National-scale 6PPD-quinone Relative Heat Index and Map Tool

Stephanie Gordon, USGS, Eastern Ecological Science Center

Brianna Williams, USGS, NJ Water Science Center

Daniel Jones, USGS, UT Water Science Center

December 2025

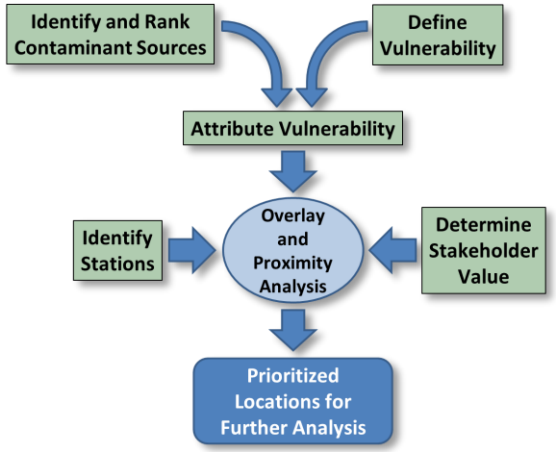
USGS
science for a changing world

Geospatial Analyses and Applications Lab

Lab Mission

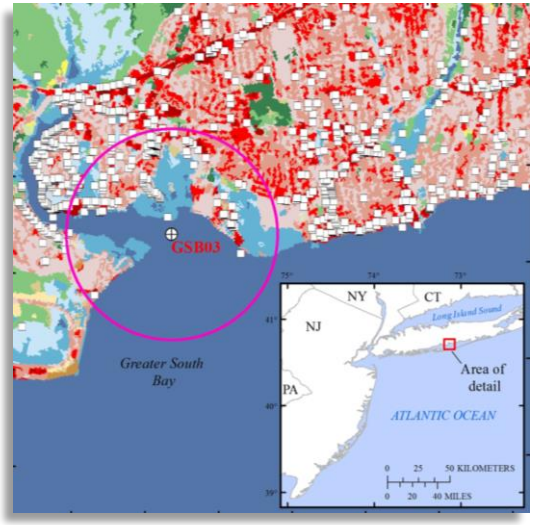
Develop and utilize geospatial methods to investigate source-sink and cause-effect relationships between contaminants and vulnerable communities.

Quantify relationships to develop risk assessments and make predictions across broad, regional scales.



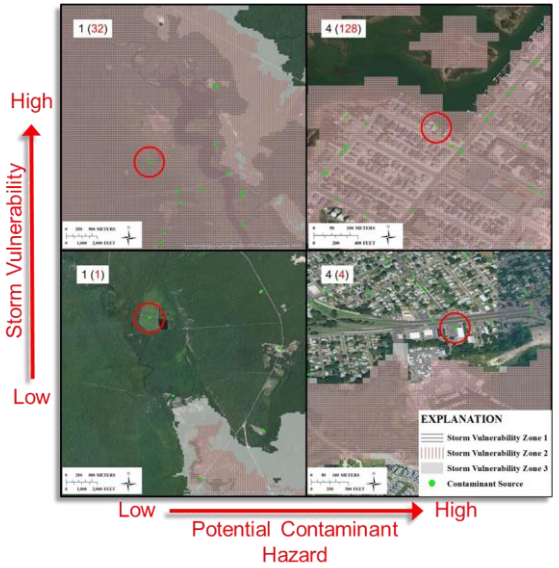
Key Analytical Capabilities

- Study site selection and characterization
- Vulnerability assessment
- Multivariate statistics
- Big-data analysis
- Landscape analysis
- Hydrological modelling and analysis
- Geomorphic assessment



Analytical Tools and Products

- Statistical analysis in R
- Field-form development
- Database design and development
- Geo-narratives and Web Applications
- Public data and metadata

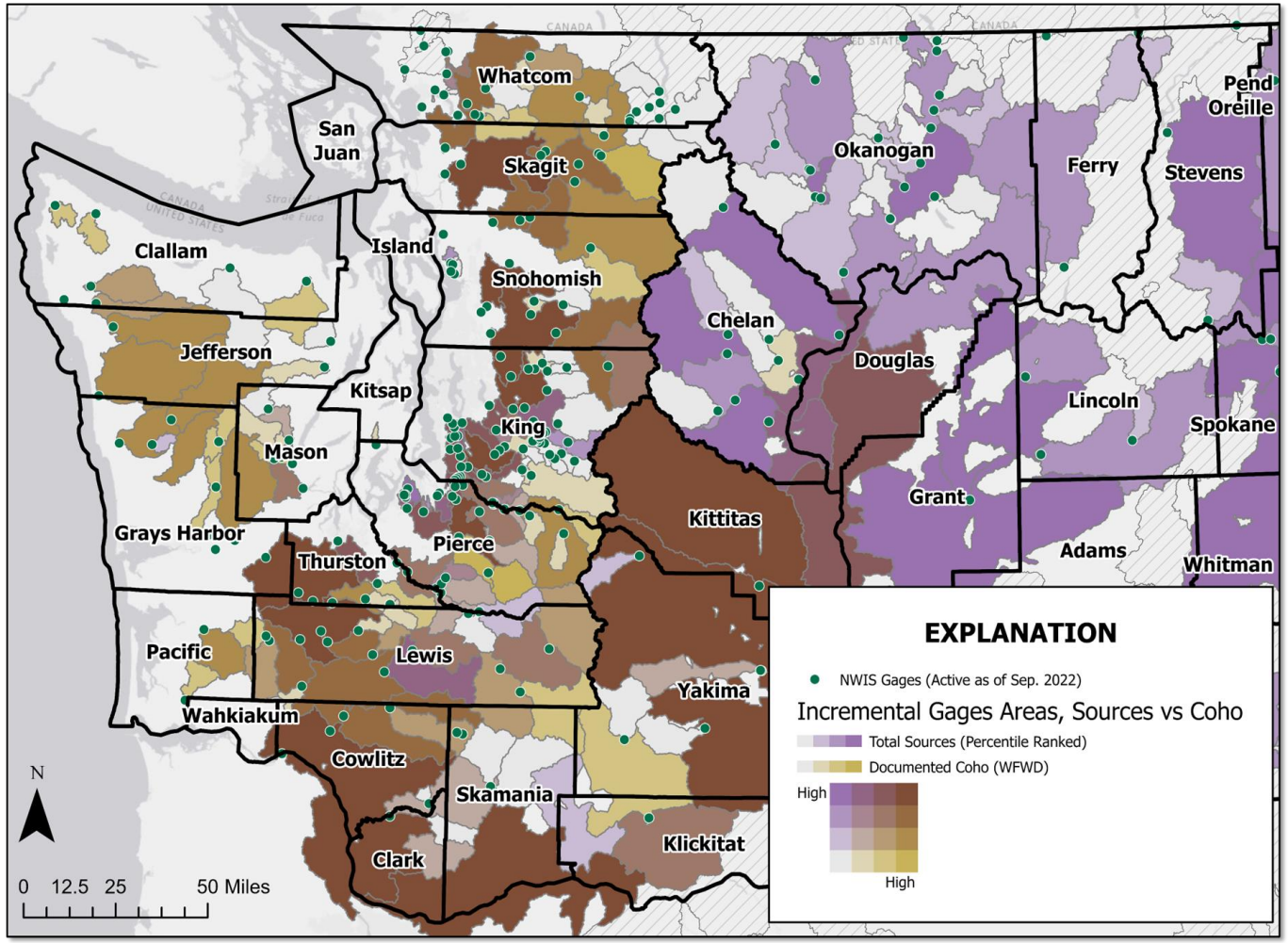


Questions around 6PPDQ

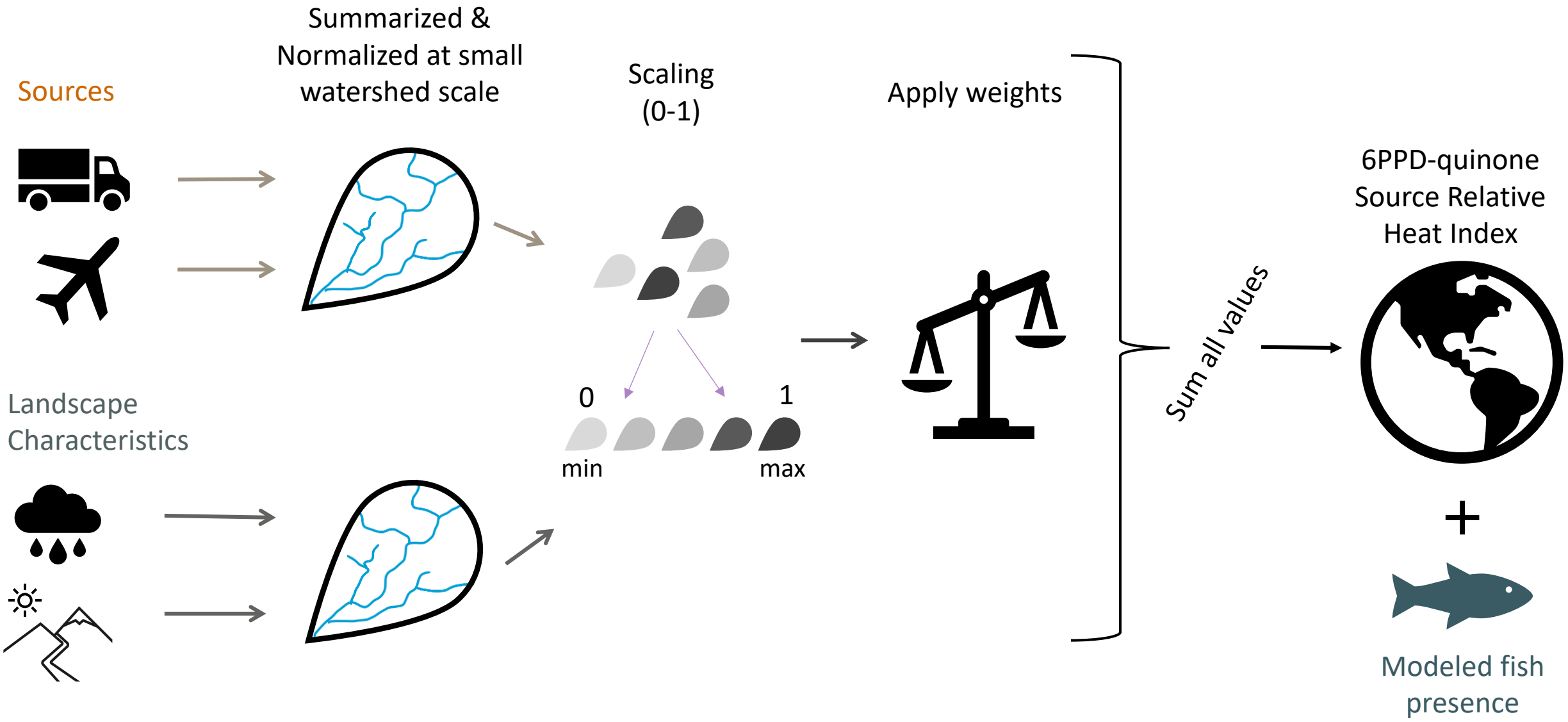
- Biologists/toxicologists/chemists are asking: where should we be sampling to assess 6PPD-quinone exposure?
  - Where are there susceptible fish?
  - Where are there relevant sources?

- How can we consider risk and exposure at a conterminous U.S. (CONUS) scale and in monitored areas?

Can we make a risk/heat map to identify areas nationally that are potentially susceptible to 6PPD-quinone exposure?



Development of spatial heat map



Sources

CENSUS

- Roads (primary, secondary, alley, ramp, service, +)
- Road-steam crossings

EPA (*leveraging Kalibrate TrafficMetrix*)

- Traffic density

USDOT

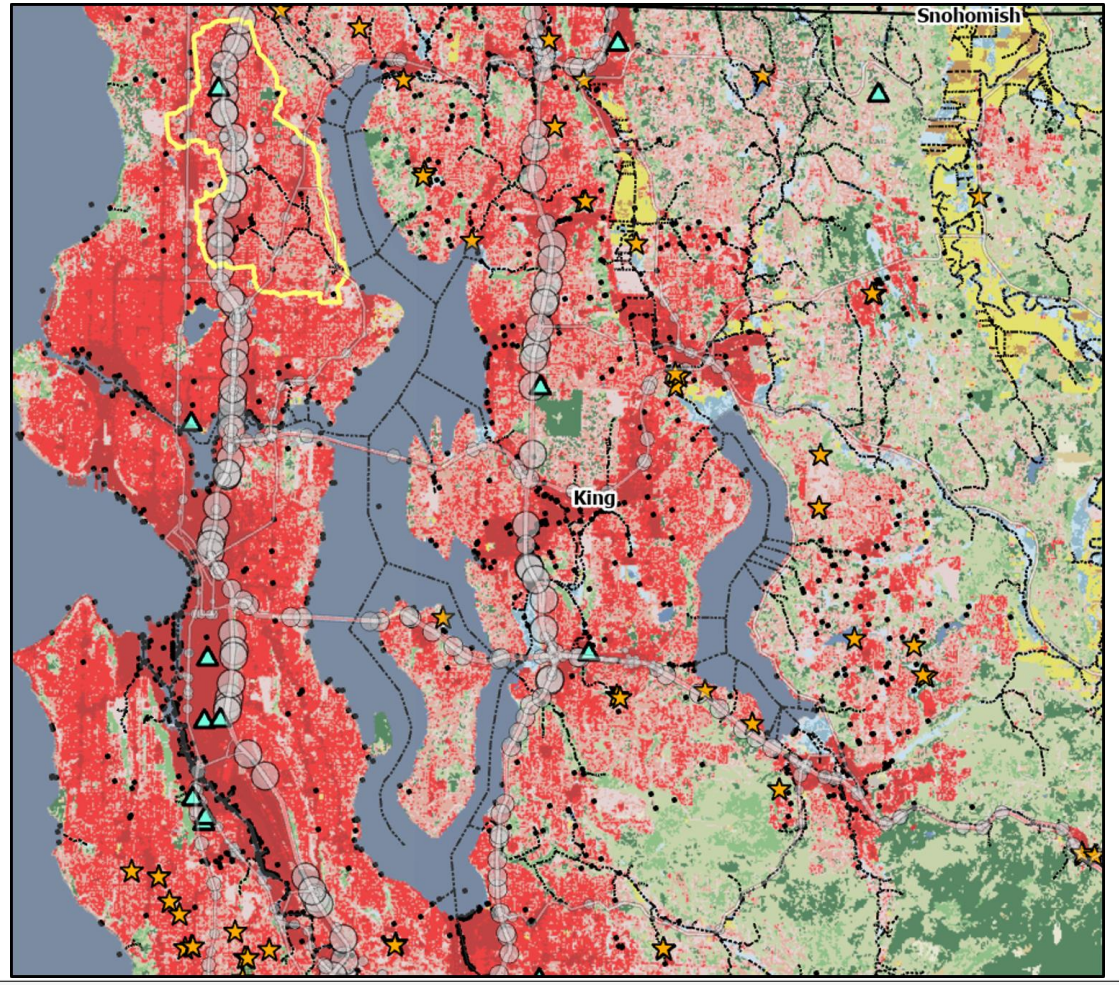
- Truck stops

EPA ECHO

- Tire-handling facilities based on NAICS codes

FAA

- Airports (runways)

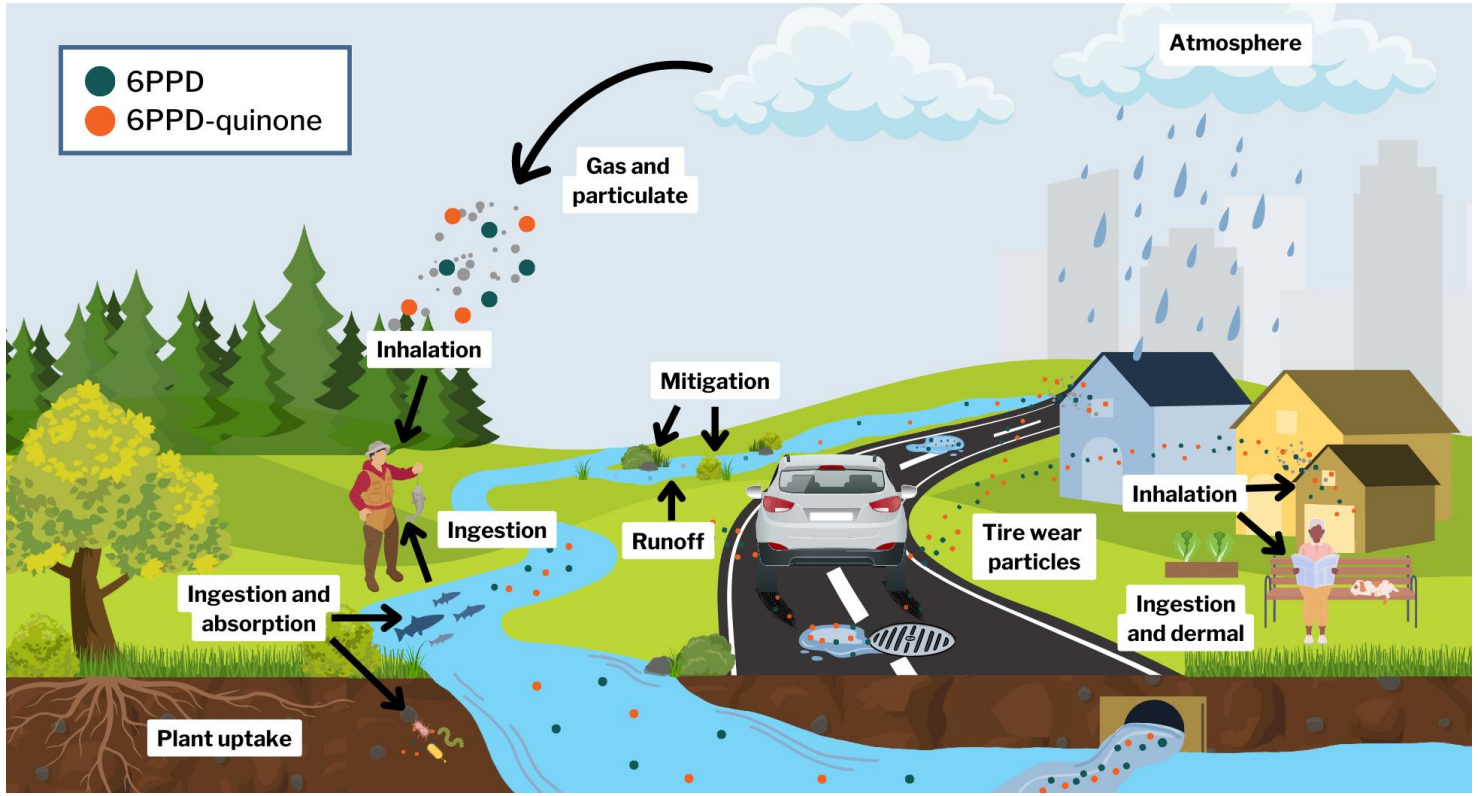


Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Landscape Characteristics

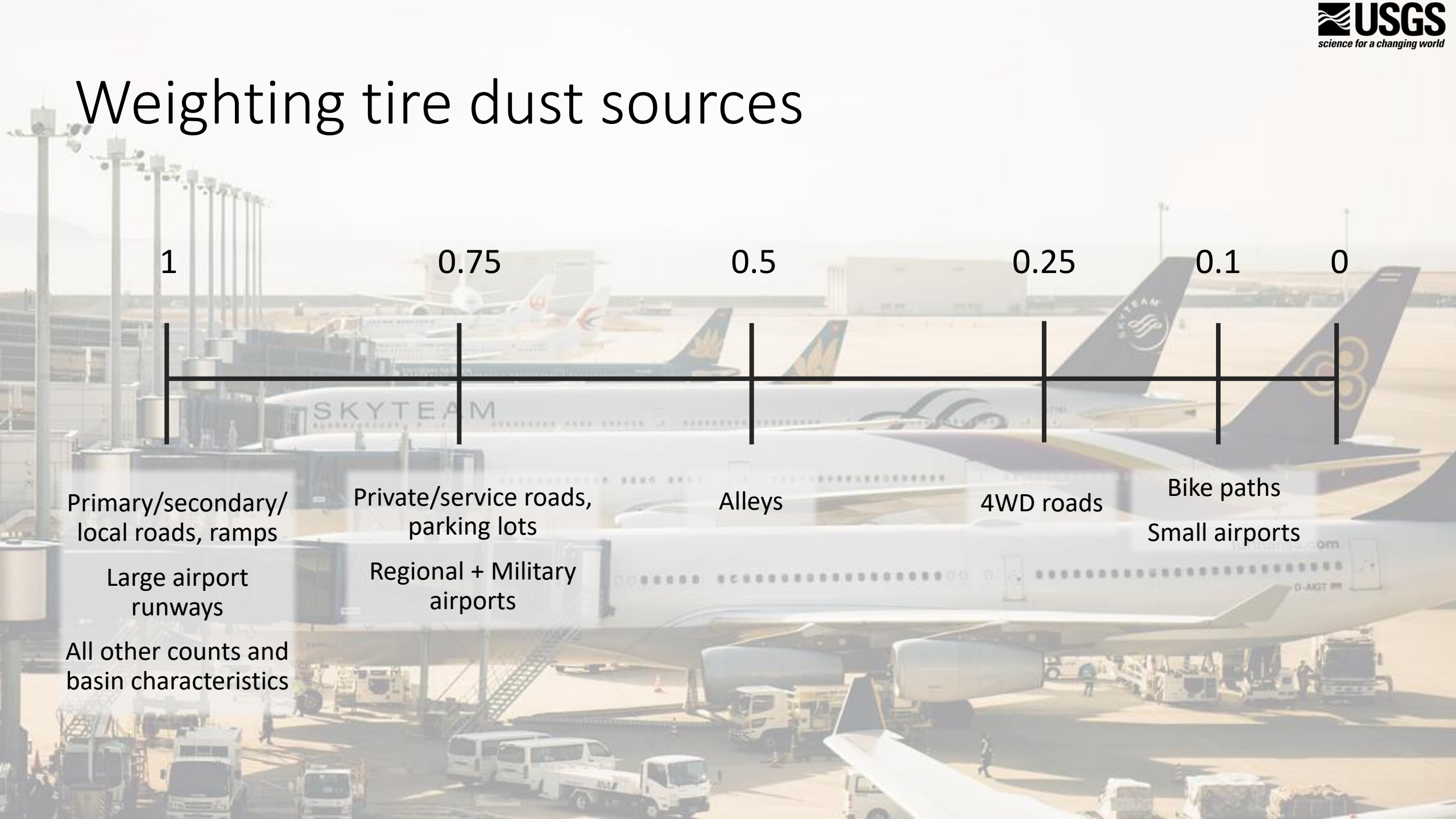
- Runoff
- Annual avg. consecutive dry days
- Catchment slope
- Imperviousness

- Fish presence *(excluded from "heat" value)*



6PPD and 6PPD-Q Sources, Transport, and Fate (Image Credit: Washington State Department of Ecology)

Weighting tire dust sources



Results

Data Release

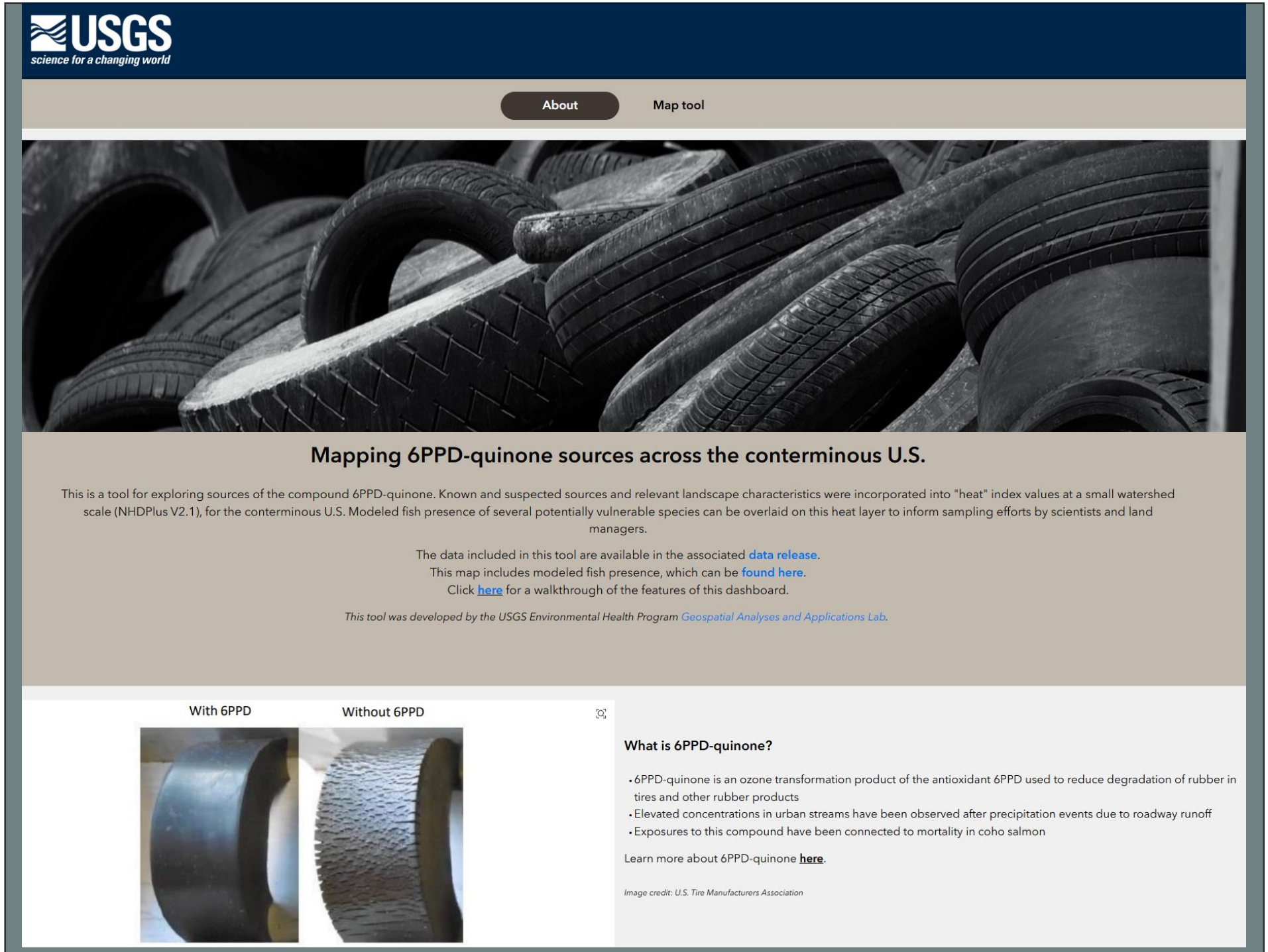
doi.org/10.5066/P1WBVJEU

Co-authors:

John Hansen, Rachael Lane, Justin Greer, Kelly Smalling

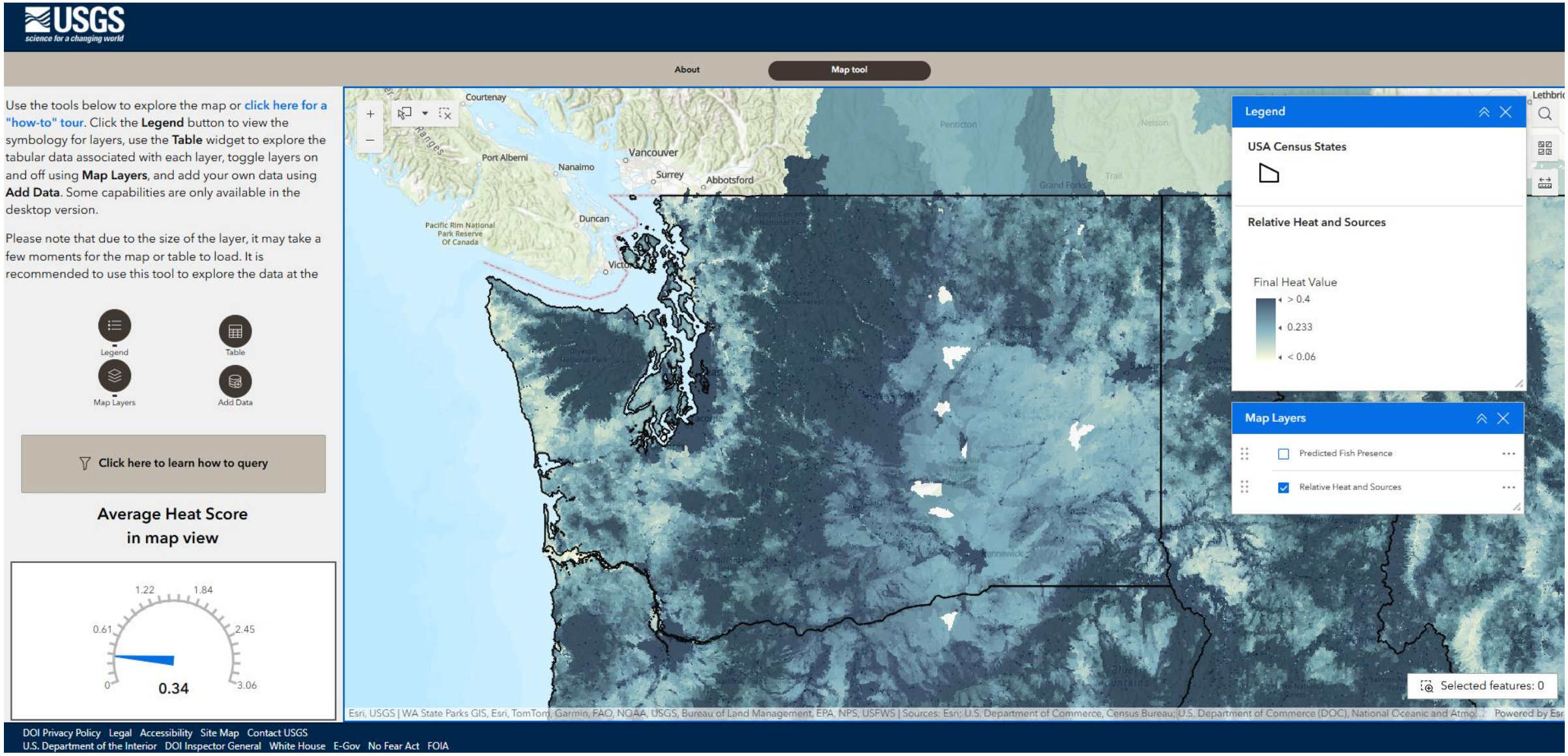
Web Tool

geonarrative.usgs.gov/6ppdqsourcedashboard/

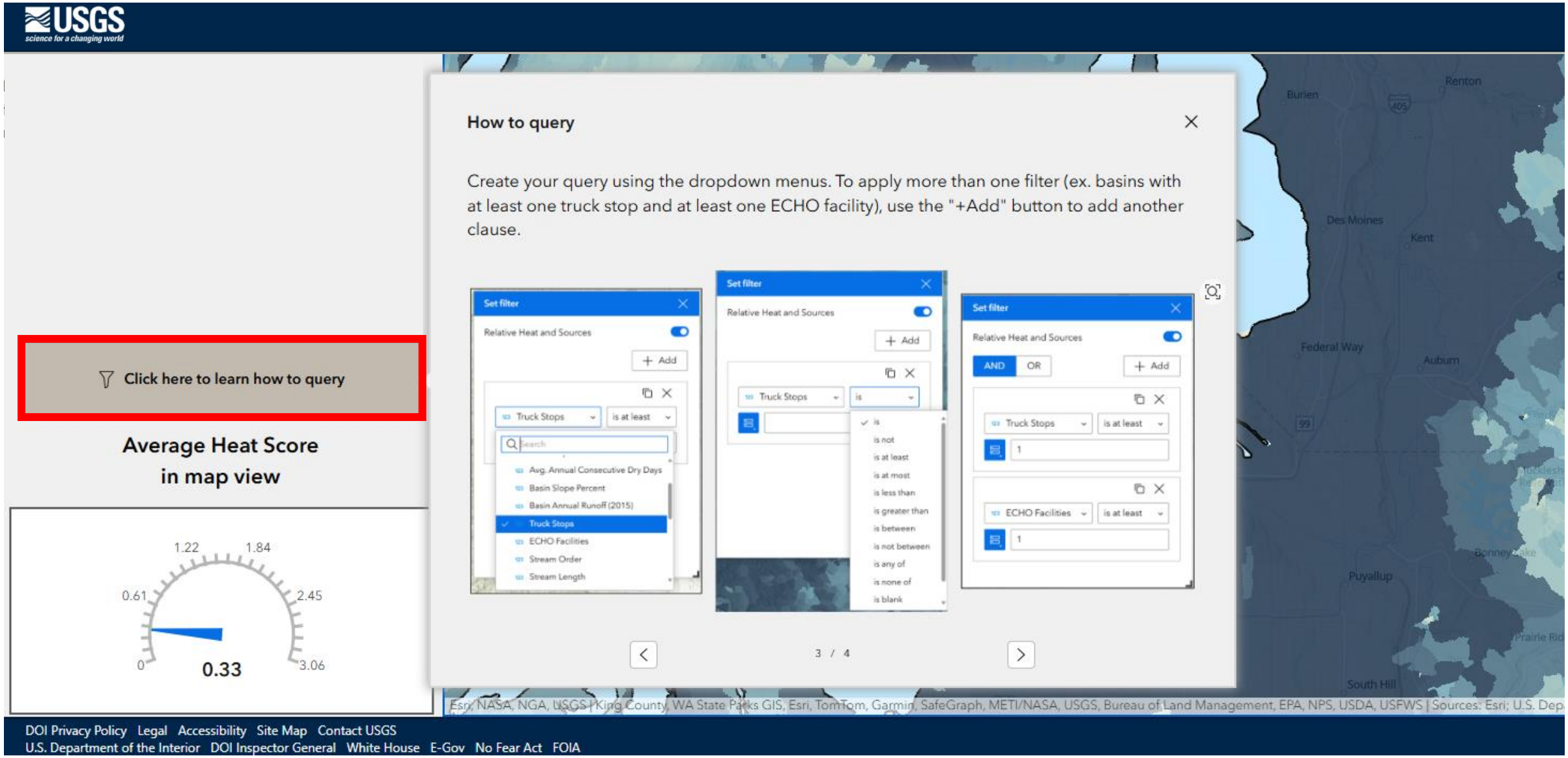


USGS
science for a changing world

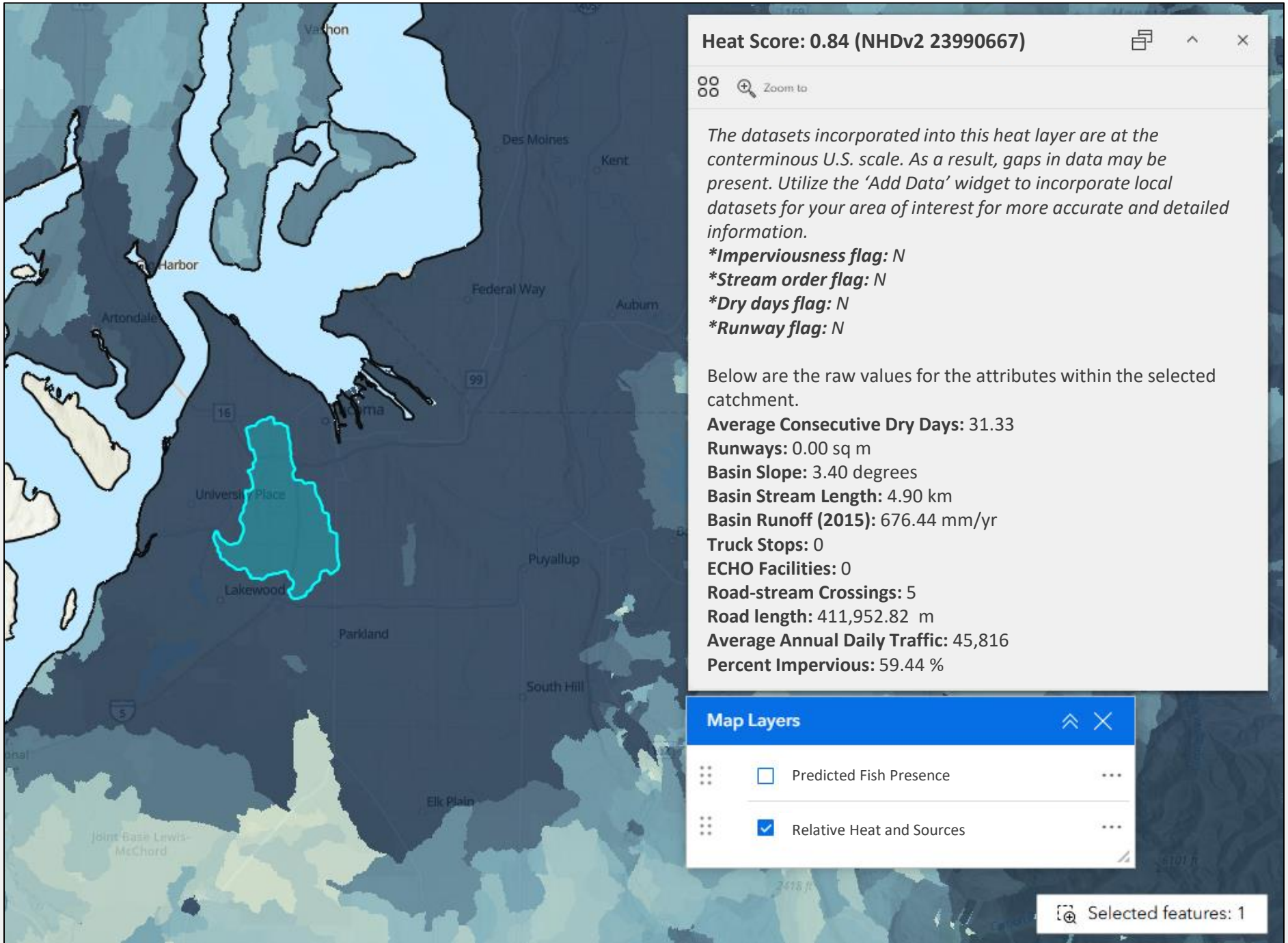
Results


USGS
science for a changing world
About
Map tool
Use the tools below to explore the map or click here for a "how-to" tour. Click the Legend button to view the symbology for layers, use the Table widget to explore the tabular data associated with each layer, toggle layers on and off using Map Layers, and add your own data using Add Data. Some capabilities are only available in the desktop version.
Please note that due to the size of the layer, it may take a few moments for the map or table to load. It is recommended to use this tool to explore the data at the
Legend
Table
Map Layers
Add Data
Click here to learn how to query
Average Heat Score in map view
1.22
1.84
0.61
2.45
0
0.34
3.06
Courtenay
Port Alberni
Nanaimo
Vancouver
Surrey
Abbotsford
Duncan
Pacific Rim National Park Reserve Of Canada
Penticton
Nelson
Grand Forks
Trail
Legend
USA Census States
Relative Heat and Sources
Final Heat Value
> 0.4
0.233
< 0.06
Map Layers
Predicted Fish Presence
Relative Heat and Sources
Selected features: 0
Esri, USGS | WA State Parks GIS, Esri, TomTom, Garmin, FAO, NOAA, USGS, Bureau of Land Management, EPA, NPS, USFWS | Sources: Esri, U.S. Department of Commerce, Census Bureau, U.S. Department of Commerce (DOC), National Oceanic and Atmo...
Powered by Esri
DOI Privacy Policy Legal Accessibility Site Map Contact USGS
U.S. Department of the Interior DOI Inspector General White House E-Gov No Fear Act FOIA

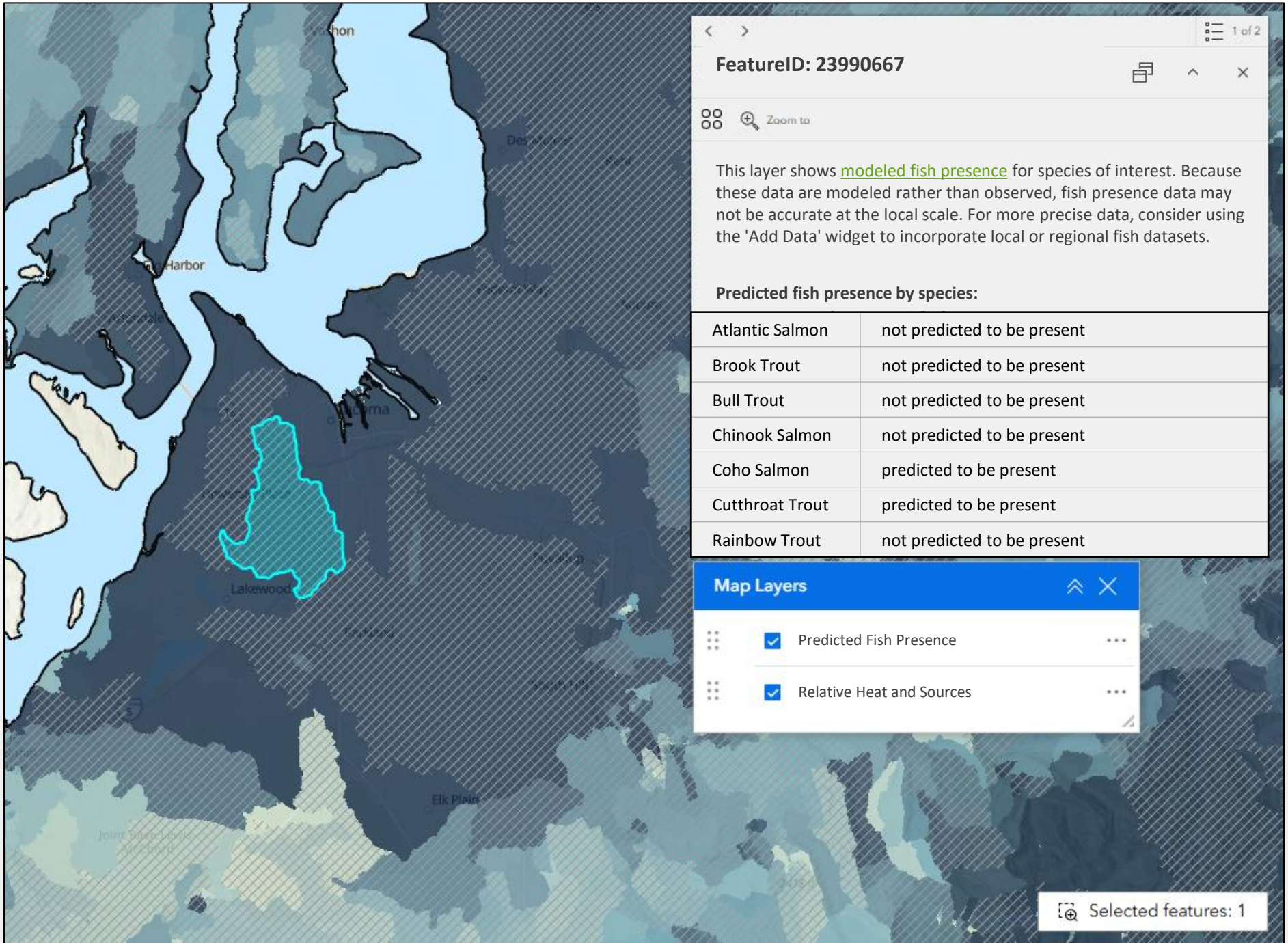
Results


USGS
science for a changing world
Click here to learn how to query
Average Heat Score
in map view
1.22
1.84
0.61
2.45
0
0.33
3.06
How to query
Create your query using the dropdown menus. To apply more than one filter (ex. basins with at least one truck stop and at least one ECHO facility), use the "+Add" button to add another clause.
Set filter
Relative Heat and Sources
Add
Truck Stops
is at least
Avg. Annual Consecutive Dry Days
Basin Slope Percent
Basin Annual Runoff (2015)
Truck Stops
ECHO Facilities
Stream Order
Stream Length
is
is not
is at least
is at most
is less than
is greater than
is between
is not between
is any of
is none of
is blank
AND
OR
1
3 / 4
Renton
Burien
Des Moines
Kent
Federal Way
Auburn
Puyallup
South Hill
Esri, NASA, NGA, USGS | King County, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS | Sources: Esri; U.S. Dep
DOI Privacy Policy Legal Accessibility Site Map Contact USGS
U.S. Department of the Interior DOI Inspector General White House E-Gov No Fear Act FOIA

Results


Heat Score: 0.84 (NHDv2 23990667)
Zoom to
The datasets incorporated into this heat layer are at the conterminous U.S. scale. As a result, gaps in data may be present. Utilize the 'Add Data' widget to incorporate local datasets for your area of interest for more accurate and detailed information.
*Imperviousness flag: N
*Stream order flag: N
*Dry days flag: N
*Runway flag: N
Below are the raw values for the attributes within the selected catchment.
Average Consecutive Dry Days: 31.33
Runways: 0.00 sq m
Basin Slope: 3.40 degrees
Basin Stream Length: 4.90 km
Basin Runoff (2015): 676.44 mm/yr
Truck Stops: 0
ECHO Facilities: 0
Road-stream Crossings: 5
Road length: 411,952.82 m
Average Annual Daily Traffic: 45,816
Percent Impervious: 59.44 %
Map Layers
Predicted Fish Presence
Relative Heat and Sources
Selected features: 1
Des Moines
Kent
Federal Way
Auburn
Artondale
Puyallup
Lakewood
Parkland
South Hill
Elk Plain
Joint Base Lewis-McChord

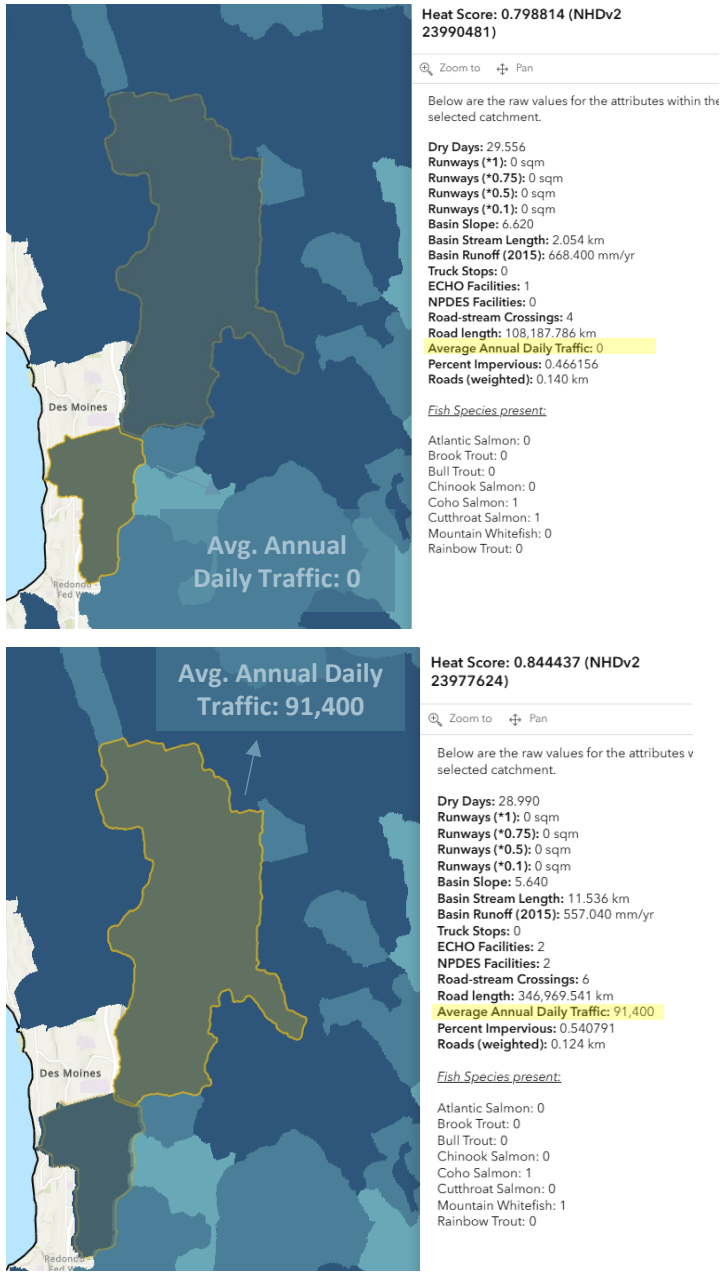
Results


1 of 2
FeatureID: 23990667
Zoom to
This layer shows modeled fish presence for species of interest. Because these data are modeled rather than observed, fish presence data may not be accurate at the local scale. For more precise data, consider using the 'Add Data' widget to incorporate local or regional fish datasets.
Predicted fish presence by species:
Atlantic Salmon | not predicted to be present
Brook Trout | not predicted to be present
Bull Trout | not predicted to be present
Chinook Salmon | not predicted to be present
Coho Salmon | predicted to be present
Cutthroat Trout | predicted to be present
Rainbow Trout | not predicted to be present
Map Layers
Predicted Fish Presence
Relative Heat and Sources
Selected features: 1
Harbor
Lakewood
Elk Plain

Caveats and Limitations

- Data sources may not be capturing the full picture
  - Traffic not consistent across catchments
  - Modeled fish data used for now, actual sampled locations with fish presence would be more accurate
- Regional/local nuances
  - Ex. PNW incorporates shredded tires into playgrounds, soccer fields, etc. which is not available at CONUS scale
  - Higher resolution data (traffic, LULC, fish) could also be incorporated at smaller scales

Adjacent catchments with a traffic count difference of 91,400



Ideas for Future Work & Next Steps

Regional focal areas to incorporate detailed data

Illinois & Delaware River Basins

Chesapeake Bay Watershed

- Example: Pennsylvania – tire dump locations, detailed traffic counts, brook trout spawning, stocking, & prime streams

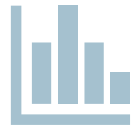
Using next iteration of heat layer for continued Chesapeake Bay sampling efforts summer 2026

Incorporating field data for model validation and improvement.

Expand communication with scientists, resource managers, and other interested groups

Application function improvements.

Regional focal areas to be added to web tool as they're developed.



Predictive modeling using landscape factors and observational data

Compiling database of sample locations & results processed through USGS labs

USGS
science for a changing world

Stephanie Gordon

sgordon@usgs.gov

Brianna Williams
bmwilliams@usgs.gov

Daniel Jones

dkjones@usgs.gov

https://www.usgs.gov/programs/toxic-substances-hydrology/science/geospatial-analyses-and-applications-core-technology