

Fish and Fire in the West

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Rio Grande Watershed
Emergency Action Coordination Team





Background

Wildfires are **increasing** and wildfire season is getting **longer** in the Western U.S.



Average number
of large wildfires
per year

bigger than 1,000 acres



1980-1989
~140



1990-1999
~160



2000-2012
~250

Average length of wildfire season

Early 1970s: 5 months



Today: 7+ months

Image from Union of
Concerned Scientists

Data from Federal Wildland
Fire Occurrence Data;
Westerling et al. 2006; and
Stewart et al. 2005



BURN AREA WILL INCREASE IN THE FUTURE

Projected increase in annual burn area
with an additional 1.8° F rise in temperature



By mid-century, temperatures in the Western U.S. are expected to increase even more **(2.5°–6.5° F)** due to heat-trapping emissions from human activity.

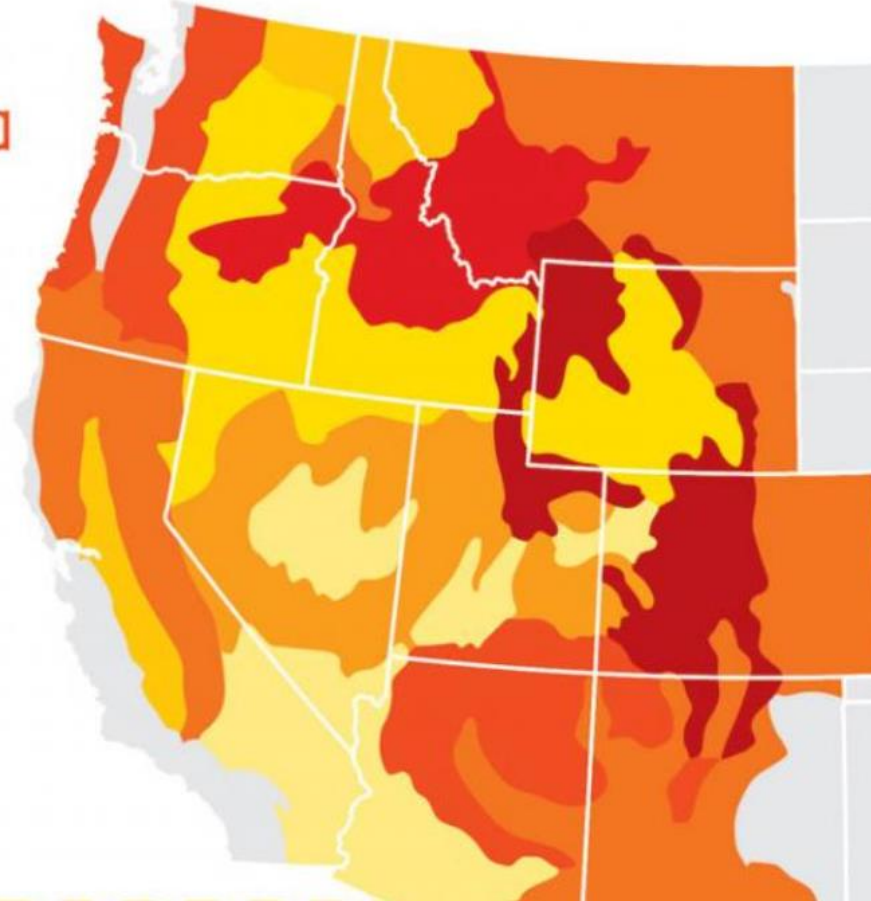


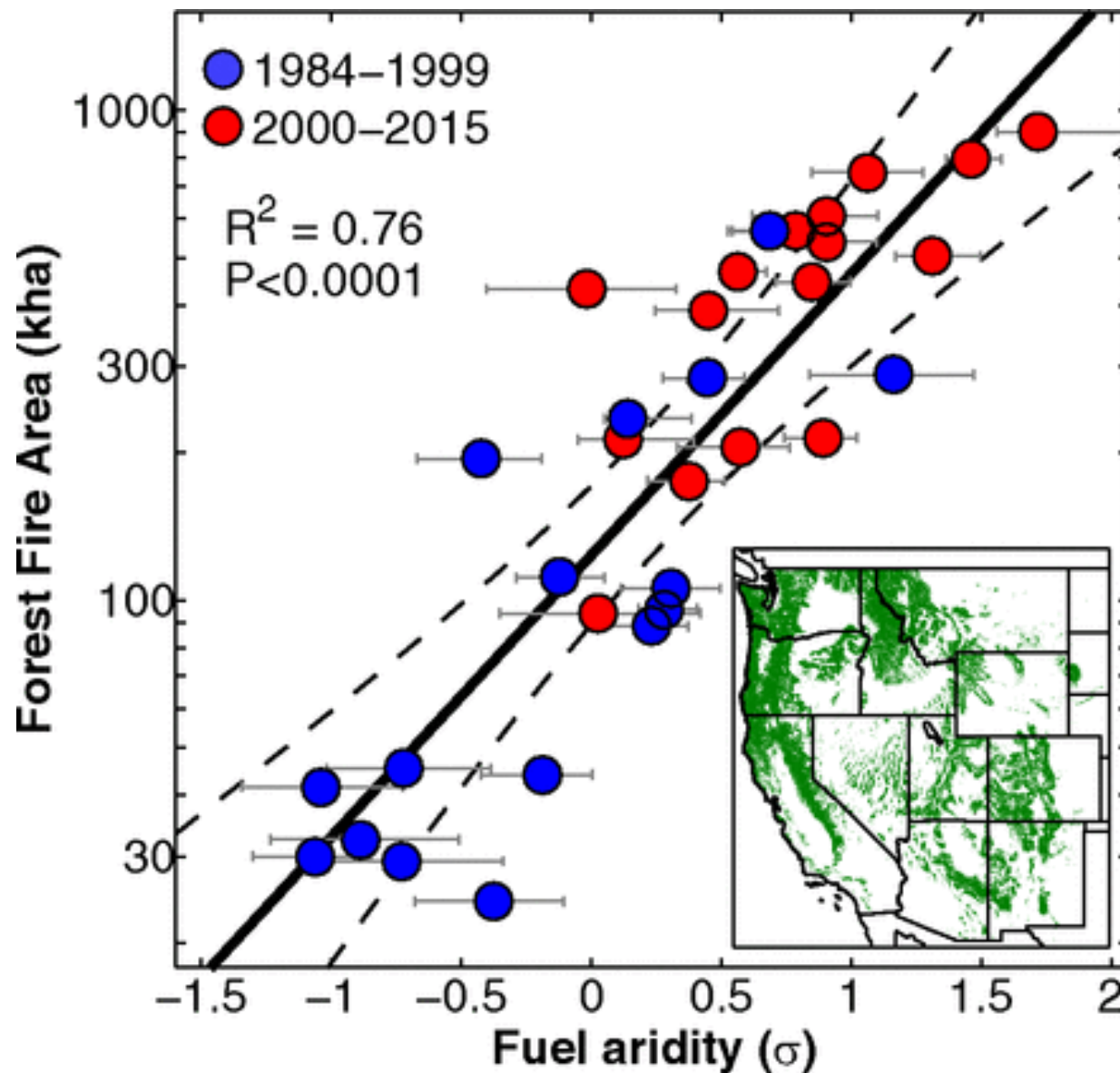
Image from Union of
Concerned Scientists

Data from Federal
Wildland Fire
Occurrence Data;
Westerling et al. 2006;
and Stewart et al. 2005



Background

INCREASED ARIDITY IN WESTERN US FORESTS





Background

FIRE IMPACT ON WATER SUPPLY & AQUATIC ECOSYSTEMS

2/3 of municipalities in the U.S. and 1/3 of large cities worldwide get their drinking water from forested areas

Post-fire erosion of sediments and ash impact water quality

Wildfires release significant amounts of nutrients

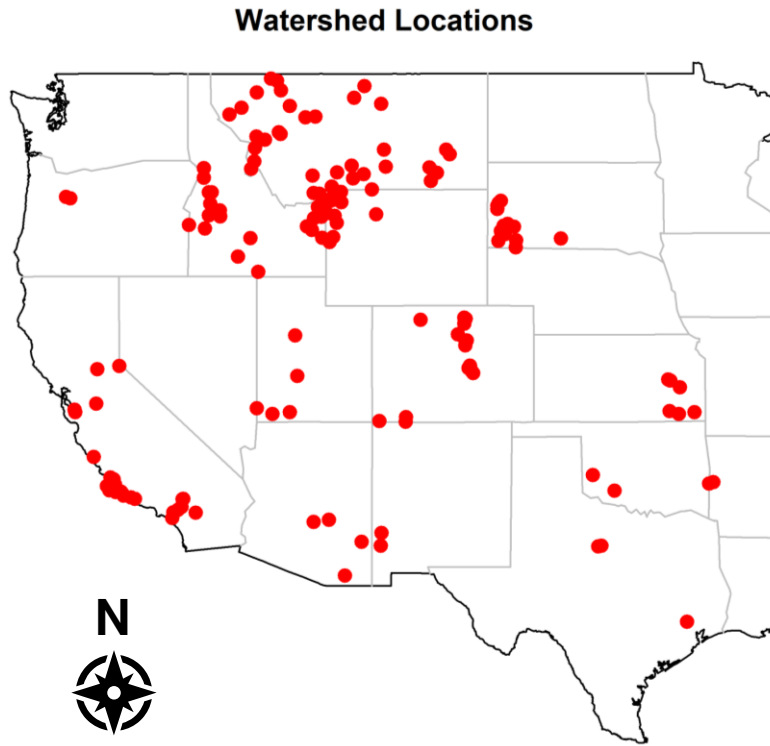
Wildfires cause heavy metals to be mobilized

Sediments, nutrients, and metals alter water quality and harm the aquatic ecosystem



Background

STUDY AREA



We created a Fire-Water Quality Database:
using fire data from 1984-2012 (www.mtbs.gov)
159 fires, from 153 burned watersheds,
89 water quality parameters

Evaluated percent change in concentration from 5 year
baseline period to 5 year post-fire period

Calculated flux, or loading rate, with flow data,
evaluated percent change in flux and percent change in
concentration for each of the 89 water quality
parameters

COMMON WATER QUALITY RESPONSE

Nitrogen: **particulate** forms increase  in concentration after 30% of fires; **dissolved** forms decreased  after 30-45% of fires all forms of N increased  in loading rate (flux)

Phosphorus: **Dissolved** and **particulate** forms increased  in concentration and flux after 33% of fires

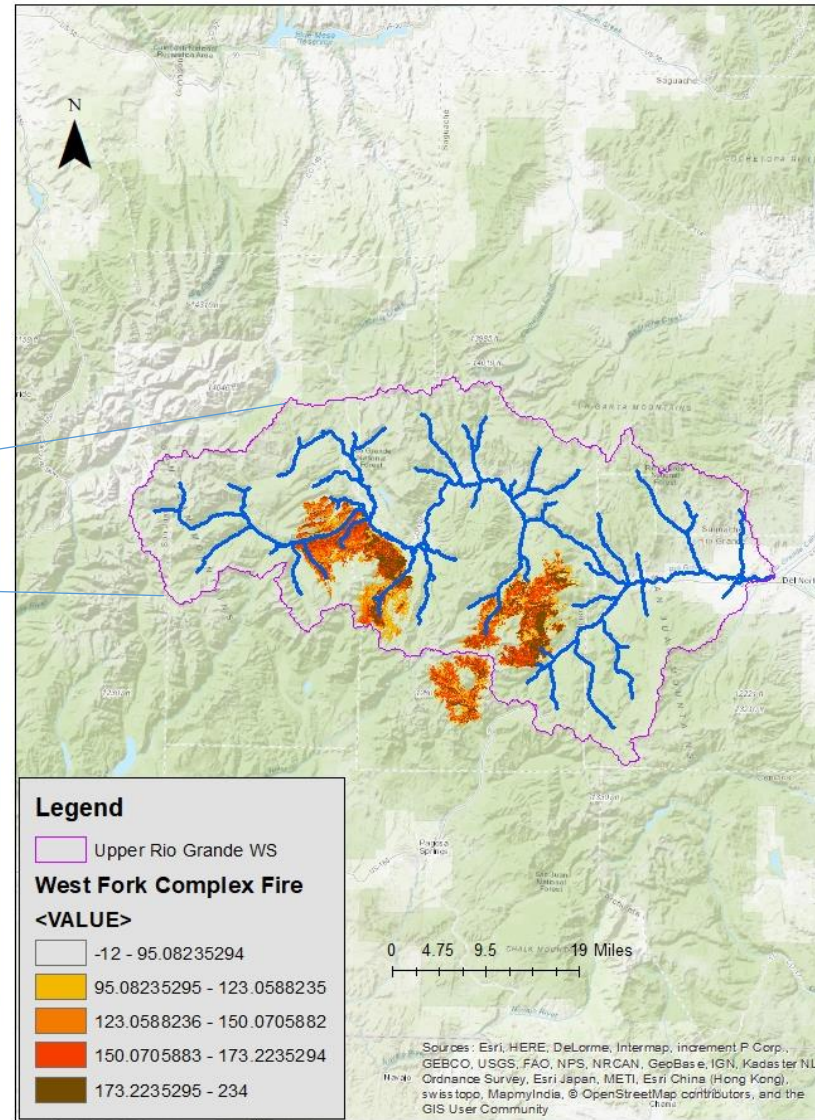
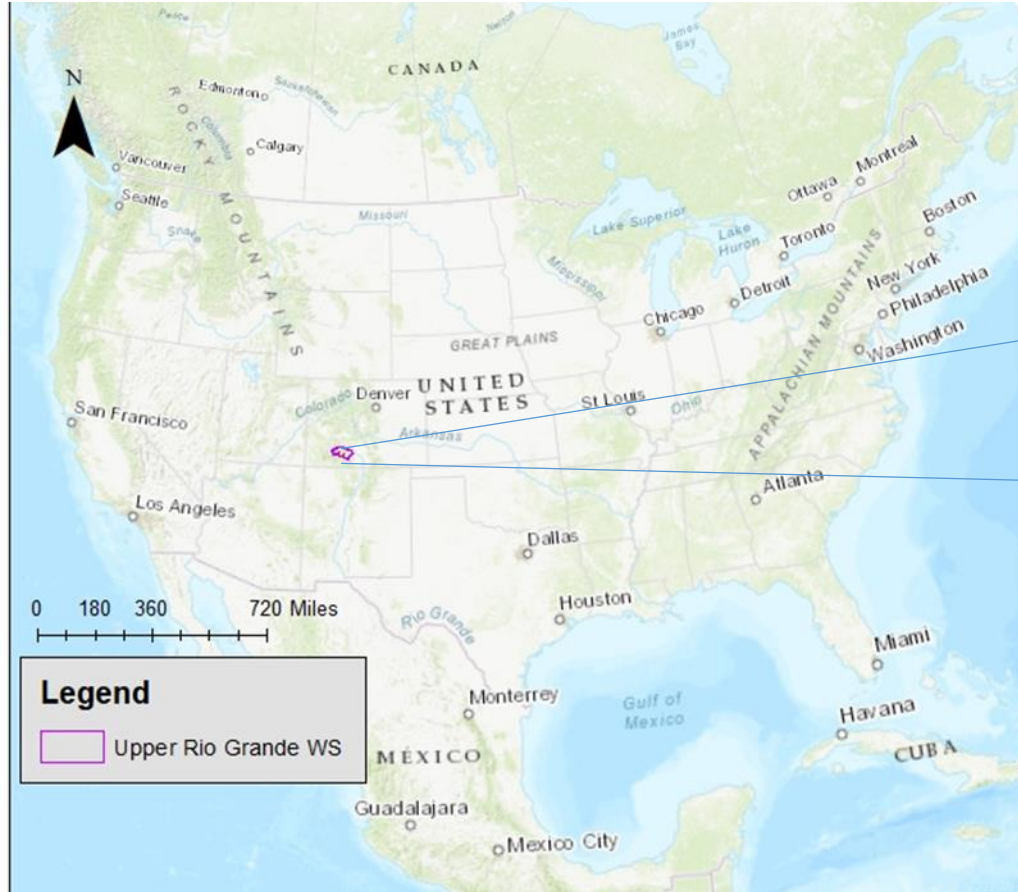
Metals: **Dissolved** forms decreased , **particulate** forms increased , and flux for both increased  in 33% of fires

DRIVER OF WATER QUALITY RESPONSE: VEGETATION RECOVERY



**WEST FORK COMPLEX FIRE, RIO GRANDE,
COLORADO USA**

WEST FORK COMPLEX FIRE



Fires start June 5, 2013

2nd largest fire by area in Colorado history

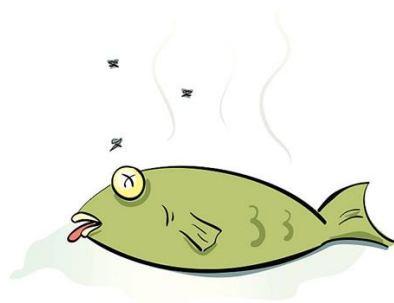
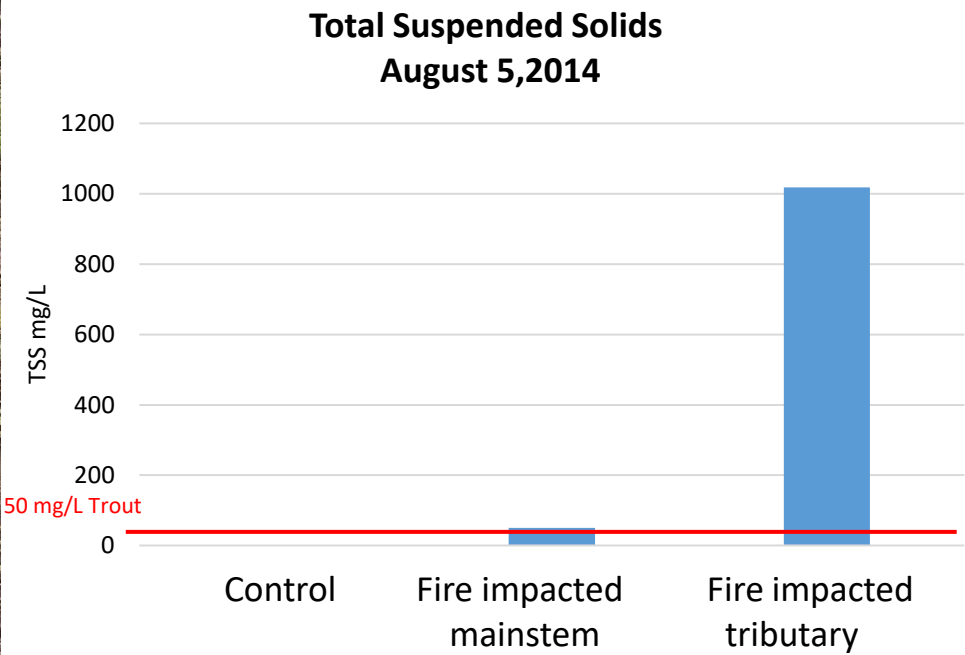
110,000 acres burned

60% moderate to severe burn

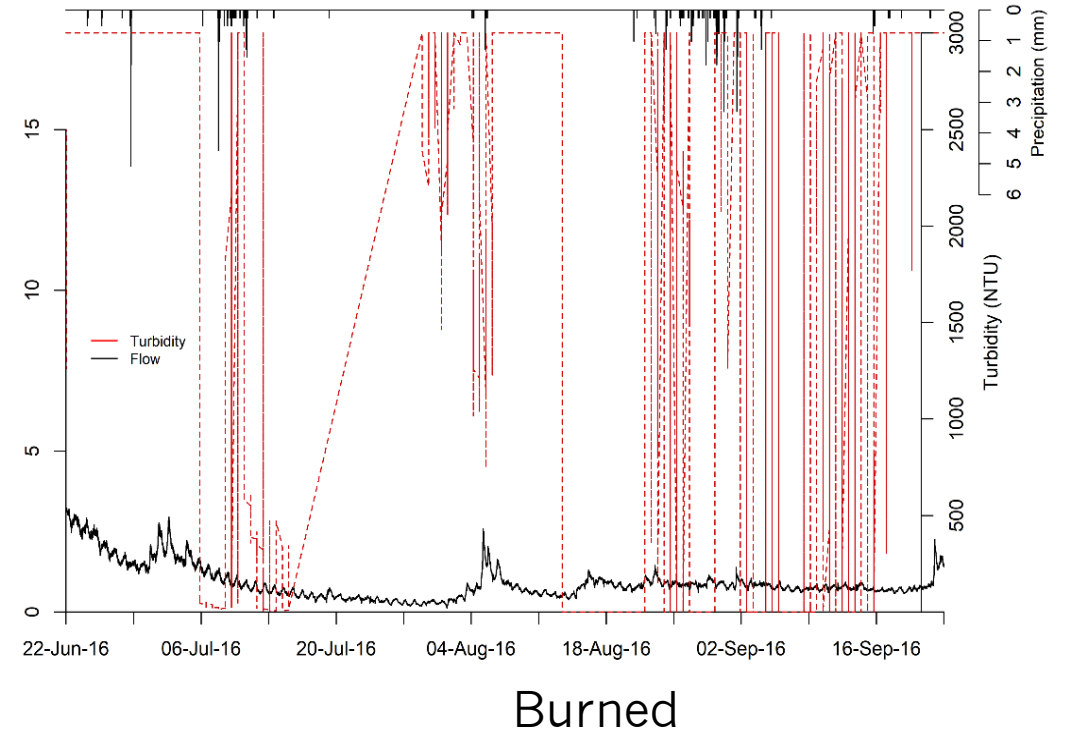
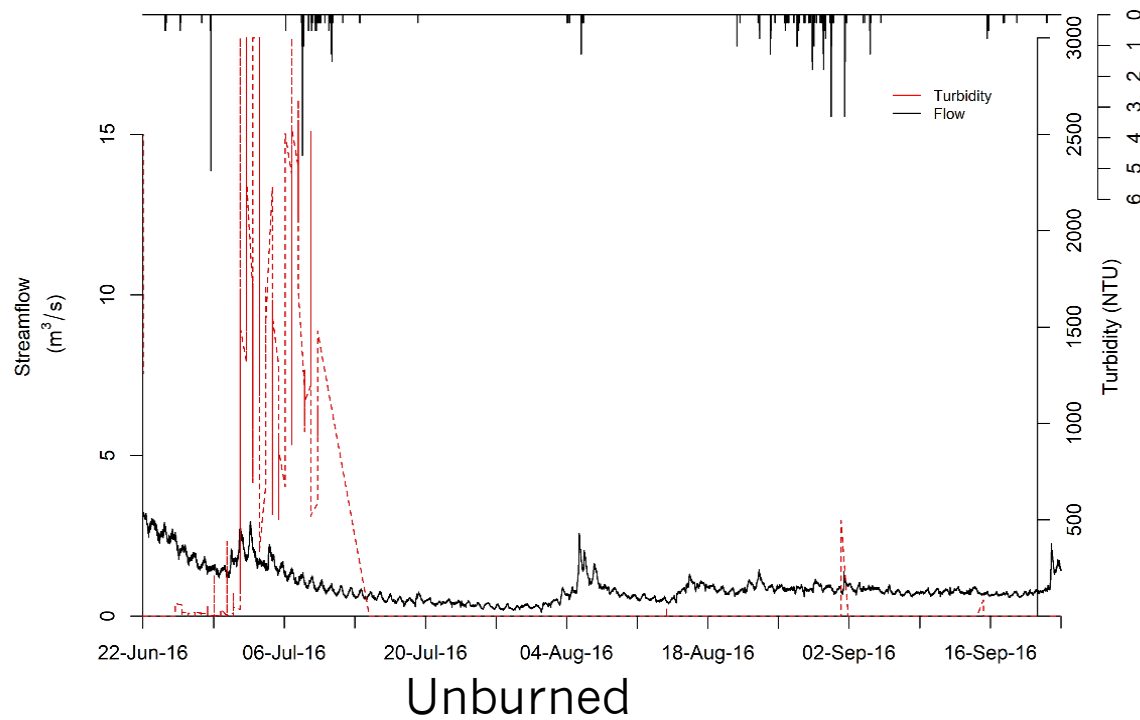


A landslide event caused by summer monsoon rain events one year after the fire.

The high suspended solids killed fish through suffocation.

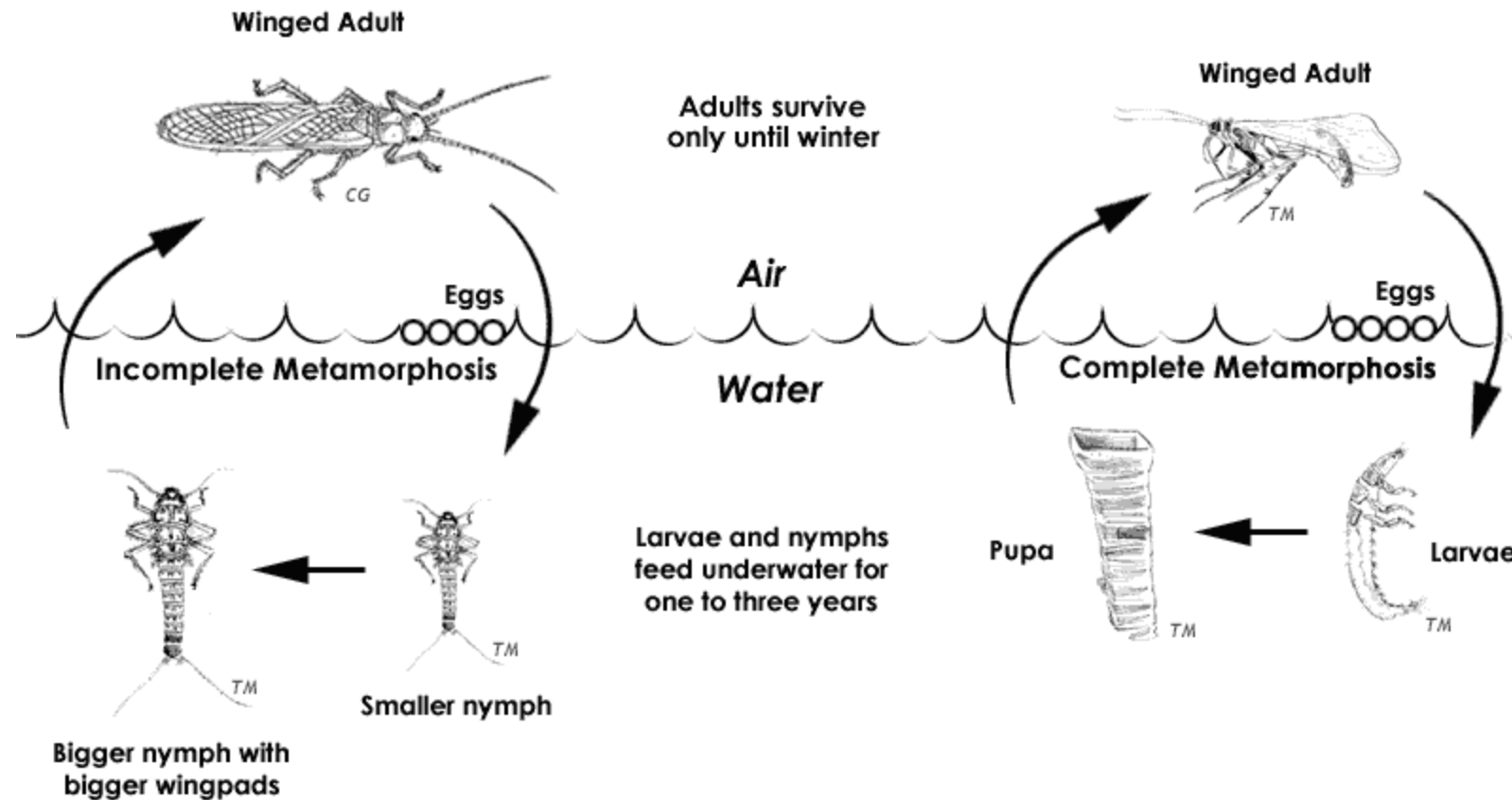


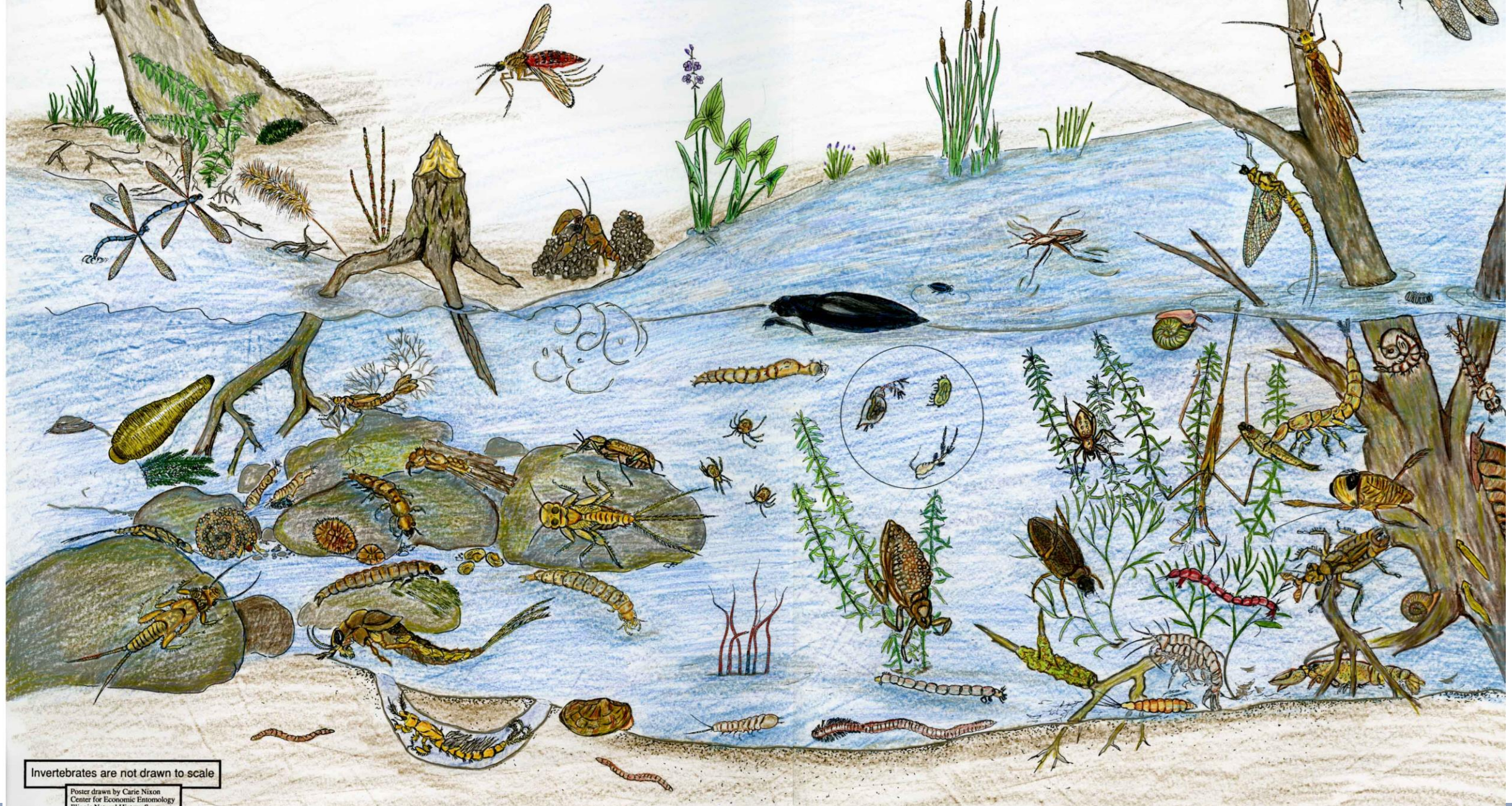
POST-FIRE MONSOON RAIN STORM DRIVEN TURBIDITY EVENTS IN THE RIO GRANDE



Hydro-hyetographs with turbidity data plotted in red.
Turbidity over the rainy season in the control (unburned) and impact (burned) stream sampling sites
Turbidity frequently exceeded thresholds for aquatic life

AQUATIC MACROINVERTEBRATES





Invertebrates are not drawn to scale

Poster drawn by Carrie Nixon
Center for Economic Entomology
Illinois Natural History Survey

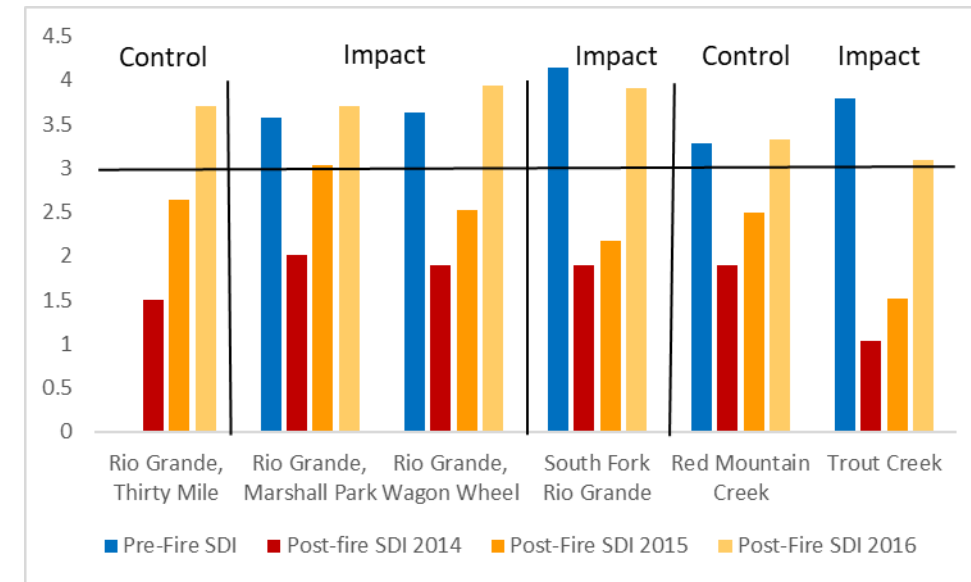


HOGUE
HYDROLOGY GROUP

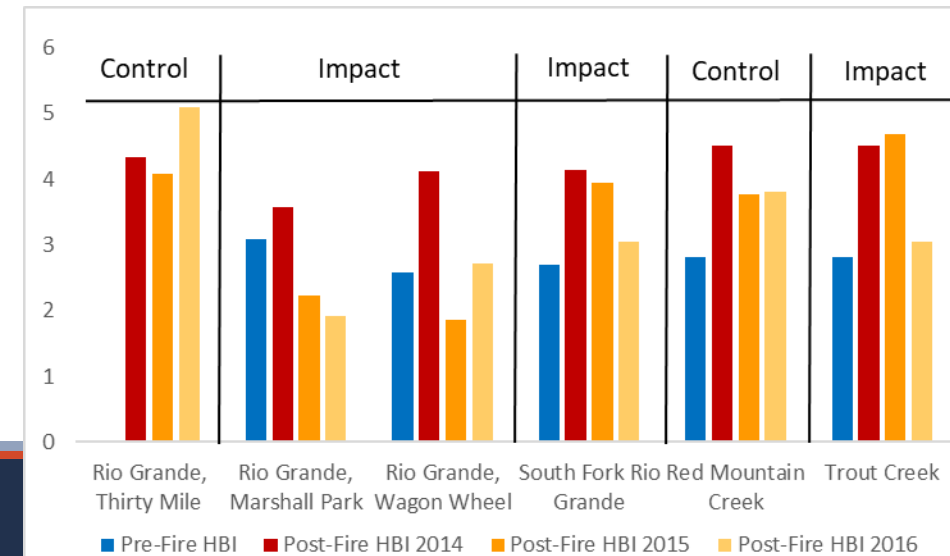
FIRE IMPACT ON MACROINVERTEBRATES

Number of taxa & sensitive taxa significantly decreased at ALL sites the first two years after fire, recovered to pre-fire levels by year 3

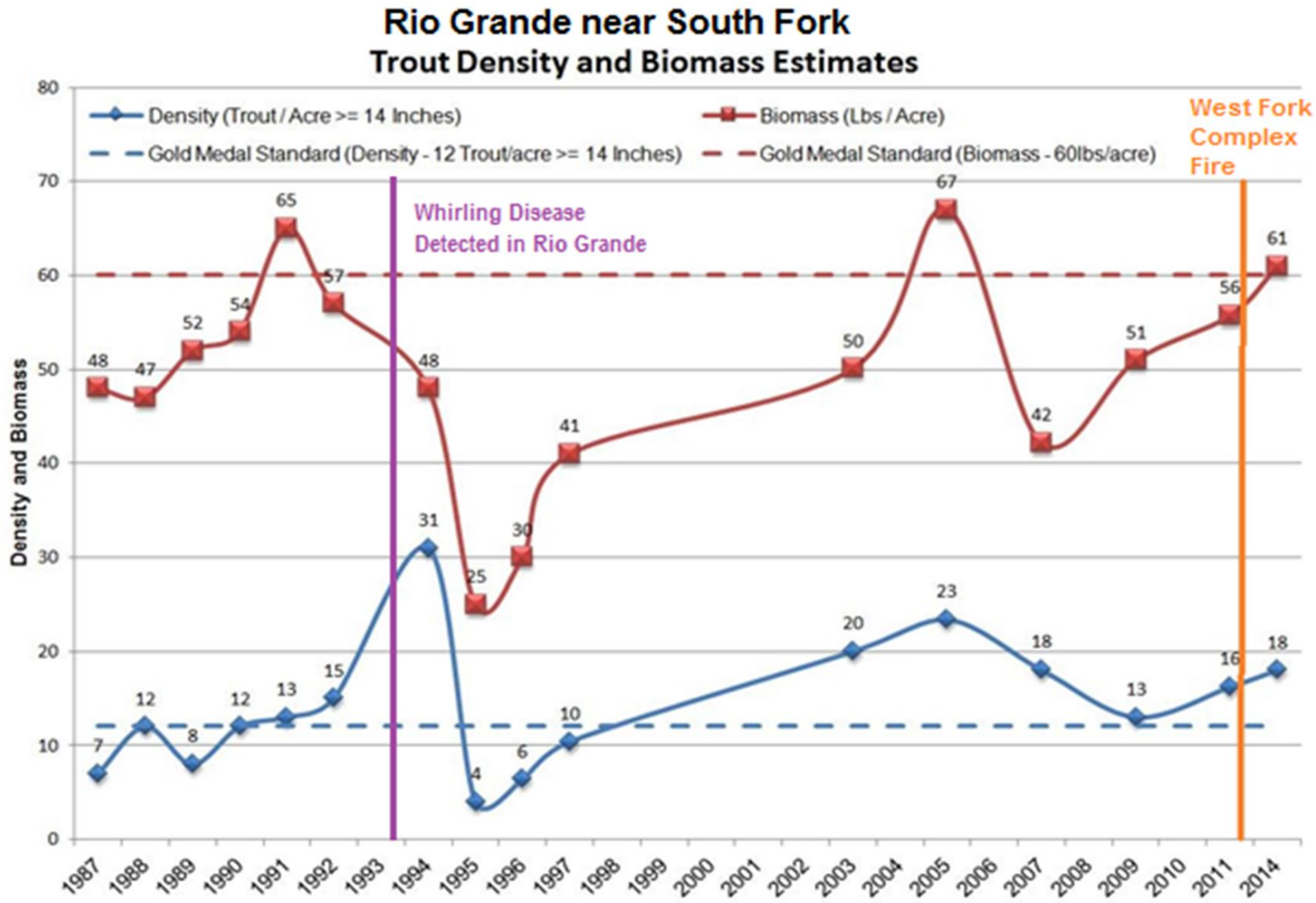
Shannon-Wiener Diversity Index



Hilsenhoff Biotic Index



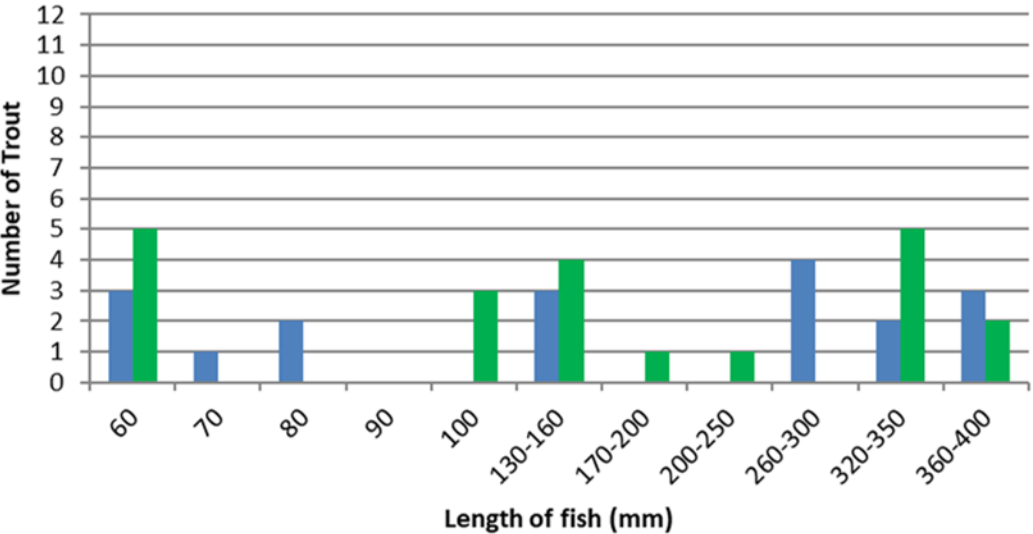
FISH POPULATION: RESILIENCE ON THE RIO GRANDE



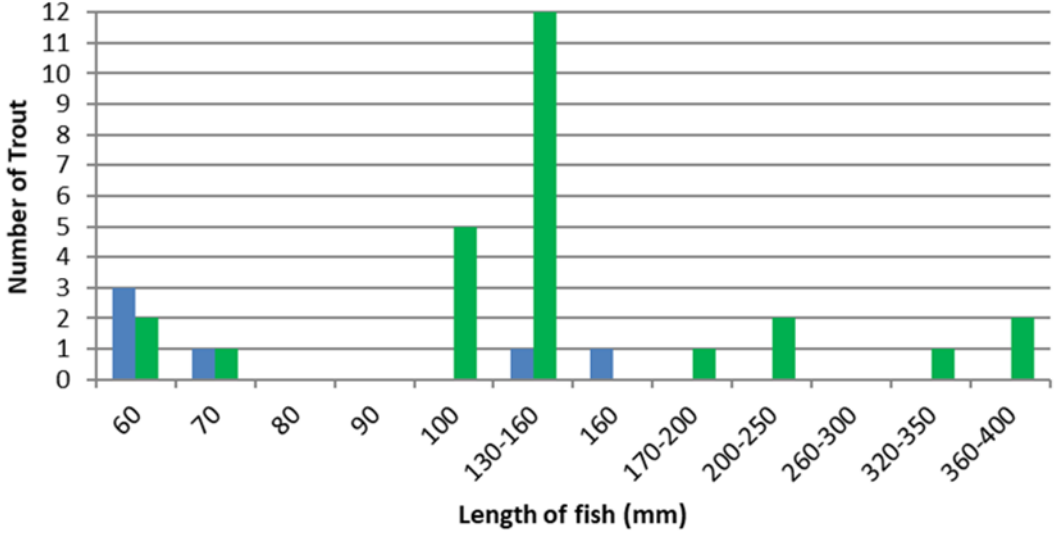
FISH POPULATION IMPACT & RECOVERY

Tributary: Trout Creek

Above Landslide



Below Landslide





THE 416 FIRE

- June 1 – July 31, 2018
- Durango, CO
- 54,120 acres, or 21,000 ha

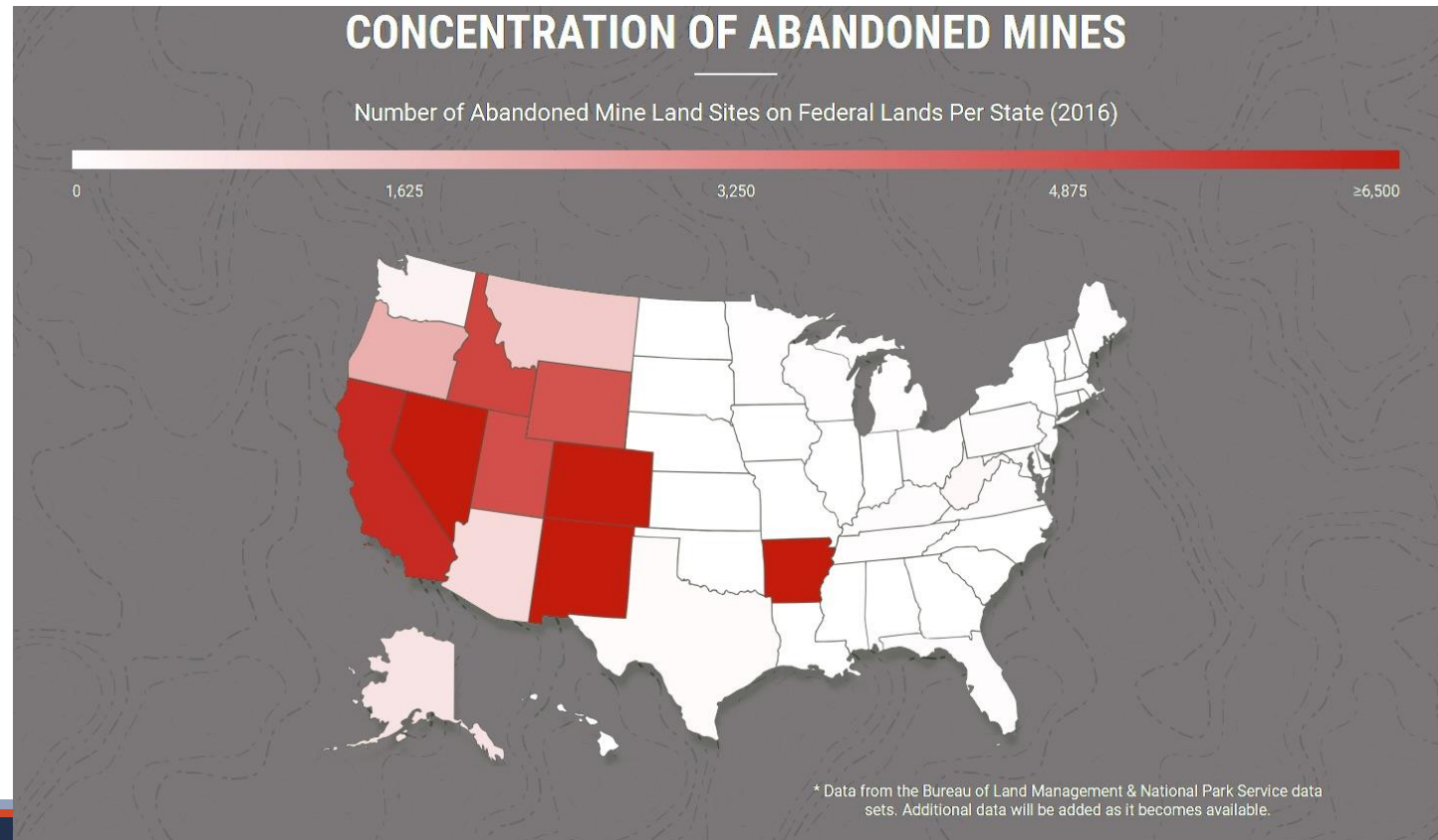




Background

ABANDONED MINES

- Estimates of up to 500,000 abandoned mines in the USA (from BLM, USDA)



From
Abandonedmines.gov

The Gold King Mine: From An 1887 Claim, Private Profits And Social Costs

By Colorado Public Radio Staff | August 17, 2015

The New York Times

Colorado Spill Heightens Debate Over Future of Old Mines





416 FIRE

Background

THE Durango HERALD

Animas River suffered 80% die-off after 416 Fire ash flows



Survey shows aquatic population severely depleted through Durango

By Jonathan Romeo County & environment reporter
Saturday, Sept. 21, 2019 5:03 AM



Colorado Parks and Wildlife staff members Pete Deren, center, throws an anode to shock fish last week as Ryan Votta prepares to net them, while Jim White walks the raft down the Animas River during a fish count. The anode is used to shock fish so they can be collected, counted and then released back into the river.

Jerry McBride/Durango Herald



A bluehead sucker was collected last week during a fish count on the Animas River by Colorado Parks and Wildlife. The suckers were caught in record numbers this year.

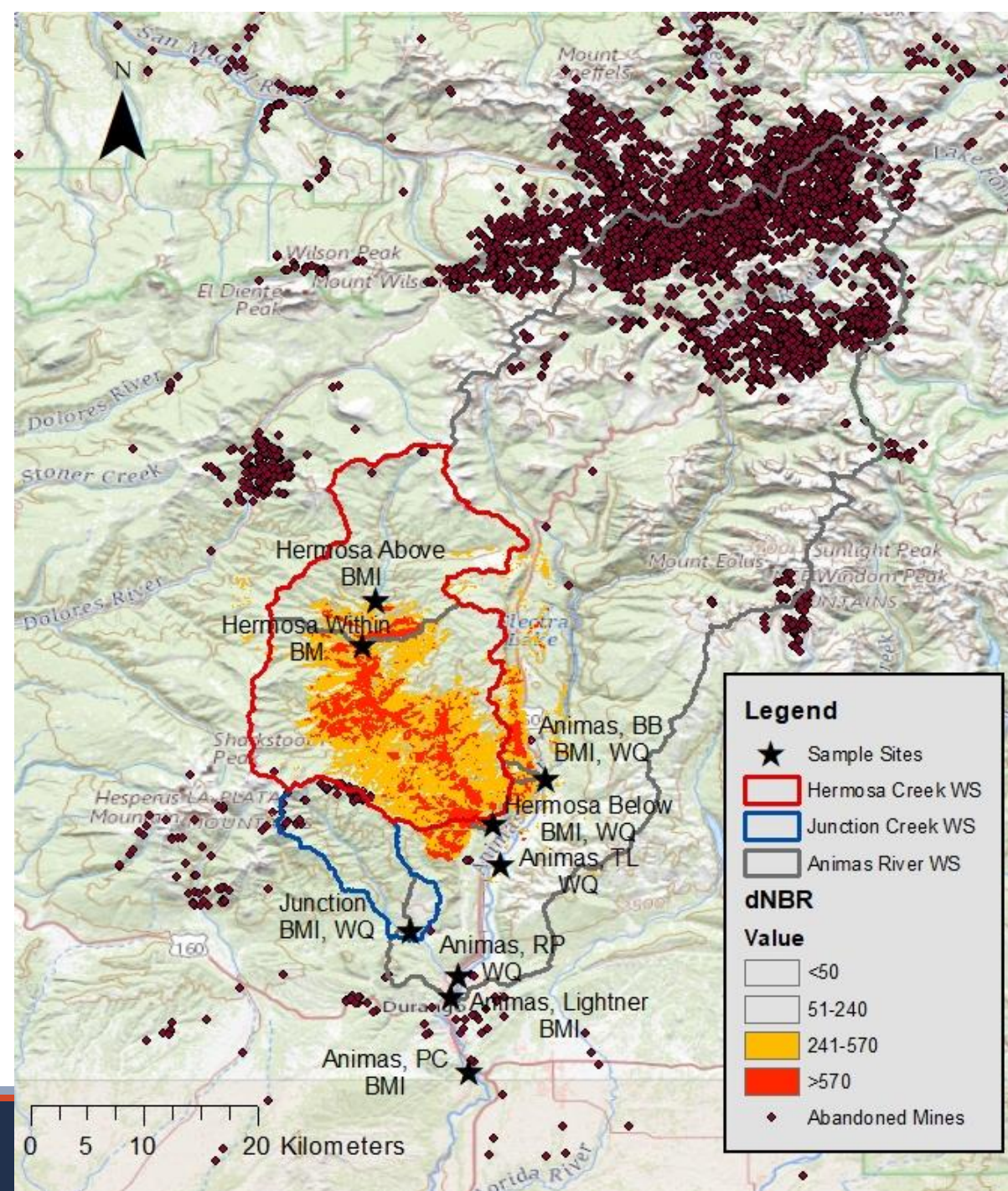
Jerry McBride/Durango Herald

SCIENCE QUESTIONS

- I. Do aquatic ecosystems impacted by legacy mining respond differently to forest fire?
- II. Do heavy metals mobilized by fire move up the food chain?

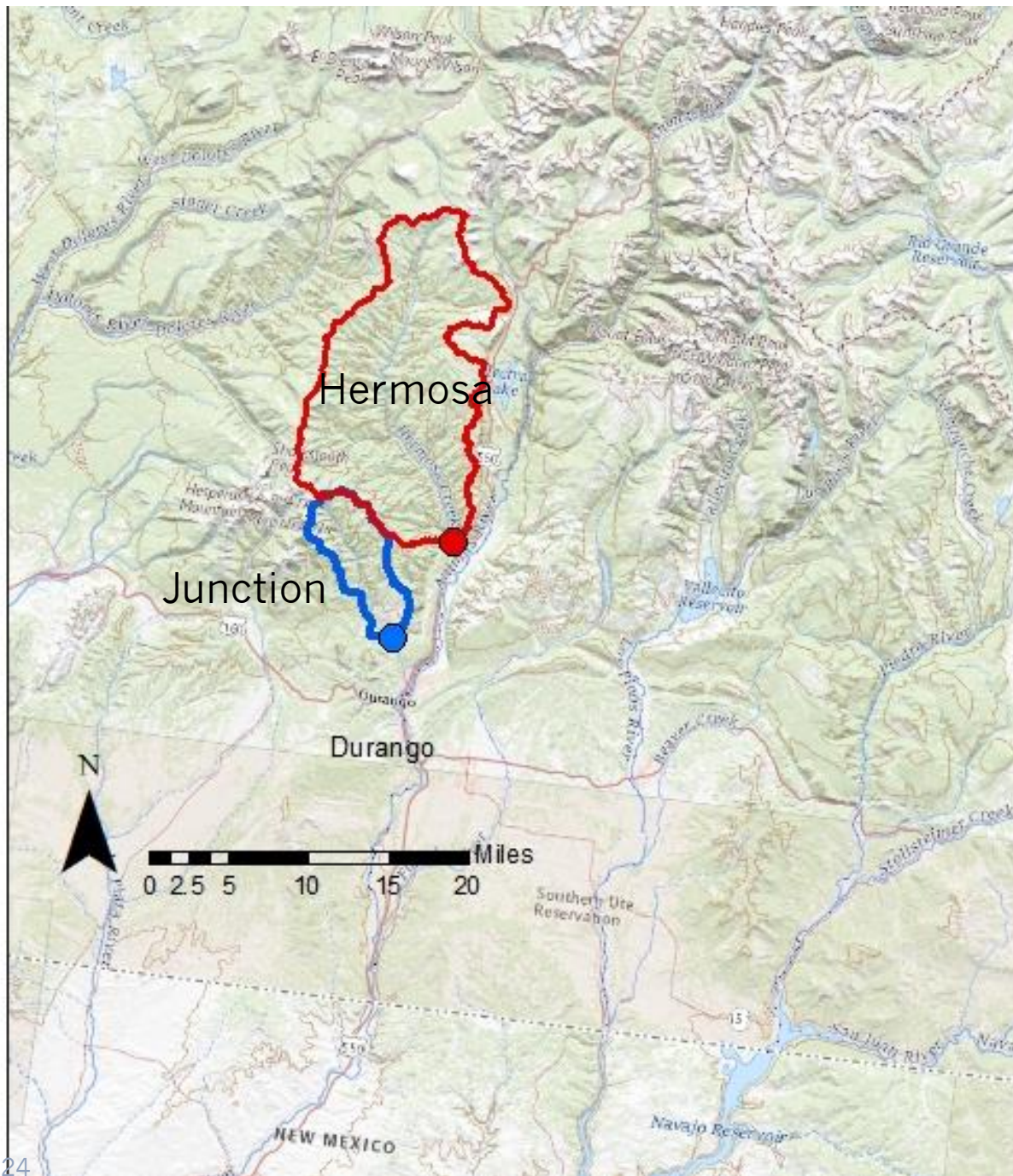
METHOD

5 main water quality & macroinvertebrate monitoring sites
Animas River above & below fire
All with data from before the fire



METHOD

Paired tributaries:
Hermosa (burned) &
Junction Creek (not burned)



HERMOSA CREEK STILLING WELL



HERMOSA CREEK STILLING WELL



May 30, 2019 – June 20, 2019

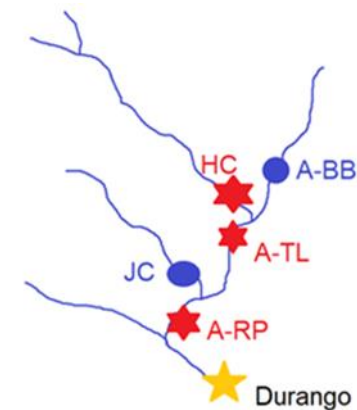
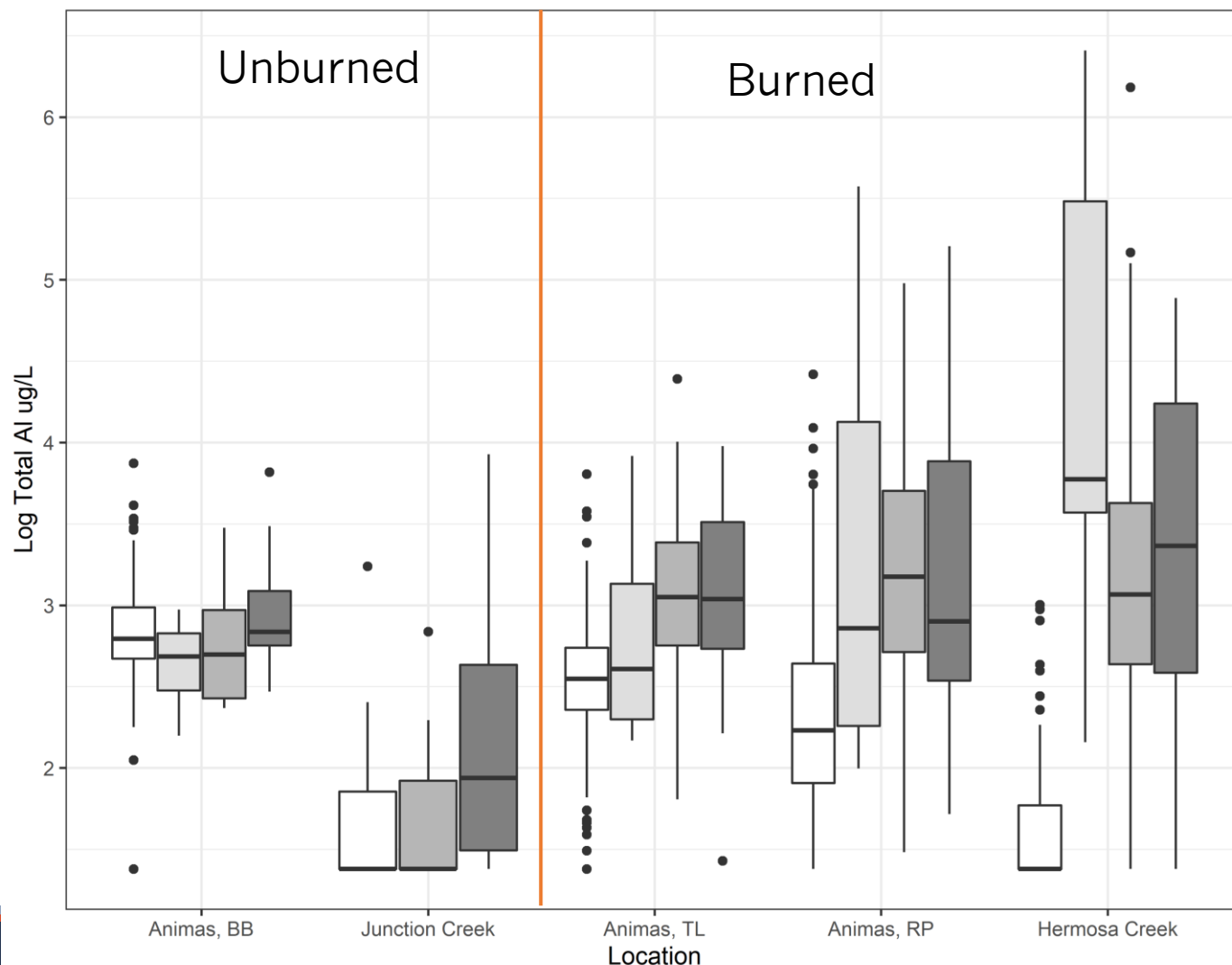
...yes, I lost a few things to the water.

Photos courtesy of Mandy Eskelson with MSI



Results

TOTAL ALUMINUM SIGNIFICANTLY INCREASED IN BURNED TRIBUTARY, HERMOSA CREEK; MAINSTEM OF ANIMAS RIVER ALREADY IMPACTED WITH METALS

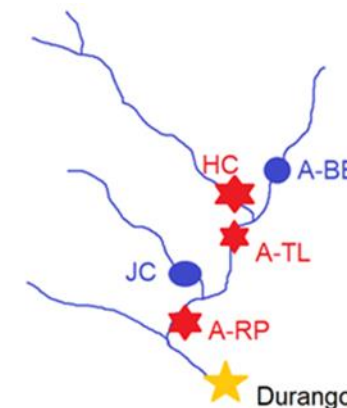
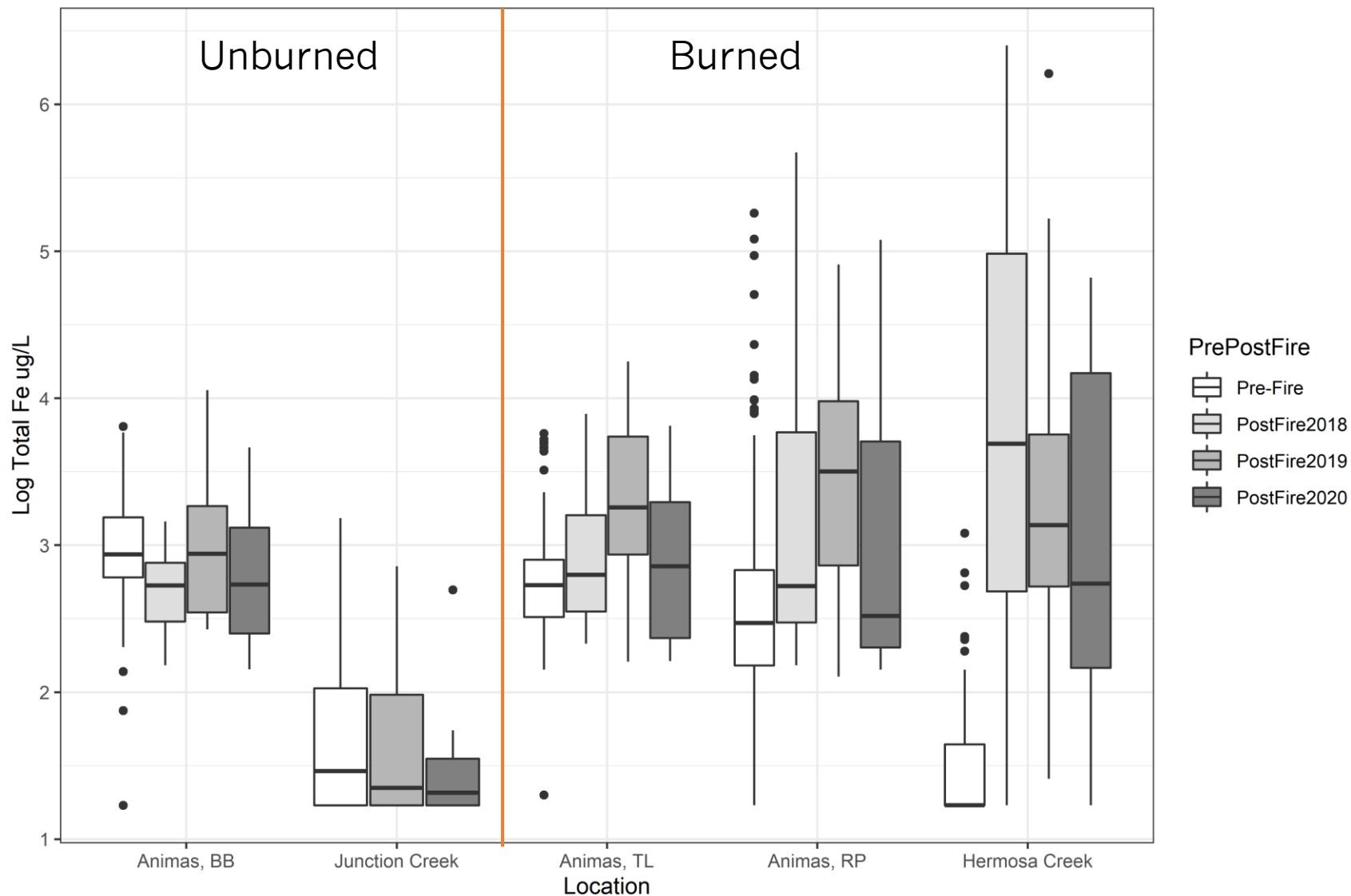


Mann-Whitney U test
 $p < 0.05$



Results

TOTAL IRON SIGNIFICANTLY INCREASED IN BURNED TRIBUTARY, HERMOSA CREEK; MAINSTEM OF ANIMAS RIVER ALREADY METAL IMPACTED



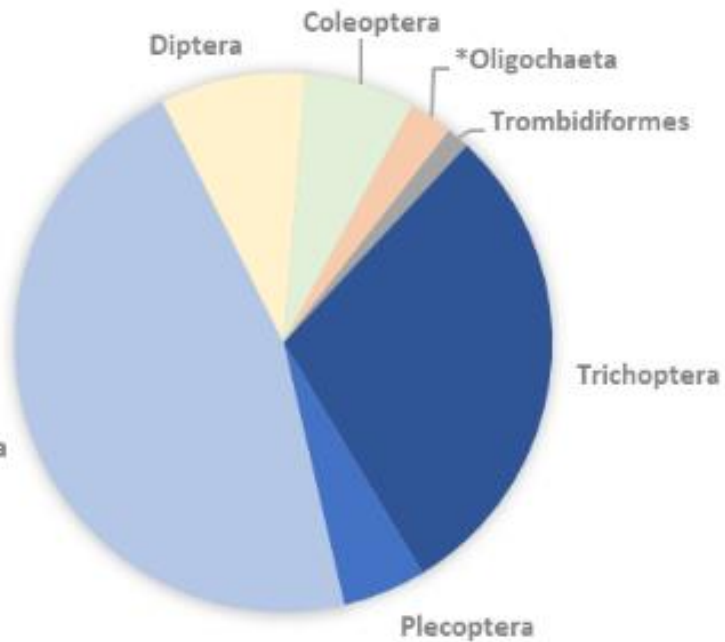
Mann-Whitney U test
 $p < 0.05$

Aquatic Life: Before and After Fire

Hermosa Creek aquatic insects



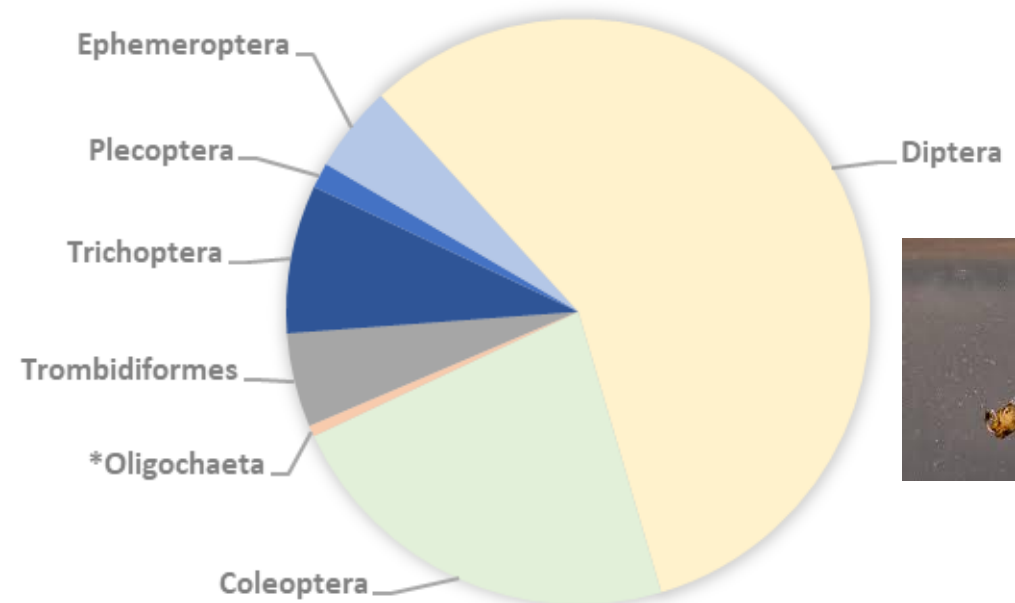
Pre-416 Fire (2016)



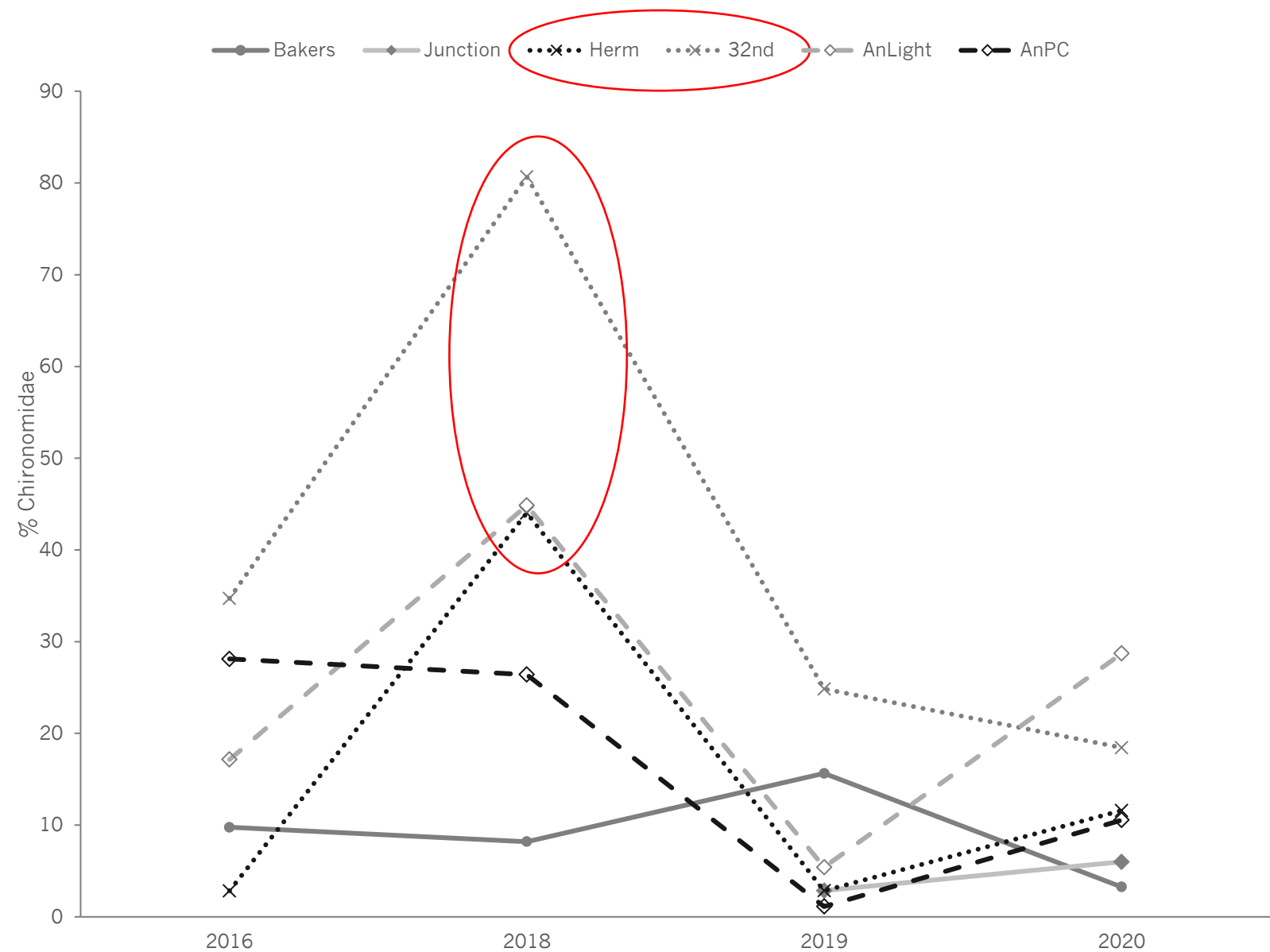
Ephemeroptera



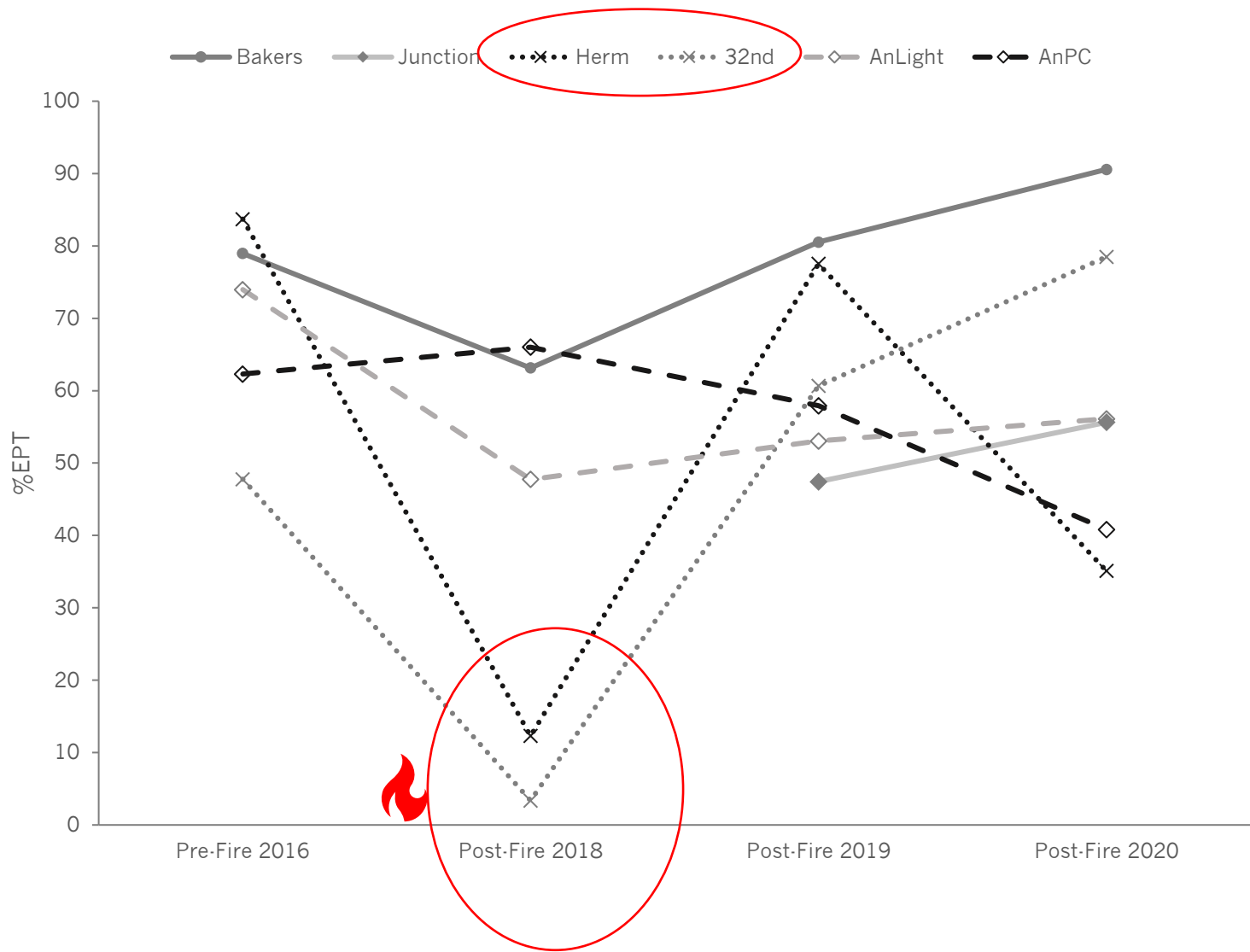
🔥 Post-416 Fire (2018)



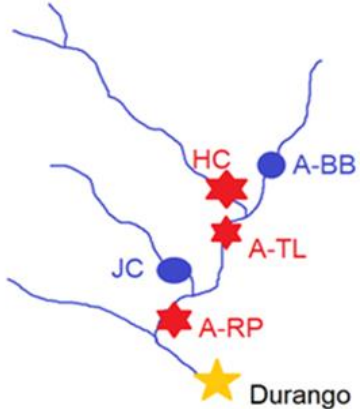
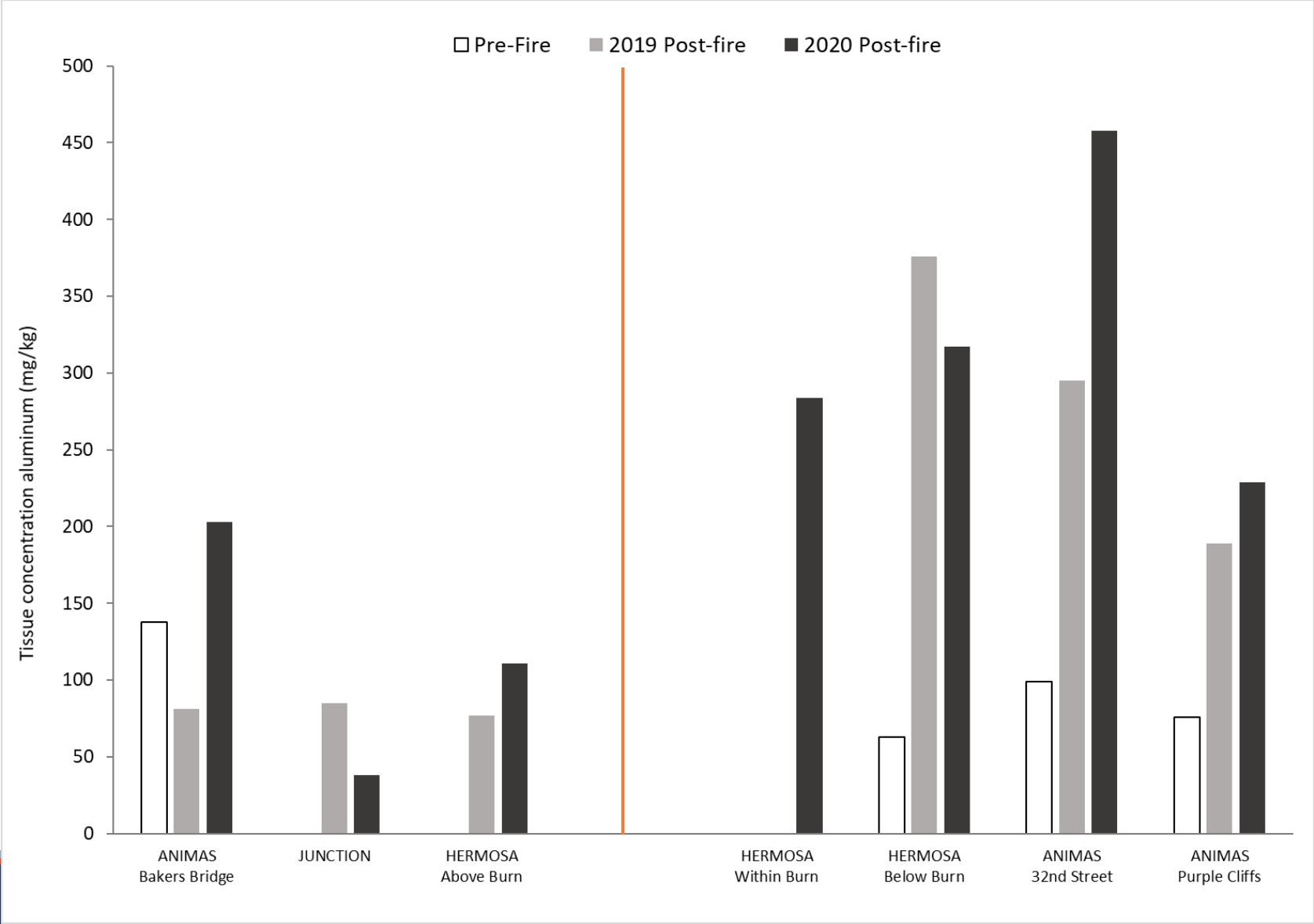
MACROINVERTEBRATE BIODIVERSITY: MORE POLLUTION TOLERANT TAXA PRESENT IN FIRE-IMPACTED LOCATIONS



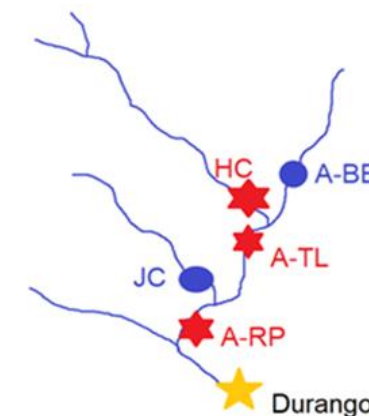
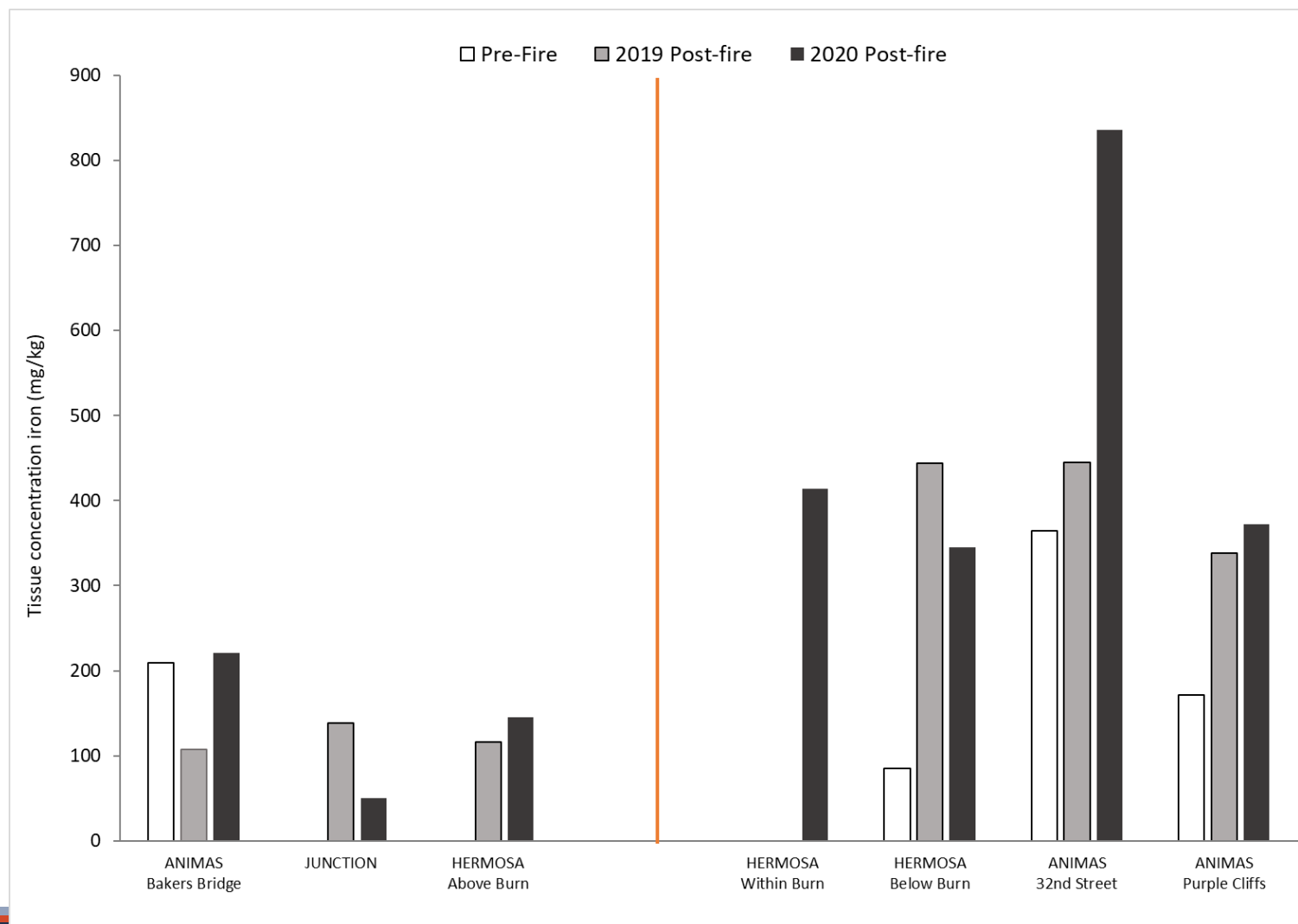
MACROINVERTEBRATE BIODIVERSITY: FEWER TAXA SENSITIVE TO POOR WATER QUALITY IN FIRE-IMPACTED STREAM LOCATIONS



ALUMINUM CONCENTRATIONS HIGHER IN MACROINVERTEBRATE TISSUE IN FIRE-IMPACTED STREAMS



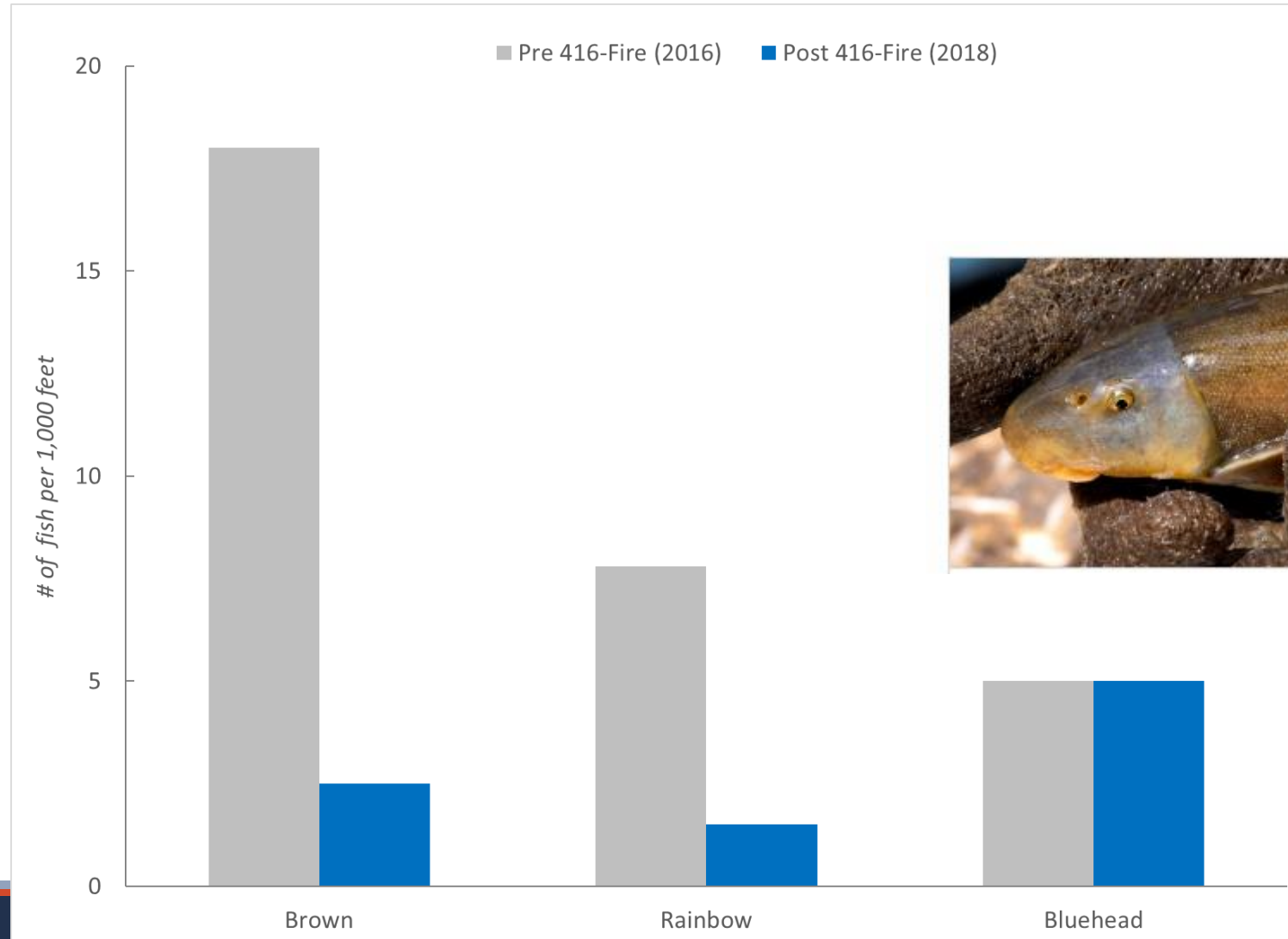
IRON CONCENTRATIONS IN MACROINVERTEBRATE TISSUE HIGHER IN FIRE-IMPACTED STREAMS





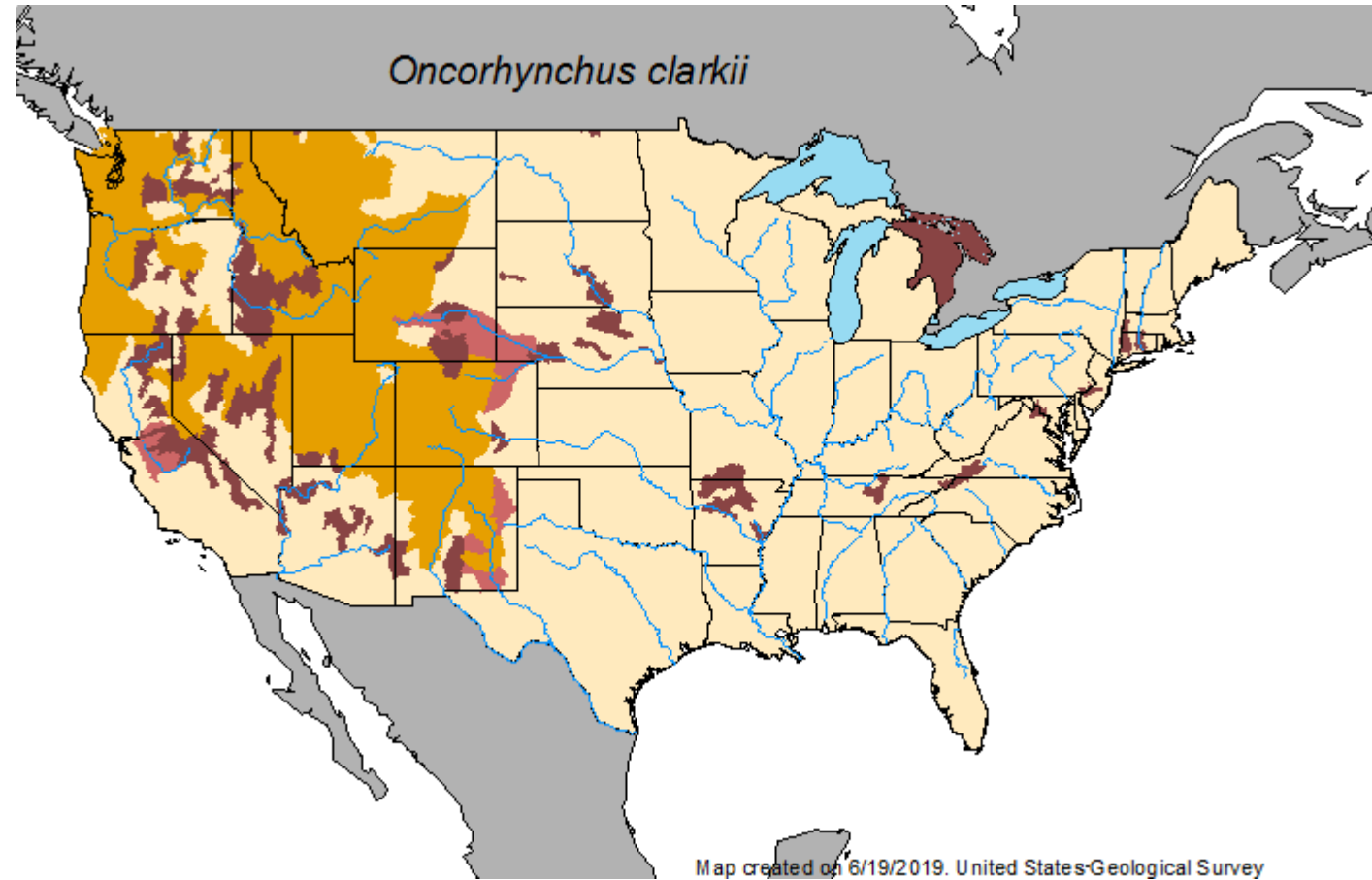
Aquatic Life: Before and After Fire

Animas River fish – Durango reach



NATIVE CUTTHROAT TROUT

21 species,
Several are threatened
Due to:
Habitat alteration &
Non-native species
introductions



From USGS.gov

Colorado biologists rediscover fish long thought to be extinct — then rescue them as wildfire advances

Ecological recovery depends on whether fish can handle changed conditions



By **BRUCE FINLEY** | bfinley@denverpost.com | The Denver Post

PUBLISHED: September 5, 2018 at 10:00 pm | UPDATED: September 6, 2018 at 10:33 am

“It has always been the Holy Grail to go back to how it was before European settlers,” CPW aquatic biologist Jim White said in an interview Wednesday. “Preserving native diversity across the landscape is part of conserving that landscape. People often want to know we’re taking care of our environment. These fish are a symbol of that. And people like to know that there are still wild places.”

CONCLUSIONS

- Forest fires impact water quality for 3+ years
- Fish can be exposed to impaired water and fish kill events can follow wildfire
- Fish populations recover quickly <3 years, as long as river is connected
- Macroinvertebrate populations shift and then also recover <3 years
- Metals mobilized from wildfire observed in insect tissue, mining areas are more susceptible

THANK YOU!

Rust, A.J., J. Randell, A. S. Todd, T. S. Hogue (2019) Wildfire Impacts on Water Quality, Macroinvertebrate, and Trout Populations in the Upper Rio Grande. Forest Ecology and Management, 453, 117636.
doi.org/10.1016/j.foreco.2019.117636

Rust, A.J., T.S. Hogue, S. Saxe and J. McCray (2018) Post-fire water quality response in the western United States. International Journal of Wildland Fire. Doi.org/10.1071/WF17115

Rust, A.J, S. Saxe, T. S. Hogue, J. McCray, C. C. Rhoades (2019) Evaluating the Factors Responsible for Post-Fire Water Quality Response in Forests in the Western USA. International Journal of Wildland Fire. WF18191

Rust, A.J., S. Roberts, M. Eskelson, J. Randell, T.S. Hogue, (2021) Forest fire mobilization and uptake of metals by biota temporarily exacerbates impacts of legacy mining. Science of the Total Environment (*in review*)

THANK YOU
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Thanks to:

*Rio Grande Watershed Emergency Action Coalition Team
City of Durango
Colorado Water Conservation Board
Colorado Parks and Wildlife
Colorado Department of Public Health and Environment
Southwestern Water Conservation District
Trout Unlimited*

Photo: Priscilla Sherman