

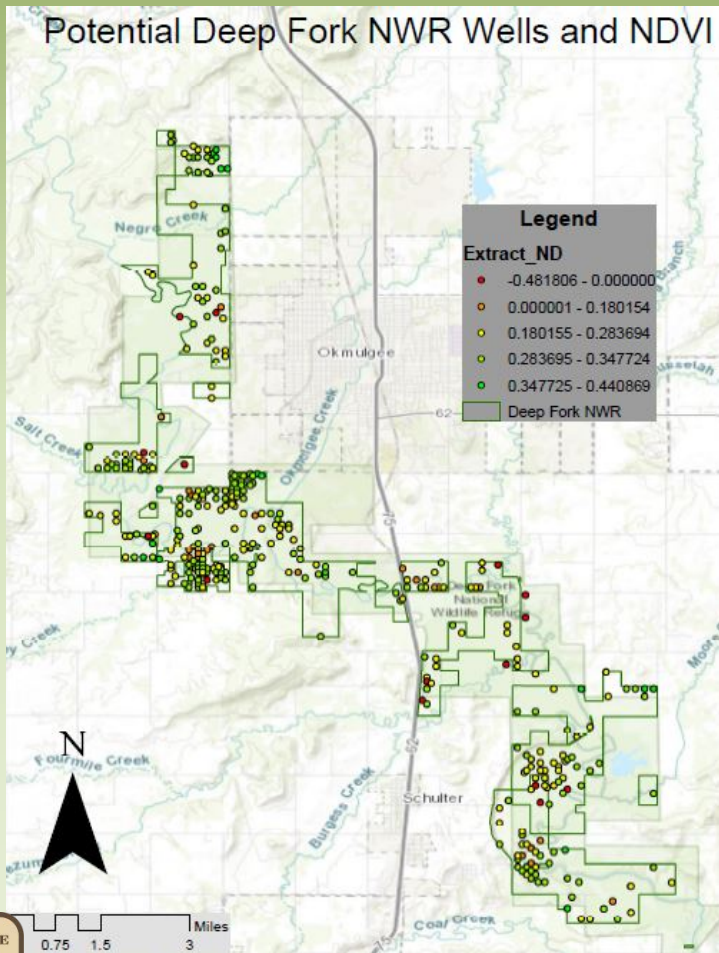
WATER QUALITY MONITORING AT THE DEEP FORK NATIONAL WILDLIFE REFUGE WITH CONSERVATION IMPLICATIONS FOR UNIONID MUSSELS

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Deep Fork NWR



- Unique bottomland hardwood forests
- Current issues
 - Periodic oil spills
 - Abandoned oil infrastructure
 - Farming and nutrients
 - Point discharges
- Current study is baseline data collection

Disclaimer: All data presented is preliminary and subject to change. Do not cite.



Bacterial Synthesis



Bacterial
Synthesis → K^+ production

Okmulgee WWTP

- Ammonia
- CBOD

Deep Fork River



2000 Fish and Mussel Kill



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2000 Mussel Kill continued

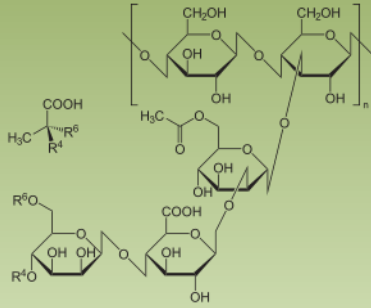
7,253 – 10,659 dead

Unionid Mussels Found in the Deep Fork River	
<i>Amblema plicata</i>	Threeridge
<i>Arcidens confragosus</i>	Rock Pocketbook
<i>Fusconaia flava</i>	Wabash Pigtoe
<i>Lampsilis teres anodontoides</i>	Yellow Sandshell
<i>Lampsilis teres teres</i>	Slough Sandshell
<i>Lasmigona complanata</i>	White Heelsplitter
<i>Leptodea fragilis</i>	Fragile Papershell
<i>Megaloniaias nervosa</i>	Washboard
<i>Potamilus ohioensis</i>	Pink Papershell
<i>Potamilus purpuratus</i>	Bleufer
<i>Pyganodon grandis</i>	Giant Floater
<i>Quadrula pustulosa</i>	Pimpleback
<i>Quadrula quadrula</i>	Mapleleaf
<i>Tritogonia verrucosa</i>	Pistolgrip
<i>Truncilla donaciformis</i>	Fawnsfoot
<i>Unio merus tetralasmus</i>	Pondhorn



- Okmulgee WWTP were put under Consent Order to update plant.
- Complied with CO and settled liability
- No compliance issues since settlement

Site History – Take 2



Xanthan Gum Production

- Okmulgee WWTP stopped carrying industrial waste after 2000 kill
- Industrial discharge received their own permit in 2005
- Additional Mussel Kills occurred in 2005 and 2011 below industrial discharge
- Consent Order placed after 2005

Bacterial Synthesis → K^+ discharge

Municipal Wastes

Okmulgee WWTP

Deep Fork River



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Sample Plan

- Monthly grab samples
 - Aug 2014 - Oct 2015
 - Apr 2016 - Mar 2017
- 3 low flow (<100 cfs) collections
- Field parameters collected by handheld multiprobe
- Aliquots separated with churn splitter
- Delivered to ODEQ within 24 hours
- Discharge measurements from USGS station near Beggs, OK (07243500)



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Analytes

Analyte	EPA Method Number
Total Alkalinity	EPA 310.2
Chloride	EPA 325.2
Sulfate	EPA 375.4
Ammonia	EPA 350.1
Nitrate/Nitrite	EPA 353.2
Total Kjeldahl Nitrogen	EPA 351.2
Total Phosphorus	EPA 365.3
Total Hardness	EPA 130.1
True Color	EPA 110.2
Cyanide	EPA 335.4
Dissolved Potassium	EPA 200.7
Total Potassium	EPA 200.7
Total Chromium	EPA 200.8
Total Copper	EPA 200.8
Dissolved Iron	EPA 200.7
Lead	EPA 200.8
Dissolved Aluminum	EPA 200.8

Field Parameters
pH
Dissolved Oxygen
Oxygen Reduction Potential (ORP)
Conductivity
Salinity (calculated from conductivity)
Total Dissolved Solids (TDS)
Water Temperature
Sample Depth

*Oil and Grease, Gasoline Range Organics, Diesel Range Organics, and Lube Oil Range Organics added for year 2

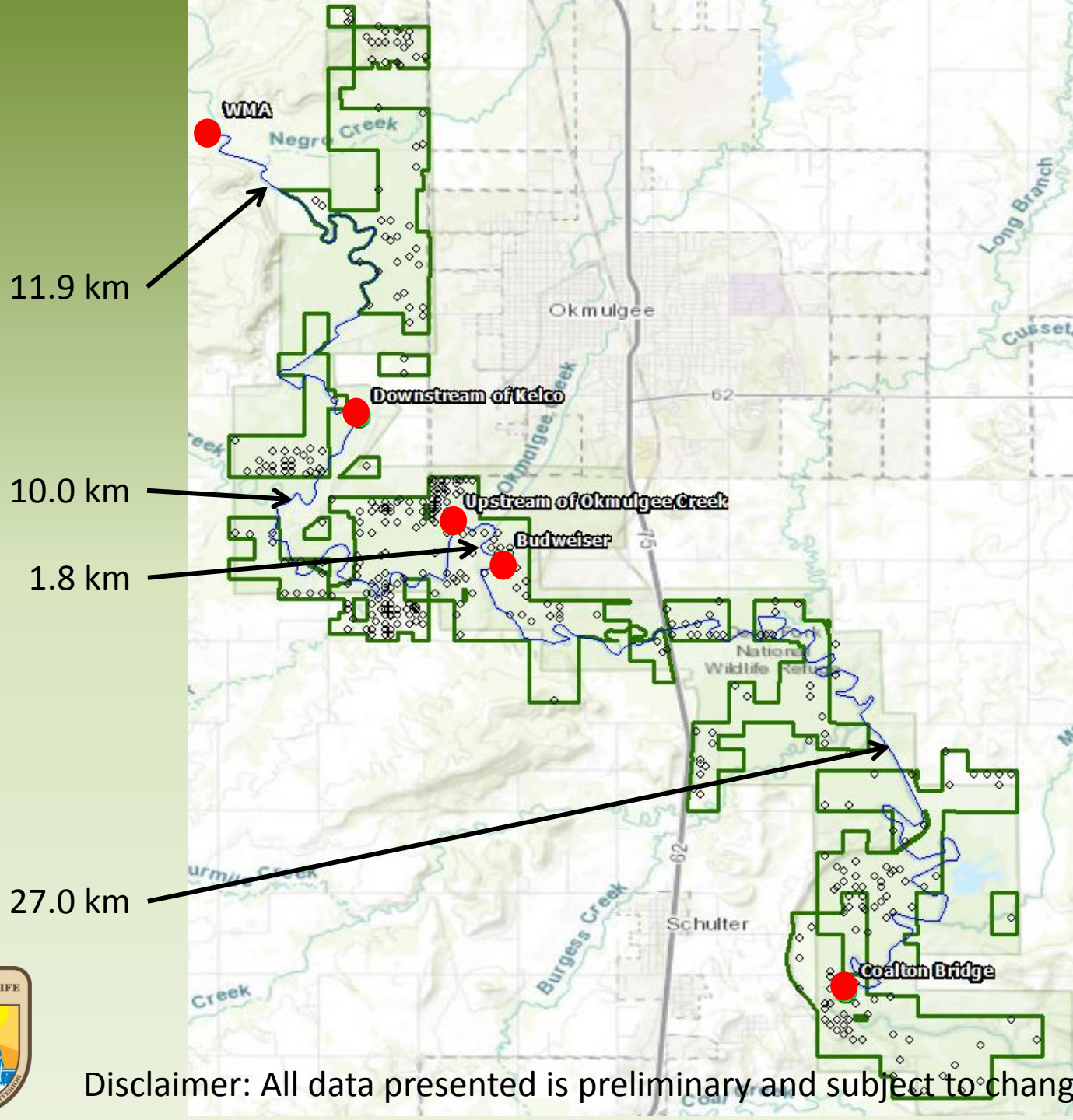
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The Permitted Discharge



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Results



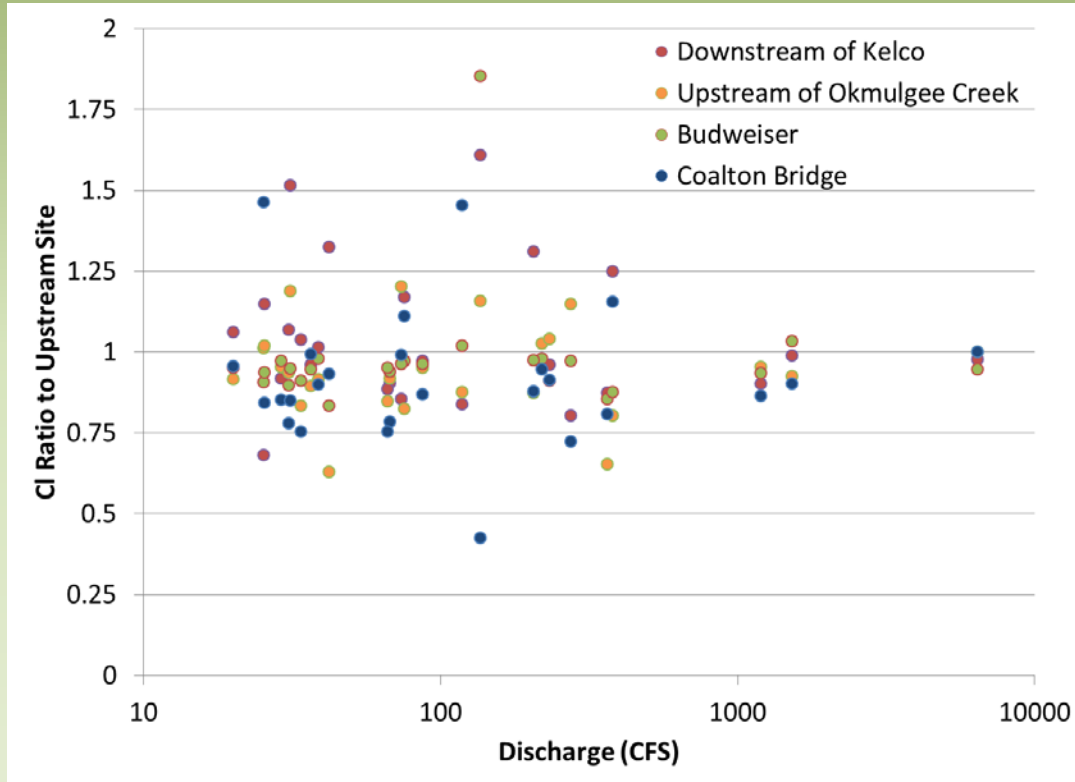
- Did not vary predictably
 - DO, pH, Chloride, Metals
- Did not occur
 - Hydrocarbons, cyanide, ammonia
- Varied Seasonally
 - Temperature
- Varied with flow
 - Hardness, conductivity, True Color, almost everything
- Changed below discharge
 - K, Total Phosphorus, N

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Oil & Gas Indicators

Cl Ratio between sites



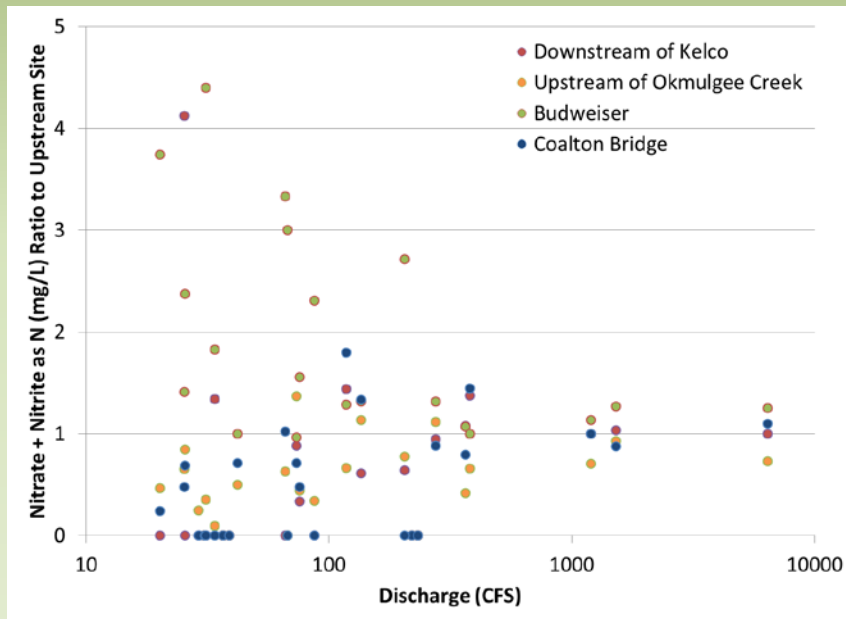
- Hydrocarbons
 - TPH: no hits
 - Oil & Grease: 1 event at 4 sites
- Brine – Cl ratios
 - Occasionally elevated
 - Can indicate other sources



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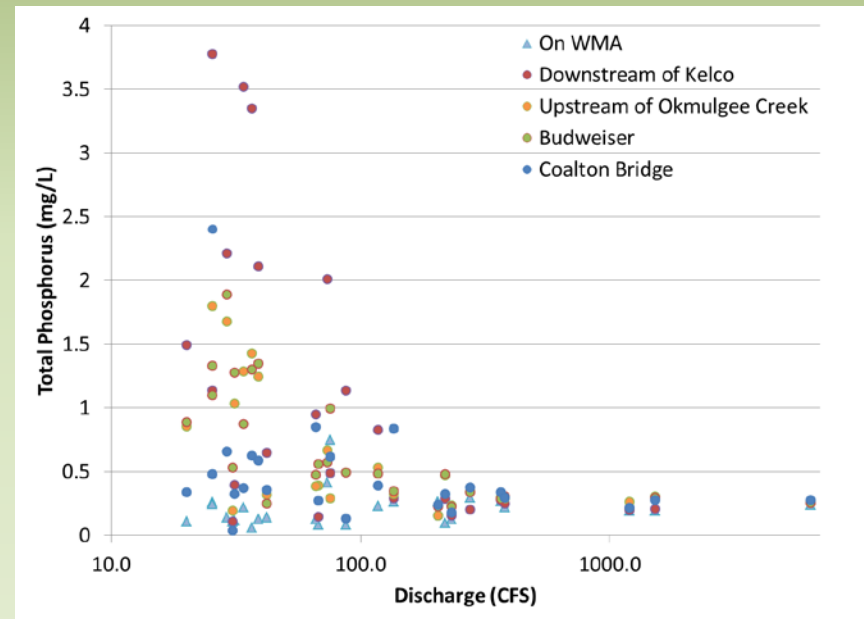
Nutrients

N Ratio between sites



N source above Budweiser, likely WWTP

Total P concentration

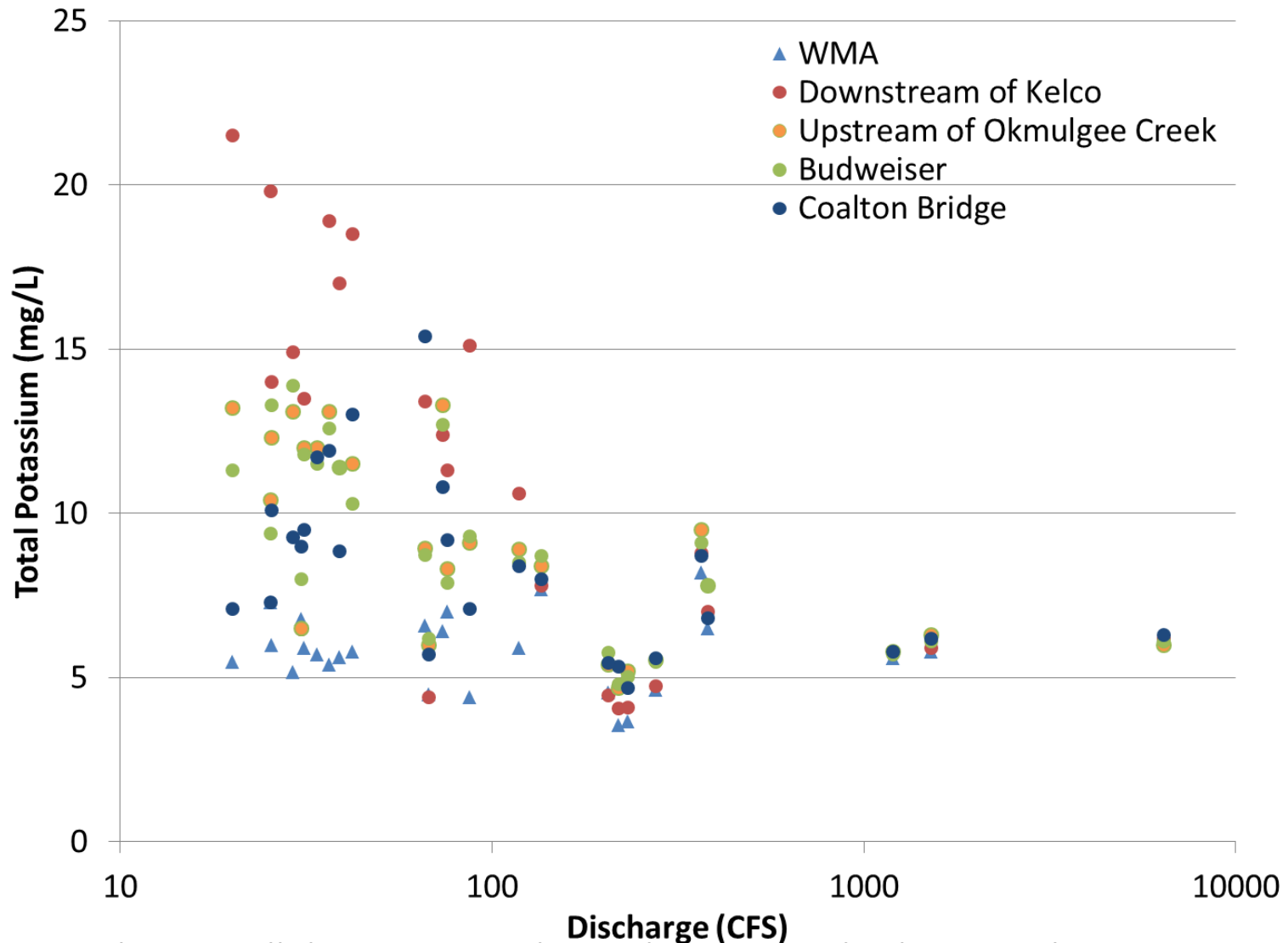


Industrial point source is largest P contributor



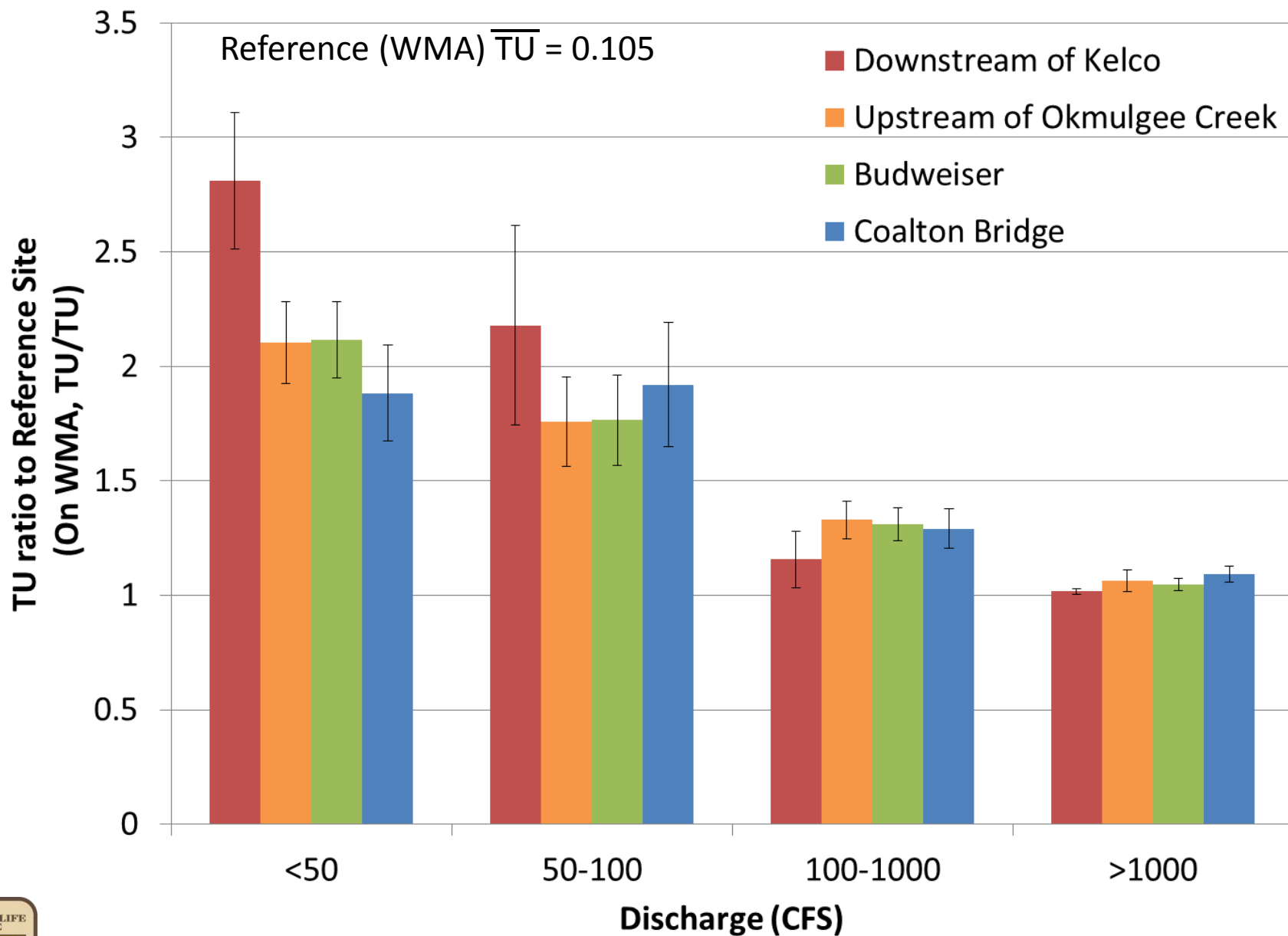
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Point Source



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