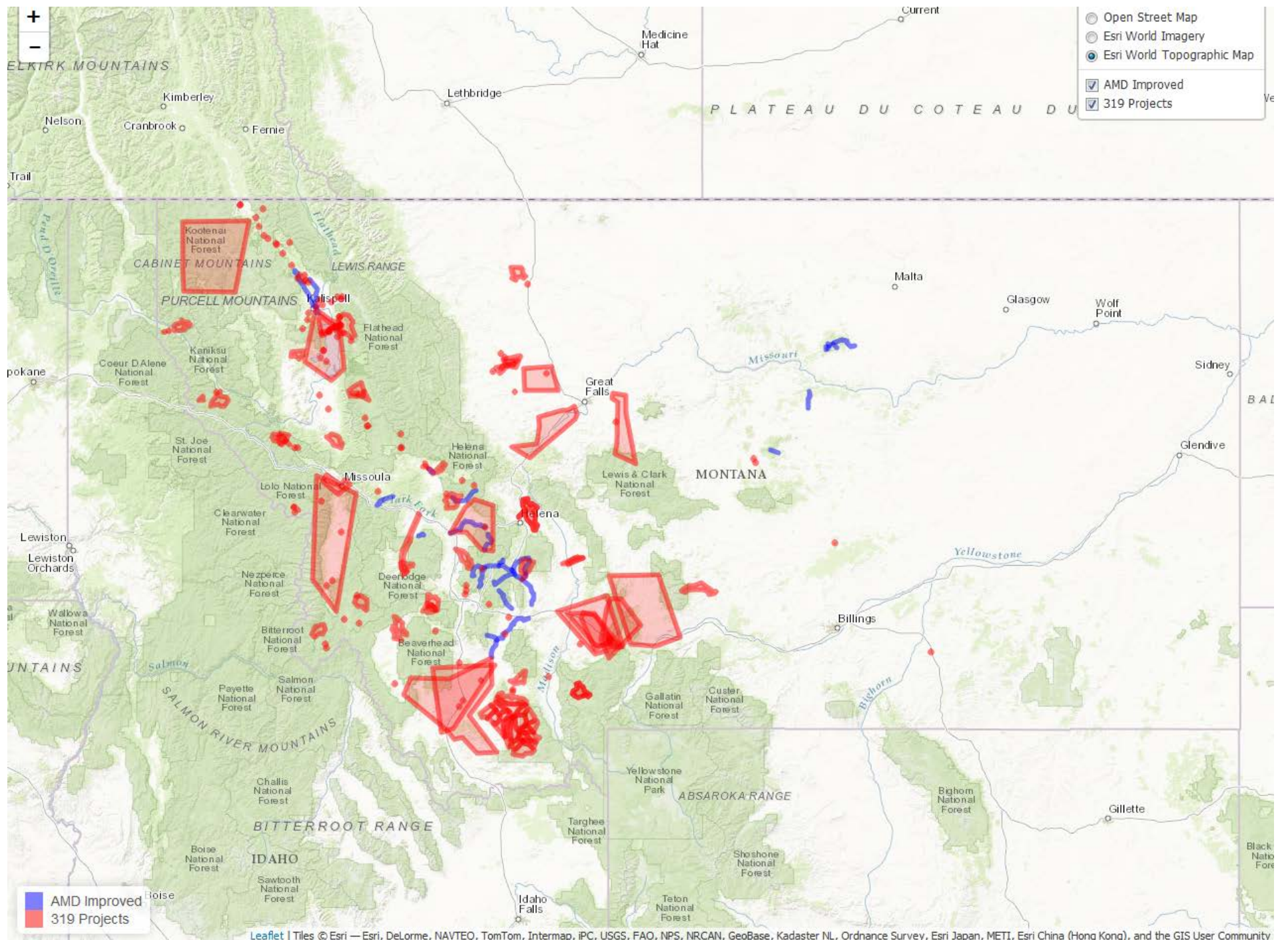
The screenshot displays the RStudio environment with the following components:

- Environment Panel:** Lists variables: `grtspoint` (Formal class SpatialPoints...), `grtspoly` (Large SpatialPolygonsDataFr...), `grtsstarte...` (Formal class SpatialPoints...), `m` (Large leaflet (8 elements, ...)), and `metal_impr...` (Formal class SpatialLinesDa...).
- Map Viewer:** Shows a map of Montana with a legend for "AMD Improved" (blue) and "319 Projects" (red). A layer selection menu is open, showing options for "Open Street Map", "Esri World Imagery", "Esri World Topographic Map", "AMD Improved", and "319 Projects".
- Console:** Contains R code for plotting the map, including `addCircles` and `addMarkers` functions.
- Script Editor:** Shows the full R code for creating the map, including package installation, library loading, map initialization, and layer addition.

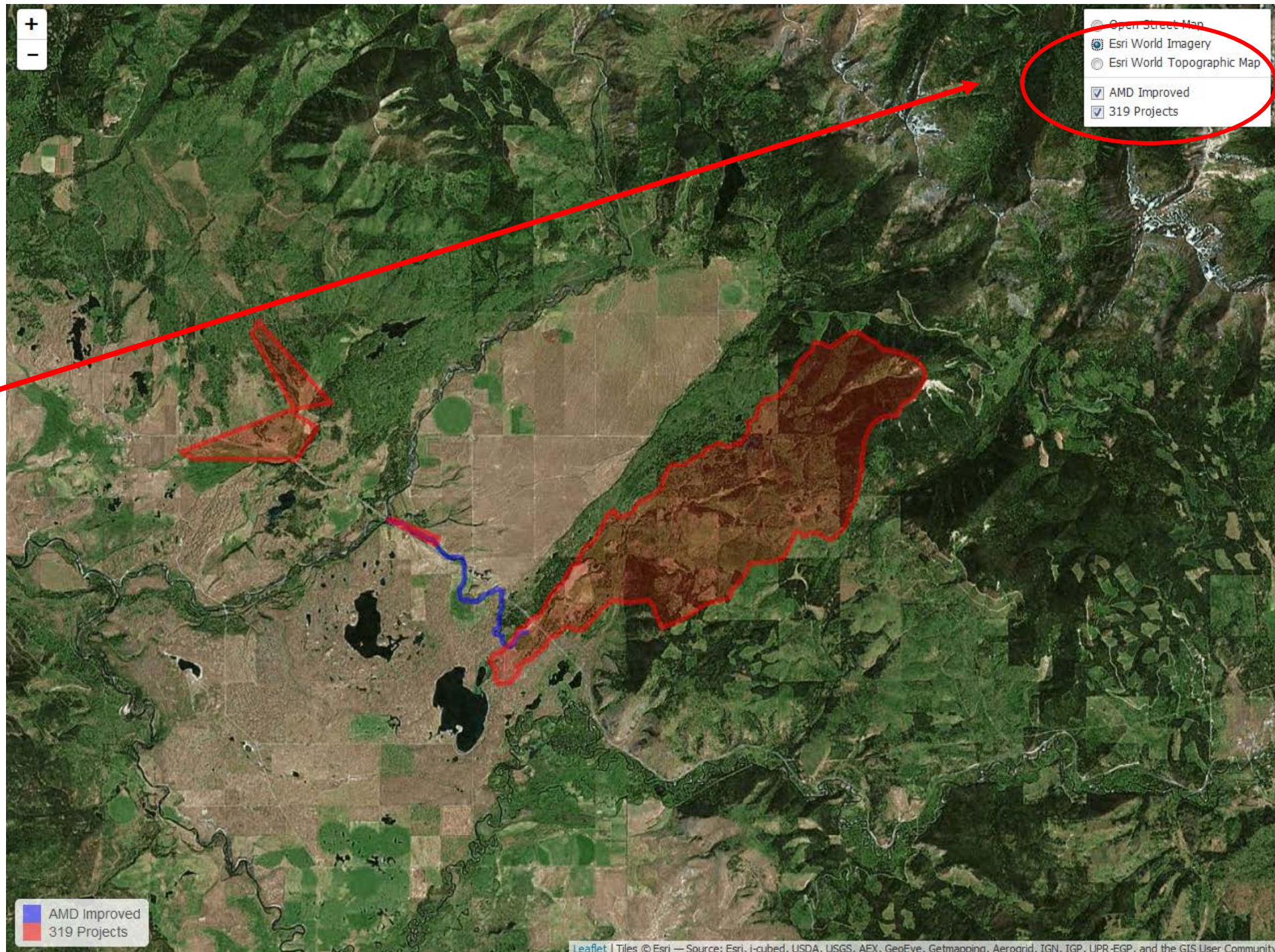
Resulting stand alone webpage

*319 data not filtered
based on metals/pH/etc
as seen in earlier slides.

Also, start/stop hydro not
shown (just 2 points)

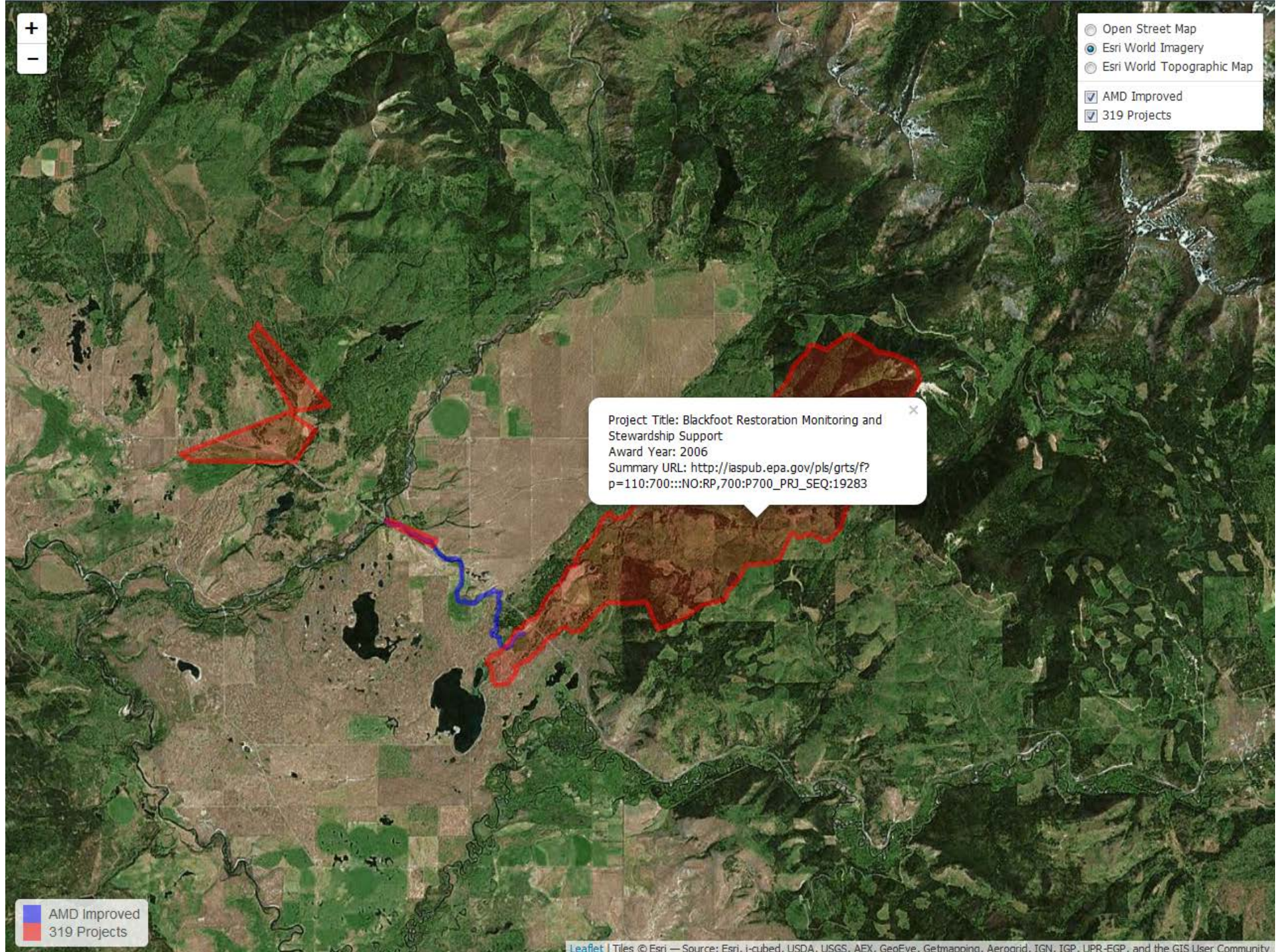


Include
Base
maps such
as aerial
imagery

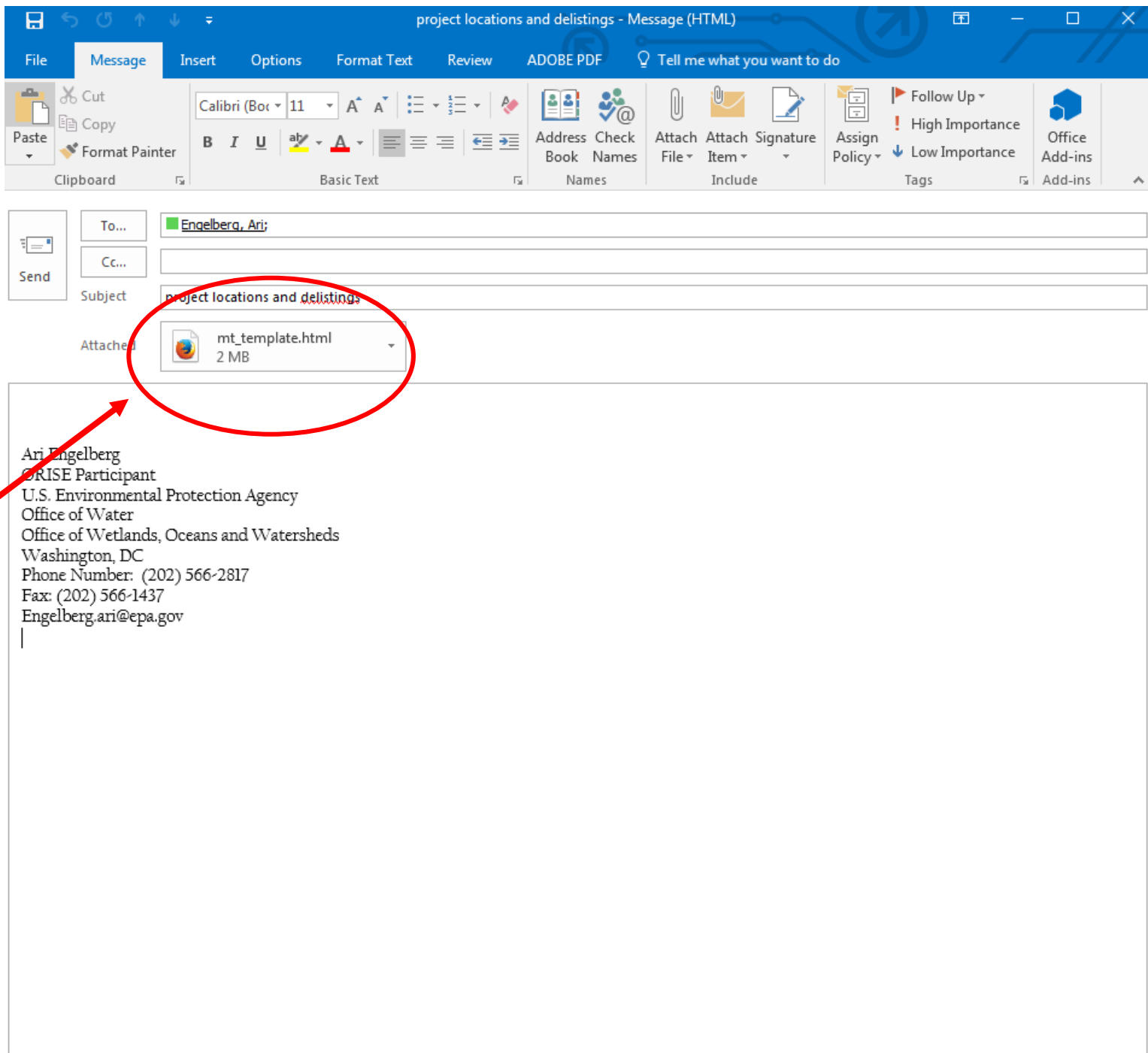


Add
popups.

E.g., Project
title, award
year, etc.



Share map
with
others!



Html map
document

Simple web mapping to explore NPS data

D. Auerbach and A. Engelberg, (ORISE, USEPA Office of Water, Office of Wetlands, Oceans and Watersheds)

Workflow structure

This example assumes basic familiarity with R, best deployed with the RStudio IDE. You may also want to check out the nice primer on [spatial data in R](#) that Jeff Hollister has put together. Below, we'll briefly cover:

1. Data sources
2. A services-only map
3. A map based on local data

1. Data types and sources

Our goal is a simple webpage that you can view in a browser and share easily with others. The two primary ways to map information in this context are via webservices and locally-held objects (i.e., files that you download, process and make part of the page).

Webservices allow dynamic and light-weight presentation because the underlying info is stored and maintained elsewhere. You get just what you need to display or query, but connection speed can influence performance. For example:

- [EPA WATERS services](#) display a number of Office of Water datasets, many aggregated from tribal and state partners.
- [WQP](#) is the centralized place for original water quality measurements.

However, downloading the objects themselves (tables, geometries, etc.) often makes sense if you expect to do substantial offline processing.

- [EPA WATERS objects](#) offers the (sometimes large) underlying datasets for various services.
- [ATTAINS](#) houses additional datasets related to 303/305 reporting.

Fortunately, the two modes can also usually be combined, allowing you to leverage common "point-of-reference" datasets (which may be quite large and subject to regular revision like NHD/NHDPlus) alongside smaller things where you've done more "custom" work.

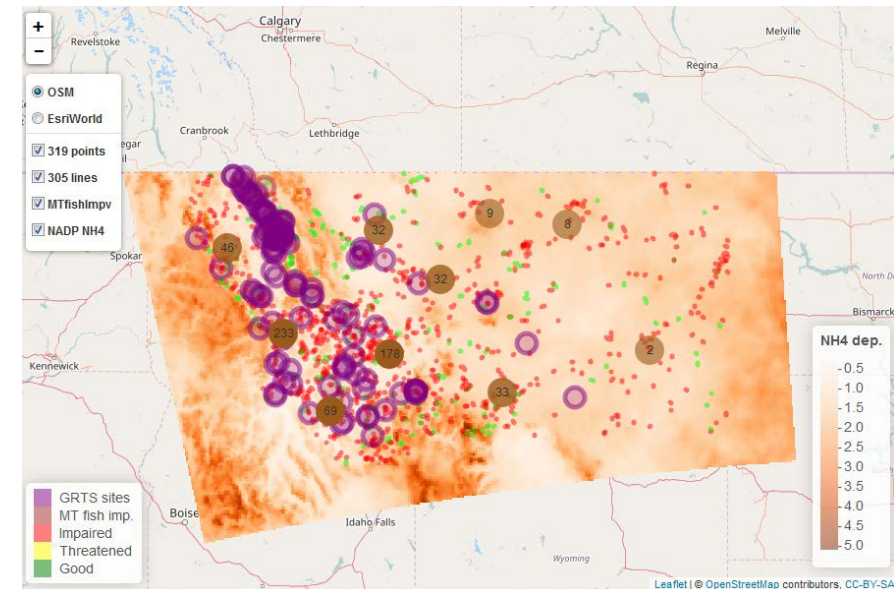
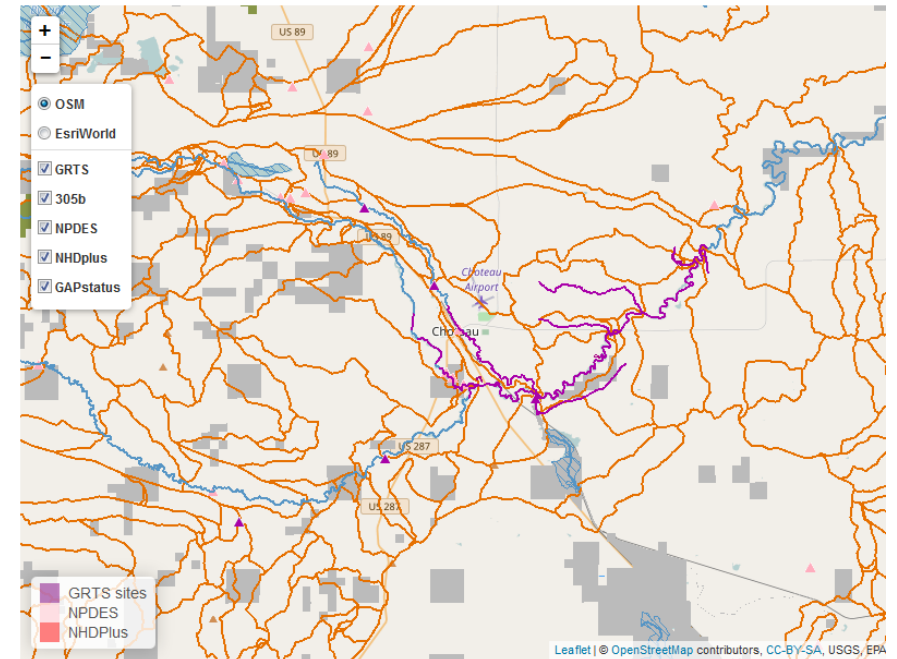
2. Services make it easy to map quickly

The R package [leaflet](#) facilitates use of this powerful javascript library for interactive maps. Leaflet output can include different basemaps as well as various overlays, and allows lots of pretty formatting. Especially nice is the option to export a "standalone" .html file that you can share and engage with via any browser.

Let's step through an example. There's a fair bit going on, but it's pretty straightforward if we take it piece by piece.

In the code chunk below, after we tell R to bring in the leaflet set of commands with `library()`, we generate an "empty" map with the function `leaflet()`, and control the size of the output with width and height arguments (these can be left out to render a full screen map). The special "pipe" character `%>%` keeps commands linked together, with the output of one going automatically into the next.

So, the next `setView()` call knows that it's working on the previously generated map. The `setView()` call is optional (and we'll see below that



Tutorial Web page

Final Points

- **Readily Available national Datasets for Water Quality and NPS Restoration in multiple formats (e.g. shapefile, web maps, etc).**
- **Mapping the data supports program implementation efforts, cross agency collaboration, stakeholder outreach, and preliminary data analyses.**
- **ArcGIS and R provide straight forward approaches for interactive mapping.**