Grant number: 02J19601

STORMWATER, 6PPD-Q, AND CRAYFISH

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salish school of spokane

WSDOT

University of Idaho

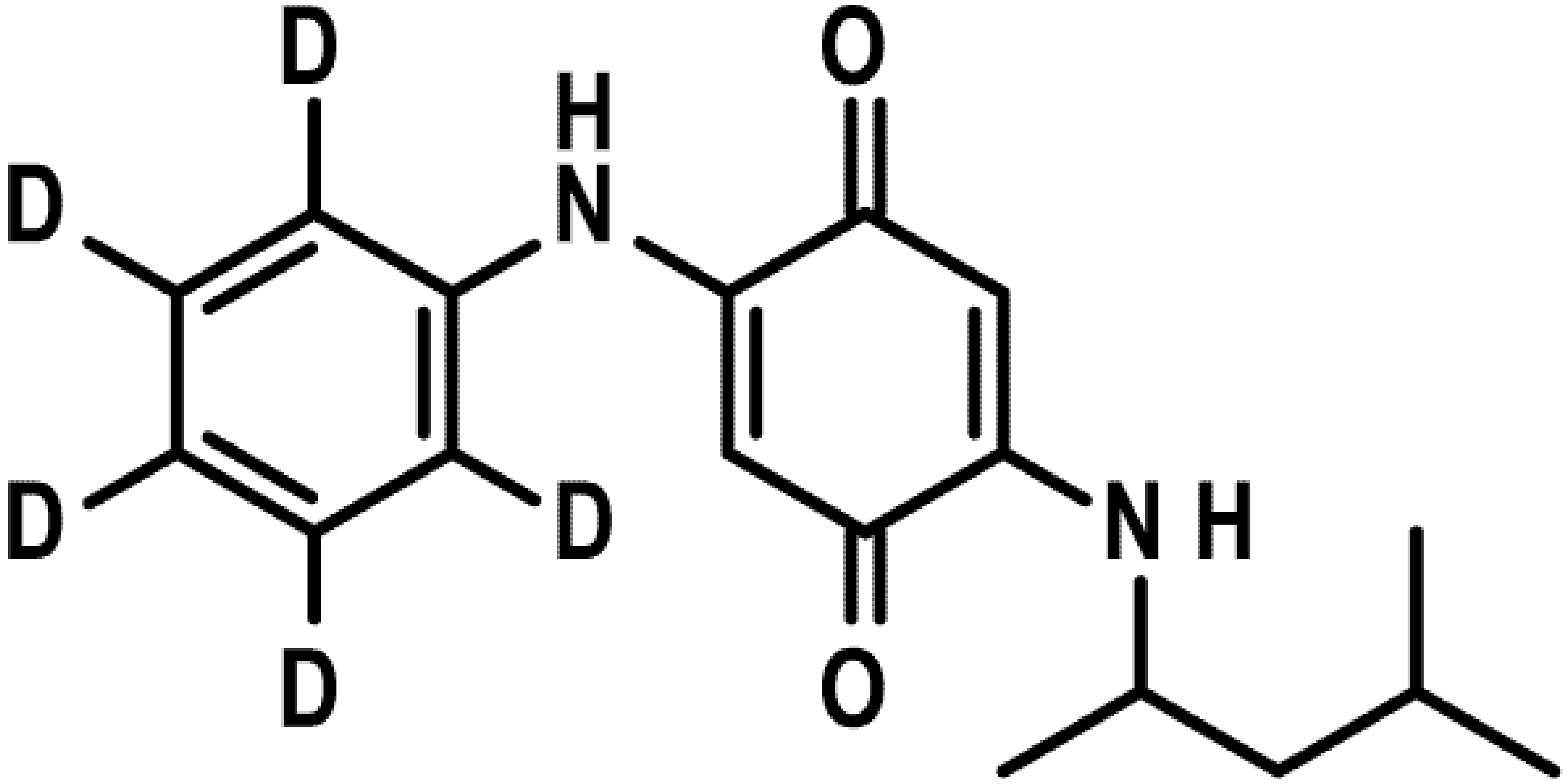
Montana Fish, Wildlife & Parks

Clark Fork Coalition
Connecting Rivers and Communities

TALK OUTLINE

- Project overview
- Method development
- Preliminary results
- Future work
- Thanks and Questions

6PPD-QUINONE



- Recently discovered (Tian et al. 2021)
- Degradation product of 6PPD, a commercial antioxidant
- Main source is from tire wear particulates in stormwater
- Toxic to Coho salmon and other aquatic organisms
- Thought to bioaccumulate
- **Distribution is unknown**

THE PROBLEM

https://tenor.com/view/washington-state-north-cascades-river-nature-majestic-gif-1111063

https://giphy.com/gifs/columbia-o0vKra8rn7hVm

THE SOLUTION?

- Known effective bio-indicators (Kuklina, Kouba, Kozak, 2013)
- Reflect local site conditions
- React quickly to environmental change
- Occupy multiple trophic levels
- Interact extensively with sediments
- Widely distributed in the CRB (both native and invasive species).

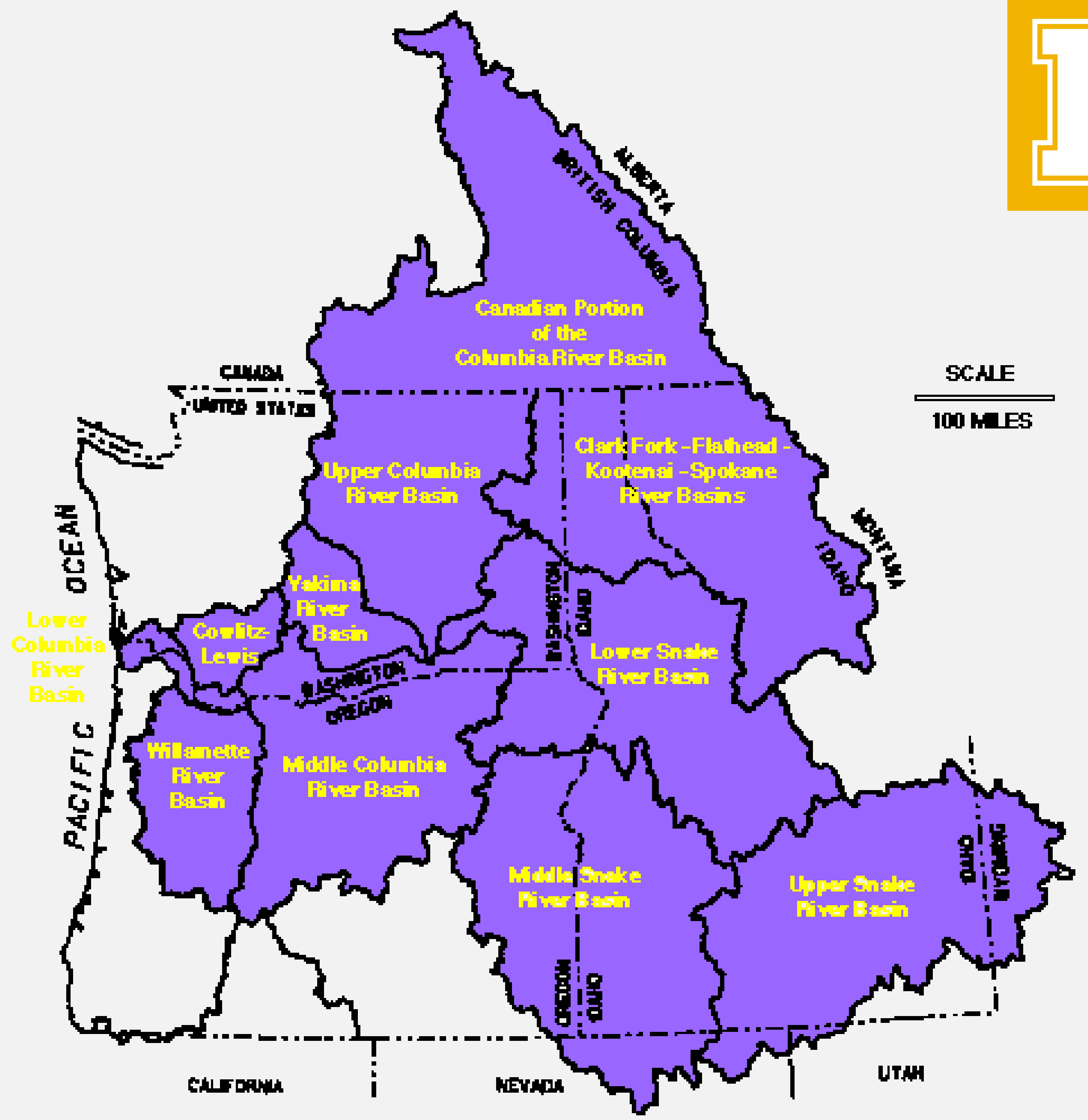
PROJECT OVERVIEW

Phase 1: Field Sampling	Phase 1: Laboratory Analysis	Phase 2: Field Sampling	Phase 2: Laboratory Analysis
Phase 3: Citizen Science Monitoring and Outreach Education			

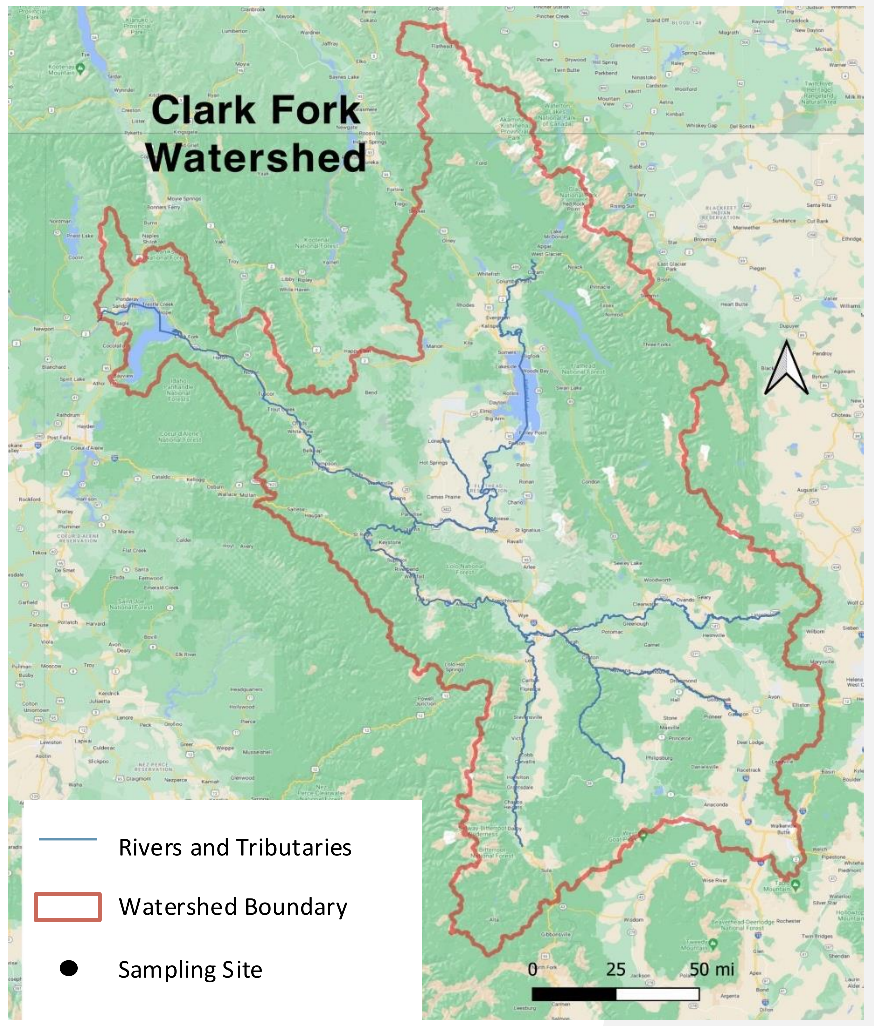
- **Phase 1:** Assess the accumulation of 6PPD-q in crayfish tissues under different exposure regimes.
  - Ecotox laboratory exposure study
    - Invasive: *Faxonius rusticus* (Rusty Crayfish)
    - Native: *Pacifastacus leniusculus* (Signal Crayfish)
- **Phase 2:** Assess the presence of 6PPD-q and TWP in water, sediment, and crayfish and fish tissues in the middle and upper CRB.
  - a field sampling, collection, and monitoring campaign at 40 sites across the upper CRB
- **Phase 3:** Enhance public awareness of 6PPD-q and TWP as aquatic pollutants in the CRB through the project period.
  - a public awareness campaign tied to citizen science collection of crayfish, student outreach, and a public facing website.

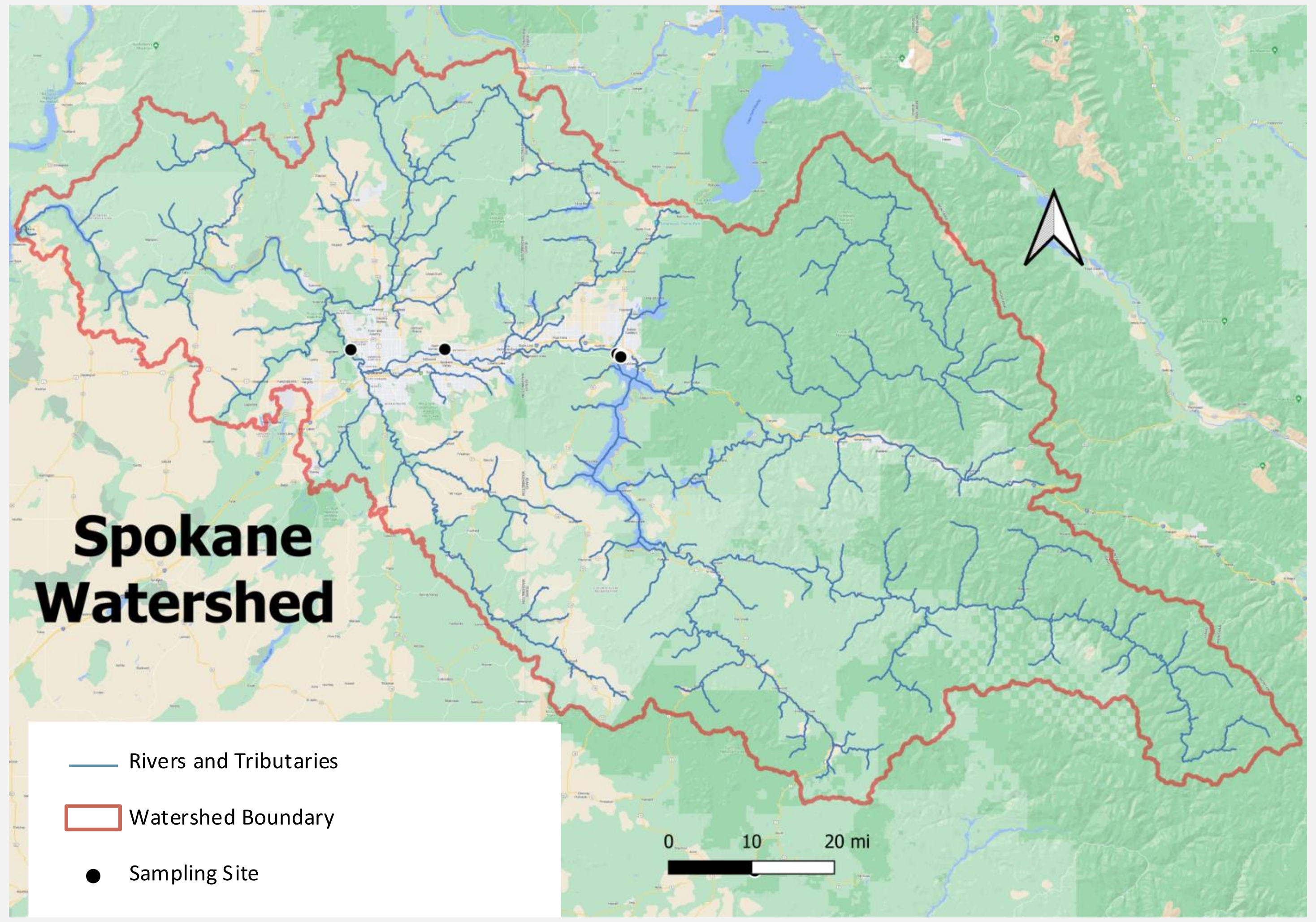
PROJECT GOALS

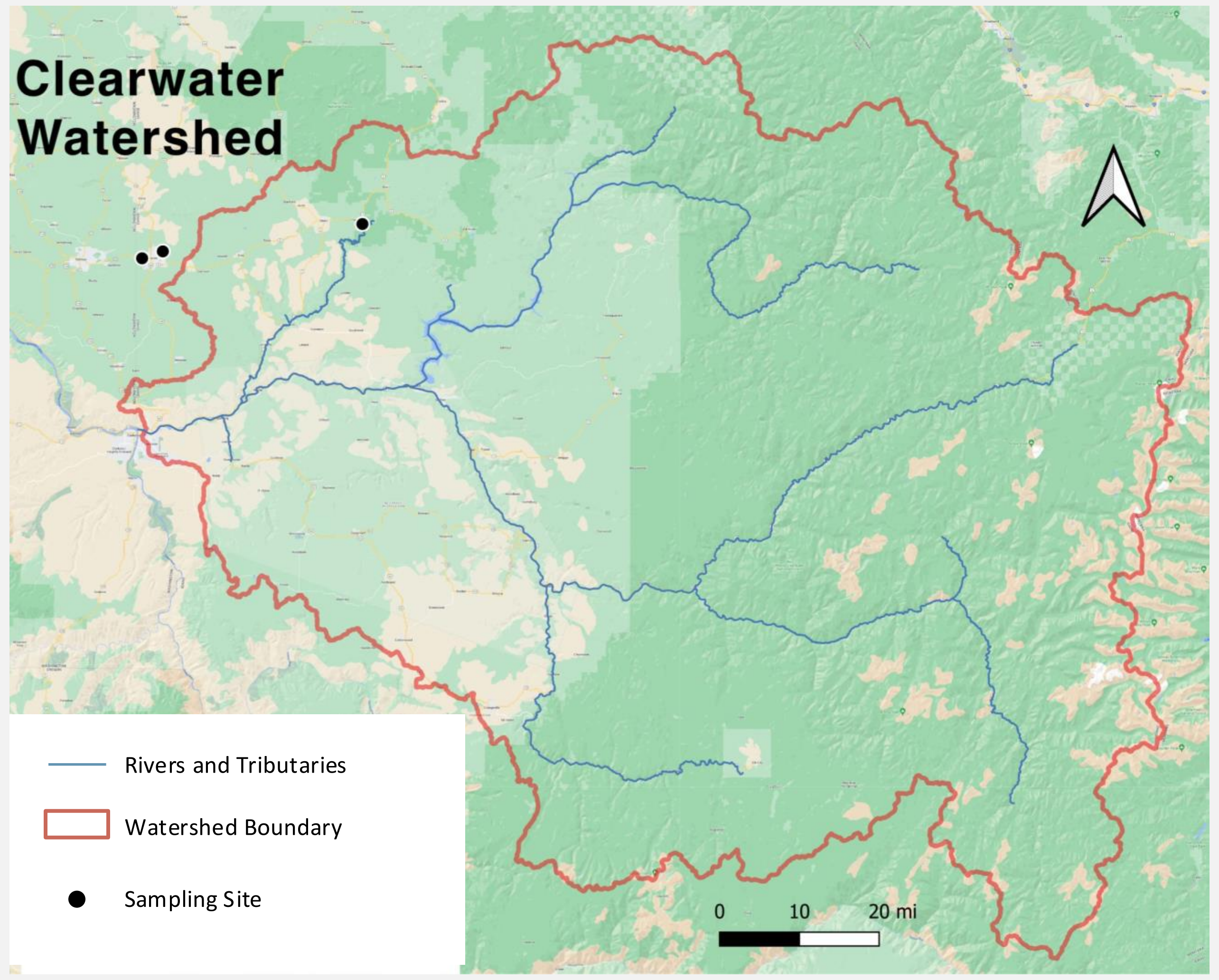
- To demonstrate the applicability of native and non-native crayfish as monitoring organisms for 6PPD-q contamination across a variety of environmental conditions.
- To promote citizen engagement and knowledge of aquatic contamination by tire wear particulates and 6PPD-q.

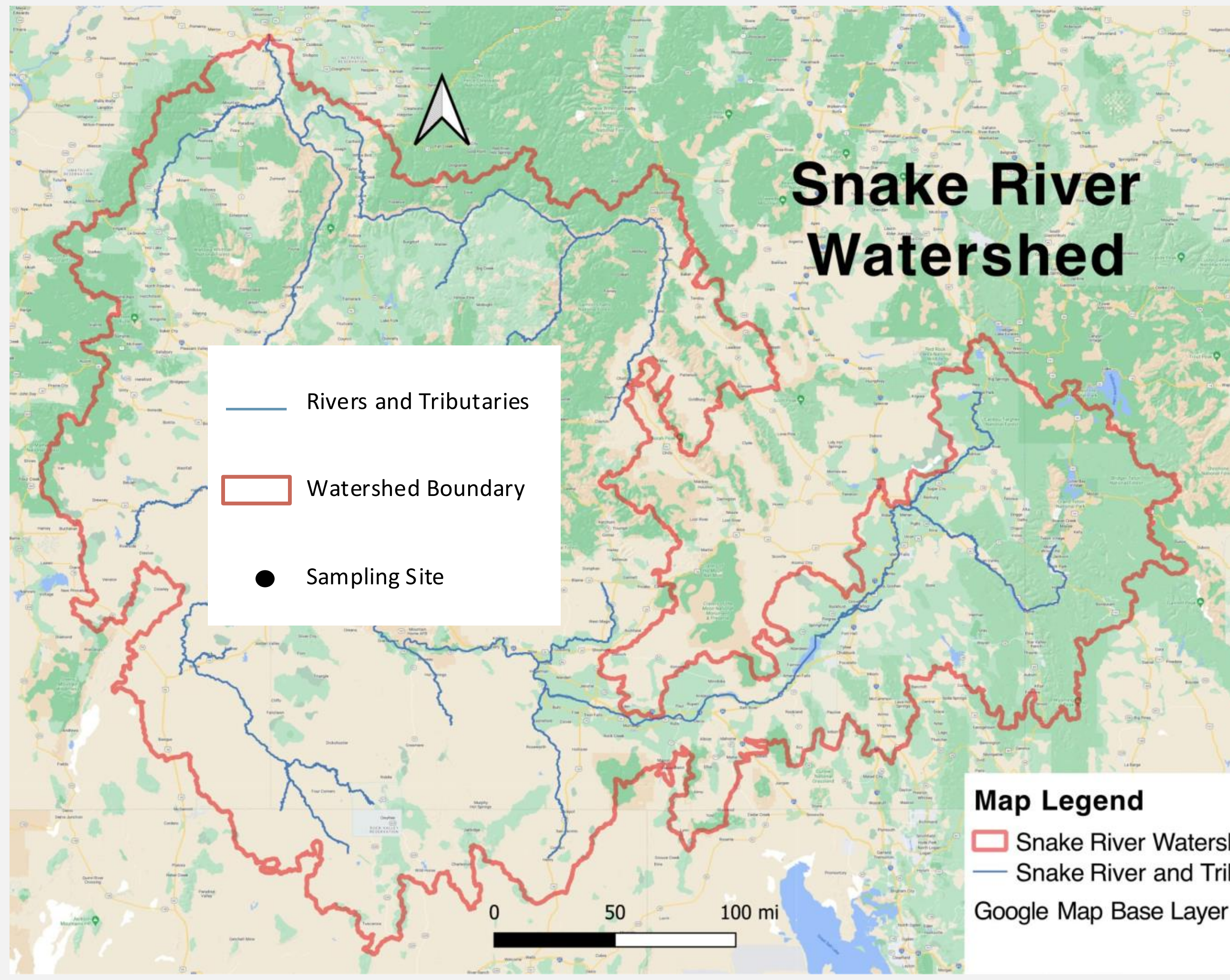


Focus Watersheds in the CRB





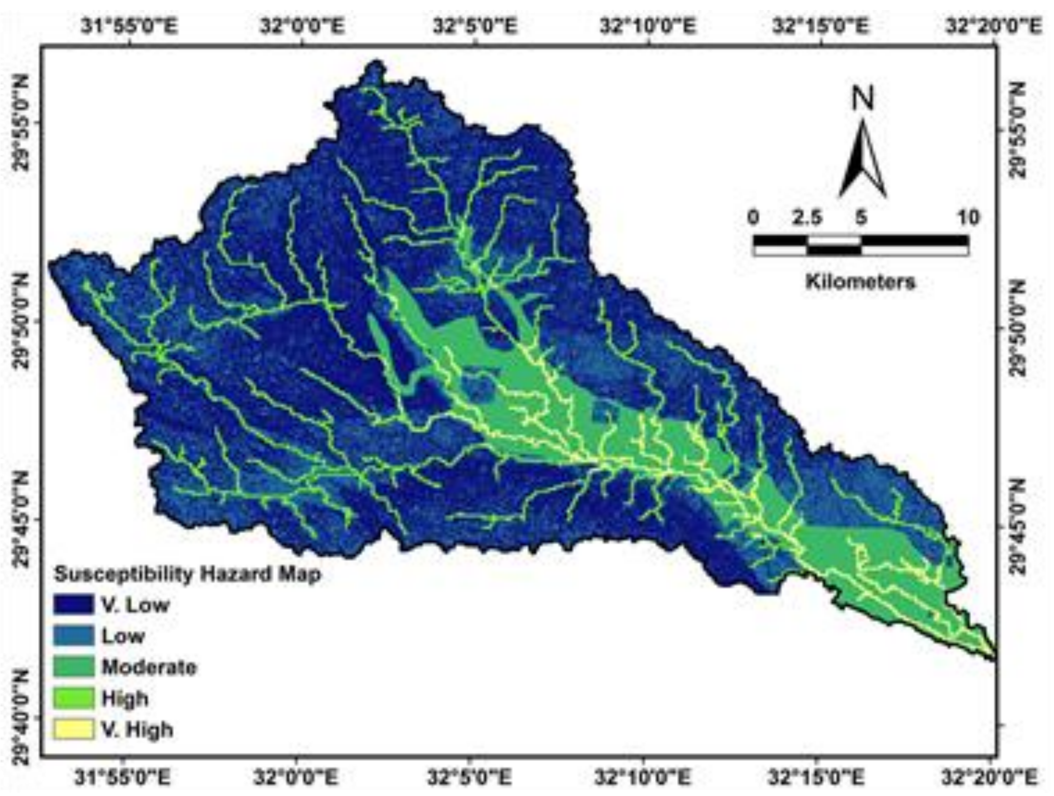


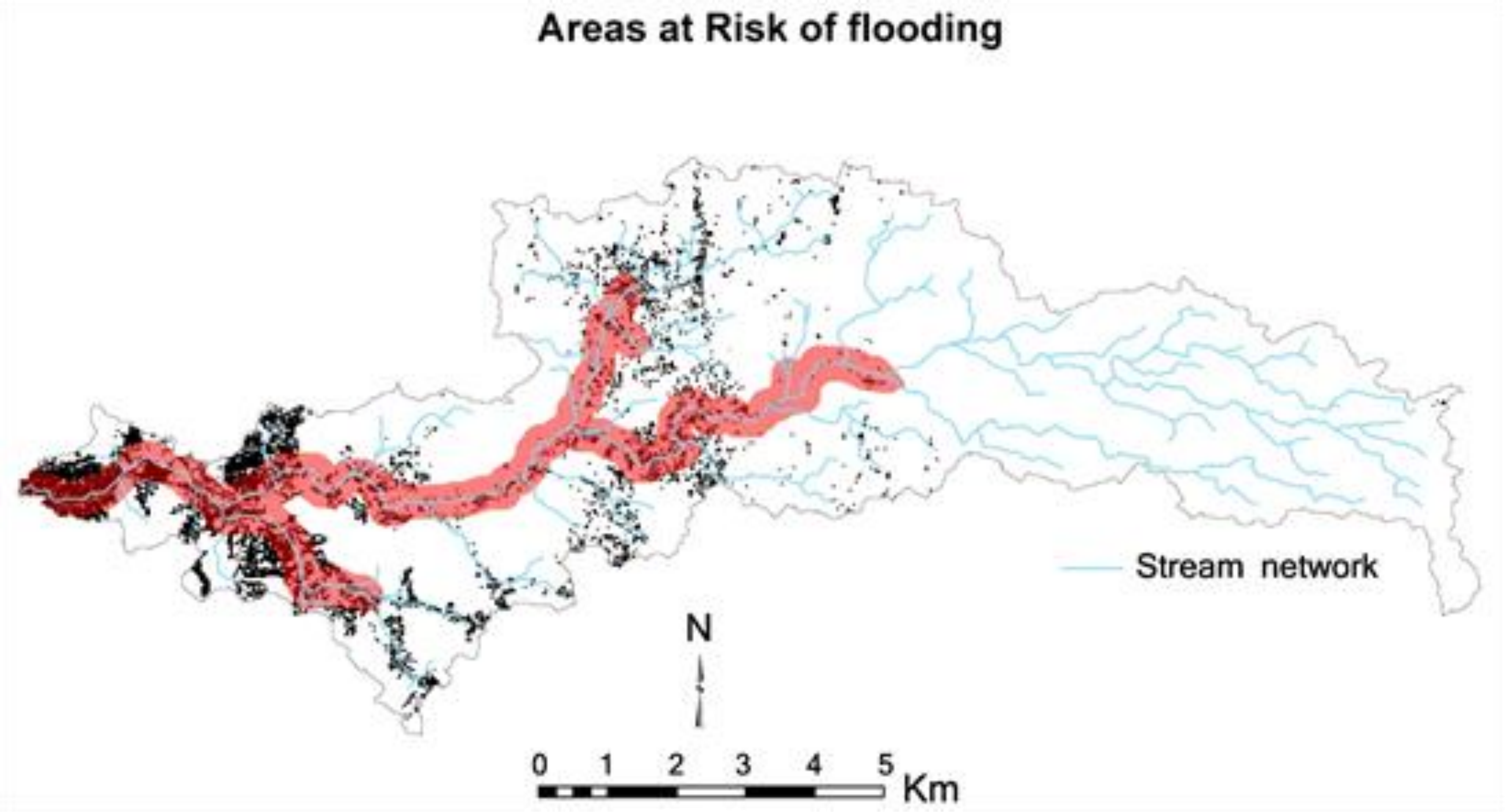


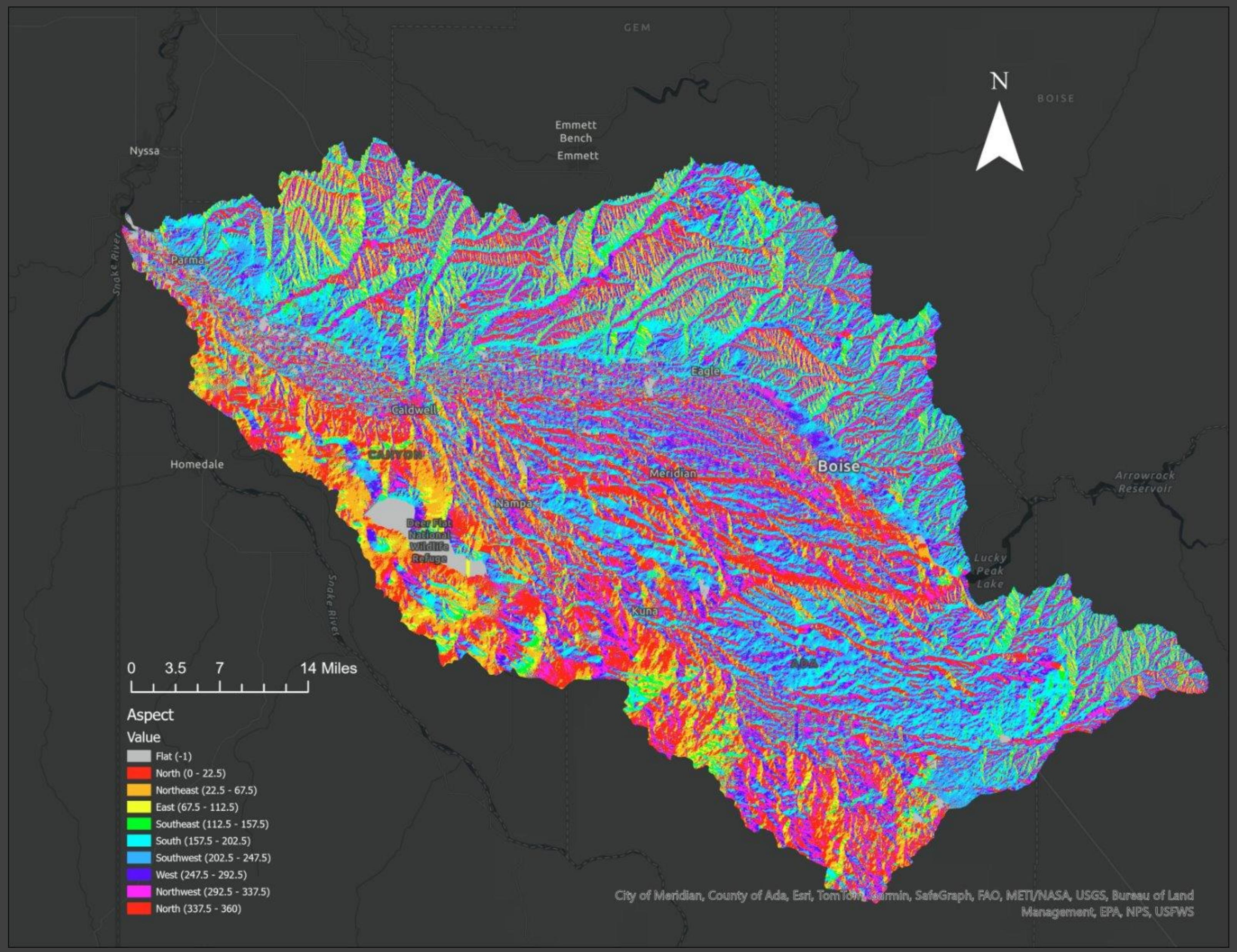
FINDING 6PPD-Q

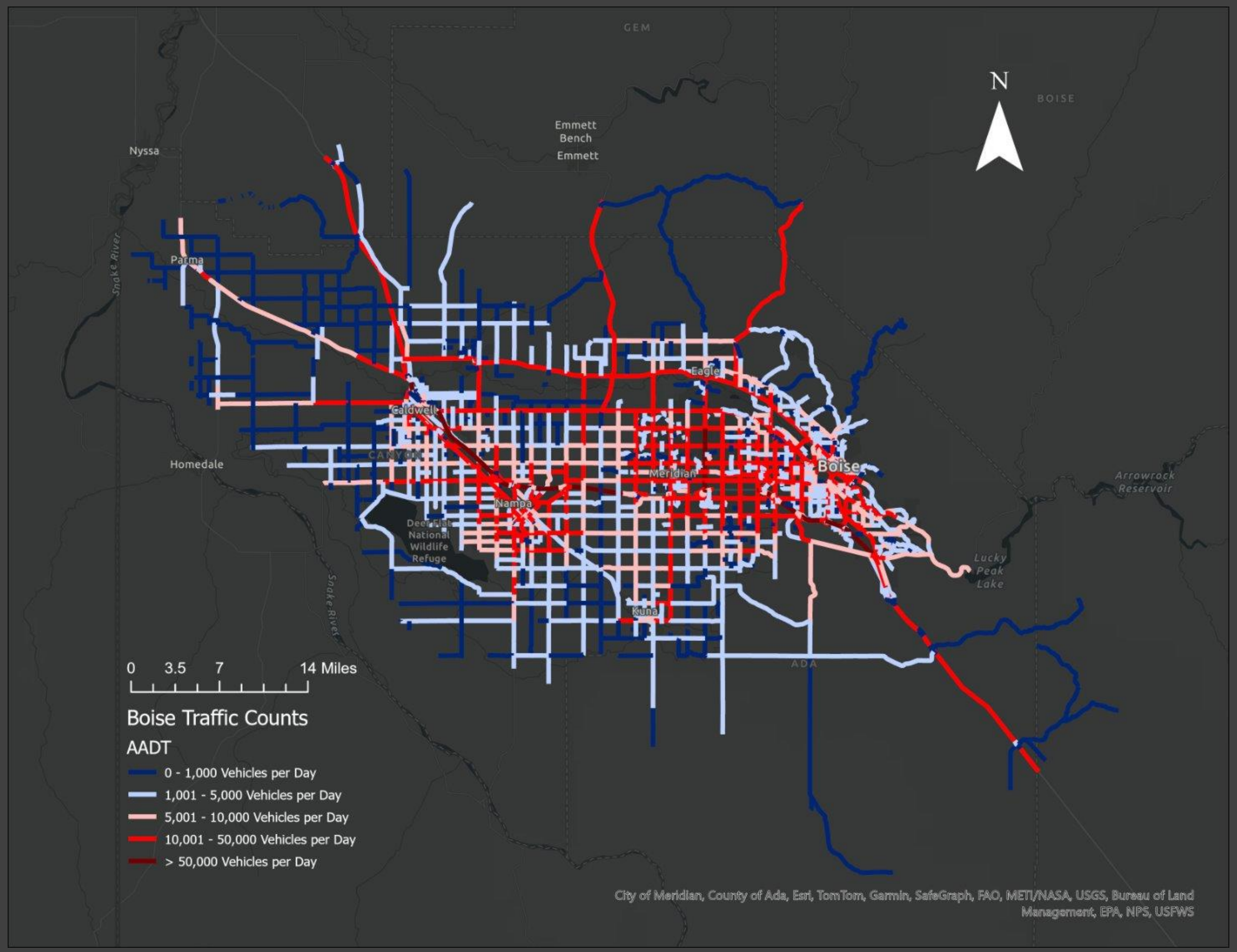
We know there are areas outside urban environments with higher risk of TWP and 6PPD-q contamination.

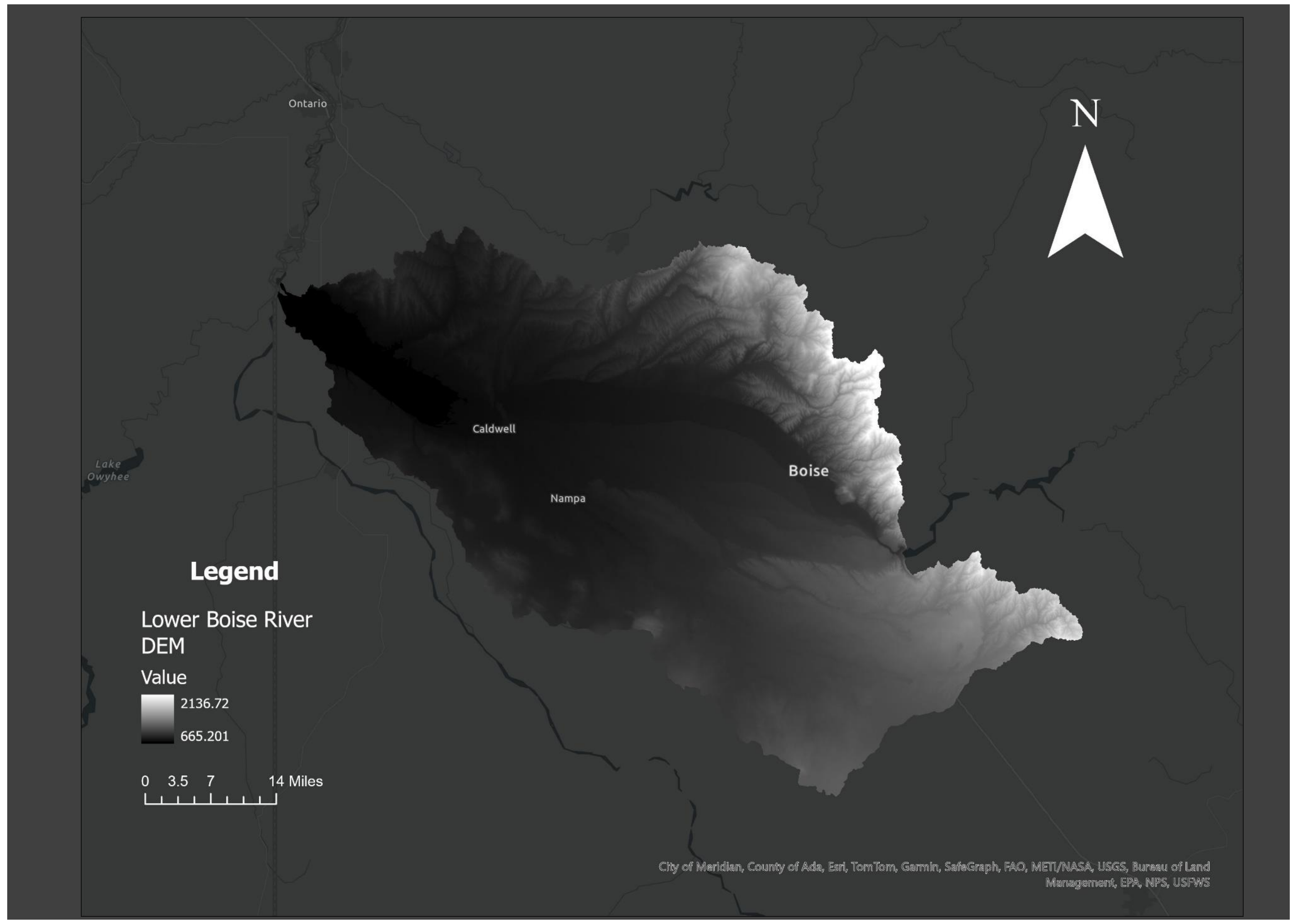
Our aim: create a simple map of potential TWP and 6PPD-q contamination risk at the watershed scale

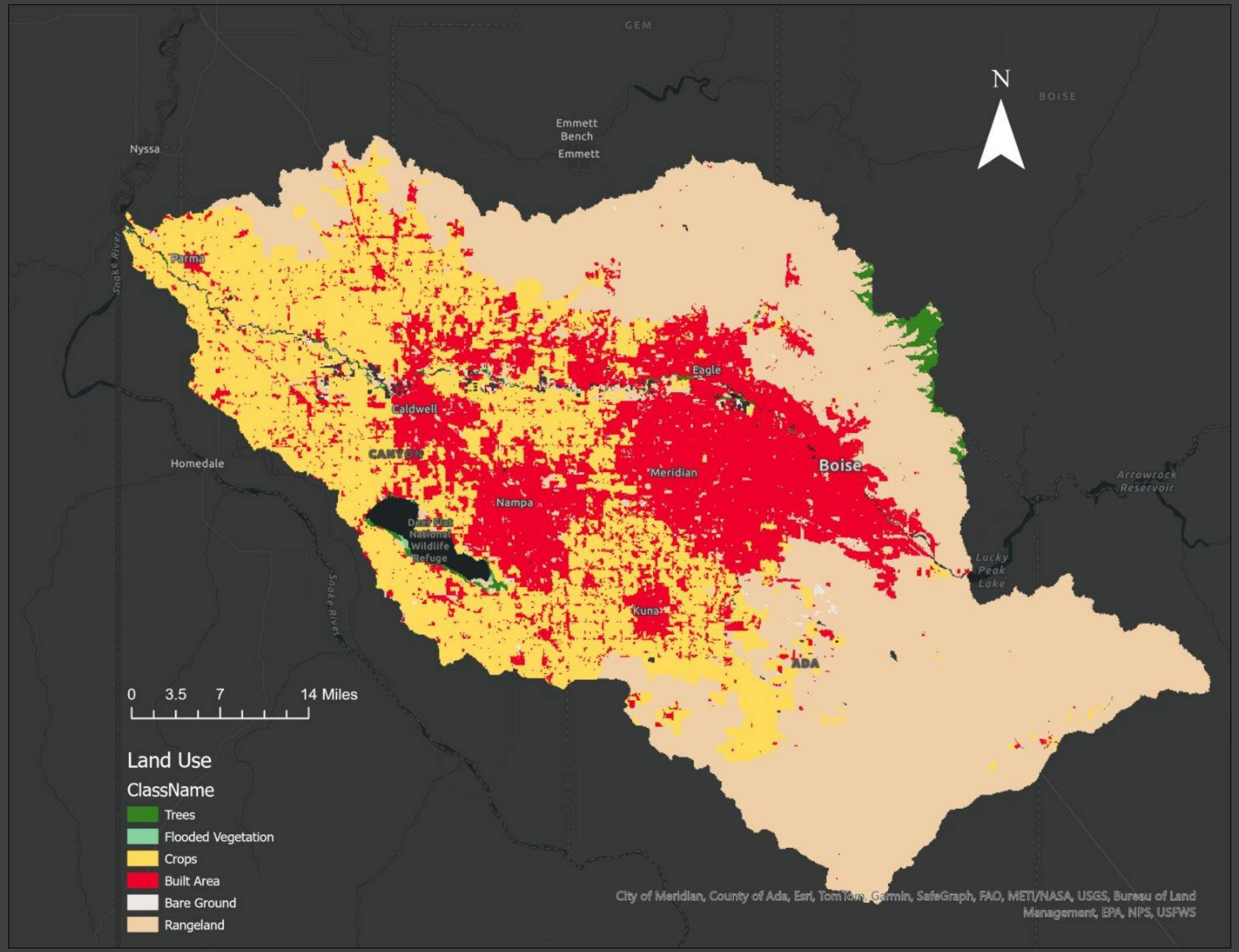


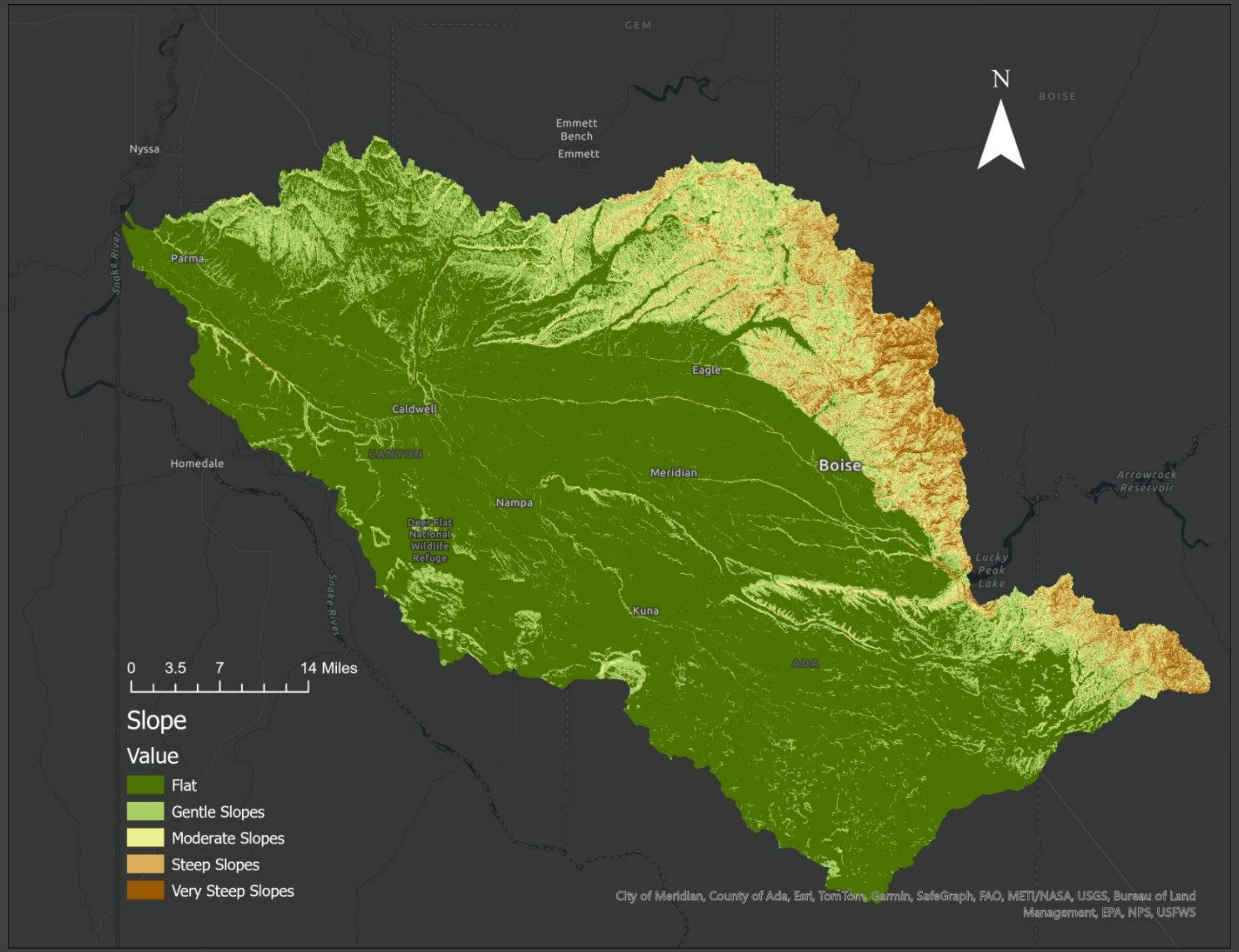



N
Nyssa
Emmett Bench
Emmett
Homedale
Boise
0 3.5 7 14 Miles
Aspect
Value
Flat (-1)
North (0 - 22.5)
Northeast (22.5 - 67.5)
East (67.5 - 112.5)
Southeast (112.5 - 157.5)
South (157.5 - 202.5)
Southwest (202.5 - 247.5)
West (247.5 - 292.5)
Northwest (292.5 - 337.5)
North (337.5 - 360)
City of Meridian, County of Ada, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS

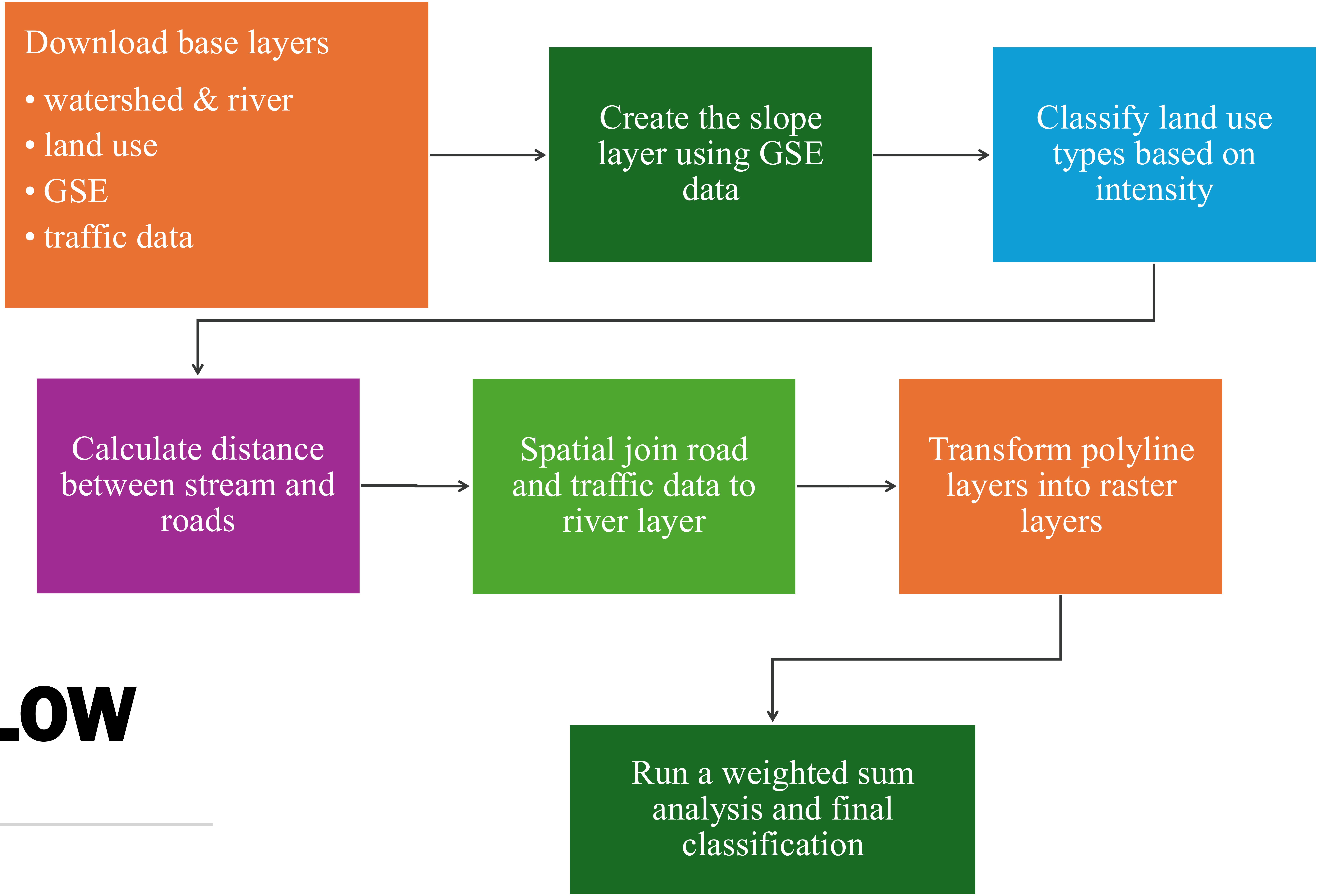

N
Nyssa
Emmett Bench
Emmett
Homedale
Boise
0 3.5 7 14 Miles
Boise Traffic Counts
AADT
0 - 1,000 Vehicles per Day
1,001 - 5,000 Vehicles per Day
5,001 - 10,000 Vehicles per Day
10,001 - 50,000 Vehicles per Day
> 50,000 Vehicles per Day
City of Meridian, County of Ada, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS


N
Ontario
Caldwell
Nampa
Boise
Legend
Lower Boise River DEM
Value
2136.72
665.201
0 3.5 7 14 Miles
City of Meridian, County of Ada, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS

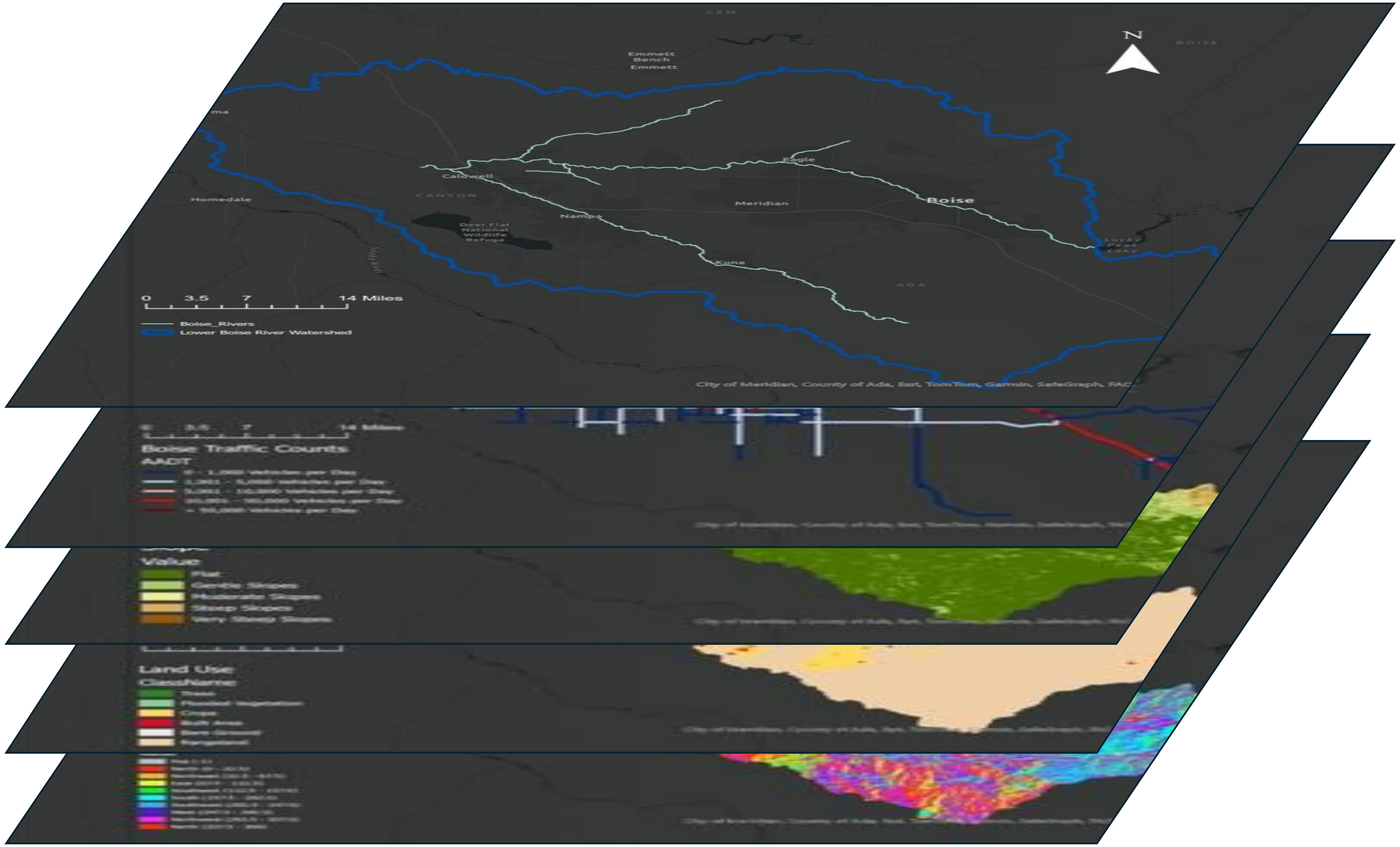

N
Nyssa
Emmett Bench
Emmett
Homedale
Eagle
Caldwell
Meridian
Boise
Nampa
Kuna
0 3.5 7 14 Miles
Land Use
ClassName
Trees
Flooded Vegetation
Crops
Built Area
Bare Ground
Rangeland
City of Meridian, County of Ada, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS


N
Nyssa
Emmett Bench
Emmett
Homedale
Parma
Eagle
Caldwell
Meridian
Boise
Nampa
Kuna
0 3.5 7 14 Miles
Slope
Value
Flat
Gentle Slopes
Moderate Slopes
Steep Slopes
Very Steep Slopes
City of Meridian, County of Ada, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS

WORKFLOW


Download base layers
• watershed & river
• land use
• GSE
• traffic data
Create the slope layer using GSE data
Classify land use types based on intensity
Calculate distance between stream and roads
Spatial join road and traffic data to river layer
Transform polyline layers into raster layers
Run a weighted sum analysis and final classification

VISUAL WORKFLOW REPRESENTATION



Rivers

+

Traffic and road proximity

+

Slope

+

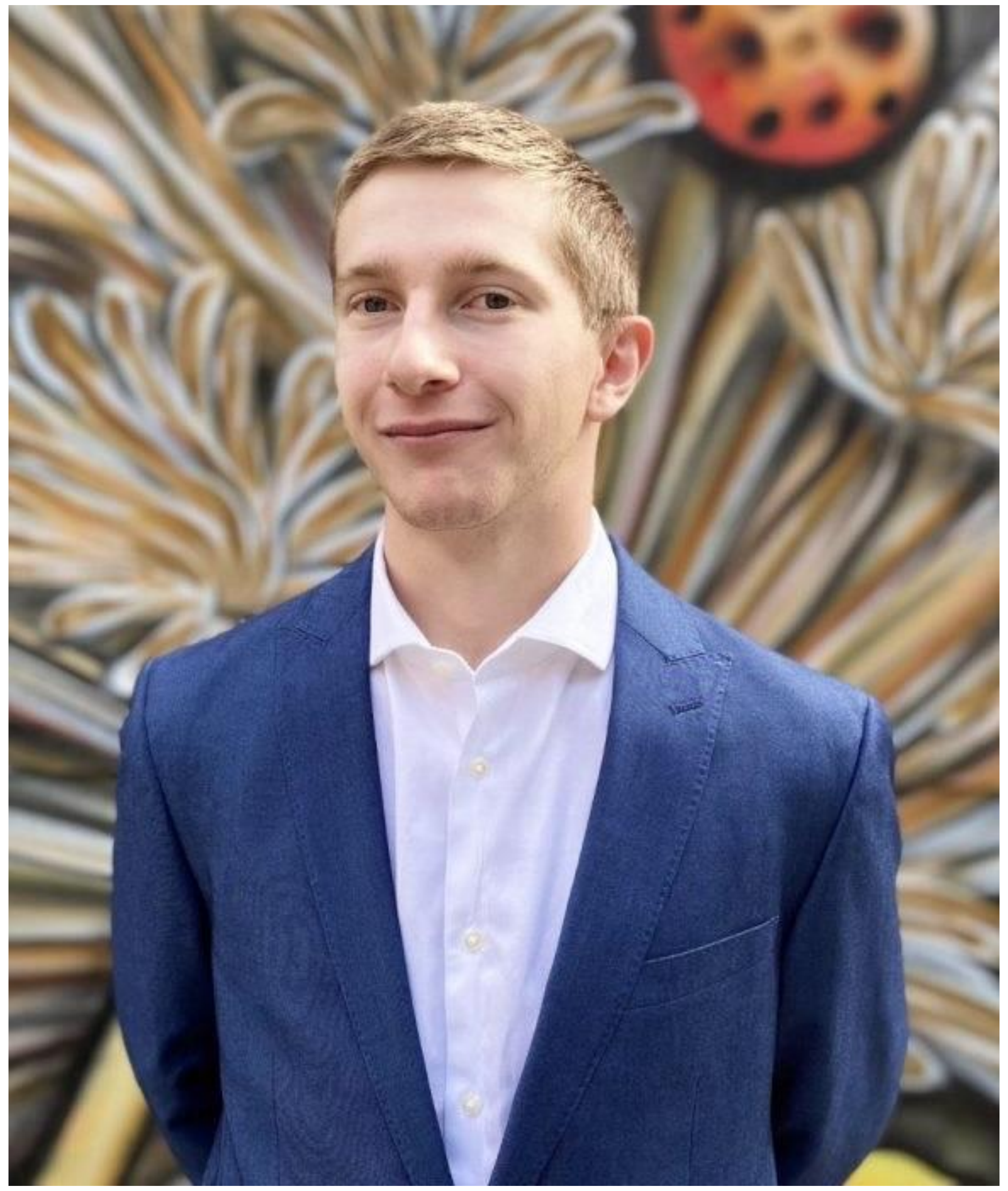
Land use

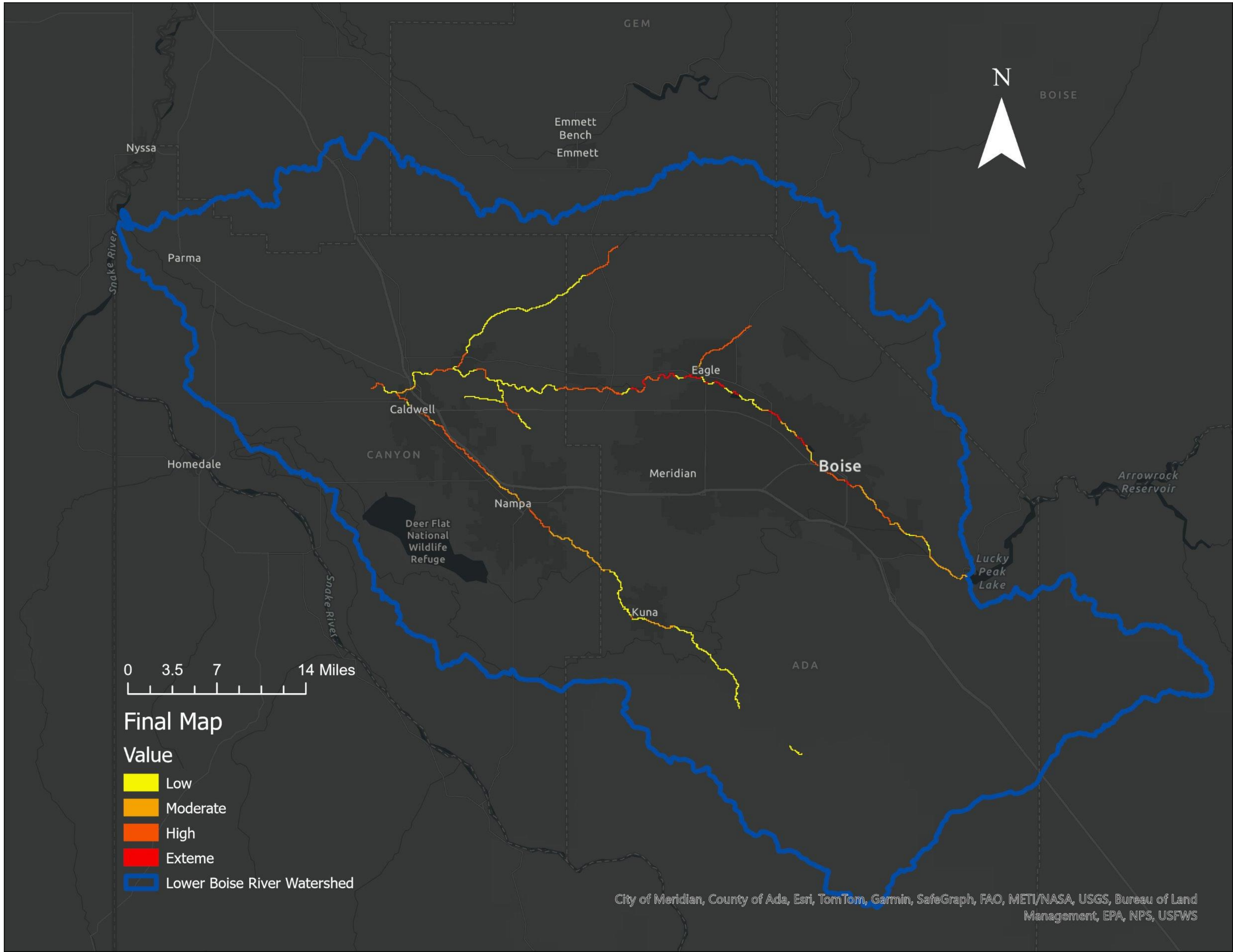
+

Aspect

BOISE, ID WATERSHED

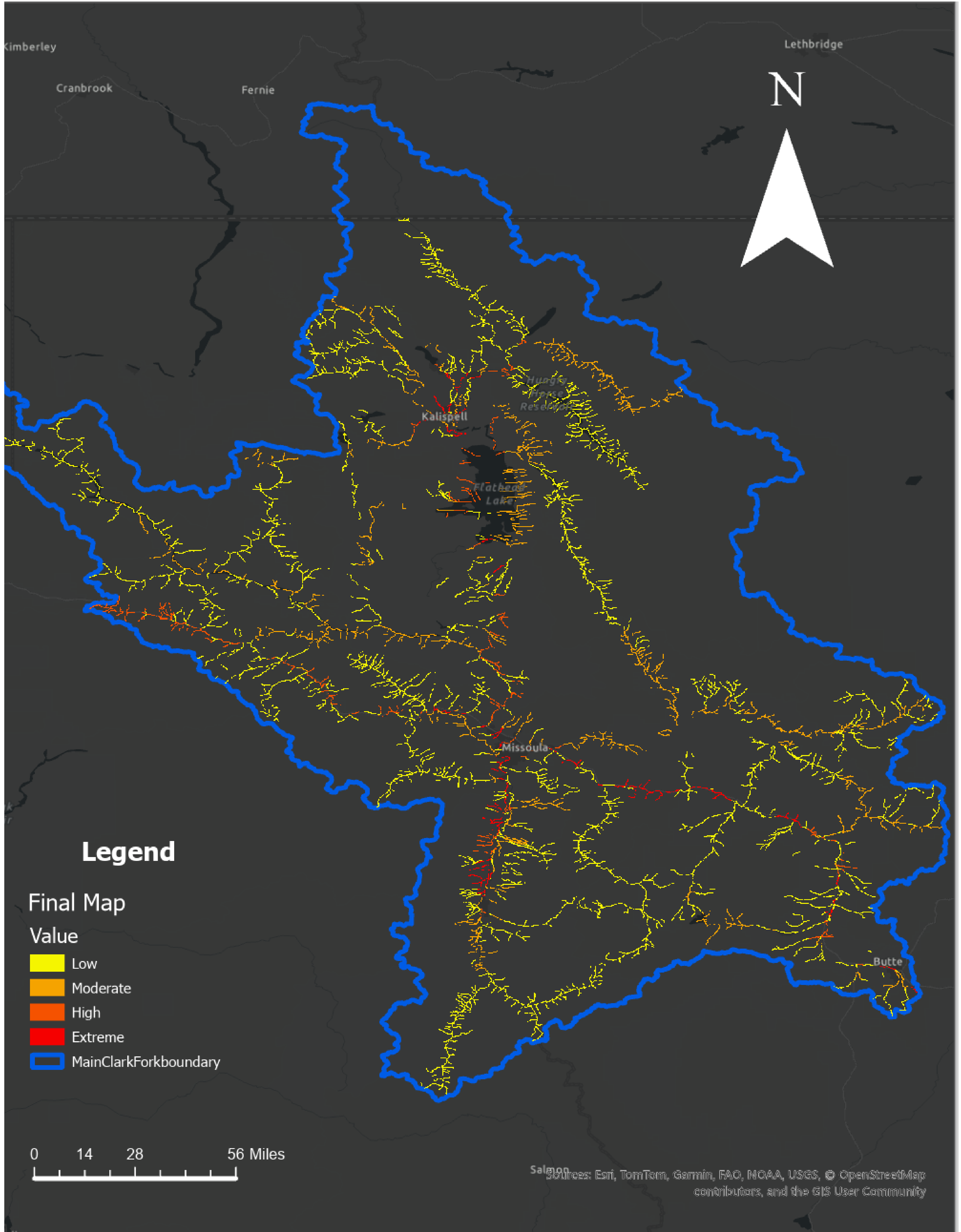
Created by Miles Butler





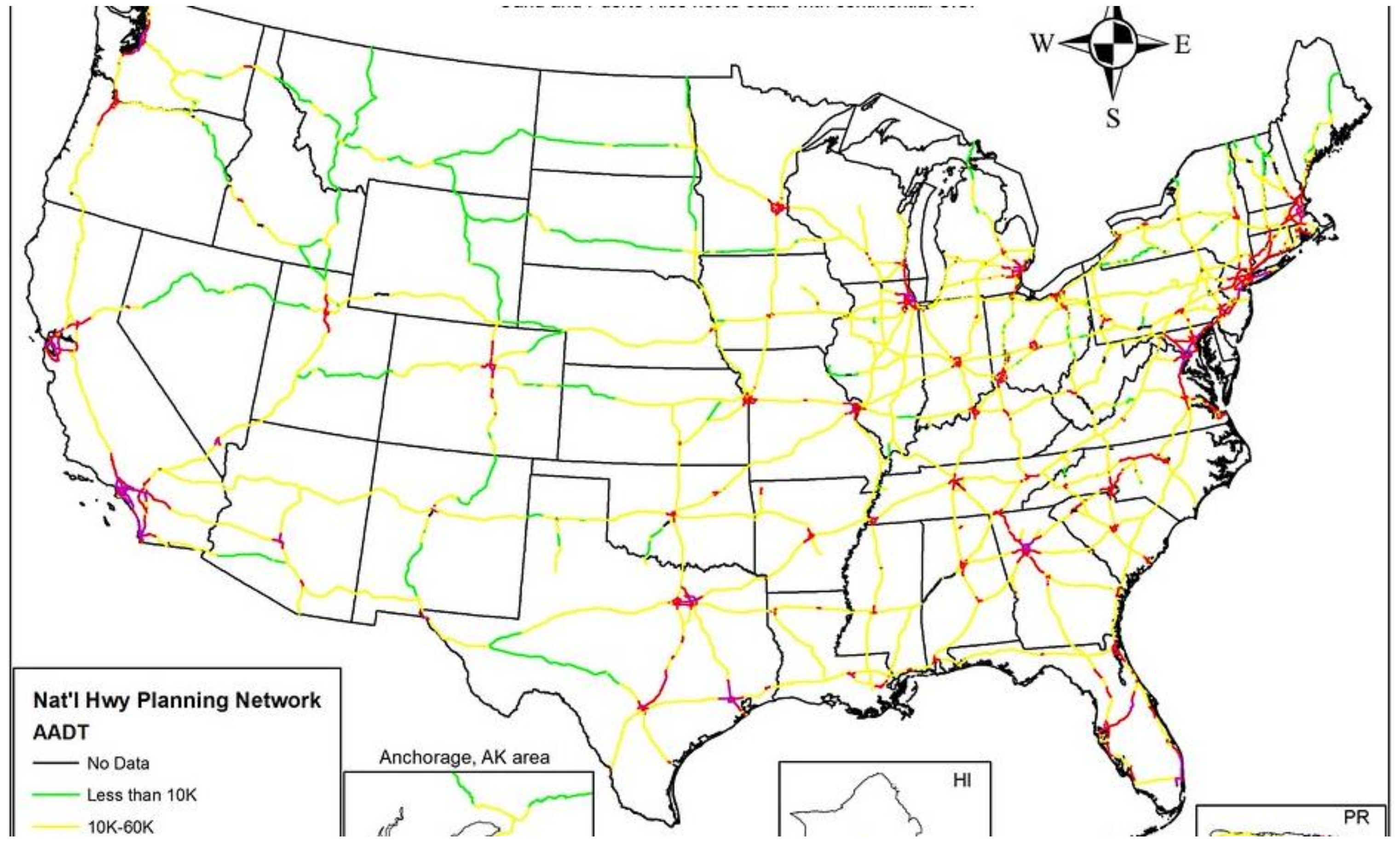
CLARK FORK, MT WATERSHED

Created by Chloe Arthaud



Limitations and Additions

- Traffic data
- Stream width
- State differences
- Weights
- Flow regime
- Point source pollution



FINDING 6PPD-Q: METHOD DEVELOPMENT

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Water

- Started work in 2023, prior to EPA draft method publication
- Initially followed Tian et. al (2022) methods
- Updated to EPA draft method with two internal standards in 2024
- QAQC checks align with EPA draft method

FINDING 6PPD-Q: METHOD DEVELOPMENT

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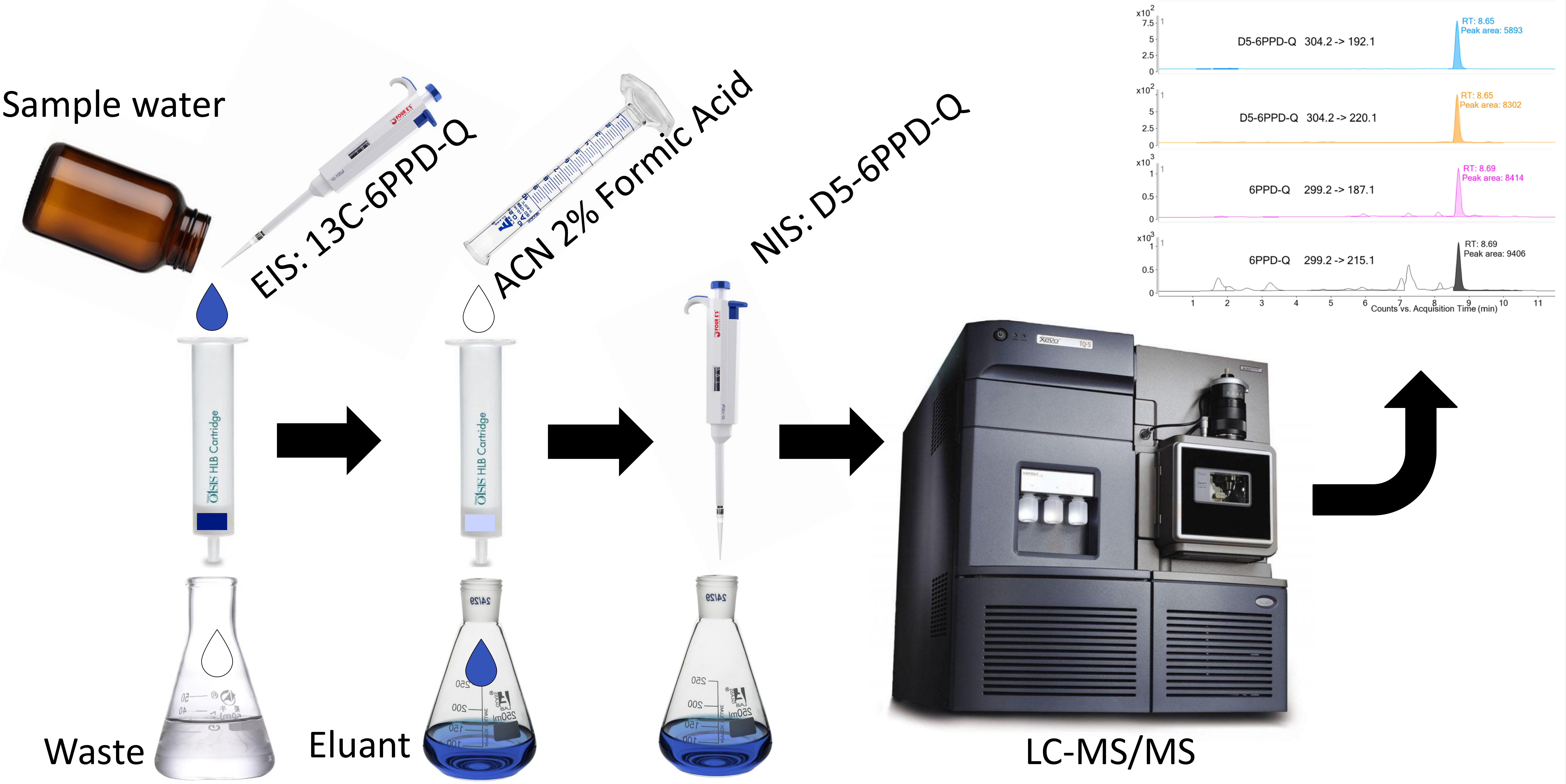
Tissue

- Tissue Methods didn't exist for crayfish
- Assessment of QuEChERS based method based on Yang et al (2021)
- Assessment of Agilent PFAS Method (Pulster and Giardina, 2022)
- QAQC checks align with EPA draft method (2024)

WATER METHOD

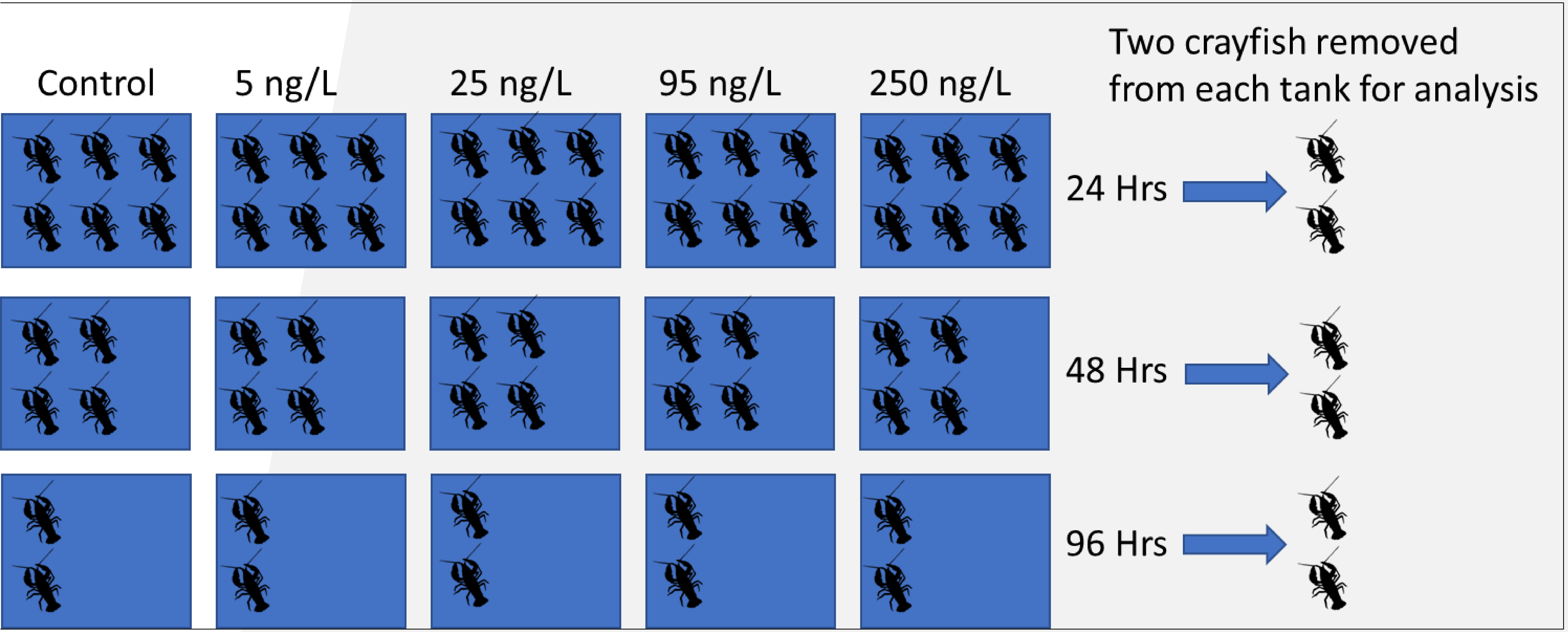


TISSUE METHOD

PHASE ONE

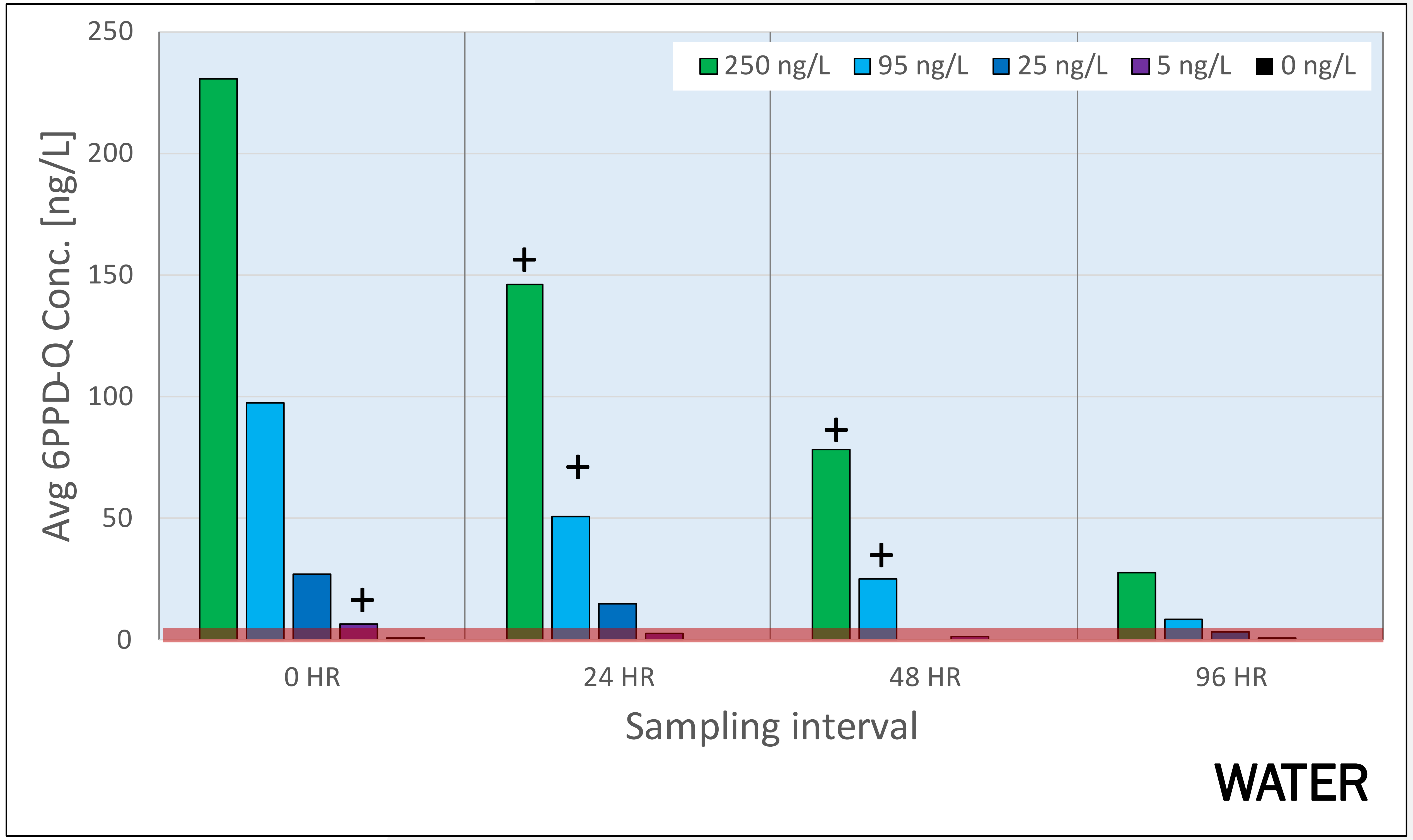
EXPERIMENTAL SETUP

- 60 liters of dechlorinated lab water
- Constant aeration
- Controlled conditions of temperature and light.
- No food
- Two species
  - *Faxonius rusticus (Rusty Crayfish)*
  - *Pacifastacus leniusculus (Signal Crayfish)*

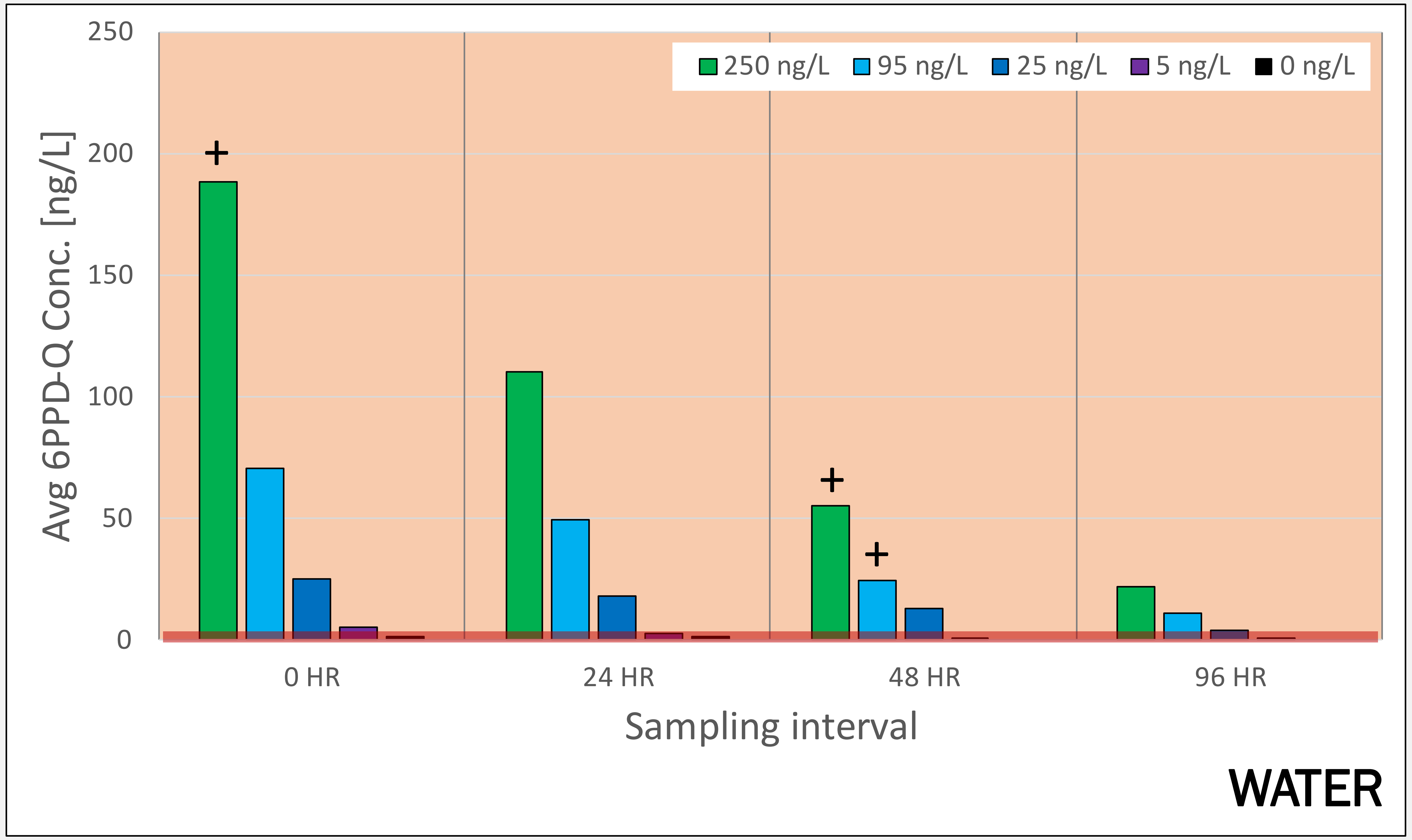


RESULTS PHASE 1: TANK WATER

SIGNAL CRAYFISH TANKS



RUSTY CRAYFISH TANKS



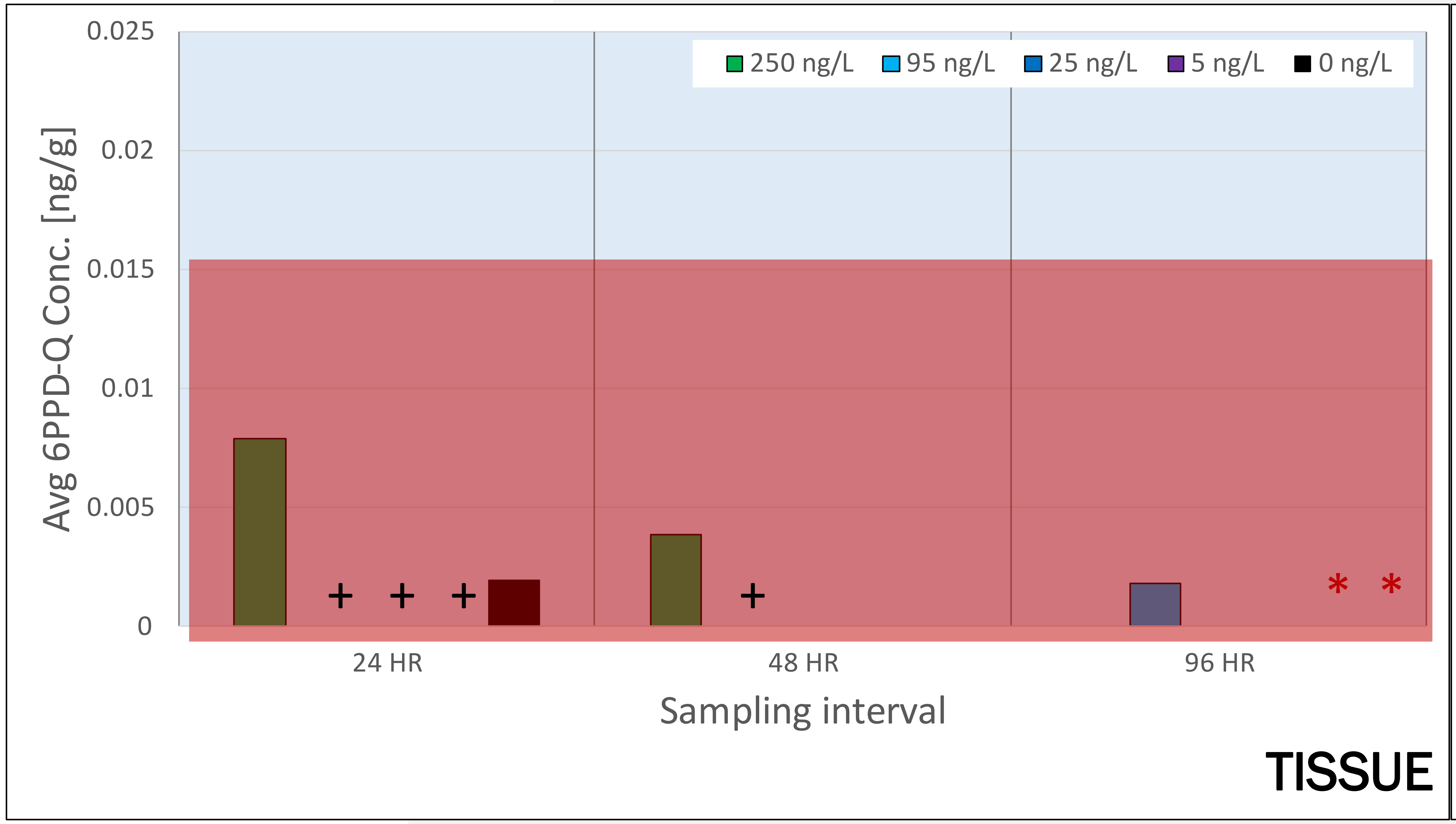
< LOQ

* Sample loss

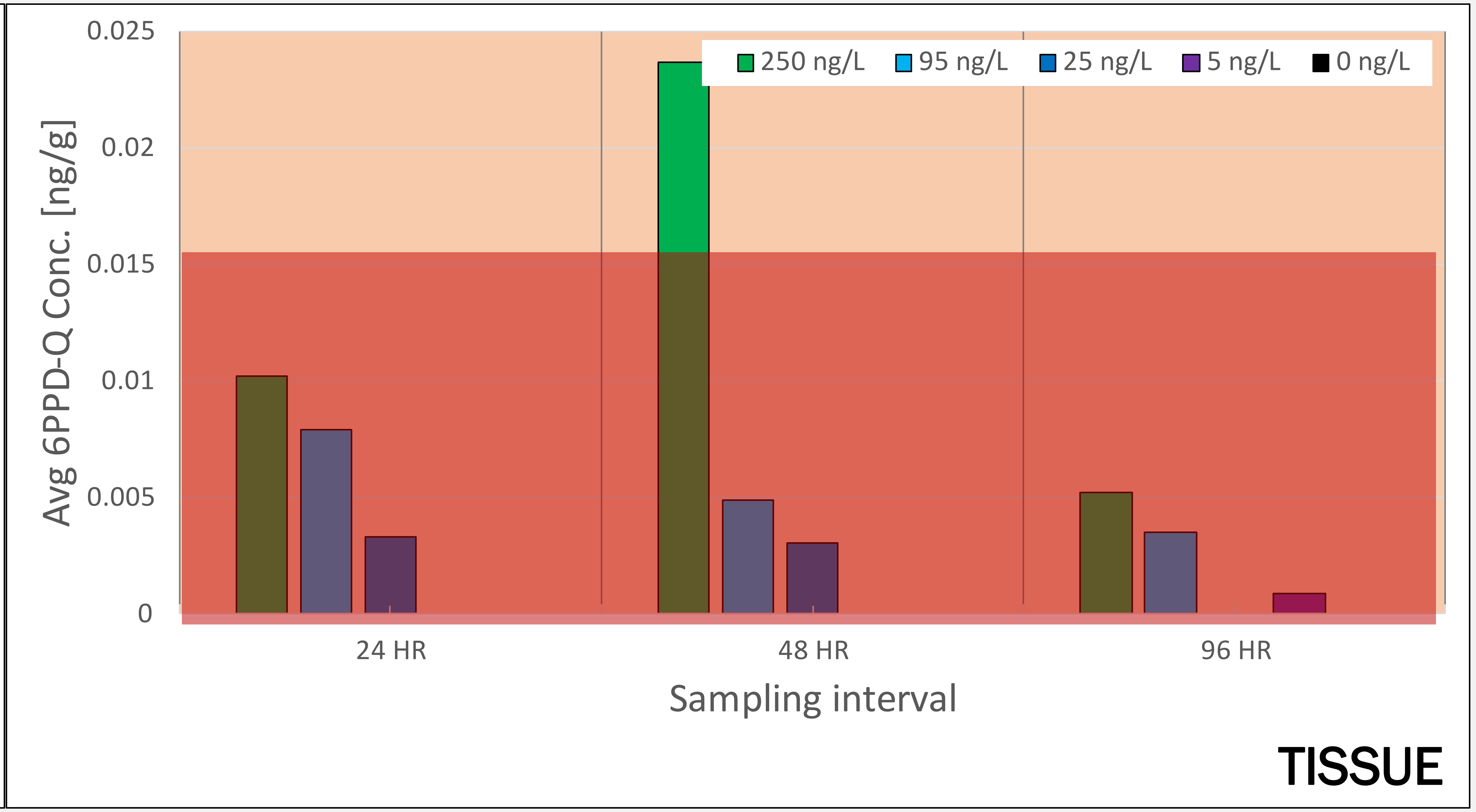
\+ Single sample

RESULTS PHASE 1: CRAYFISH TISSUE

SIGNAL CRAYFISH



RUSTY CRAYFISH



< LOQ

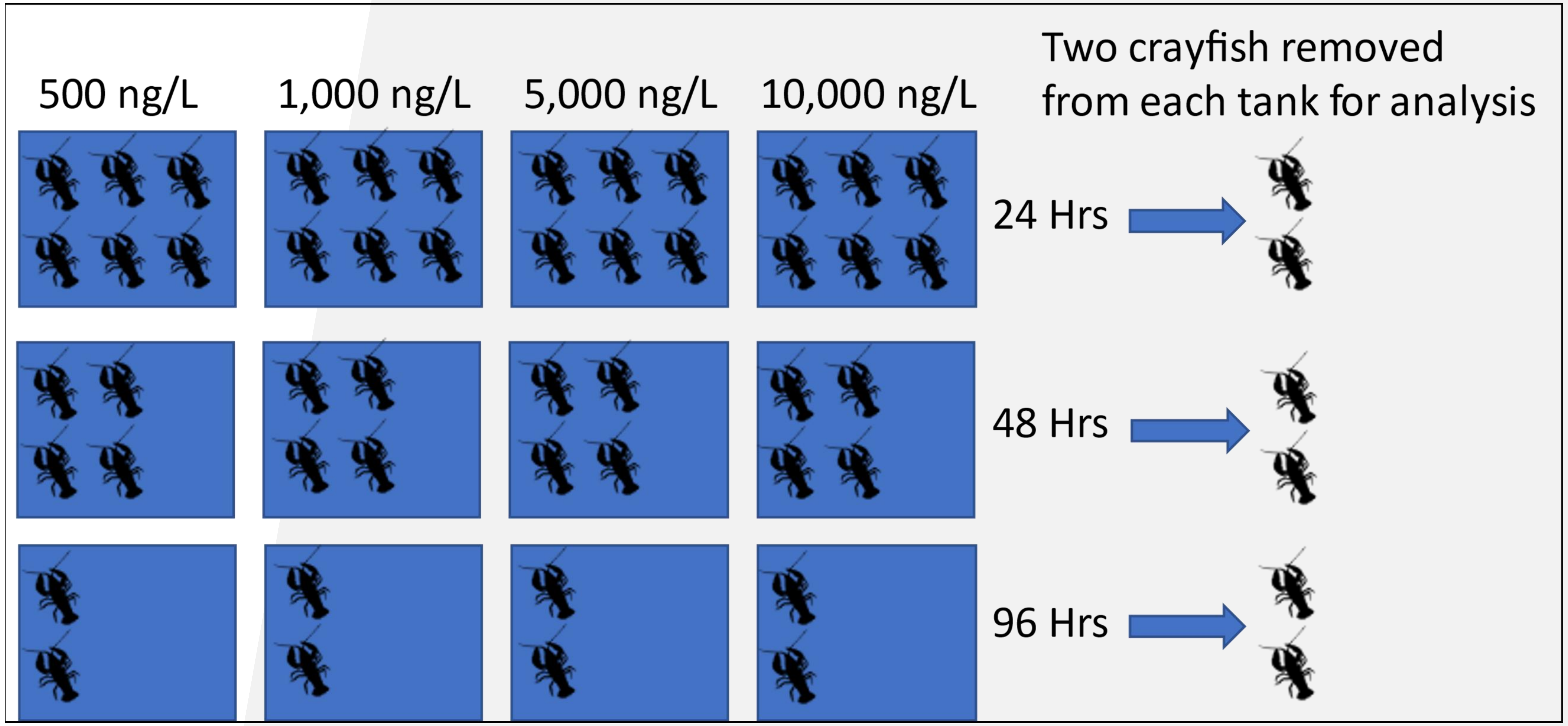
* Sample loss

+ Single sample

PHASE ONE – P2

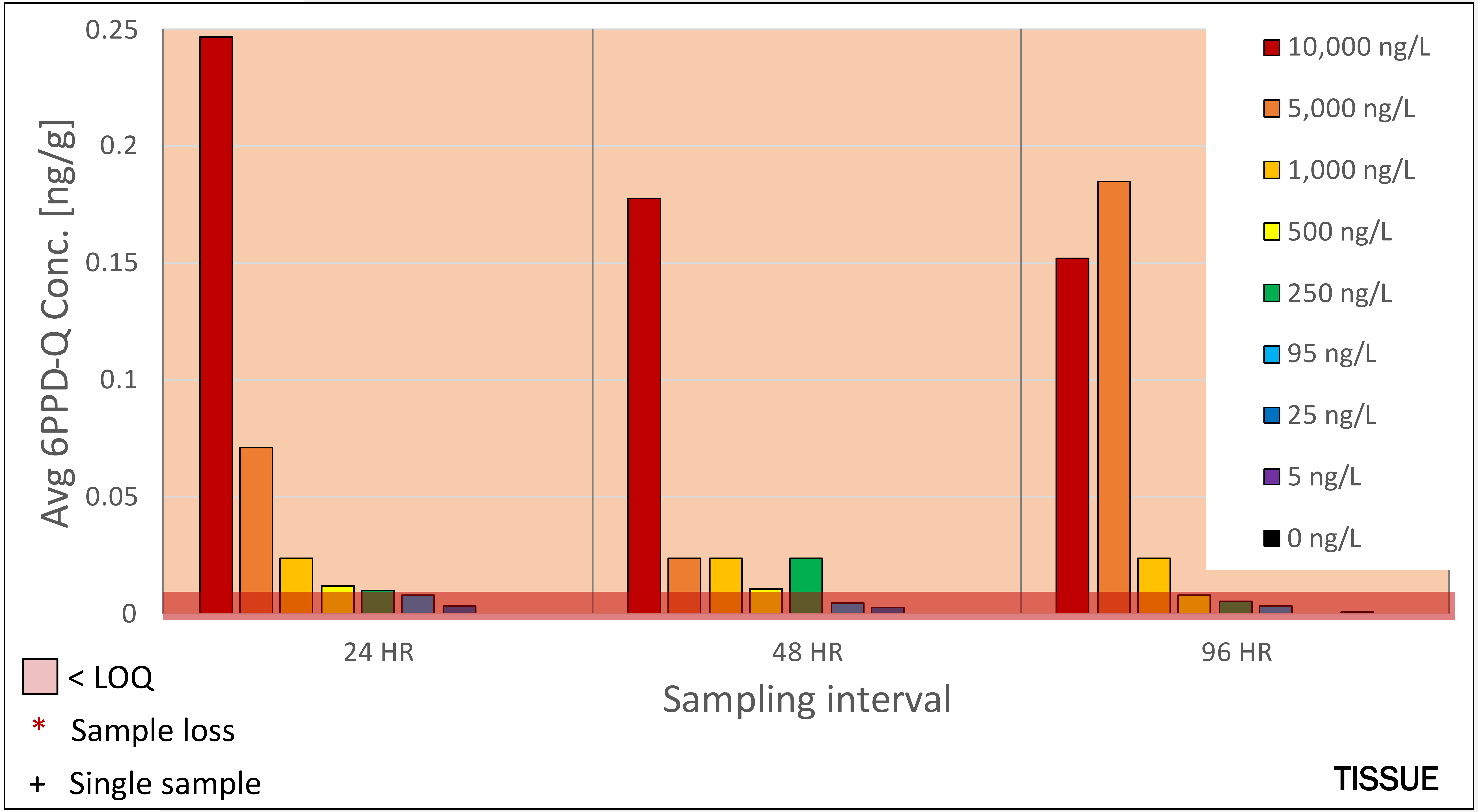
EXPERIMENTAL SETUP

- 60 liters of dechlorinated lab water
- Constant aeration
- Controlled conditions of temperature and light.
- No food
- One species
  - *Faxonius rusticus (Rusty Crayfish)*

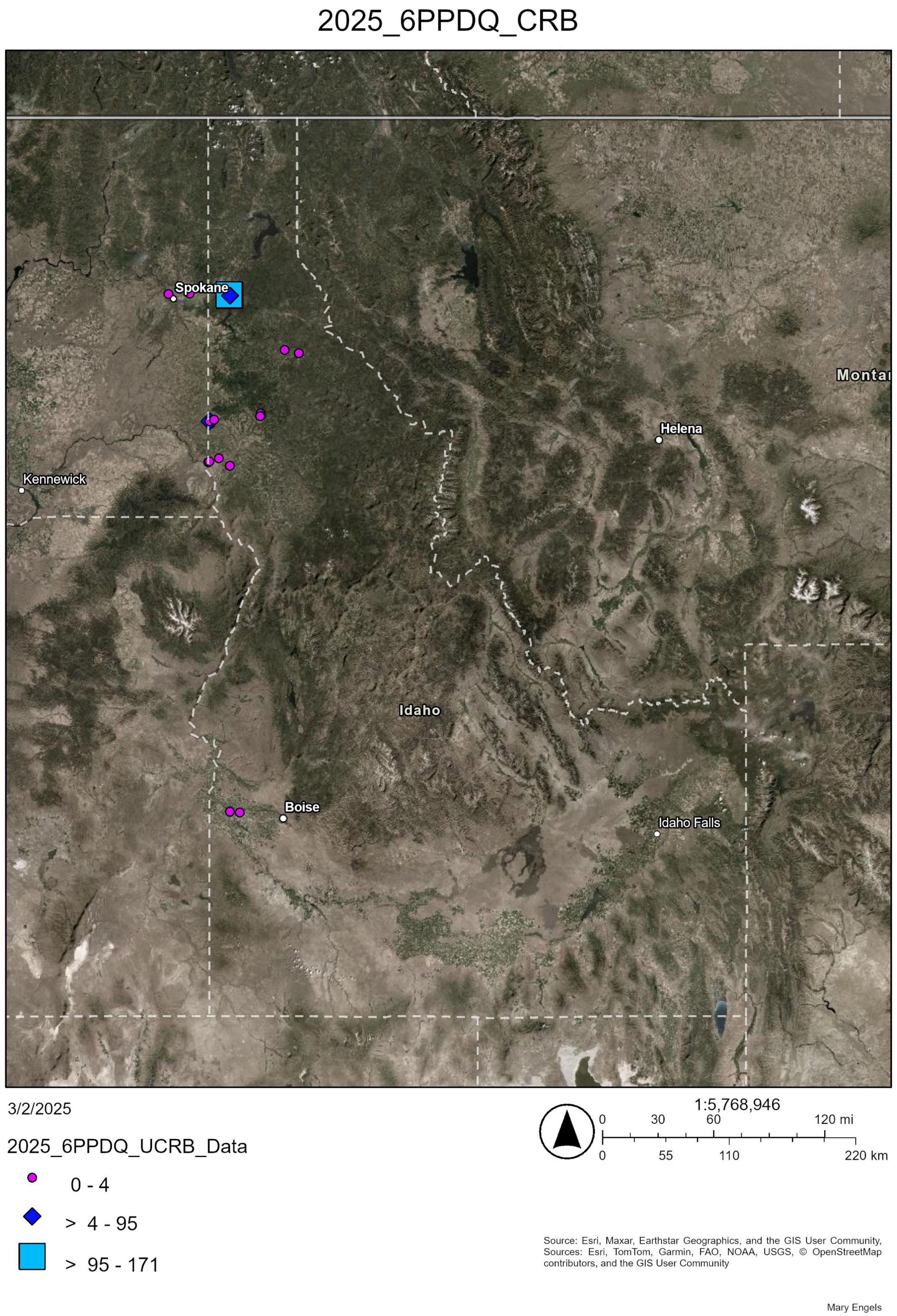


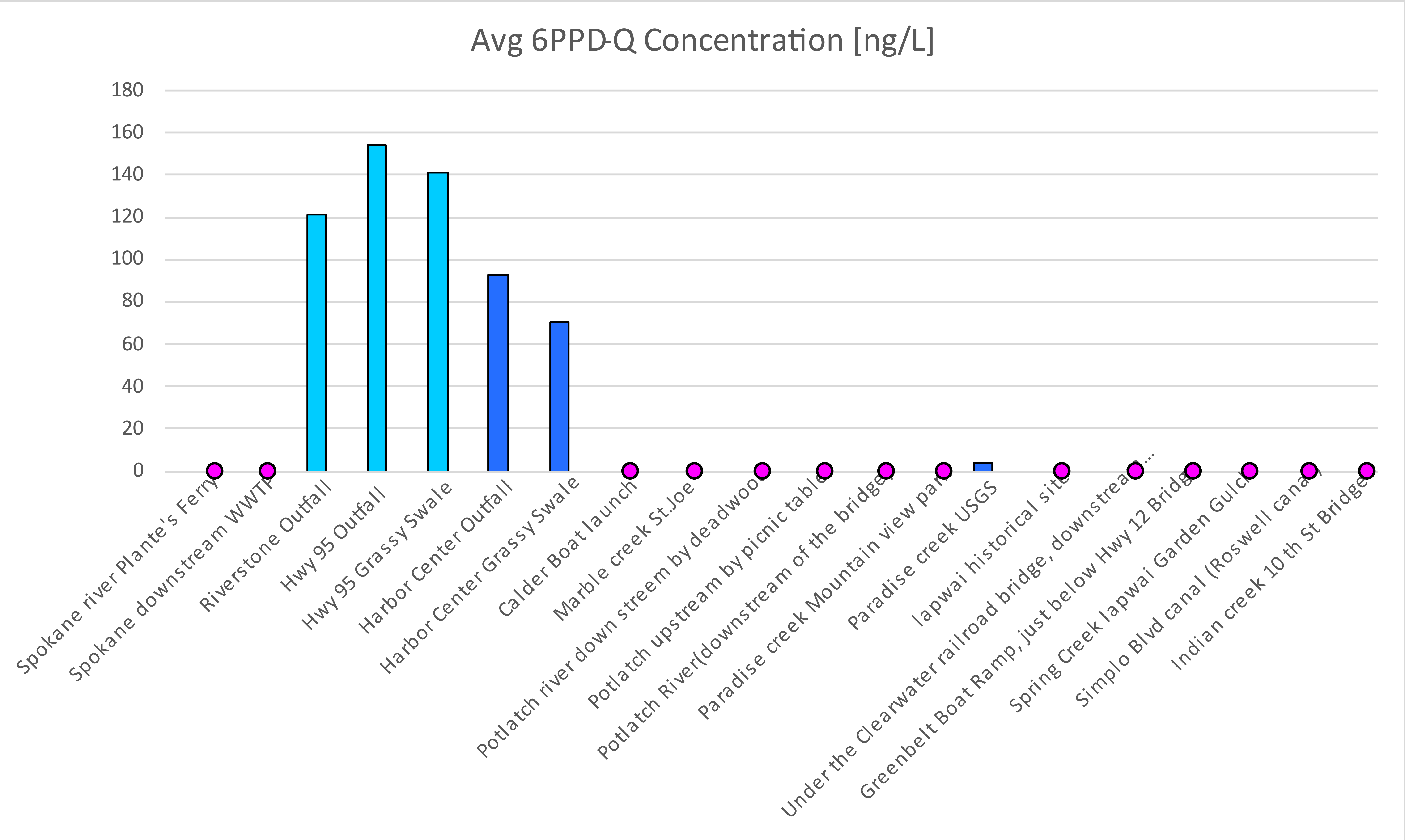
RESULTS PHASE 1- P2: CRAYFISH TISSUE

RUSTY CRAYFISH



RESULTS PHASE 2: WATER SAMPLES





*** TISSUE DATA IN PROCESS...STAY TUNED!**

RESULTS PHASE 3: OUTREACH EDUCATION

WWW.TIRETOX.ORG

FUTURE WORK

LABORATORY

- Increase sensitivity of LCMS methods – in progress
- Sediment methods (TWP and extraction) – in progress
- Write-up results for publications – in progress
- Depapuration study – future work

Field

- Summer sampling campaign 2025 (Idaho and MT)
  - Water, crayfish, sediment and fish samples
  - Ground truth 6PPD-Q hazard atlas

THANKS AND QUESTIONS?

- Engels lab group – Eliza, Sultan, Chloe, Miles, Abbie, Zoie
- Project partners – SSS, MFWP, CFC, WDOT
- Analytical Services Laboratory – University of Idaho
- Mass Spectrometry Core Laboratory – University of Idaho