

# Metal concentrations in streams in relation to time since fire

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Franke Freshwater Conservation Initiative

Confederated Salish and Kootenai Tribes



# Fire Effects on Watersheds and Streams



*Credit: <https://montanafreepress.org>*



*Credit: Rachel Malison*

# Metals and Metalloids

1 IA 1A <b>H</b> Hydrogen 1.008																	18 VIIIA 8A <b>He</b> Helium 4.003
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012											5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.011	7 <b>N</b> Nitrogen 14.007	8 <b>O</b> Oxygen 15.999	9 <b>F</b> Fluorine 18.998	10 <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 <b>Mg</b> Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 <b>Al</b> Aluminum 26.982	14 <b>Si</b> Silicon 28.086	15 <b>P</b> Phosphorus 30.974	16 <b>S</b> Sulfur 32.066	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948
19 <b>K</b> Potassium 39.098	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.956	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.942	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933	28 <b>Ni</b> Nickel 58.693	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.631	33 <b>As</b> Arsenic 74.922	34 <b>Se</b> Selenium 78.972	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 84.798
37 <b>Rb</b> Rubidium 85.468	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.906	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.906	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium 98.907	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.906	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.868	48 <b>Cd</b> Cadmium 112.411	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.711	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.904	54 <b>Xe</b> Xenon 131.294
55 <b>Cs</b> Cesium 132.905	56 <b>Ba</b> Barium 137.328	57-71	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.948	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.085	79 <b>Au</b> Gold 196.967	80 <b>Hg</b> Mercury 200.592	81 <b>Tl</b> Thallium 204.383	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.980	84 <b>Po</b> Polonium [208.982]	85 <b>At</b> Astatine 209.987	86 <b>Rn</b> Radon 222.018
87 <b>Fr</b> Francium 223.020	88 <b>Ra</b> Radium 226.025	89-103	104 <b>Rf</b> Rutherfordium [261]	105 <b>Db</b> Dubnium [262]	106 <b>Sg</b> Seaborgium [266]	107 <b>Bh</b> Bohrium [264]	108 <b>Hs</b> Hassium [269]	109 <b>Mt</b> Meitnerium [268]	110 <b>Ds</b> Darmstadtium [269]	111 <b>Rg</b> Roentgenium [272]	112 <b>Cn</b> Copernicium [277]	113 <b>Uut</b> Ununtrium unknown	114 <b>F1</b> Flerovium [289]	115 <b>Uup</b> Ununpentium unknown	116 <b>Lv</b> Livermorium [298]	117 <b>Uus</b> Ununseptium unknown	118 <b>Uuo</b> Ununoctium unknown

Lanthanide Series	57 <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.242	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967
Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Semimetal
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

# Essential and Trace Elements Naturally Occurring in Plants

## Essential Elements

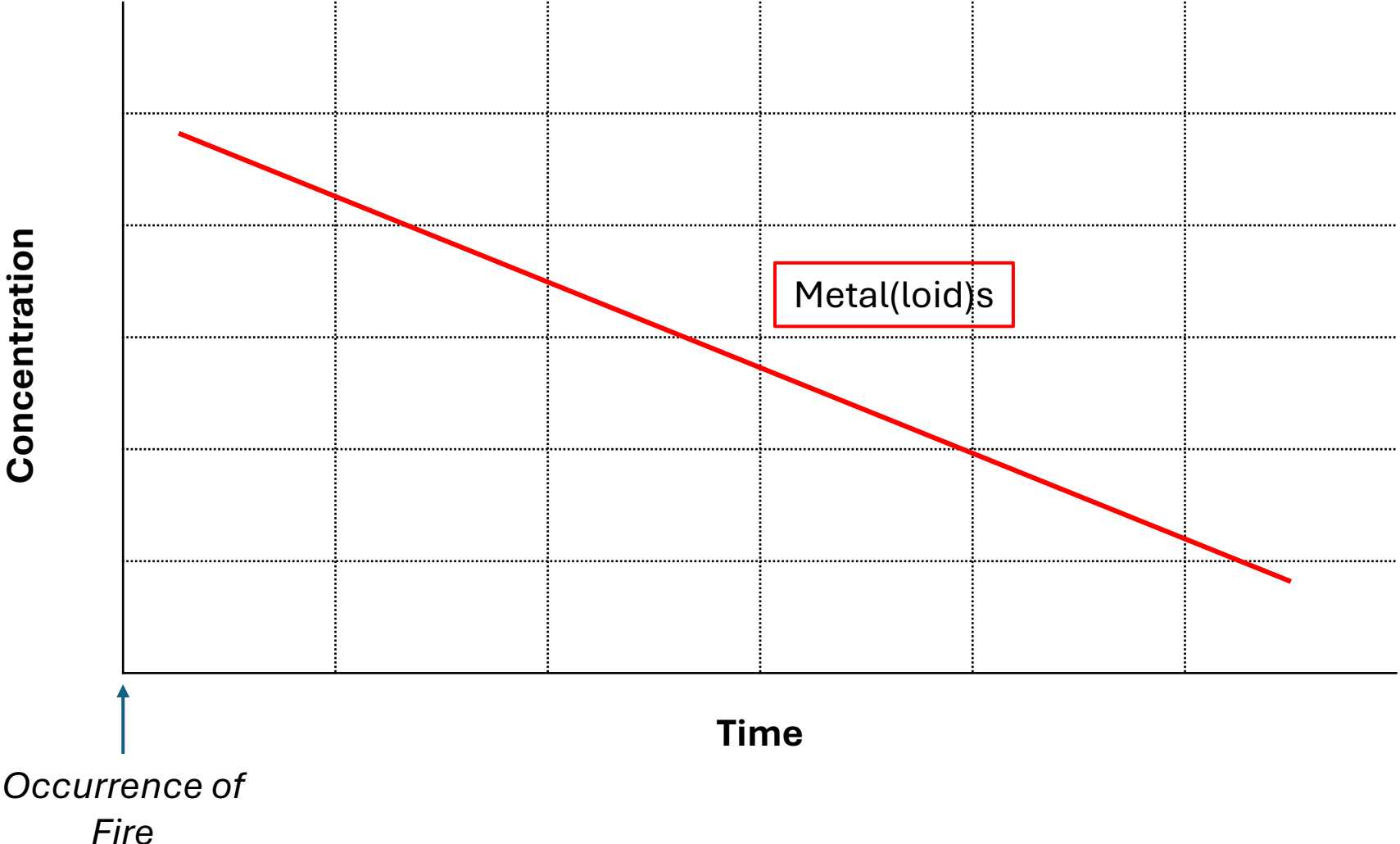
7 <b>N</b> Nitrogen	15 <b>P</b> Phosphorus	19 <b>K</b> Potassium	12 <b>Mg</b> Magnesium	16 <b>S</b> Sulfur	20 <b>Ca</b> Calcium
Macronutrients			Secondary Nutrients		
5 <b>B</b> Boron	17 <b>Cl</b> Chlorine	25 <b>Mn</b> Manganese	26 <b>Fe</b> Iron		
28 <b>Ni</b> Nickel	29 <b>Cu</b> Copper	30 <b>Zn</b> Zinc	42 <b>Mo</b> Molybdenum	1 <b>H</b> Hydrogen	6 <b>C</b> Carbon
Micronutrients				Non-fertilizer Elements	
				8 <b>O</b> Oxygen	

+ many more potential trace elements

# Metal(loid) Delivery to Streams



# Predicted Trends





Coleoptera  
"Beetles"



Diptera  
"True Flies"

# Macroinvertebrates



Ephemeroptera  
"Mayflies"



Hemiptera  
"True Bugs"



Lepidoptera  
"Butterflies & Moths"



Megaloptera  
"Alderflies,  
Dobsonflies,  
& Fishflies"



Plecoptera  
"Stoneflies"



Odonata  
"Dragonflies & Damselflies"



Trichoptera  
"Caddisflies"

# Overarching Question

How do metal(loid)s released by wildfire impact aquatic macroinvertebrate communities over time?

Water



Periphyton



Organic Matter



Macro-invertebrates

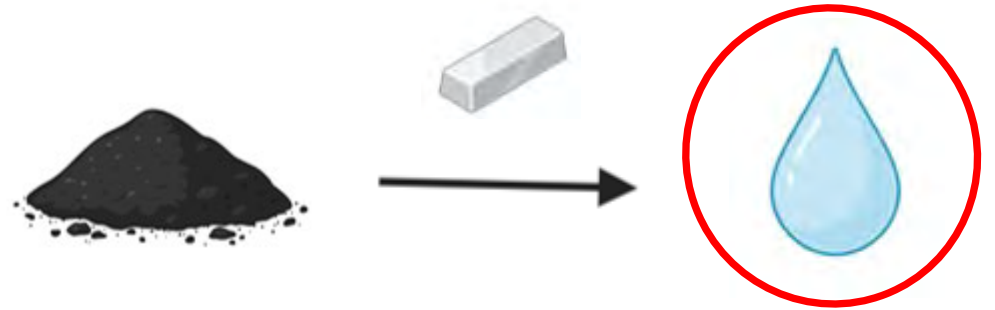


# Sub-Question 1

- **How do metal(loid) concentrations vary with time-since-fire in stream water?**

## Expectation

- **Metal(loid)s will be elevated in more recently burned streams**



# Study Design

- **Space-for-Time**
- Selected streams affected by fire
  - **Different age categories**
  - 1, 2, 3–5, 6–10, and >10 years post-fire
- Sampled metals in stream
- Collected macroinvertebrates



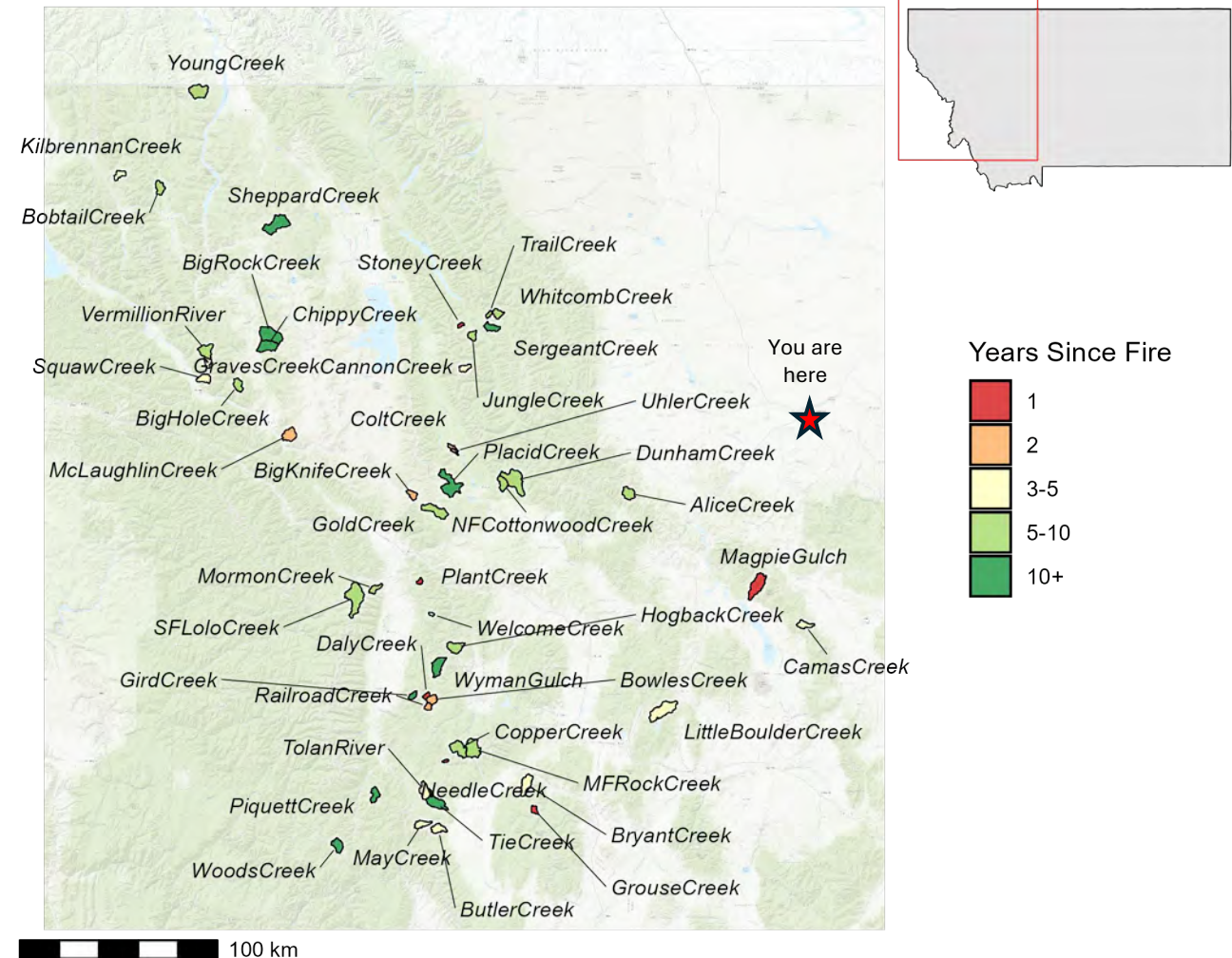
# Site Selection

## Evaluating the factors responsible for post-fire water quality response in forests of the western USA

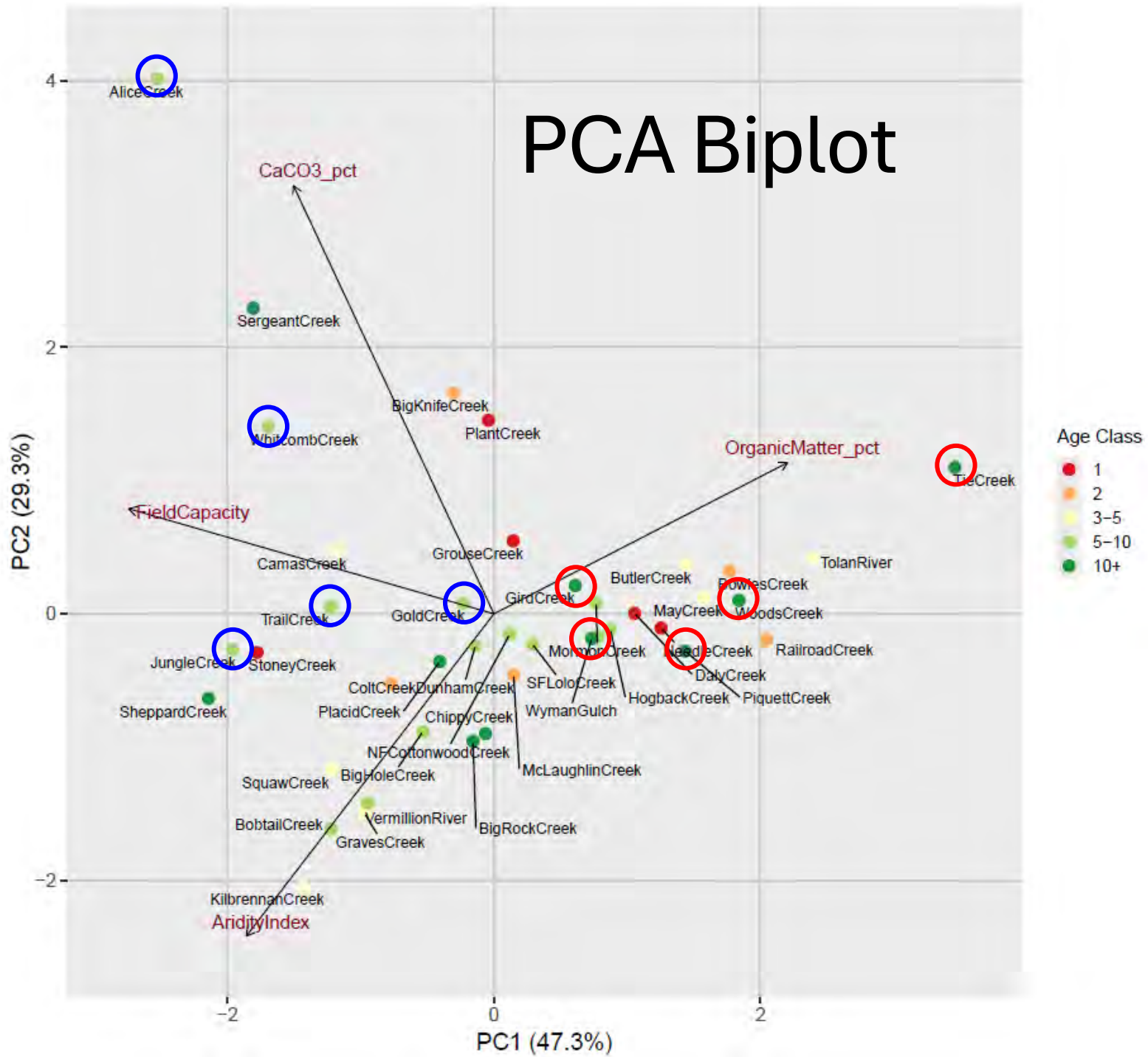
*Rust et al, 2019*

- ~~Burn Severity~~
- Pre-fire soil properties:
  - Soil Organic Matter
  - Field Capacity
  - Calcium Carbonate
- ~~Post-fire NDVI~~
- Aridity Index
- ~~Proximity to Urban Areas~~

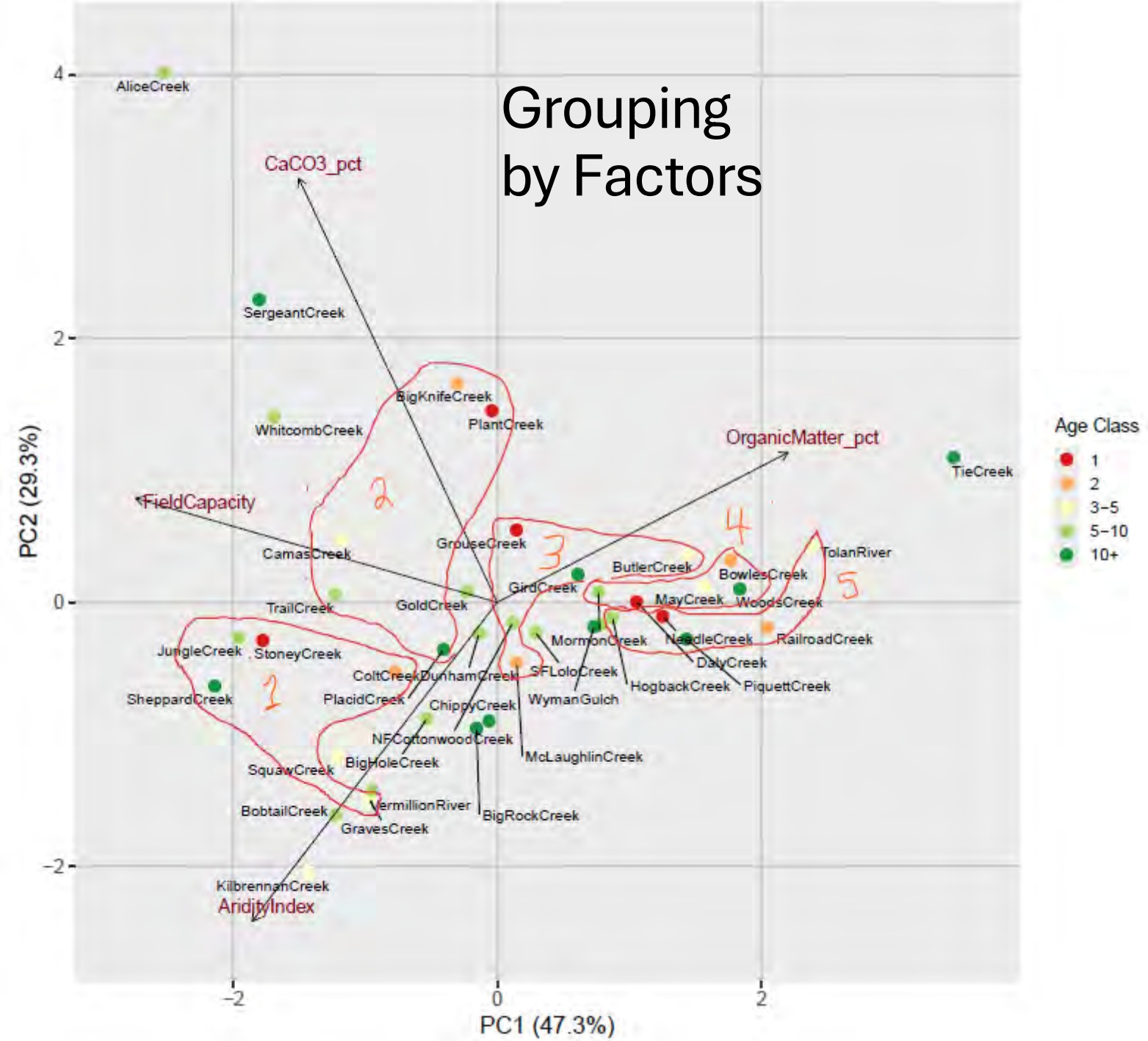
Proposed Watersheds with Fire Age



# PCA Biplot



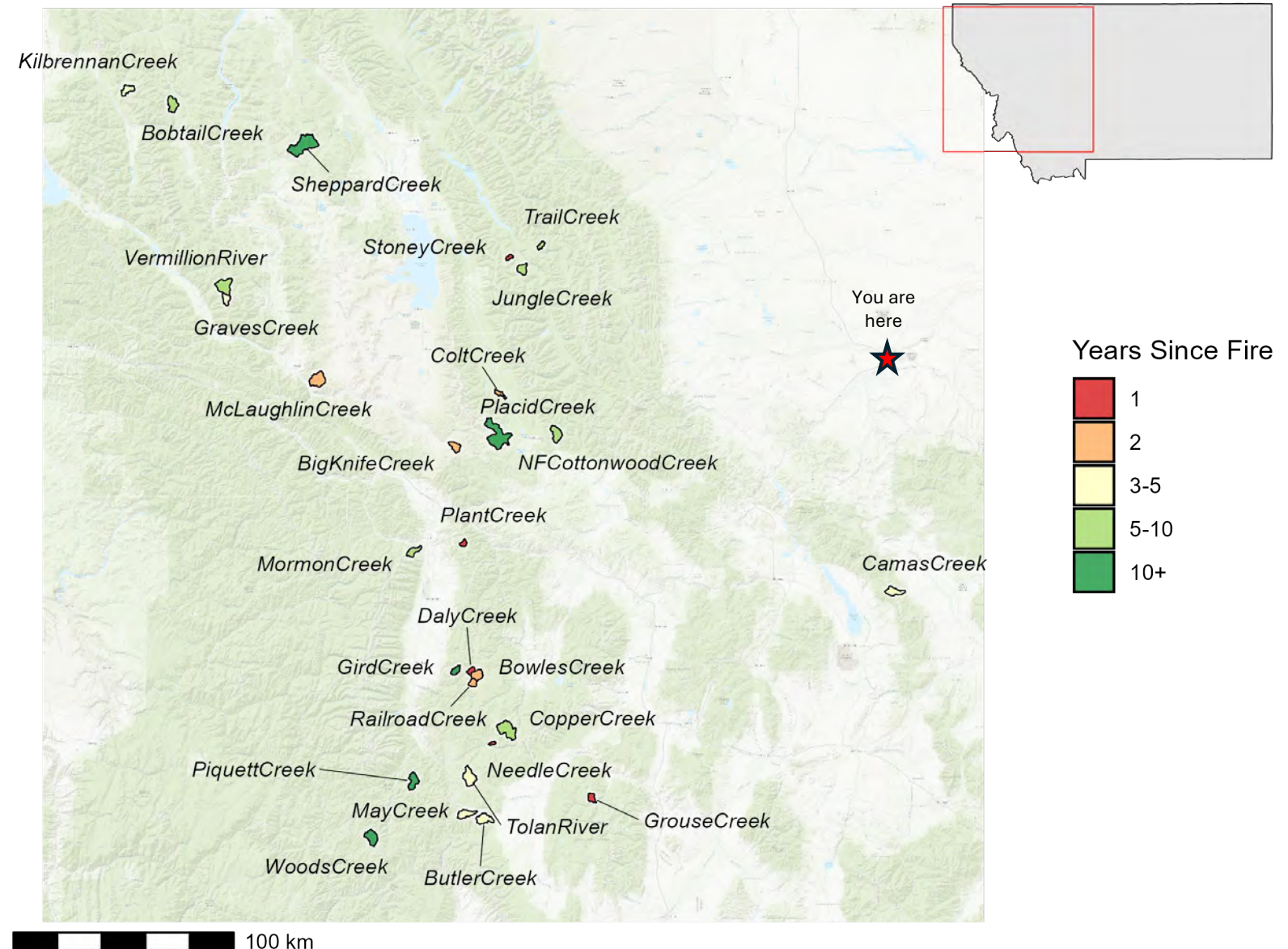
# Grouping by Factors



## Watersheds Sampled by Fire Age

# Selected Sites

- 27 sites
- 5 age classes
- <1 – 18 years since fire

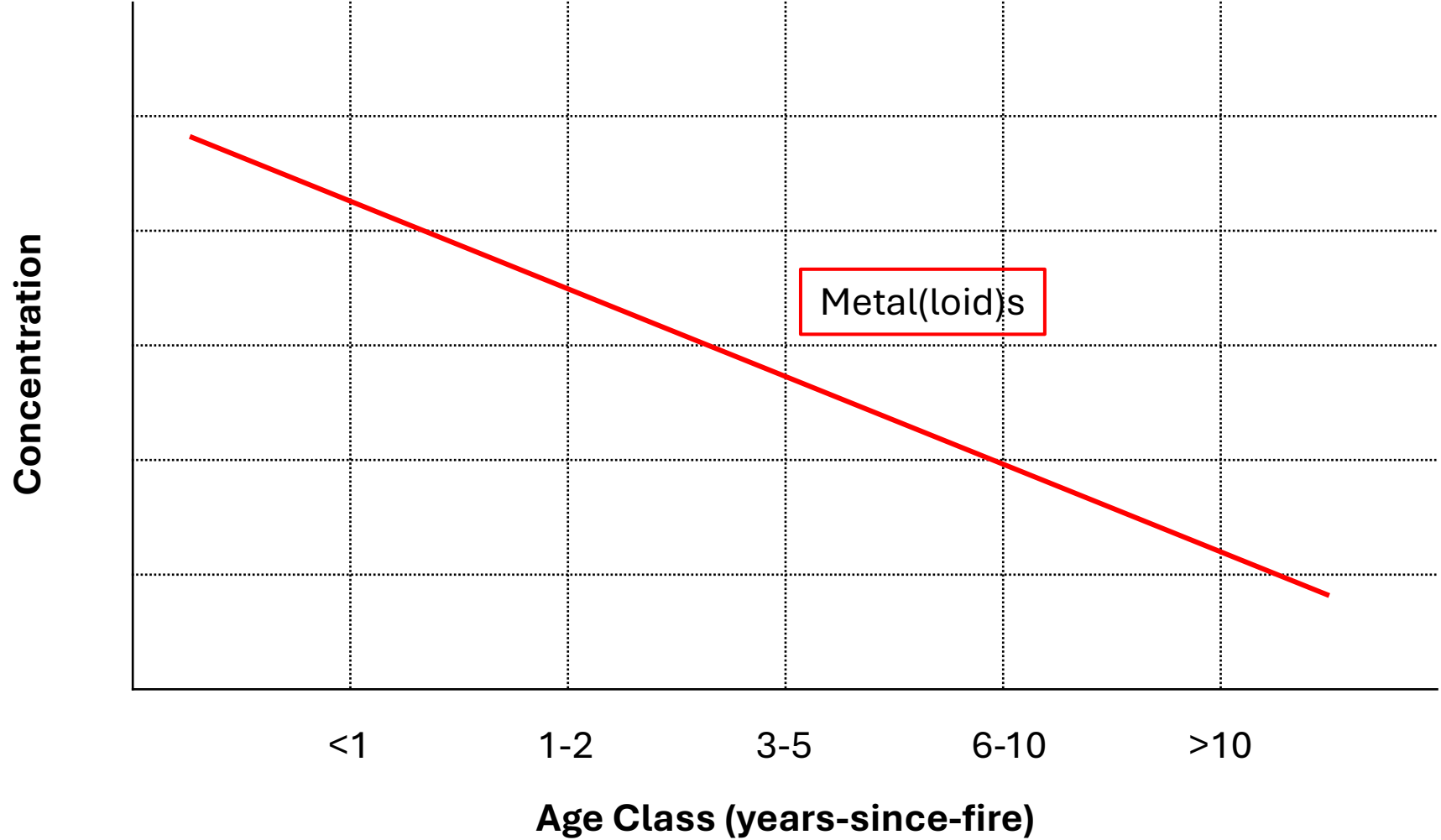


# Sampling and Analysis



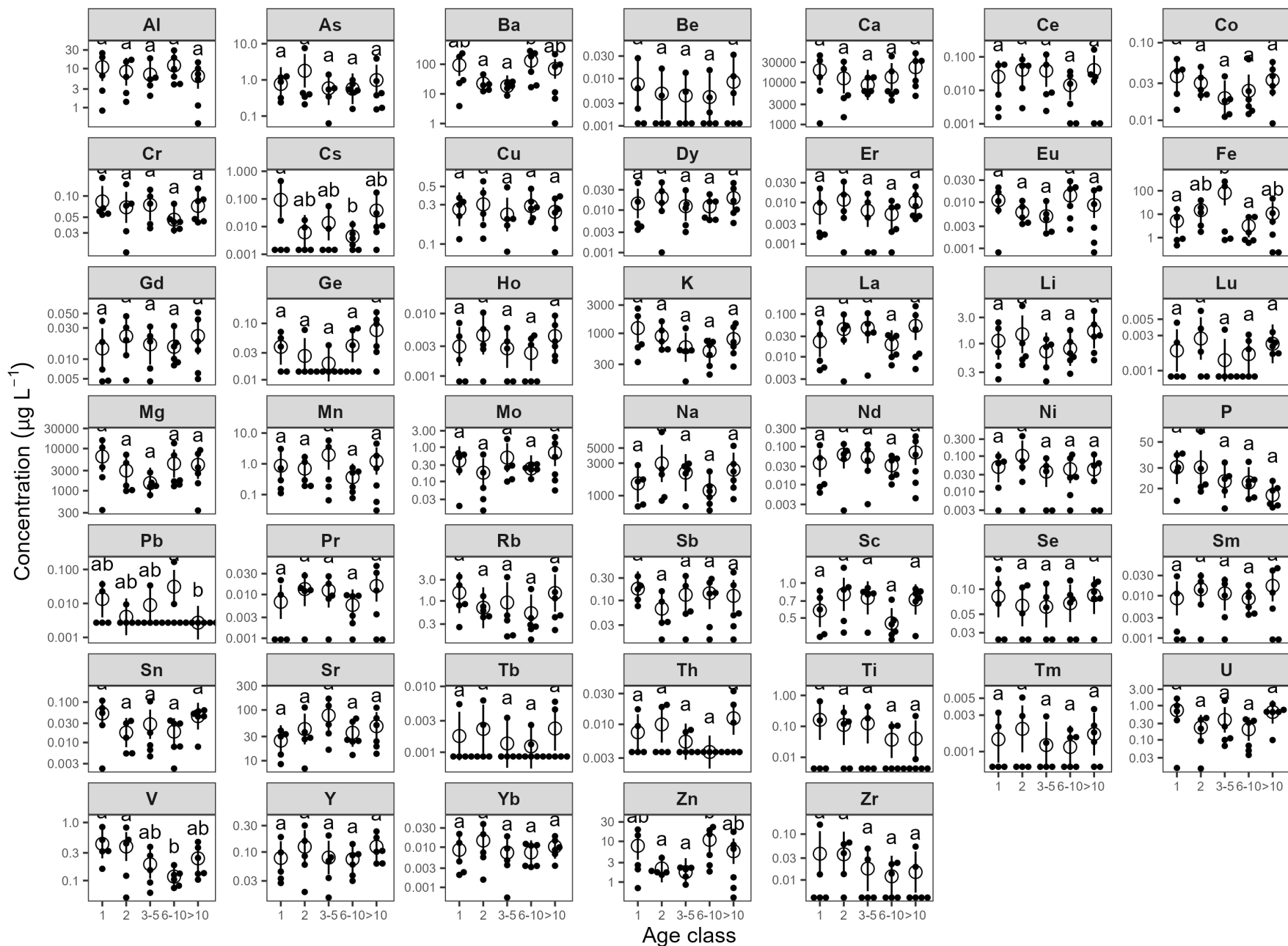
PerkinElmer NexION 5000

# Predicted Trends



# Filtered Water Element Concentrations

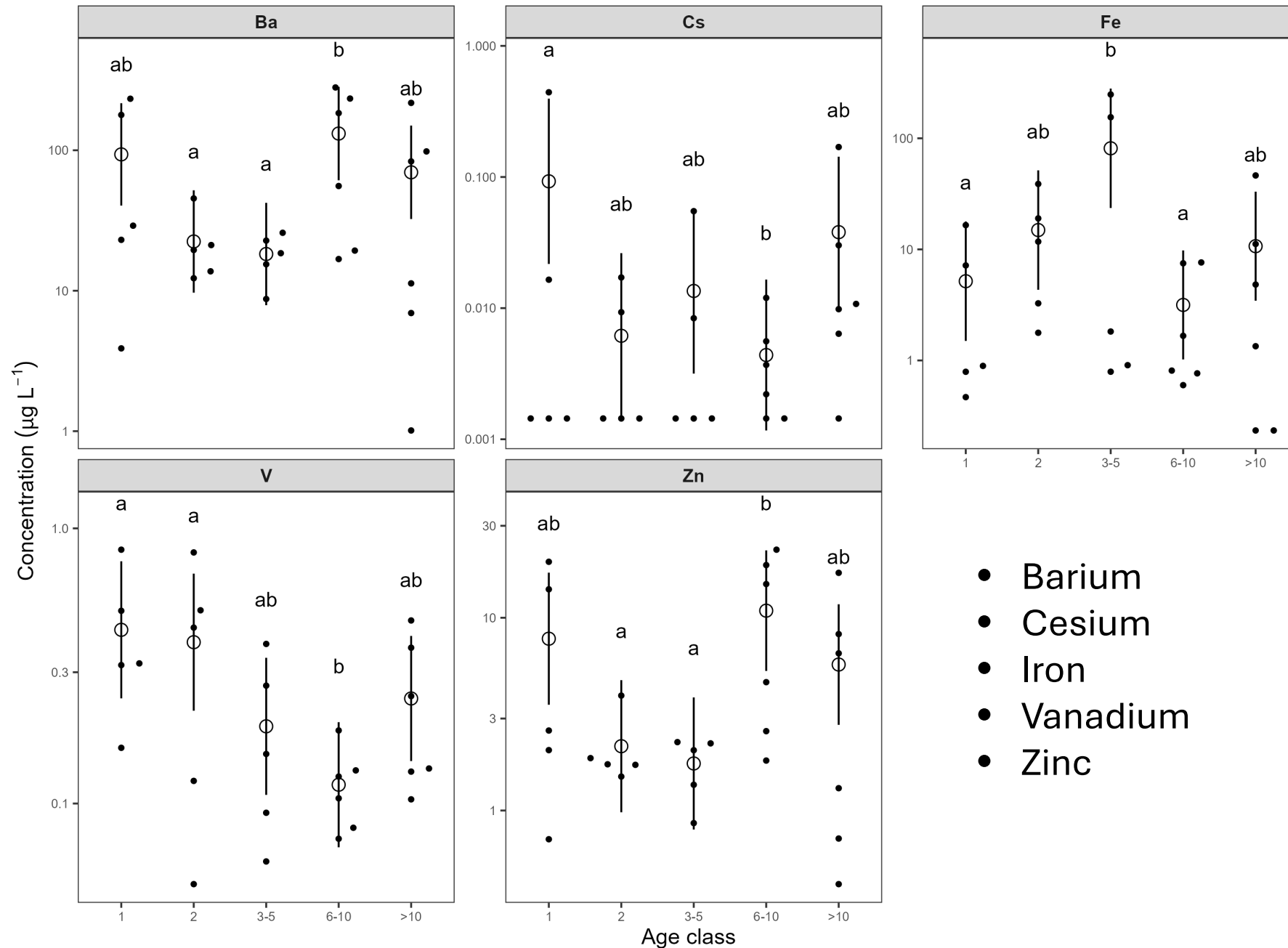
Estimated marginal means, all available elements



Letters: Sidak-adjusted compact letter display (same letter = not significantly different).

# Filtered Water Element Concentrations

Estimated marginal means, elements with adjusted P < 0.1

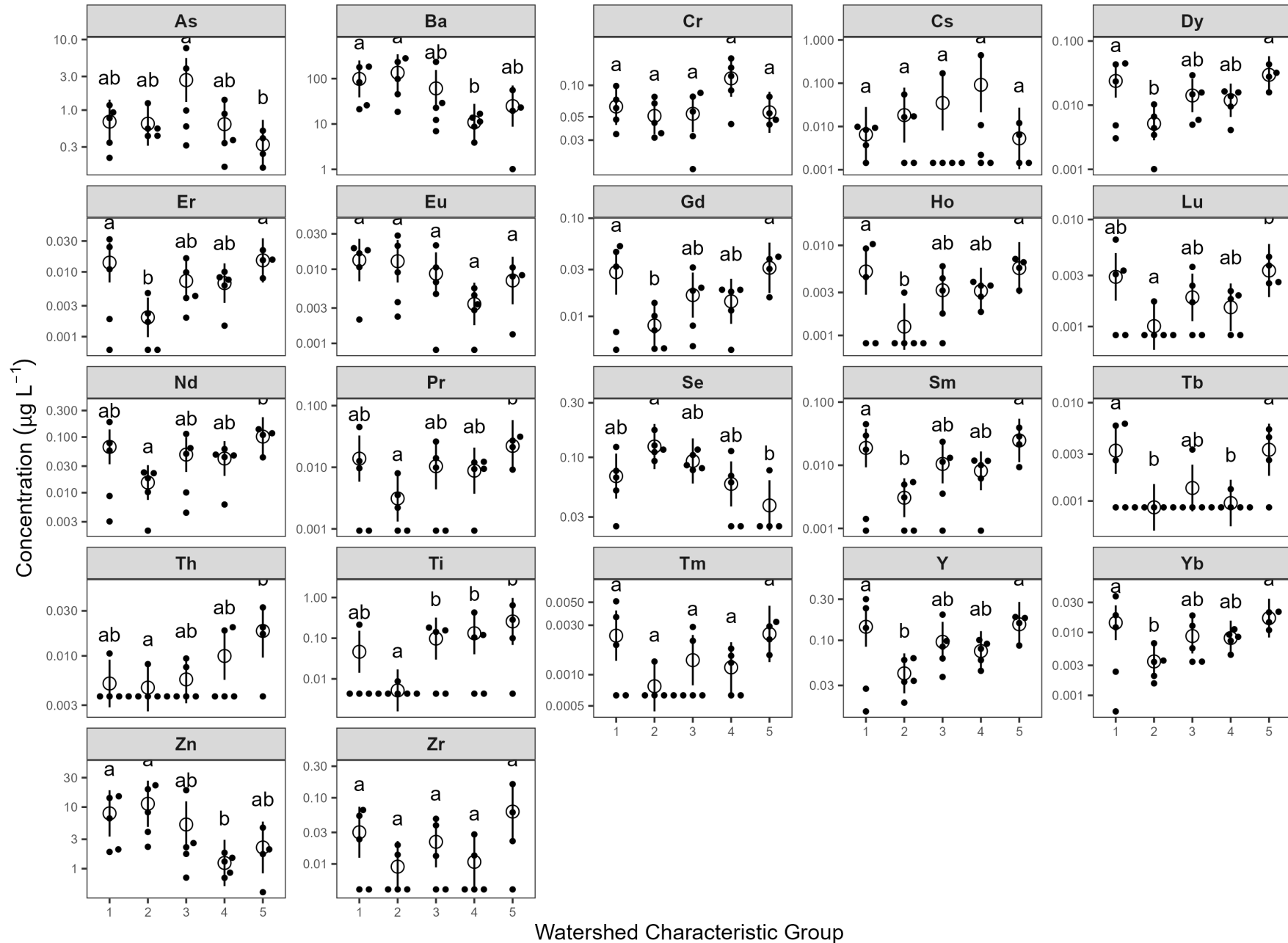


Letters: Sidak-adjusted compact letter display (same letter = not significantly different).



# Filtered Water Element Concentrations

Estimated marginal means, elements with adjusted P < 0.1



Letters: Sidak-adjusted compact letter display (same letter = not significantly different).

# Summary

**How do metal(loid) concentrations vary with time-since-fire in stream water?**

- Few apparent patterns in concentration related to age class
- Soil and climate factors are better predictors of post-fire metal(loid) concentrations in stream water

# Next Steps

- Periphyton, benthic organic matter, and macroinvertebrate tissues may act as longer-term sinks of metal(loid)s
- Relationships between metal(loid)s in basal resources and macroinvertebrates?
- Connections between metal(loid)s and macroinvertebrate community?
- More results to come soon (check back next year)

