Where are the Fish: A paradox of declining fish populations and improving insect communities in a mine-impacted ecosystem

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WY-MT Water Science Center

Clark Fork Team

USGS science for a changing world

Montana Fish, Wildlife & Parks

DEQ Montana Department of Environmental Quality

Montana Biological Survey — Aquatic Ecology Fisheries Taxonomy Assessments

United States Environmental Protection Agency

University of Montana

ARCO

Clark Fork Long Term Monitoring Network

Network of sites since 1985, expanded in 1992 with EPA (25 sites)

Surface water-quality data collected in the Upper Clark Fork Basin since 1985 including metal concentrations (As, Cu, Cd, Pb, Zn)

Biotic data collected in the Upper Clark Fork Basin since 1986 (Select macroinvertebrates, bed sediment, and biofilm ion 2022 and 2023)

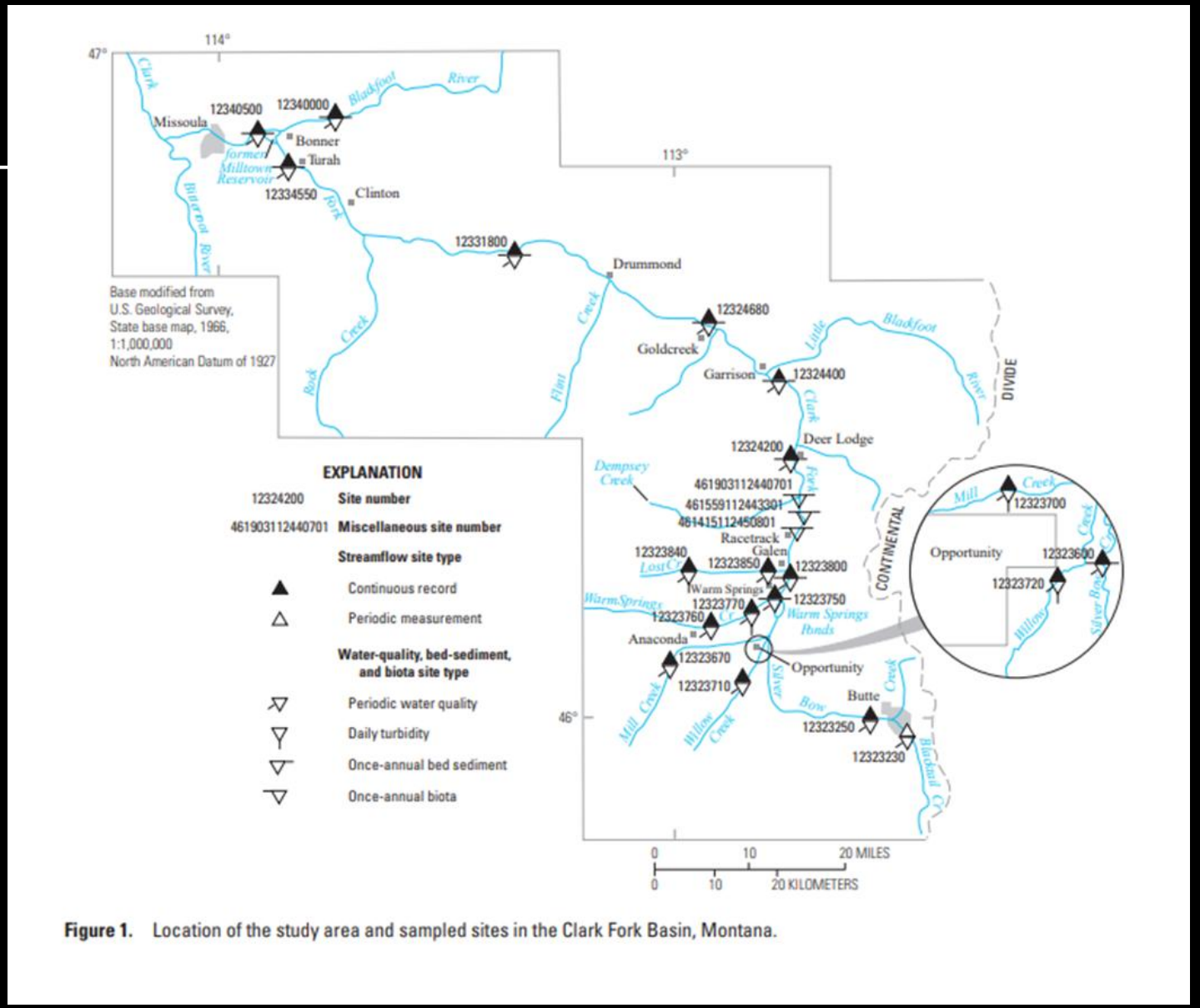

Figure 1. Location of the study area and sampled sites in the Clark Fork Basin, Montana.

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Why monitor the Clark Fork Basin?

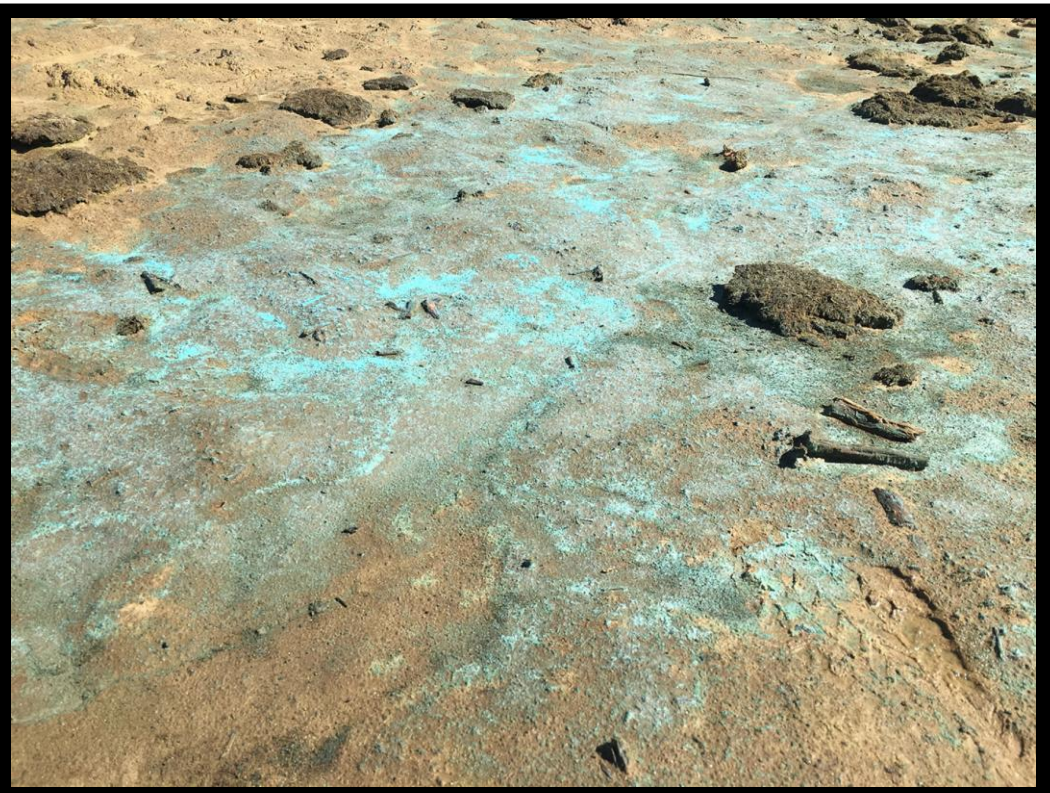
Peck, Clinton. Butte-Silver Bow Public Archives, Clinton Peck Collection Object ID: 2011.085.004.

westernmininghistory.com, gallery-image. 38827

Legacy of hard rock mining that includes extracting, smelting and refining rock for copper and gold in the Clark Fork Basin.

Why monitor the Clark Fork Basin?

Cfwep.org. Mine tailings deposits along Silver Bow Creek



Nora Saks. Montana Public Radio

Metals associated with mine waste congregate on the floodplain via dumping, surface runoff of tailings, and atmospheric deposition from smelting

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Why monitor the Clark Fork Basin?

University of Montana Masnsfield Library, Higgins Bridge 1908

Montana Standard, 2021

The flood of 1908 spread mine waste from Butte, Anaconda and Silver Bow Creek across the basin and down river

- Spurred the creation of the Warm Springs Ponds to divert and treat headwaters

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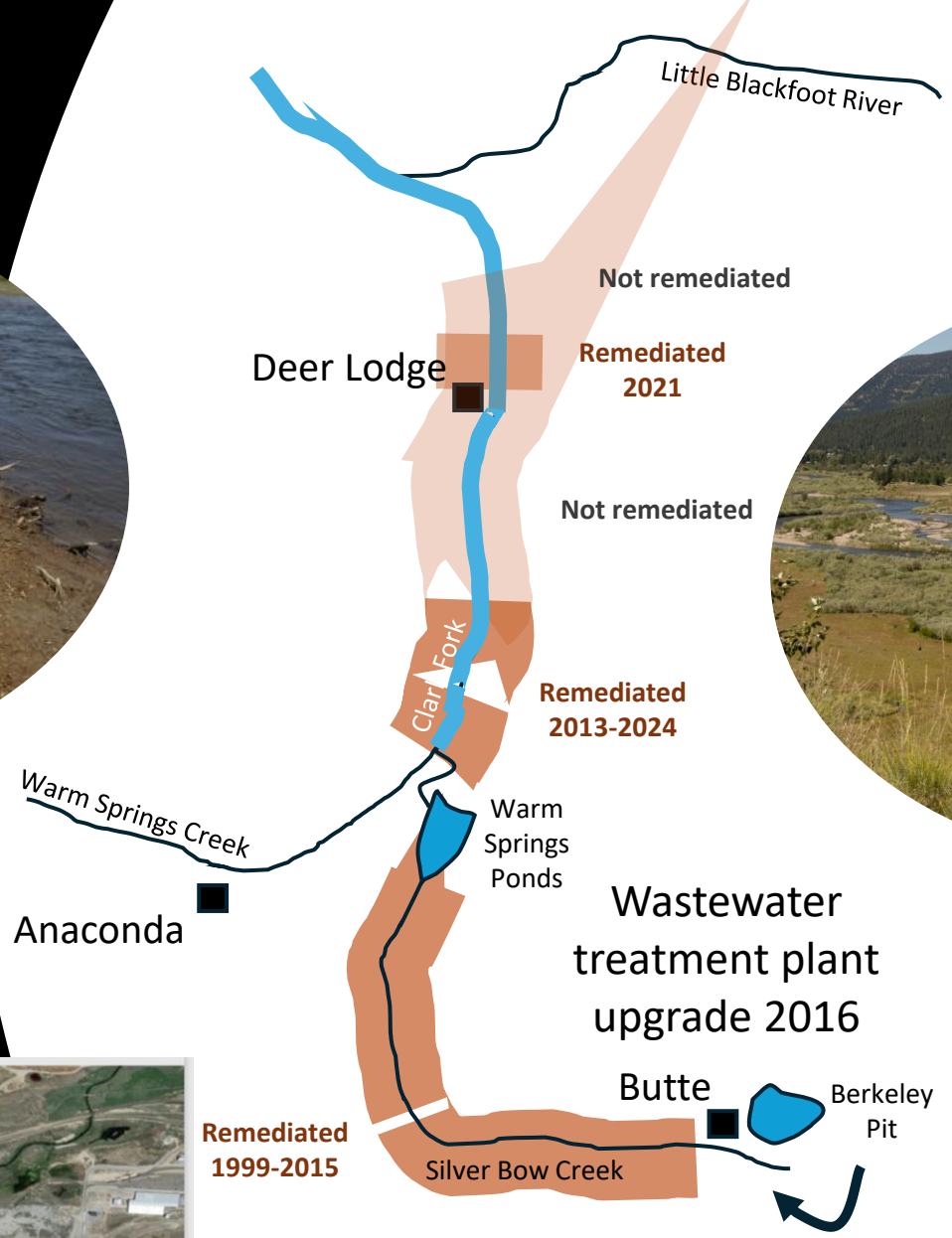
Clark Fork Basin Today

Spatially and temporally fragmented restoration on the Clark Fork Basin

- 22-mile remediation effort on Silver Bow Creek in 2014 included removal of millions of tons of mine tailings from streambed, streambanks, and floodplain
- Ongoing effort to remove mine waste and restore the river and its floodplain



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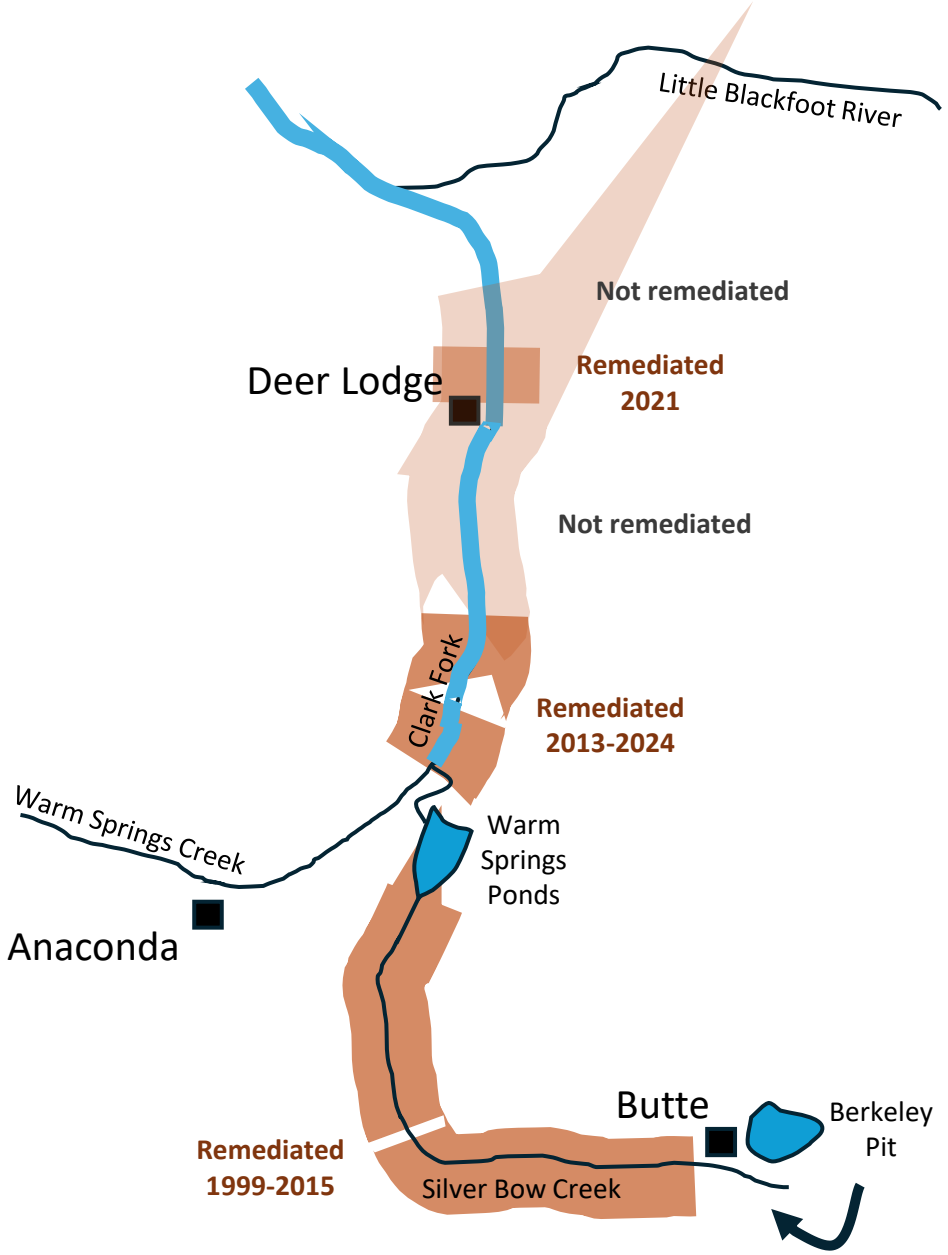
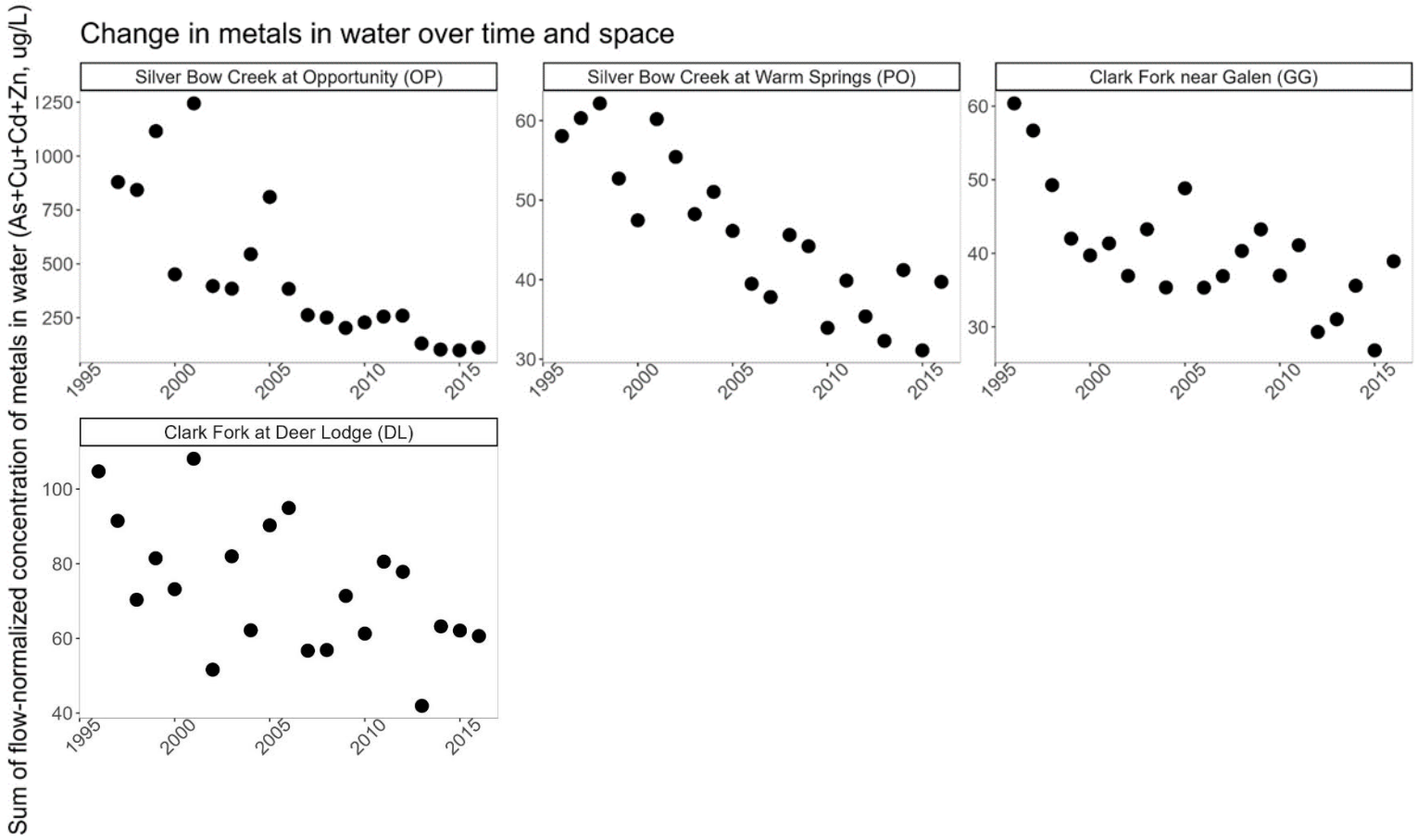
Preliminary. Not for distribution.

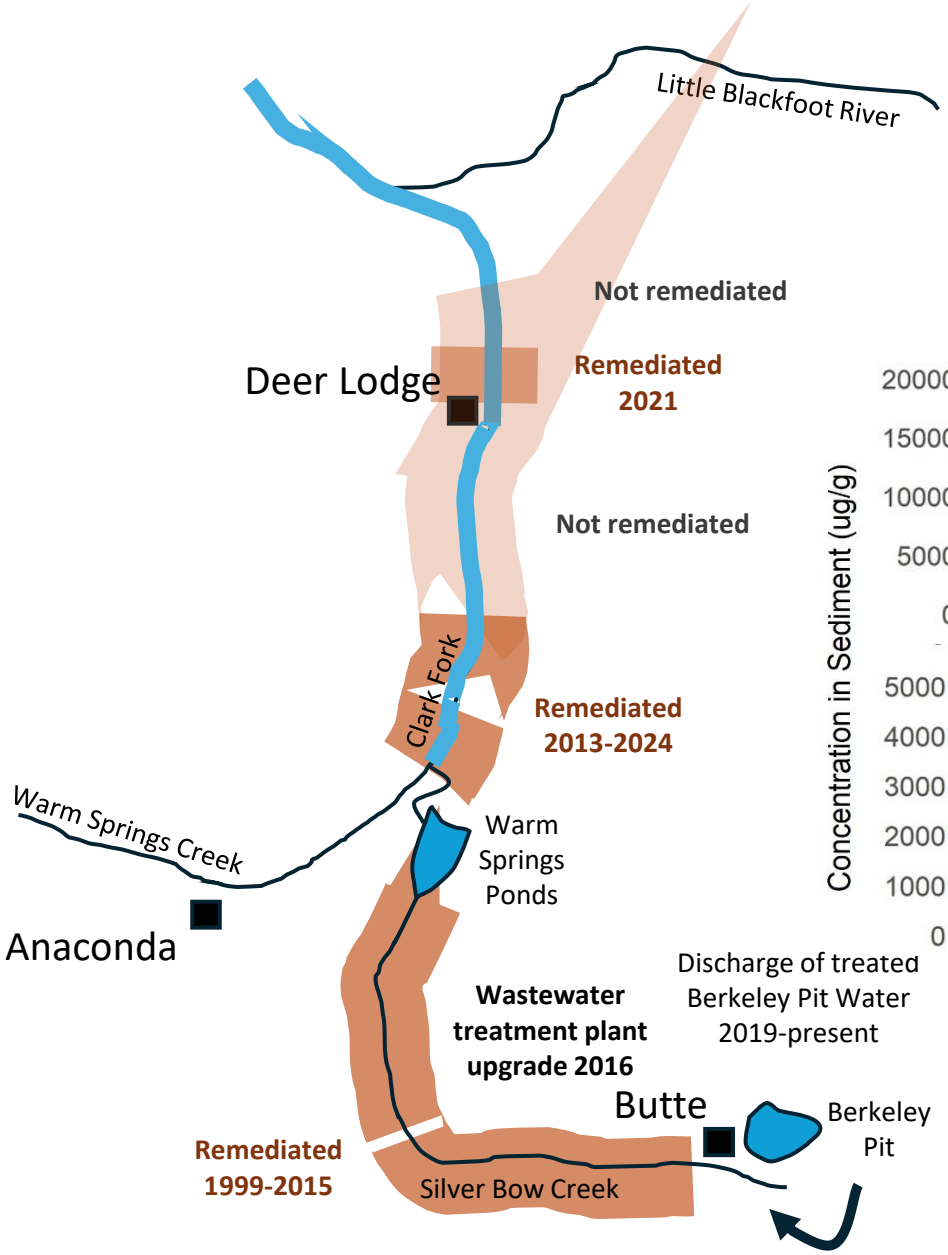
Metals in water have been decreasing over time, from 1995 to 2016

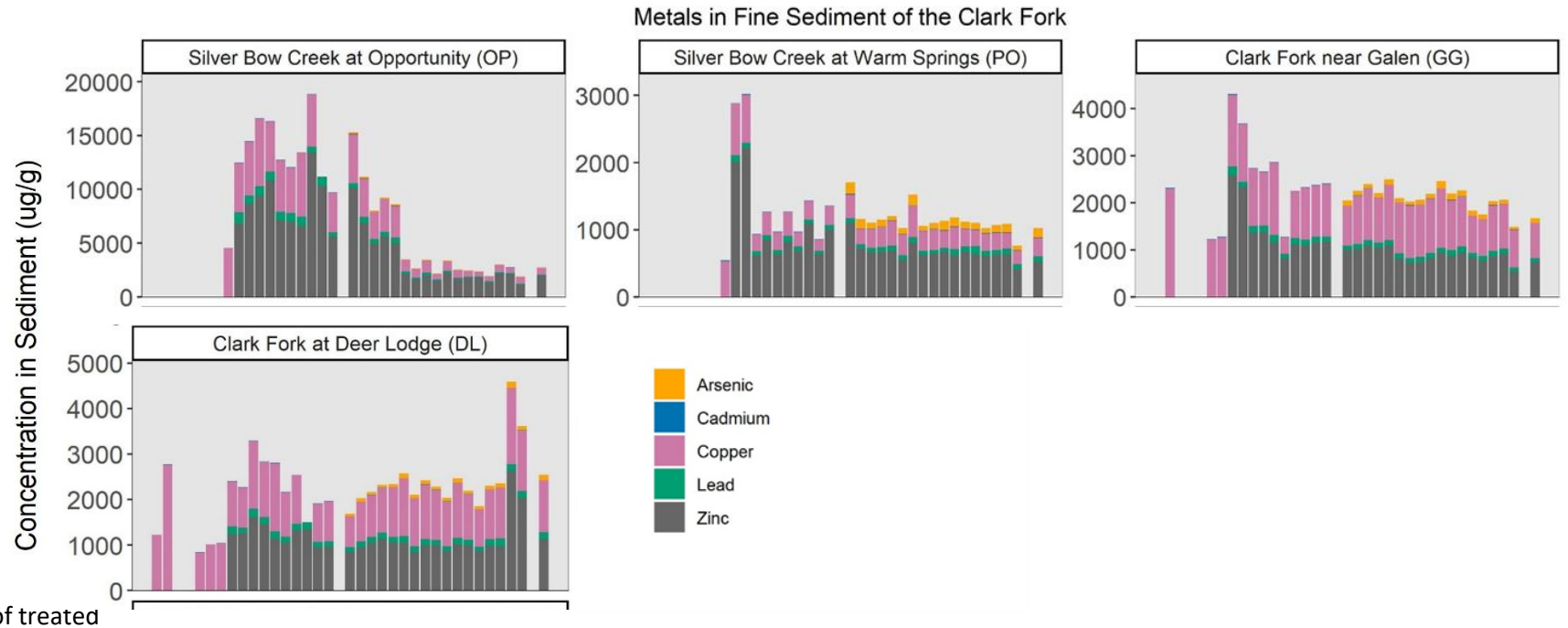




Data available on ScienceBase and rel reports

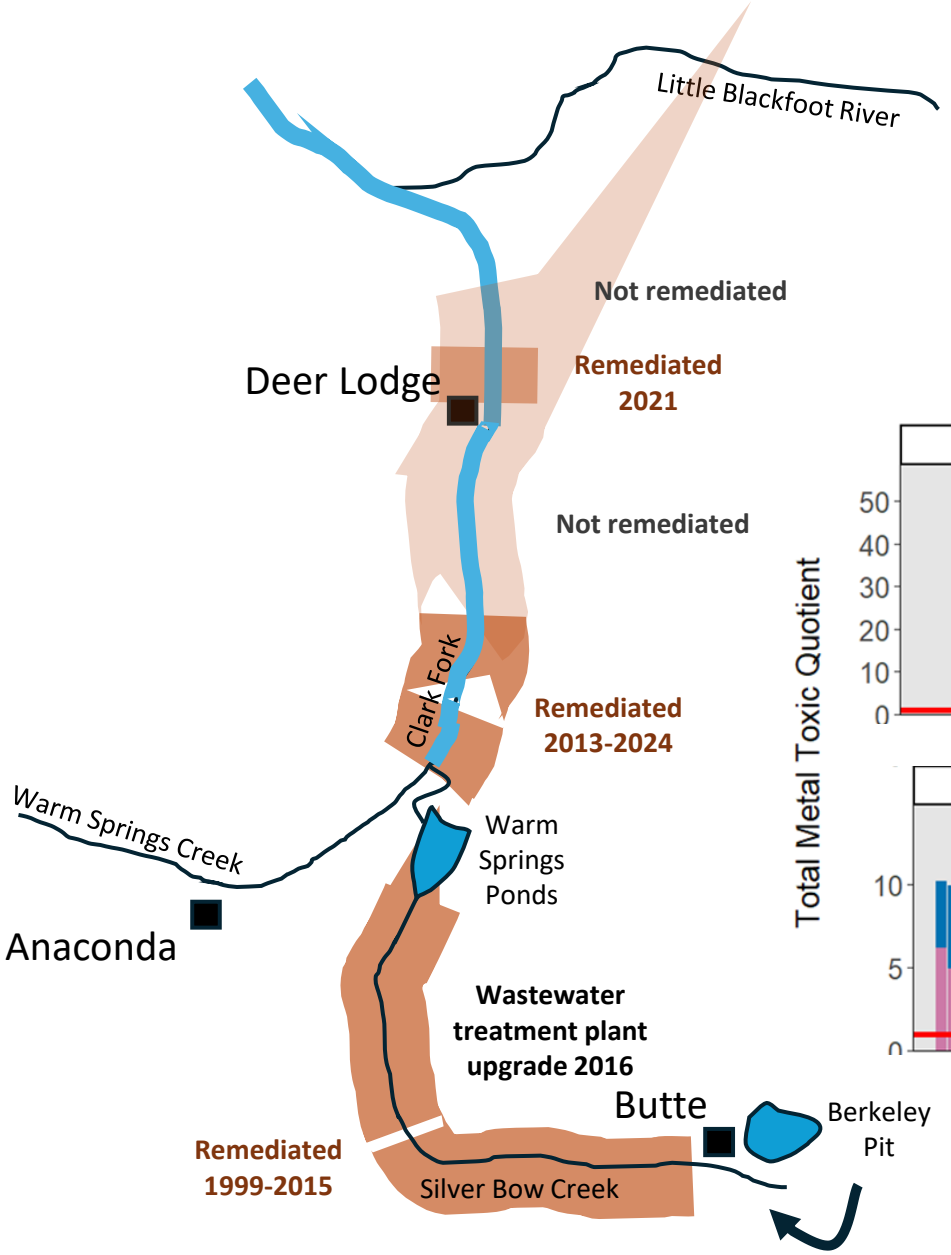
Metals in bed sediment have been decreasing over time, from 1995 to 2016

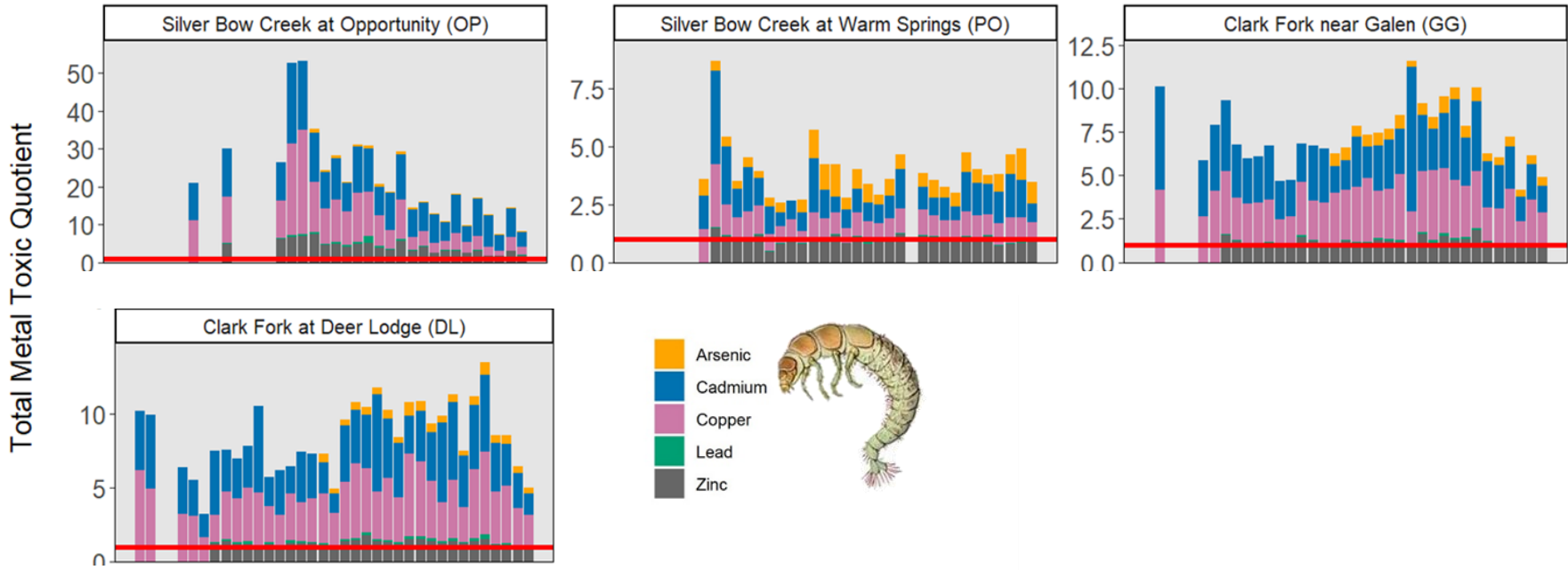




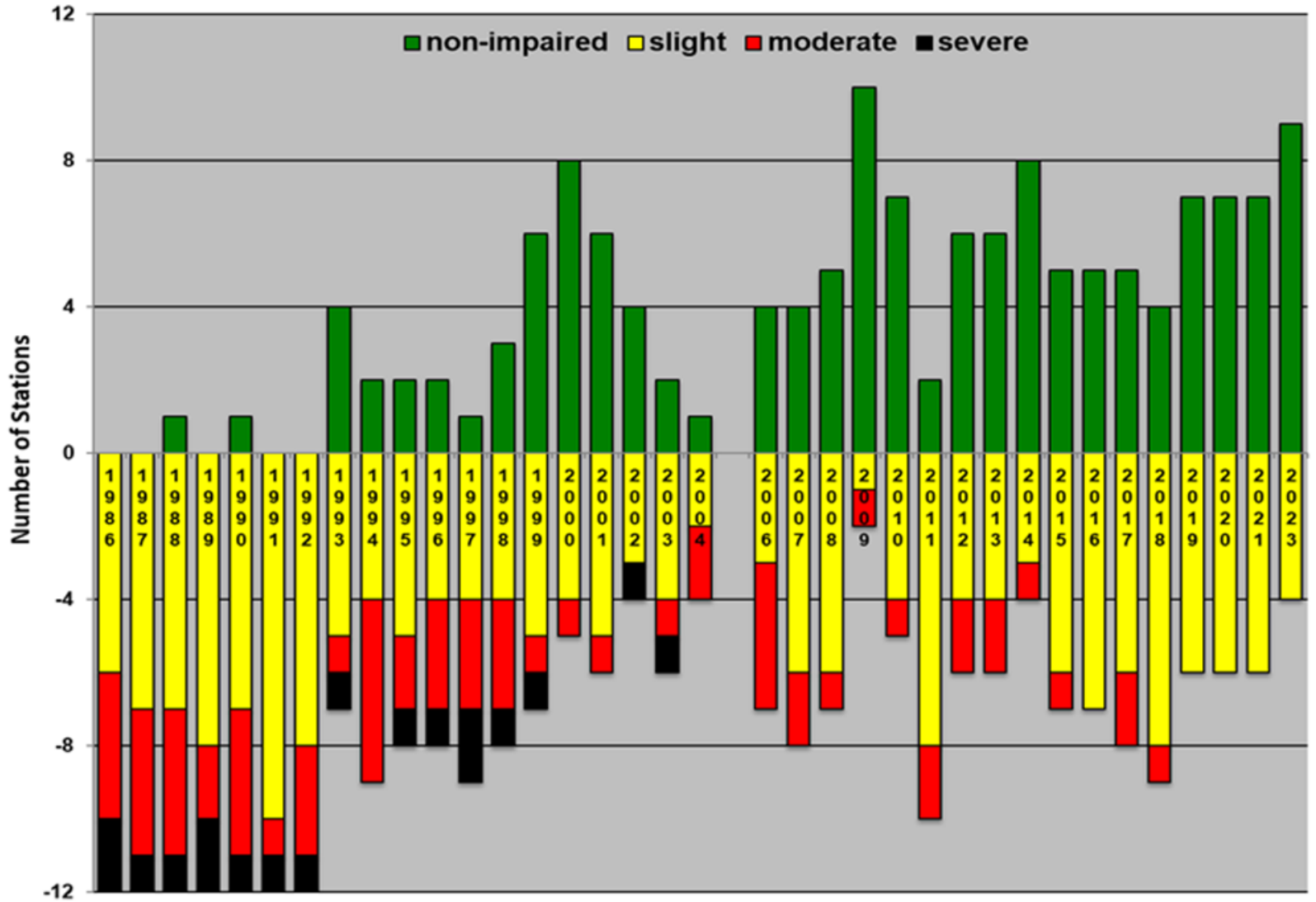
Data available on ScienceBase and rel reports

Metals in insect tissues have decreased in heavily remediated sections of the river and have remained similar at other sites in the basin over time, from 1995 to 2016





Data available on ScienceBase and rel reports



Stagliano and others in press

The number of sites listed as impaired in reference to bio-integrity ranking is declining, 1986-2023

Based on macroinvertebrate communit
compositions sampled 1x/year.

Stagliano and others, 2020 Report

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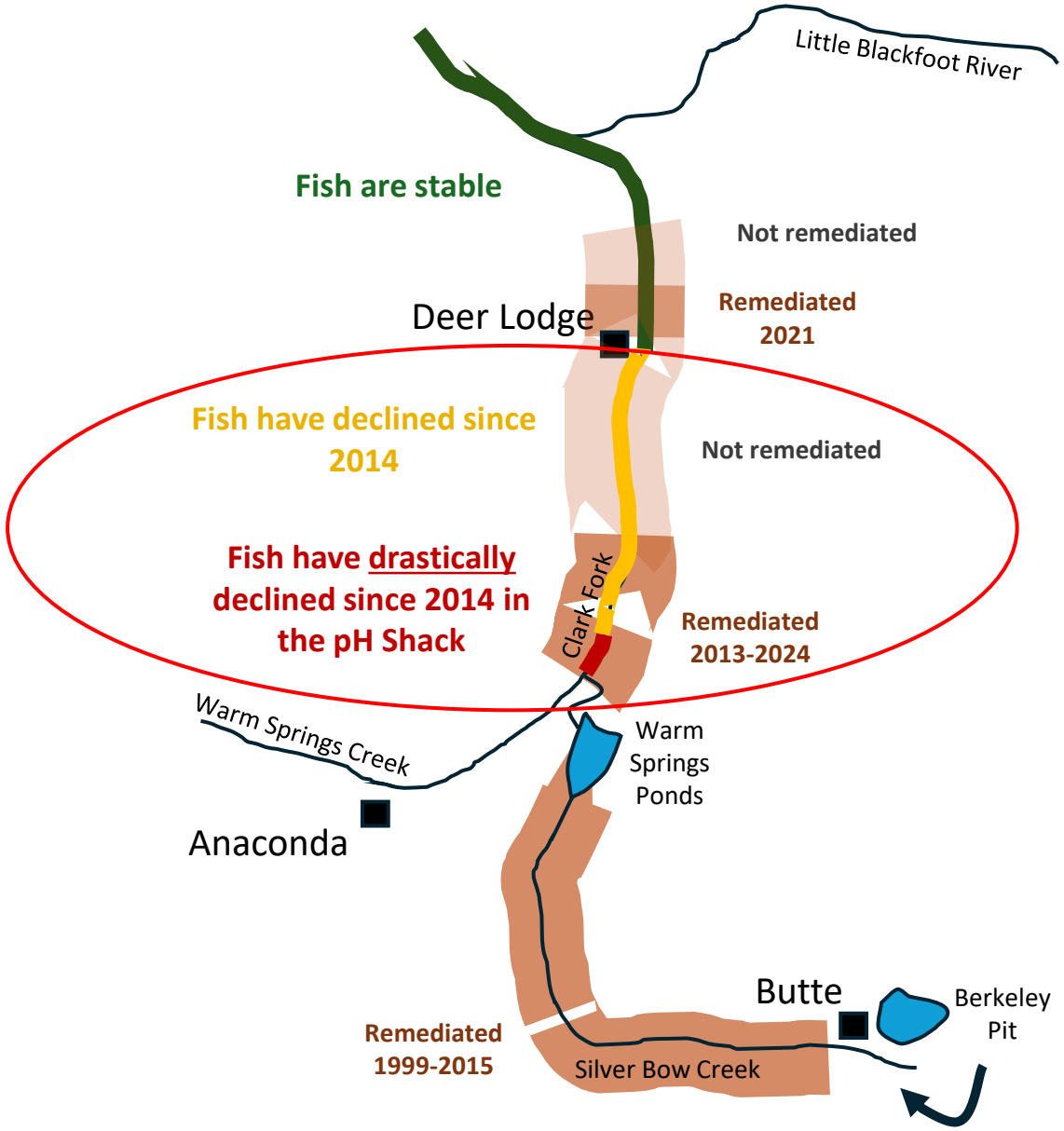
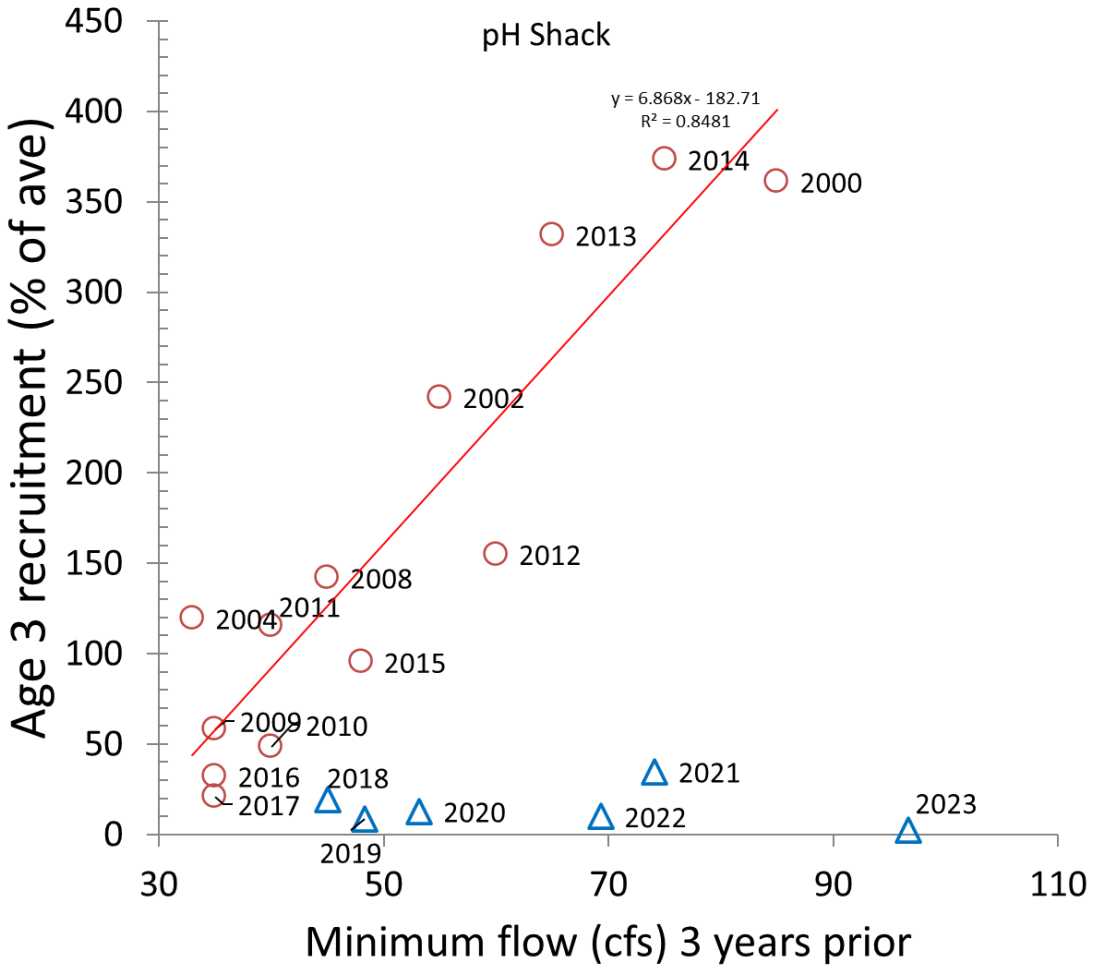
Preliminary. Not for distribution.





Elam and Cook 2021, MT FWP
FWP Data

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Metals are decreasing and the bugs are doing “fine”, so where are the fish?

NBC, Montana

Duncan Adams, The Montana Standard

Experts seek to find solution to Upper Clark Fork brown trout decline

by Josh Margolis | Sat, May 17th 2025 at 9:00 AM

'WTF': Angling for answers for brown trout decline in upper Clark Fork River

DUNCAN ADAMS

May 19, 2025

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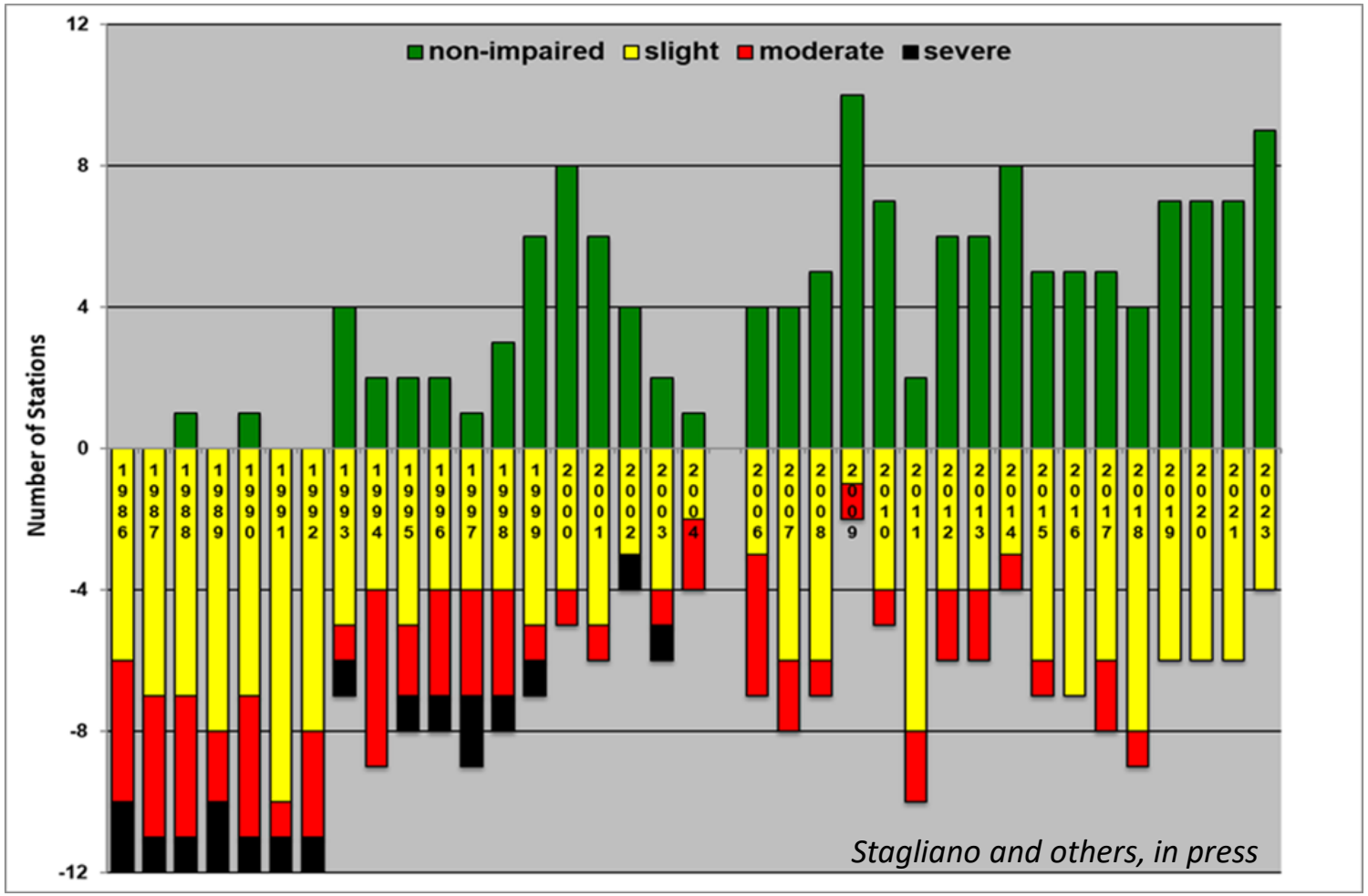
Environment

Habitat

Cold Water

Food

Viable Population



High value for taxa that are sensitive to stresses in the aquatic ecosystem

Lower or negative values for taxa that are tolerant to stresses in the aquatic ecosystem

Stagliano and others, 2020 Report

USGS science for a changing world

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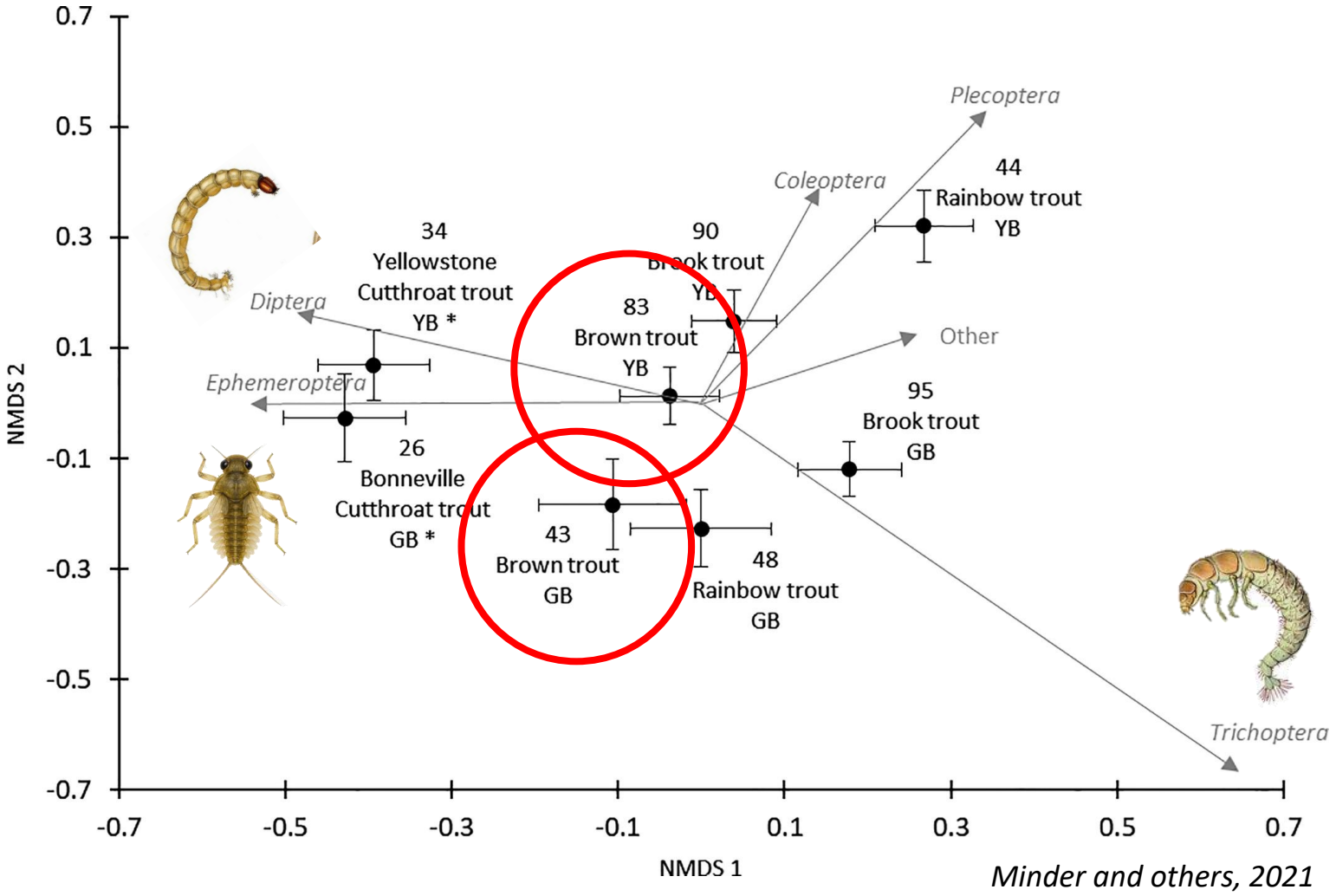

Minder and others, 2021

Brown Trout have a general diet, but trend towards mayflies and true flies

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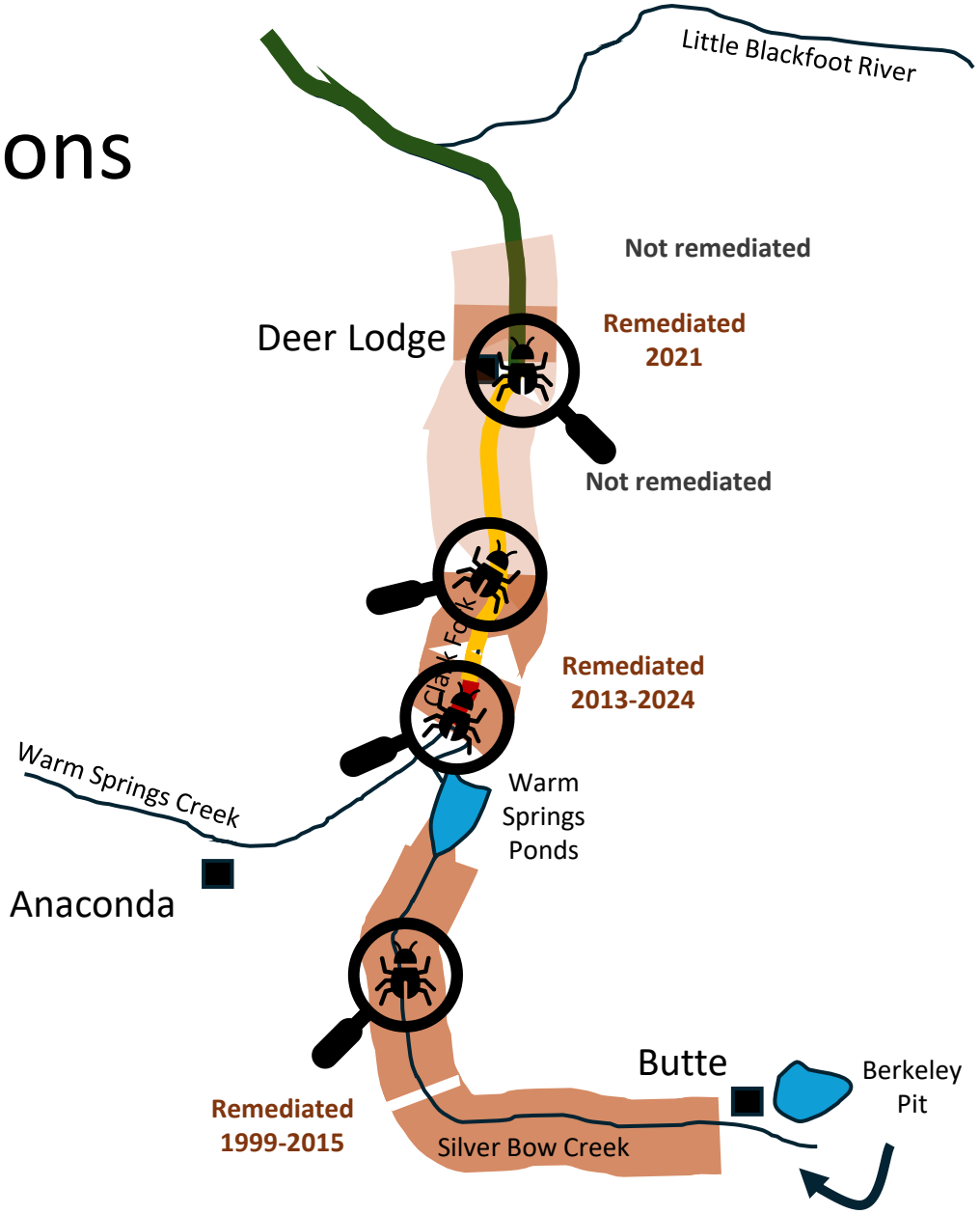
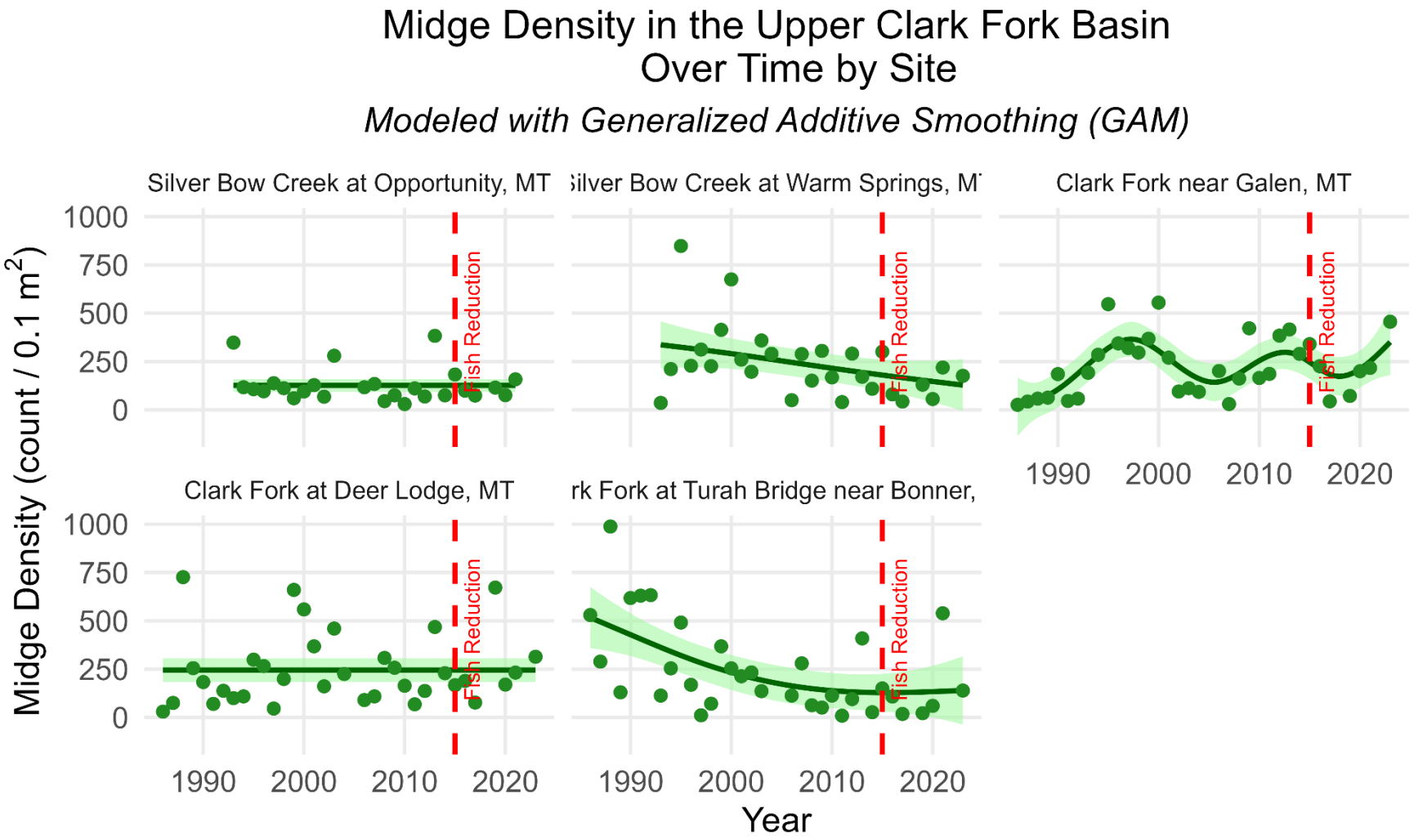
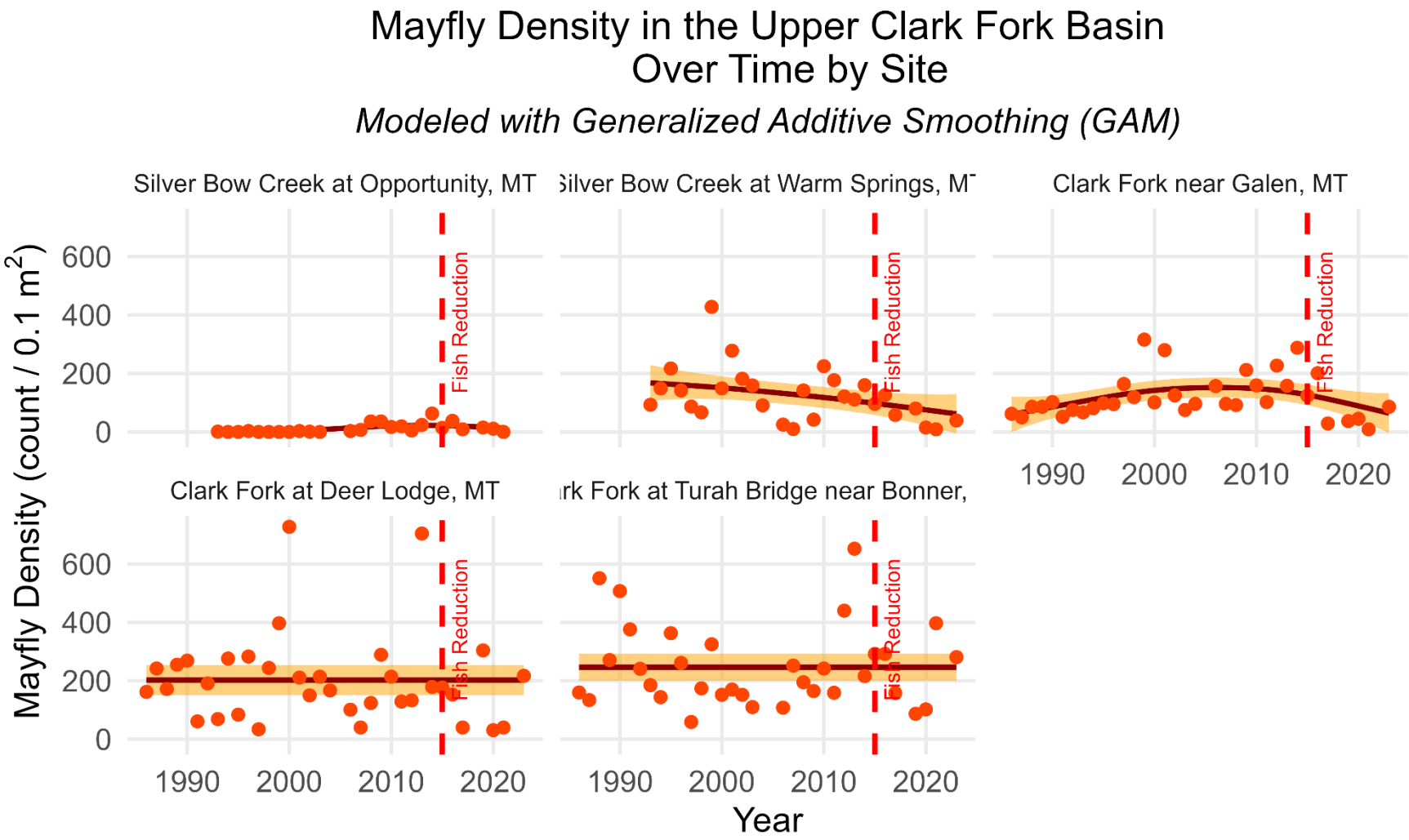
Sampling Locations





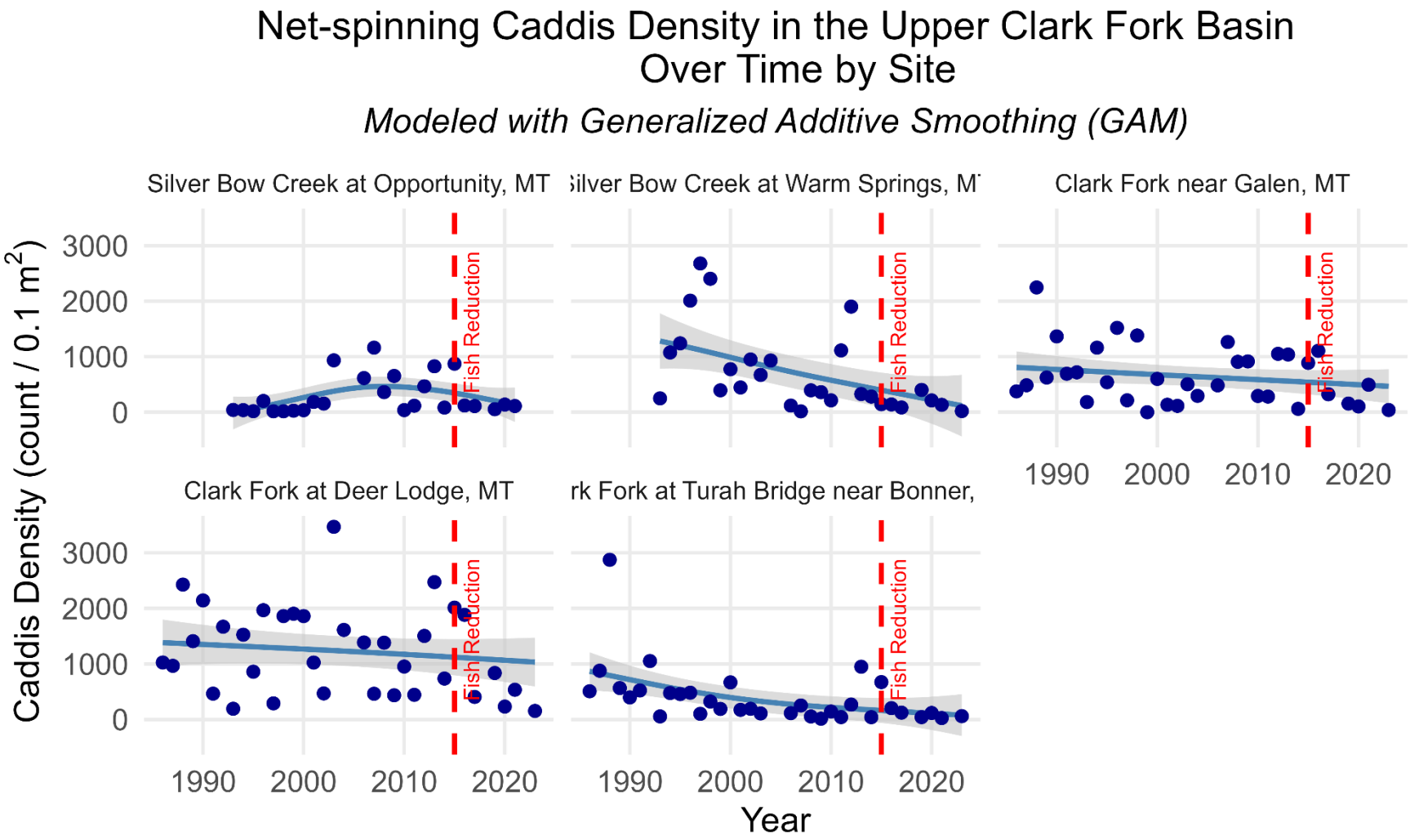
USGS Water Quality Data and EPA data by Jason Rappe

Midge densities are site specific, but remain relatively constant in the upper reaches and decline in the lower reaches



USGS Water Quality Data and EPA data by Jason Rappe

Mayfly densities are site specific, but seem to decline in the upper reaches and remain relatively constant mid basin

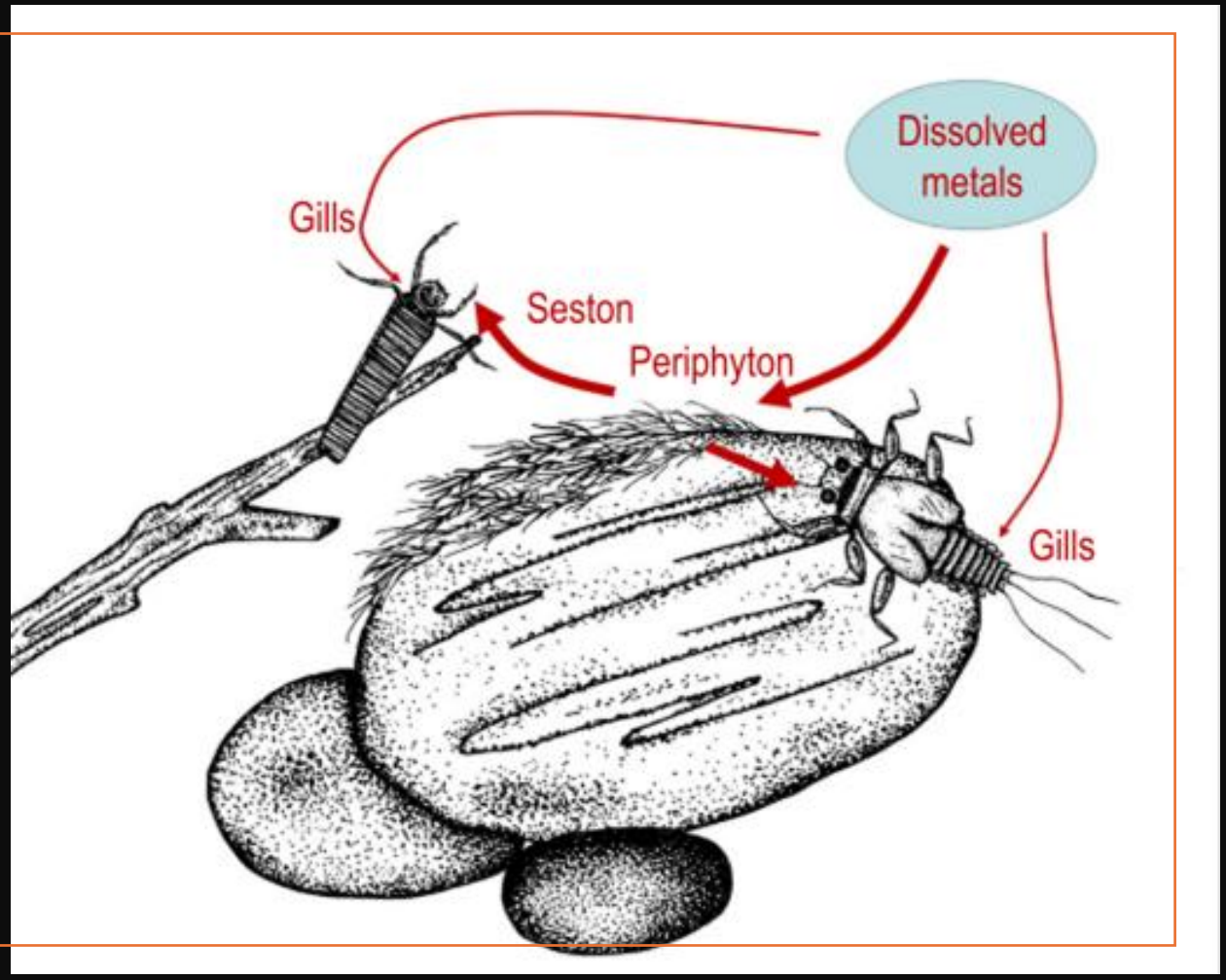


USGS Water Quality Data and EPA data by Jason Rappe

Net-spinning caddisfly densities decline across the basin

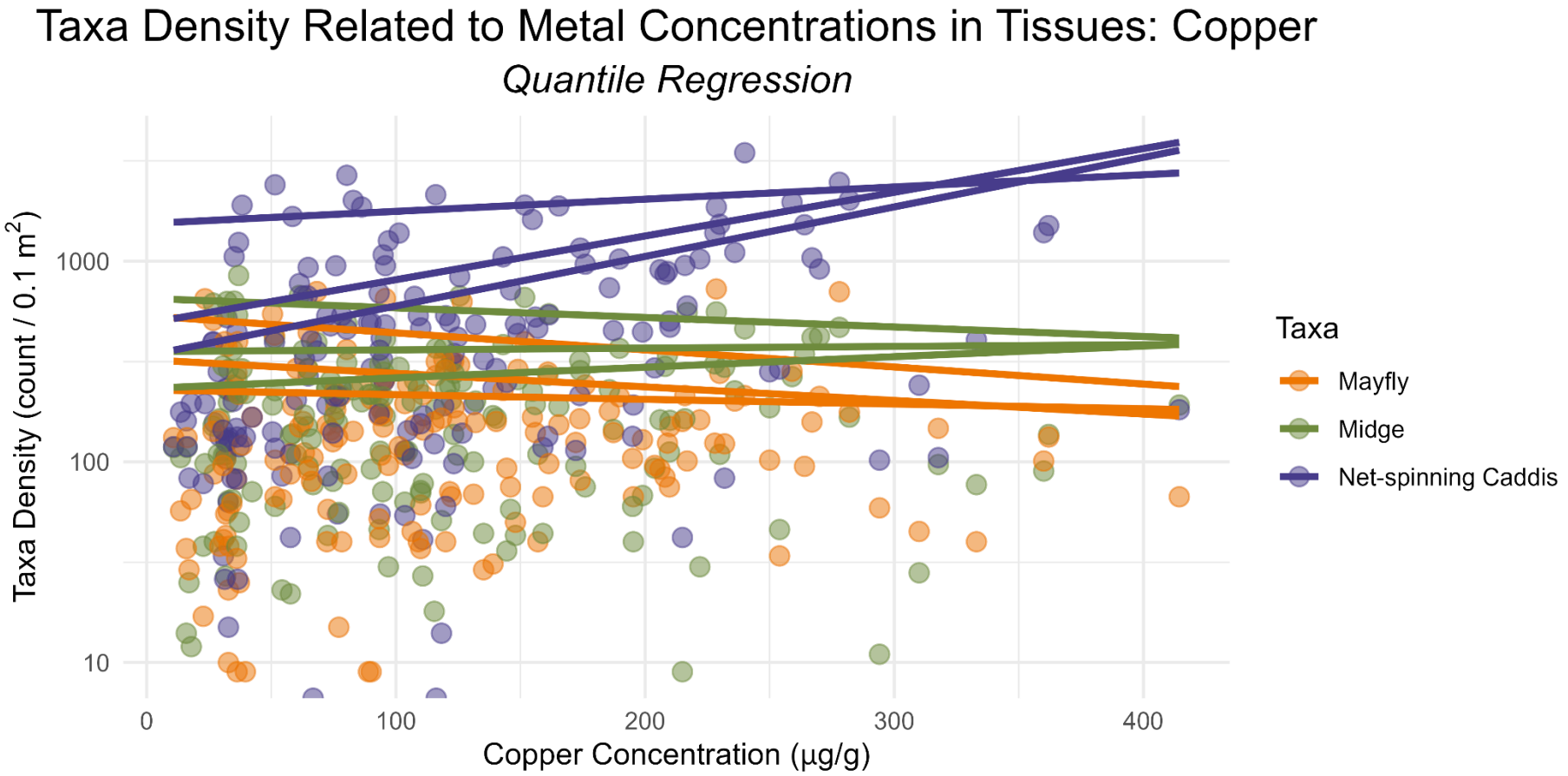
Both Quantity and Quality matter

Bugs can act as a dietary pathway of metals into fish



Mebane, 2019. Art by Amy McMahon

USGS science for a changing world



USGS Water Quality Data and EPA data by Jason Rappe

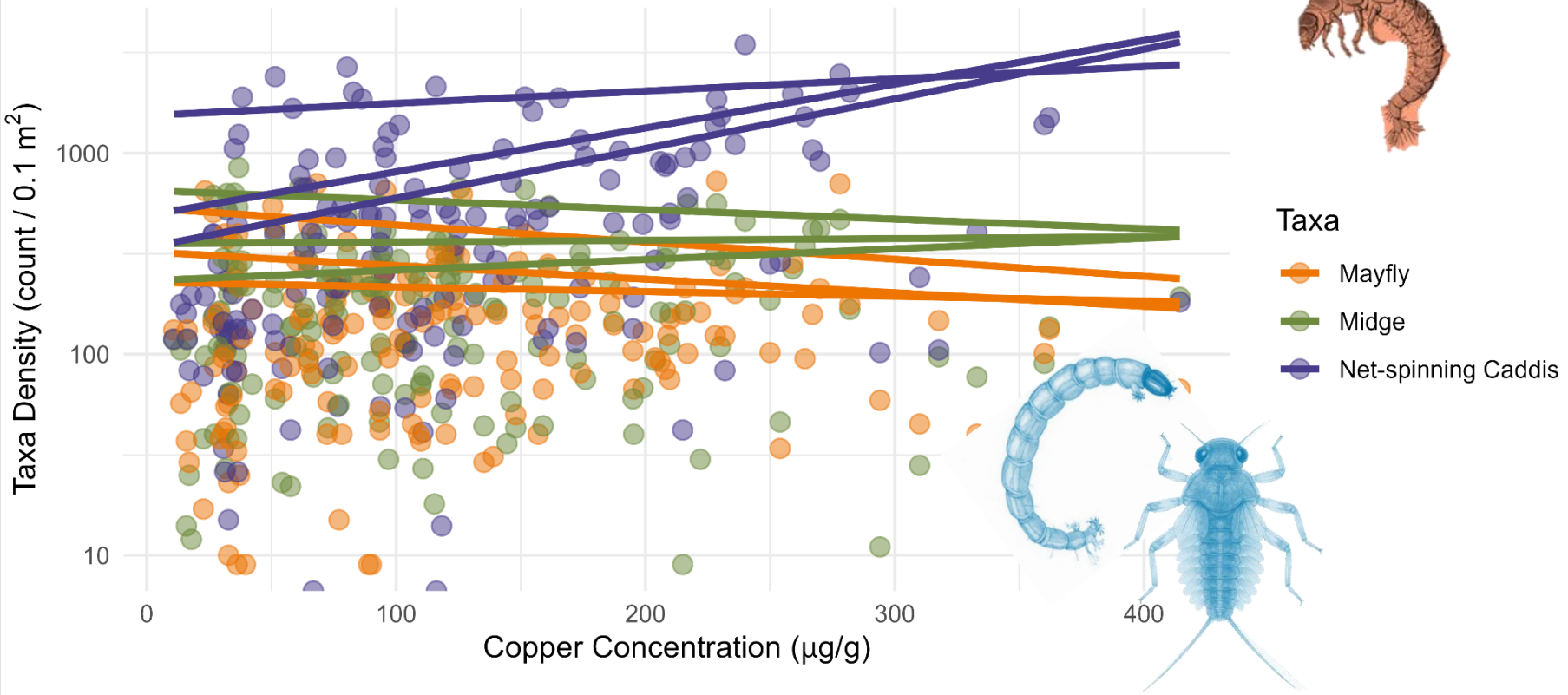
Higher caddisfly densities in areas with higher concentrations of metals

No relationship between tissue metals and mayflies and midges

Similar pattern in **Cadmium and Arsenic**

Taxa Density Related to Metal Concentrations in Tissues: Copper

Quantile Regression



USGS Water Quality Data and EPA data by Jason Rappe

Higher dietary exposure of metals to fish that eat larger prey

Constant exposure to metals to fish that eat smaller prey

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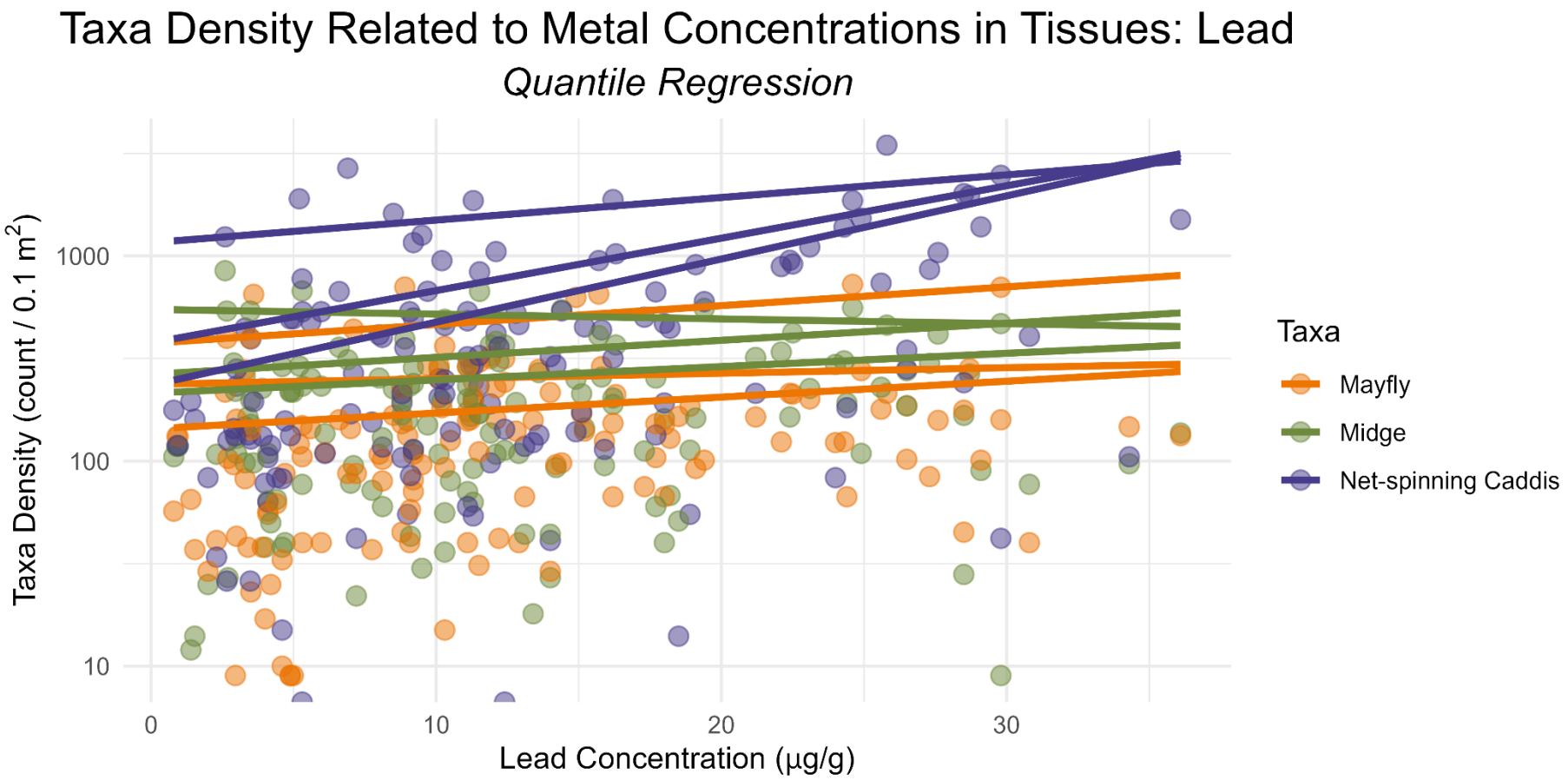
Preliminary. Not for distribution



USGS Water Quality Data and EPA data by Jason Rappe

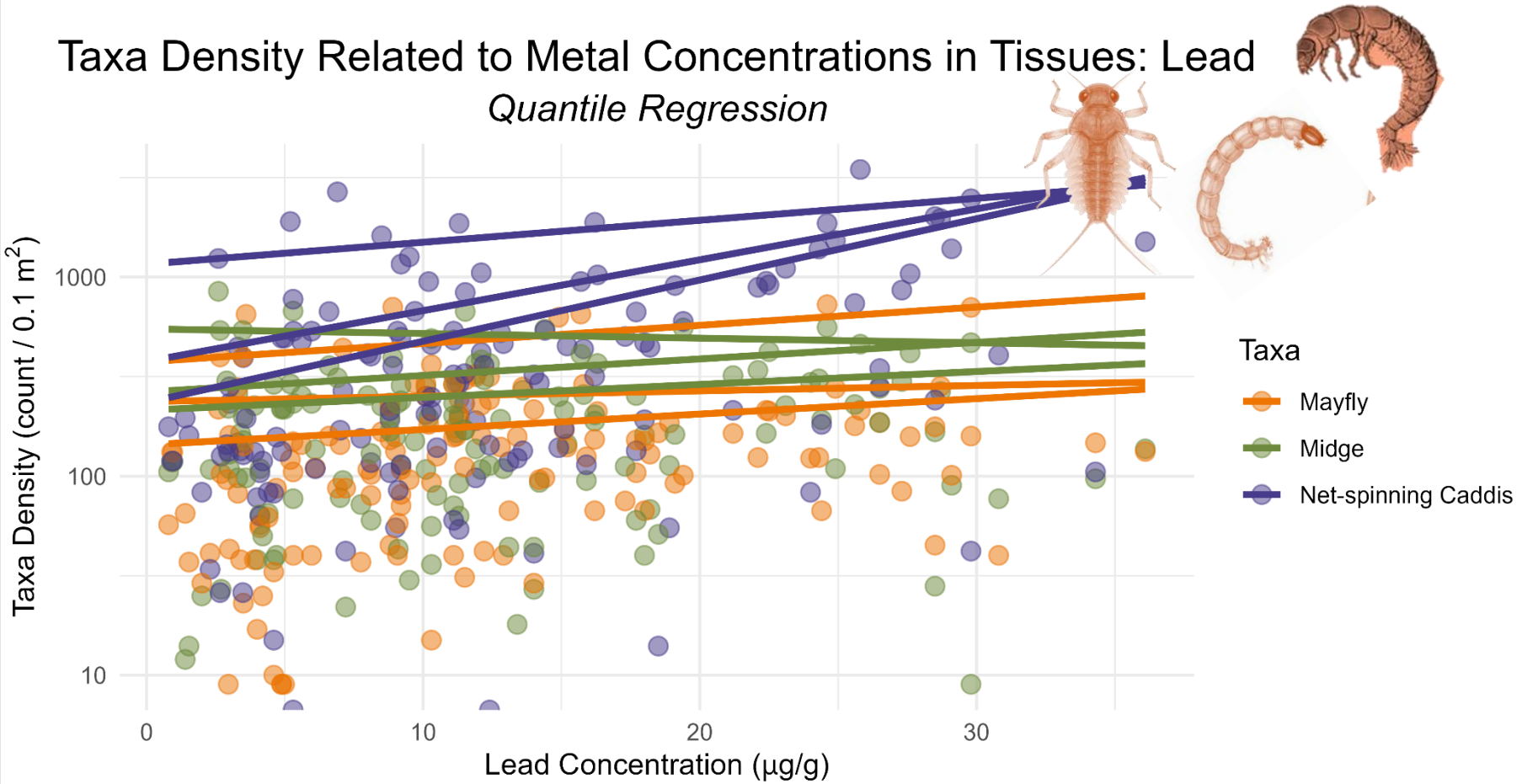
High Caddisfly densities in areas with higher concentrations of metals

High midge and mayfly densities in areas with high concentrations of metals

Similar pattern in **Zinc**

Taxa Density Related to Metal Concentrations in Tissues: Lead

Quantile Regression



USGS Water Quality Data and EPA data by Jason Rappe

High dietary exposure to metals across prey items

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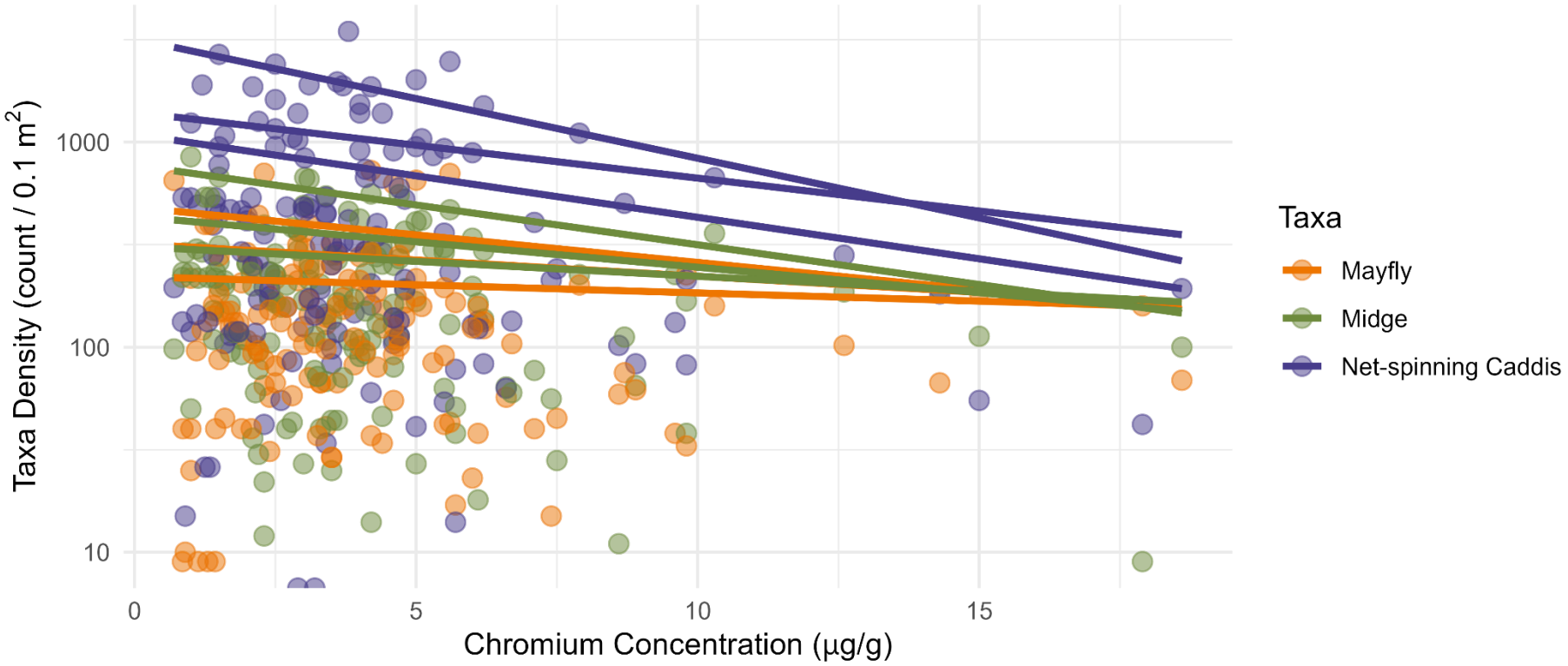
Preliminary. Not for distribution

Taxa Density Related to Metal Concentrations in Tissues: Chromium

Quantile Regression



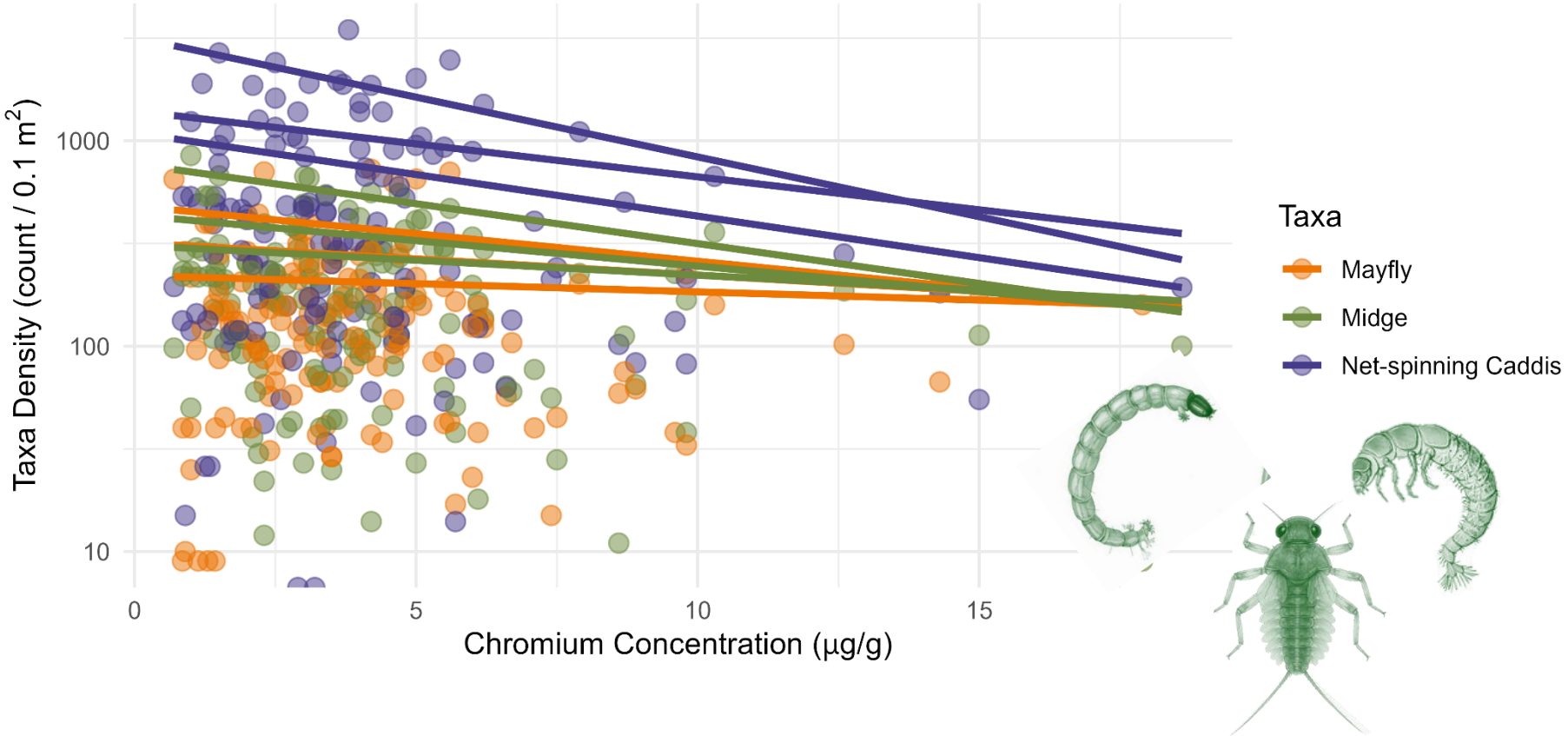
USGS Water Quality Data and EPA data by Jason Rappe

Low taxa densities in areas of high concentrations of metals

Similar pattern in **Nickle**

Taxa Density Related to Metal Concentrations in Tissues: Chromium

Quantile Regression



USGS Water Quality Data and EPA data by Jason Rappe

Low dietary exposure to metals, but also a decrease in food in areas with high metal concentrations

Take aways

Past Interpretation

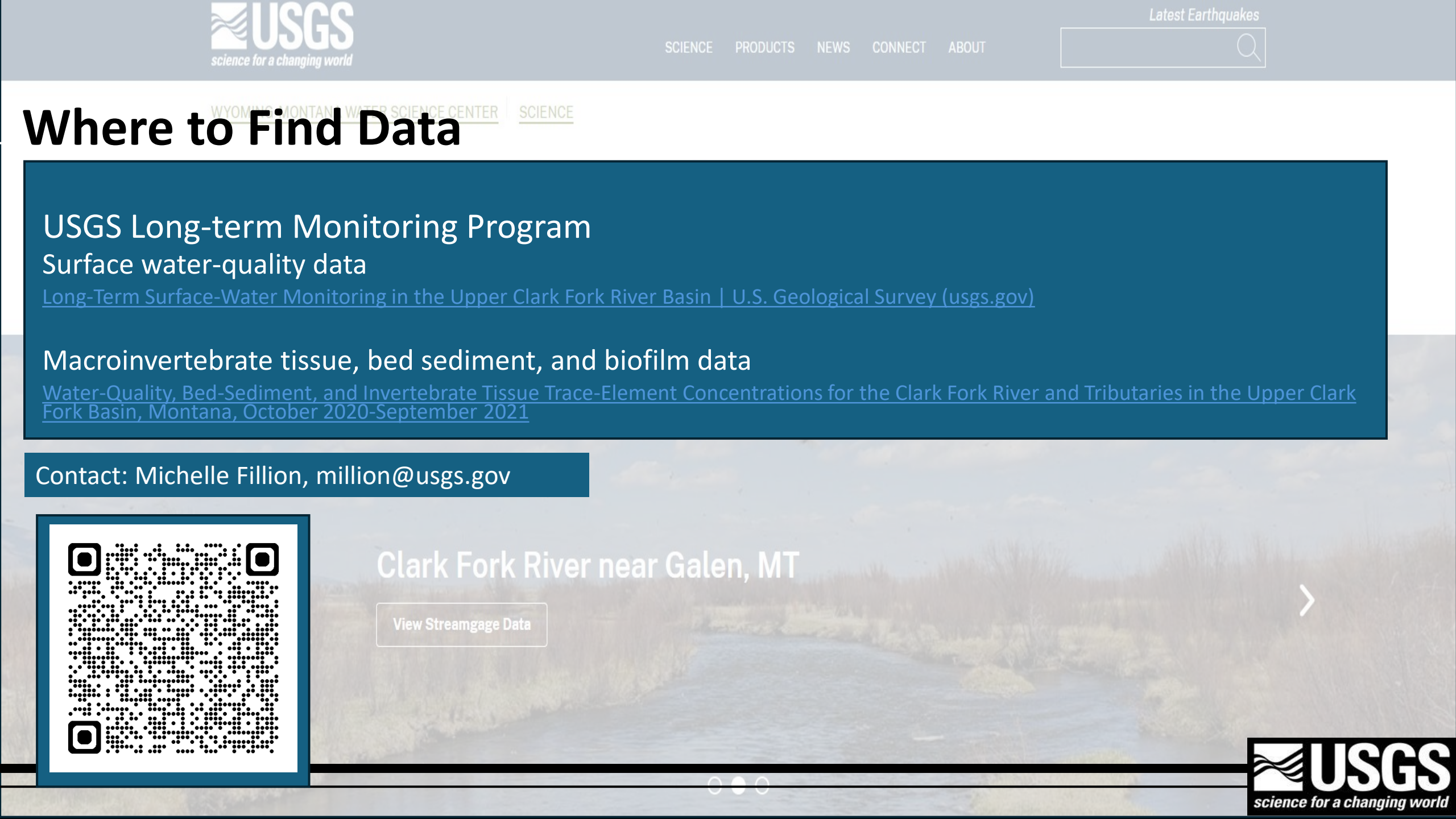
- In most sites, there is a decrease in metals in the water, bed sediments, and macroinvertebrate tissue
- Biotic indices show no “impaired” sites in the Upper Clark Fork Basin

New Interpretation

- Macroinvertebrate densities do not reflect the biotic indices
- There may be a paradox in the quality of the food that fish are eating:
  - Higher densities of bugs could mean higher metal exposure
  - Lower density of bugs could mean lower exposure, but pose a risk to starvation

Addressing the Data Gap

- Sample and characterize underrepresented taxa important in aquatic food webs of the Clark Fork Basin



Where to Find Data

USGS Long-term Monitoring Program

Surface water-quality data

Long-Term Surface-Water Monitoring in the Upper Clark Fork River Basin | U.S. Geological Survey (usgs.gov)

Macroinvertebrate tissue, bed sediment, and biofilm data

Water-Quality, Bed-Sediment, and Invertebrate Tissue Trace-Element Concentrations for the Clark Fork River and Tributaries in the Upper Clark Fork Basin, Montana, October 2020-September 2021

Contact: Michelle Fillion, million@usgs.gov