



Inland Oil Spill  
Preparedness  
Program (IOSPP)

# USGS StreamStats and Travel Time Application

A web-based map application for estimating  
plume trajectories and travel times in rivers

U.S. Department of the Interior  
U.S. Geological Survey

Peter McCarthy  
U.S. Geological Survey  
[pmccarth@usgs.gov](mailto:pmccarth@usgs.gov)  
406-457-5934

USGS Water Mission Area  
StreamStats Development Team

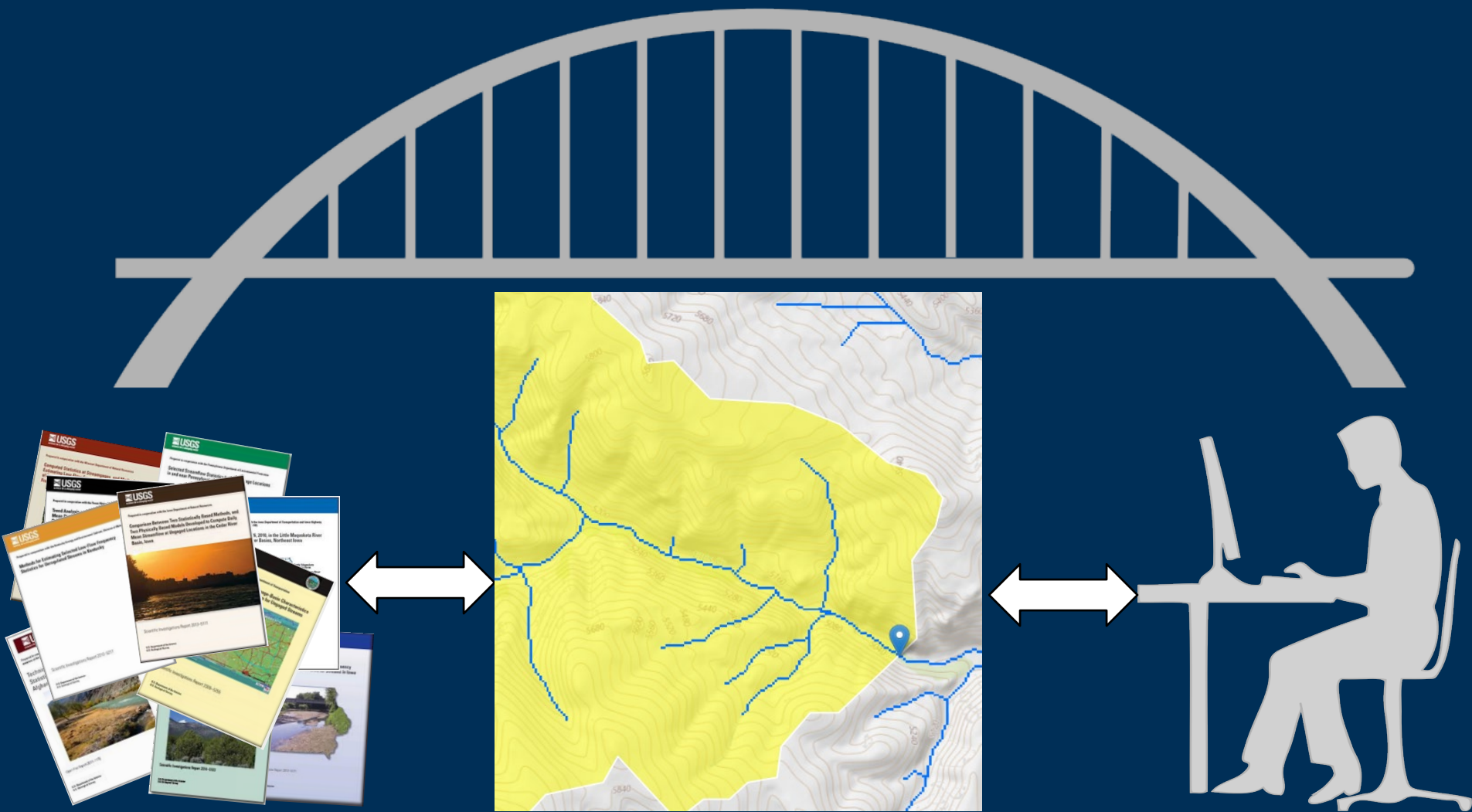


Web Informatics & Mapping

# Presentation Overview

- Introduction to StreamStats
- USGS streamgages
- Dye tracer studies
- Jobson's equations for estimating stream velocities and travel times
- Implementation of Jobson's equations in StreamStats with user interface

# StreamStats Purpose



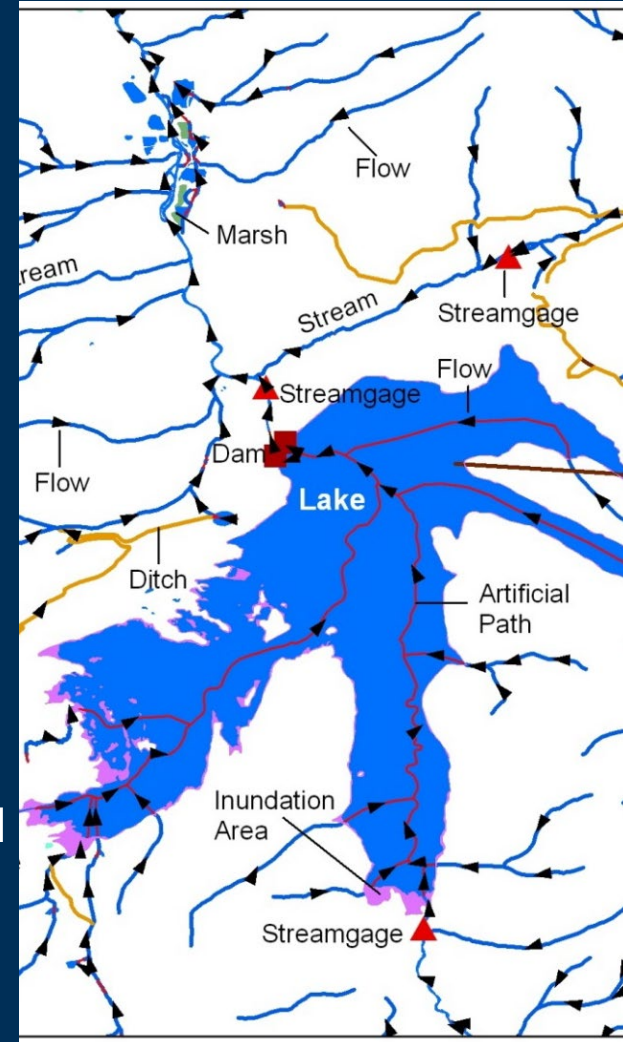
Making complex science easily available and useful

# StreamStats Overview

- The core functionality of StreamStats is to provide streamflow statistics for gaged and ungaged locations to users
  - Statistics vary from simple mean annual flows to computed flood statistics (i.e. 100 year flood).
  - Statistics for gaged locations are computed using streamflow data
  - Statistics for ungaged locations are estimated using regional regression equations and GIS data

# StreamStats Overview

- Hydrography data that digitally represents stream features
  - National Hydrography Dataset (NHD)
    - Stream network represented by flowlines
    - Attributes of flow direction, length, name, and many others
  - Watershed Boundary Dataset (WBD)
    - Seamless national framework of drainage boundaries
  - Digital Elevation Model (DEM)
    - Raster (grid) data for elevations used to create flow accumulation and flow direction grids (for delineating basins)





# National StreamStats

StreamStats will also be a national program, adding national tools and data

Adding data that is nationally consistent for national models

Adding tools that are developed nationally for consumption and modification at the local level

Application will be developed on nationally consistent data (NHDPlus)



# StreamStats User Interface

With a small amount of “reading the directions”, the application is SIMPLE to use – just zoom into your area of interest, select your region, and click on the map. If you’re already familiar with ESRI-based GIS products, this will be even easier.

The screenshot displays the StreamStats web application interface. On the left, there is a sidebar with navigation options: 'SELECT A STATE / REGION' (Wisconsin), 'IDENTIFY A STUDY AREA' (Basin Delineated), and 'Step 5: Your delineation is complete. You can now clear, edit, or download your basin, or choose a state or regional study specific function (if available). Click continue when you are ready.' Below this are buttons for 'Clear Basin', 'Edit Basin', and 'Download Basin'. A 'Continue' button is also present. The main map area shows a topographic map of Middleton, WI, with a yellow delineated basin. A blue pin is placed on the map. A 'Layers' panel is open, showing 'Base Maps', 'Application Layers', 'National Layers', and 'WI Map Layers'. A zoom level of 13 and map scale of 1:72,223 are displayed. At the bottom left, there is a scale bar (1 km, 3000 ft) and coordinates (Lat: 43.0957, Lon: -89.6242). At the bottom right, there is a small inset map showing the basin's location within a larger geographic context.

**Step 1:** You can modify computed basin characteristics here, then select the types of reports you wish to generate. Then click the 'Build Report' button

Hide Basin Characteristics

Basin Characteristics can be edited here

Parameter	Value
CLIFAC25Y	2.6
DRNAREA	5.37
FOREST	2.47
I24H2Y	2.8
CLIFAC100Y	2.7
CLIMFAC2YR	1.9
CSL10_85	27.9
DEVNLCD01	68.96
I24H100Y	7.1
I24H10Y	4.3
I24H25Y	5.2
I24H50Y	6.2
I24H5Y	3.5



# Network Navigation Tools

**USGS** StreamStats [Development Version: Not for public consumption]

SELECT A STATE / REGION  
Montana

**IDENTIFY A STUDY AREA**

Step 1: Zoom in to level 15 or greater to enable the delineation tool

Delineate

SELECT SCENARIOS

BUILD A REPORT

POWERED BY WIM

[USGS Home](#) [Contact USGS](#) [Search USGS](#)  
[Accessibility](#) [FOIA](#) [Privacy](#) [Policy & Notices](#)

**Exploration Tools**

General

- Measure Tool
- Elevation Profile Tool
- Show Your Location

Network Navigation

- Flow (Raindrop) Path
- Network Path
- Network Trace

Zoom Level: 14  
Map Scale: 1:36,111  
Lat: 46.5911, Lon: -110.1567

**Exploration Tools**

**Network Trace**  
Network trace Description.

Start point location (Required)

Latitude: 46.408673623402876  
Longitude: -109.70294952392578

Direction (Required)

downstream  
 upstream

Query Source (Required)

- flowline
- wqpsite
- gage
- bridge

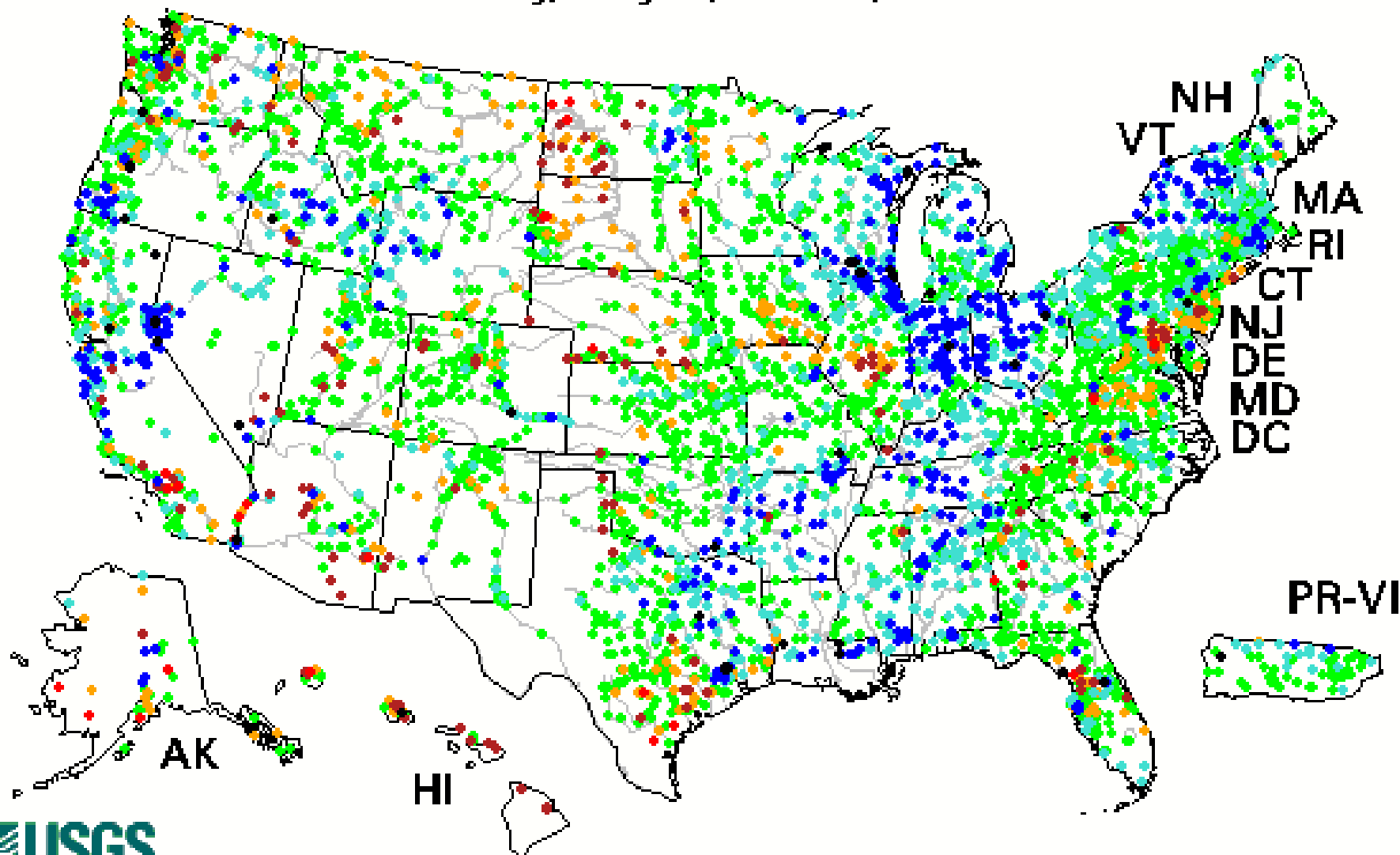
Limit (Optional)

Distance (km) 10

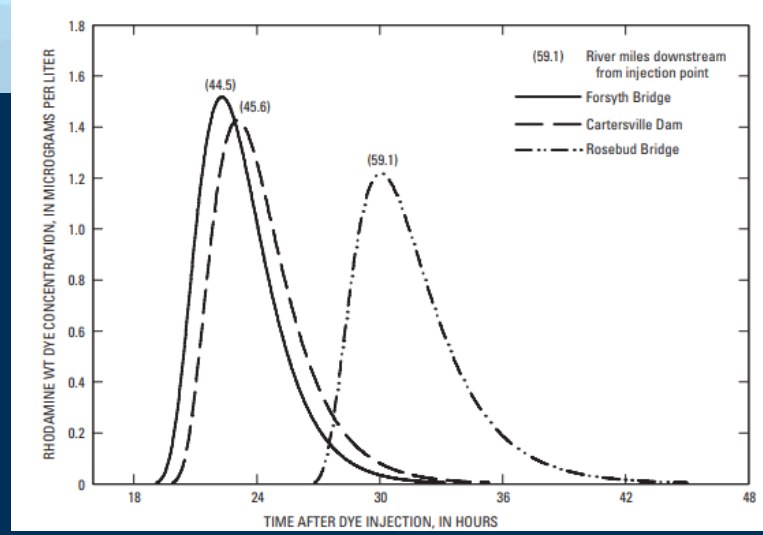
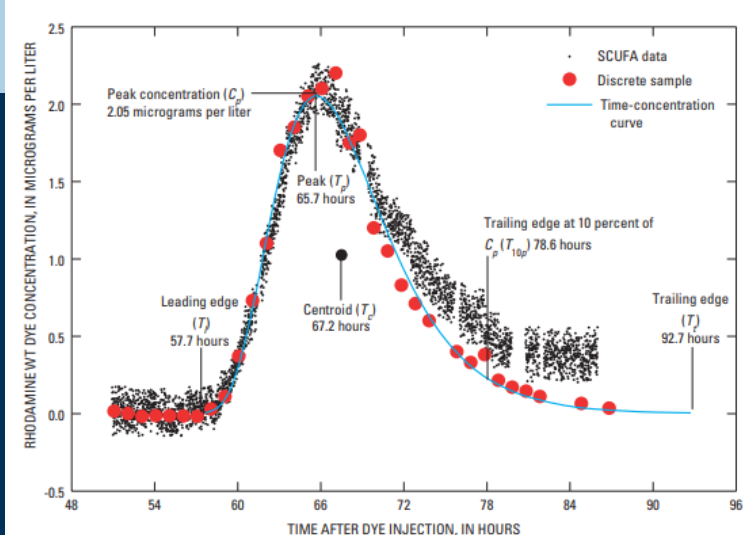
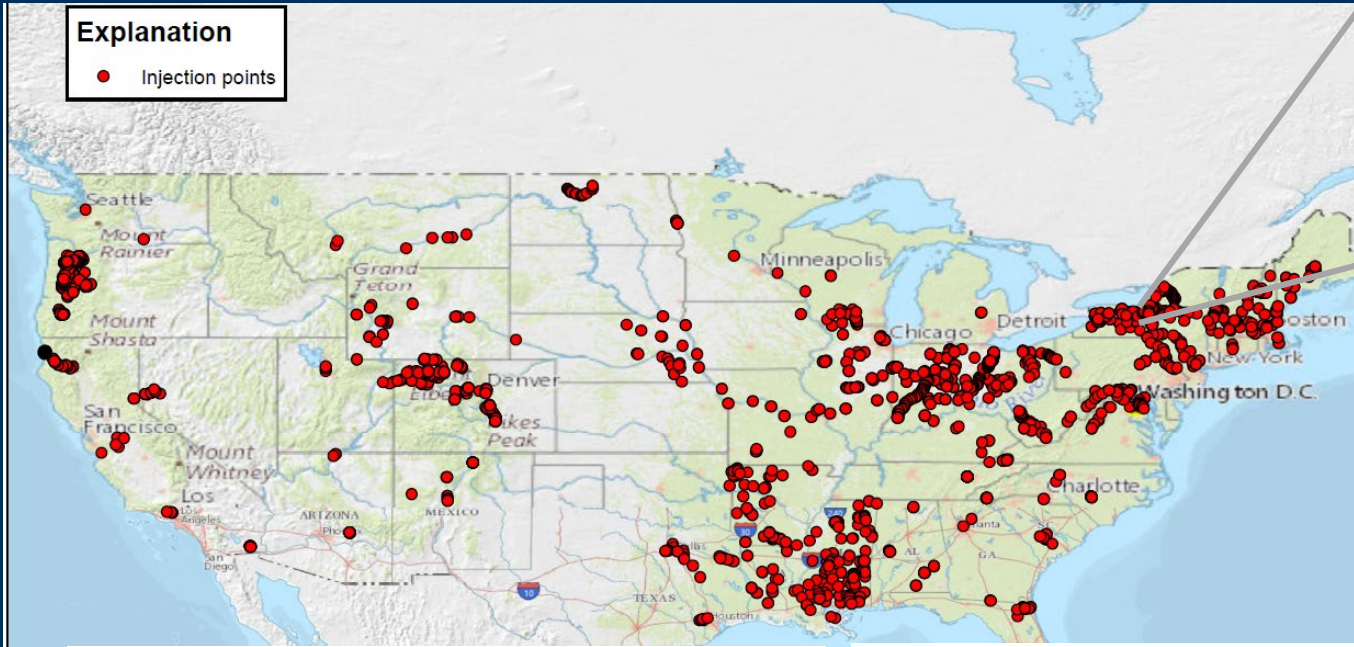


# USGS Streamgages

Monday, July 10, 2017 19:30ET



# Dye-tracer studies



# Travel Time Theory

- Jobson (1996) developed regression equations to estimate travel times and longitudinal dispersion in rivers and streams.

$$V_{pmp} = 0.094 + 0.0143(\bar{D}_a)^{0.919}(\bar{Q}_a)^{-0.469}S^{0.159}\frac{Q}{D_a}$$

- Gregory Schwarz (USGS SPARROW Team) is updating Jobson's equations with new data.



- Regression/input variables
- River slope
- River length
- Drainage area
- Mean annual discharge
- Real-time discharge
- Spill Mass

# Travel Time Theory

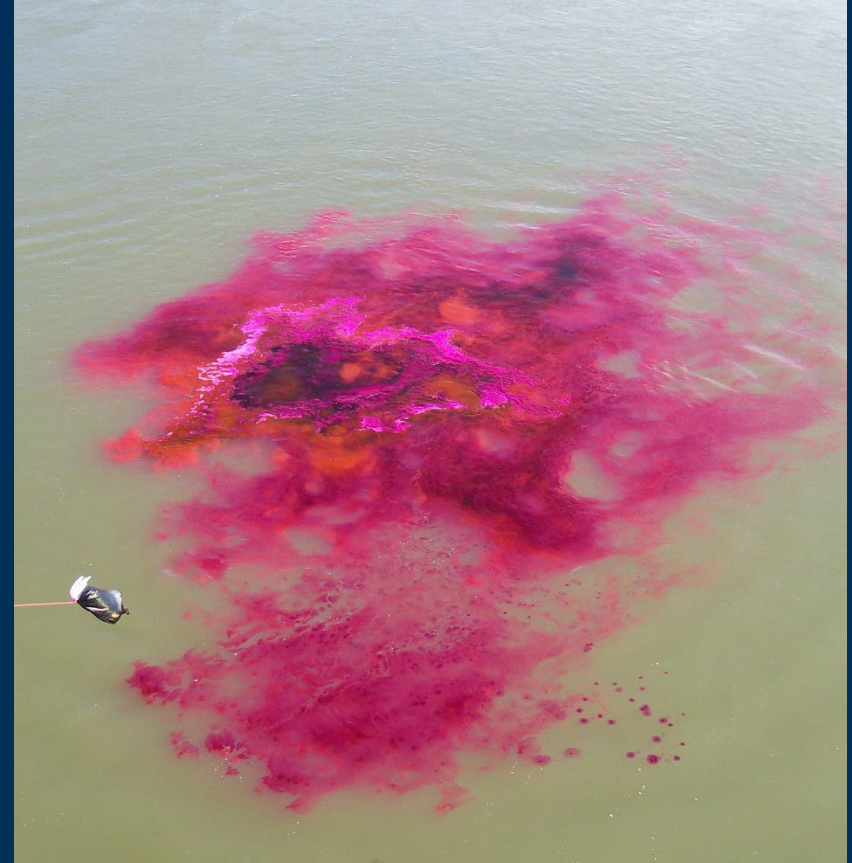
Jobson's Equations estimate the following

- **Most Probable Velocity (best predictor)**
  - Travel times for leading edge, peak, and trailing edge
  - Peak concentration
- **Maximum Probable Velocity (envelope curve)**
  - Travel times for leading edge, peak, and trailing edge
  - Peak concentration

# Current limitations of Jobson's equations

- Soluble and conservative contaminants
- Streamflow limitations (low flow to bankfull)
- Steady state flow
- Dams, reservoirs, and lakes
- Karst

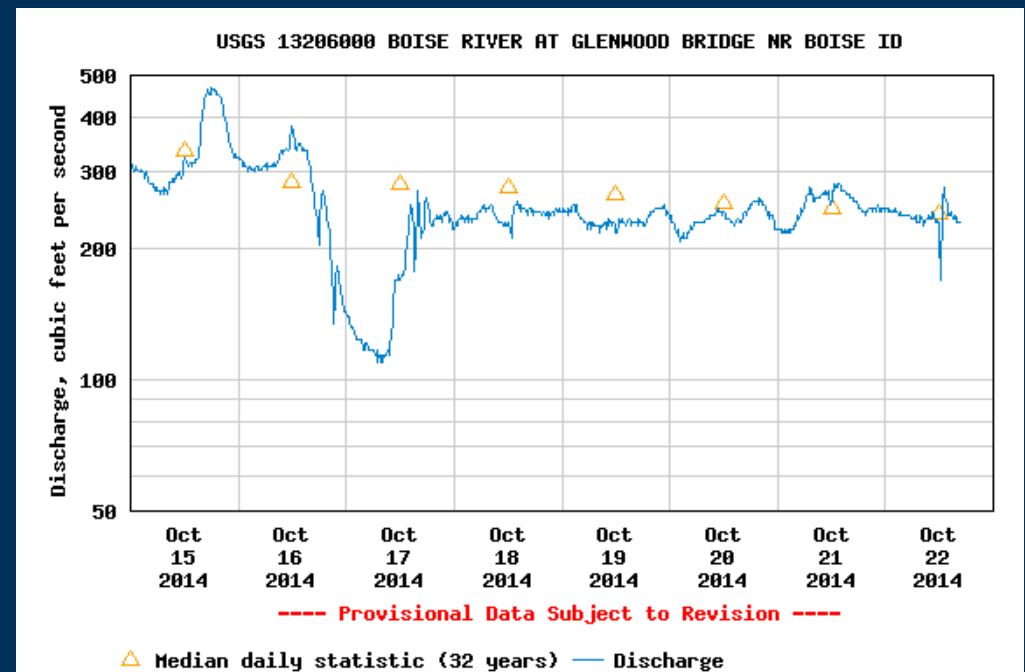
*These can be addressed over time*



# Conceptual user inputs

- StreamStats
  - River slope
  - River length
  - Drainage area
  - Mean annual discharge
  - Real-time discharge\*

- User
  - Real-time discharge\*
  - Spill location
  - Spill mass



# Implementation of Travel Time

- **Funded by Inland Oil Spill Preparedness Program**
  - **Phase I: Develop the web services (calculator) for computing travel times using Jobson's Equations and the NHDPlus data**
  - **Phase II: Develop a user interface for I/O**
  - **Submerged oil modeling and Kalamazoo spill**





# Phase I: Web services

- Spill response
- Spill planning
- Streamflow estimation
- DRIFFT<sup>1</sup> database of TOT studies



<sup>1</sup>DRIFTT – Database of Riverine Injected Fluorescent Tracer Travel times

# Phase II: User Interface

- **Interactive map template**
- **I/O options based on spill response workflow**
- **I/O options based on spill planning workflow**



# Questions?

