Manganese in the Roanoke River

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Manganese is common in rocks and minerals

- **Crustal concentration 1400 ppm (global avg)**
- **Soil concentration 437 ppm (global avg)**
- **Strong redox control on solubility**
  - **Reduced form (MnII) soluble as aqueous**
  - **Oxidized form (MnIV) insoluble as oxides**
- **Oxidizing => low aqueous Mn**
- **Reducing => can have elevated Mn**

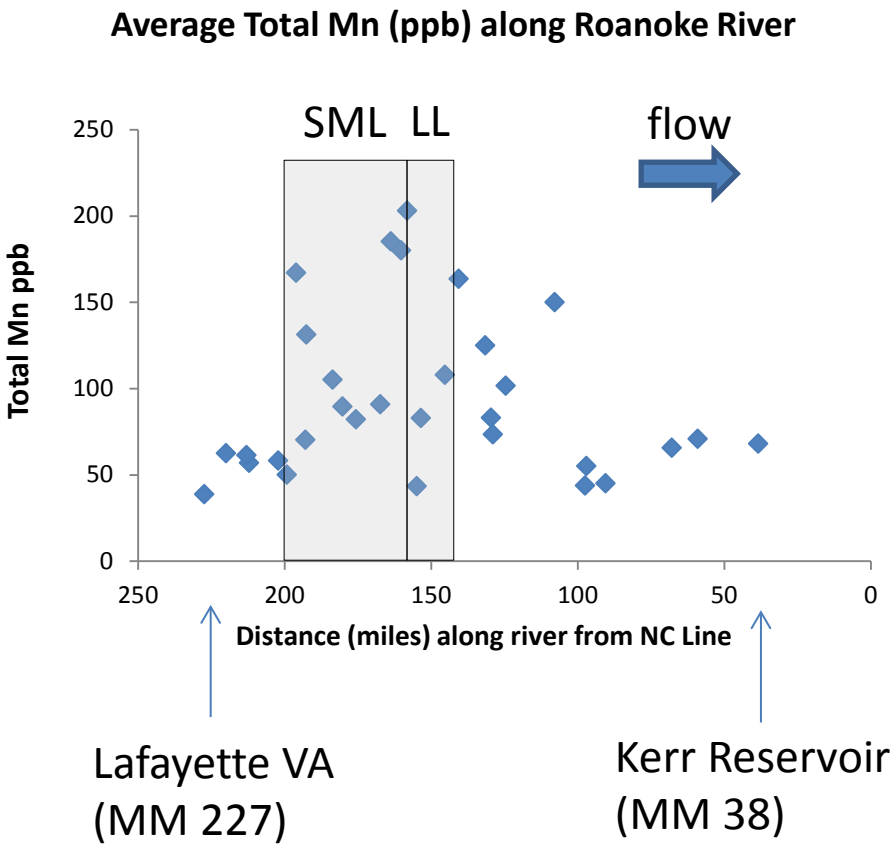
Ore containing manganite

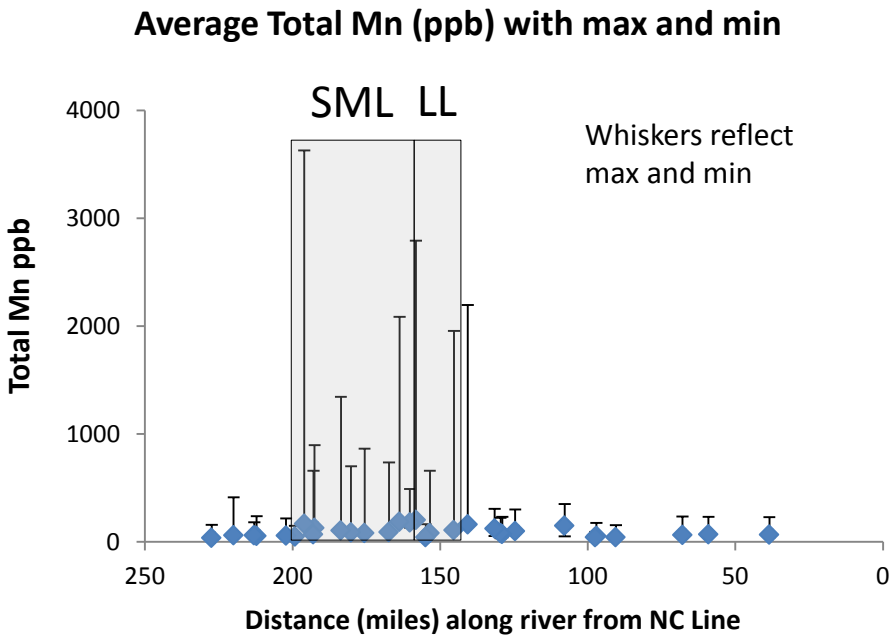
- **Dominant use of Mn for steel manufacturing and batteries**

Manganese steel

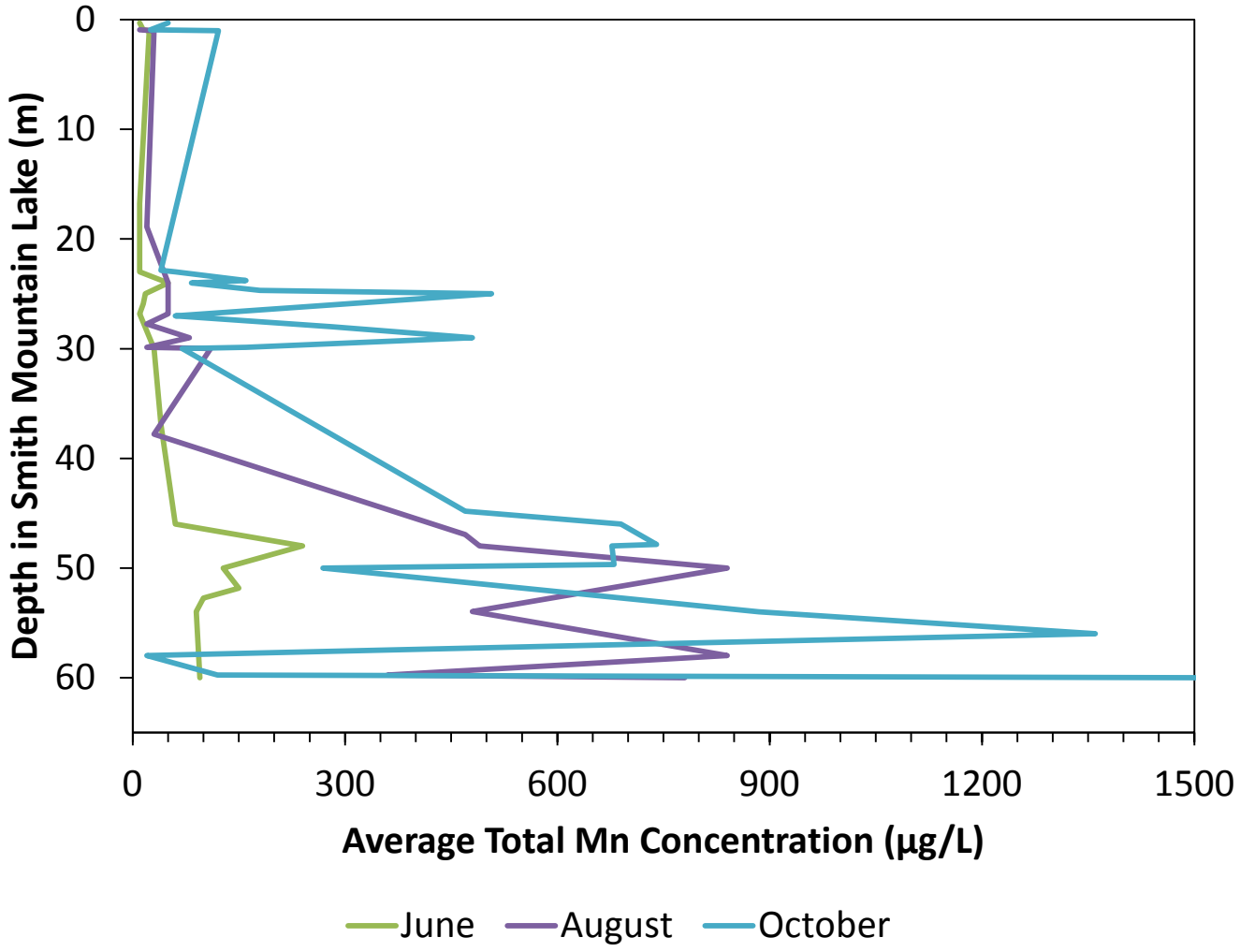
- **EPA lists Mn with a secondary maximum contaminant level of 50 ppb for aesthetic reasons (taste, staining).**

Historic DEQ Data for Roanoke River (1970s-1994)





When SML stratified during summer-fall, reducing conditions in hypolimnion promote Mn release from sediment into water

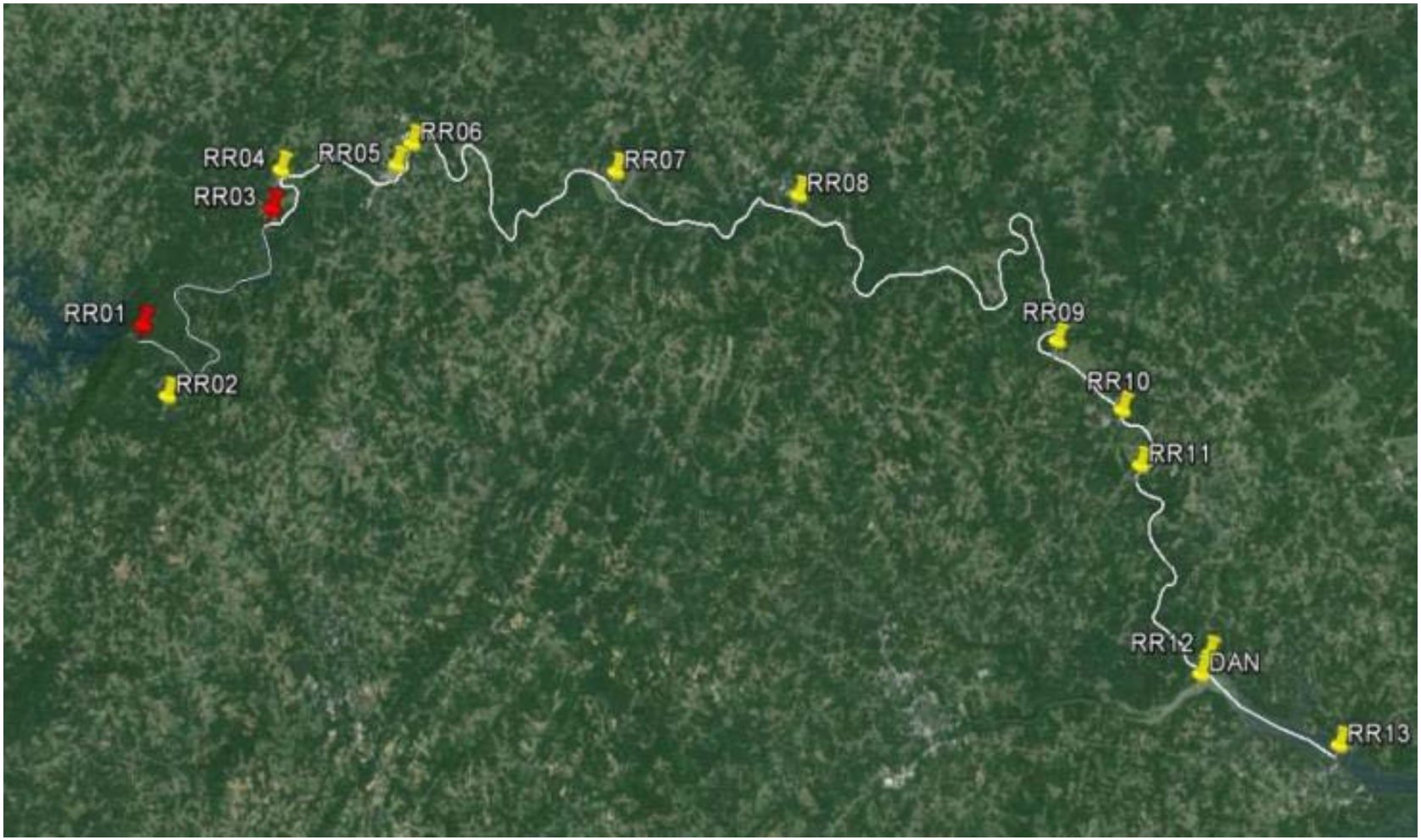


Data from DEQ

Our monitoring program examines Mn in the Roanoke River

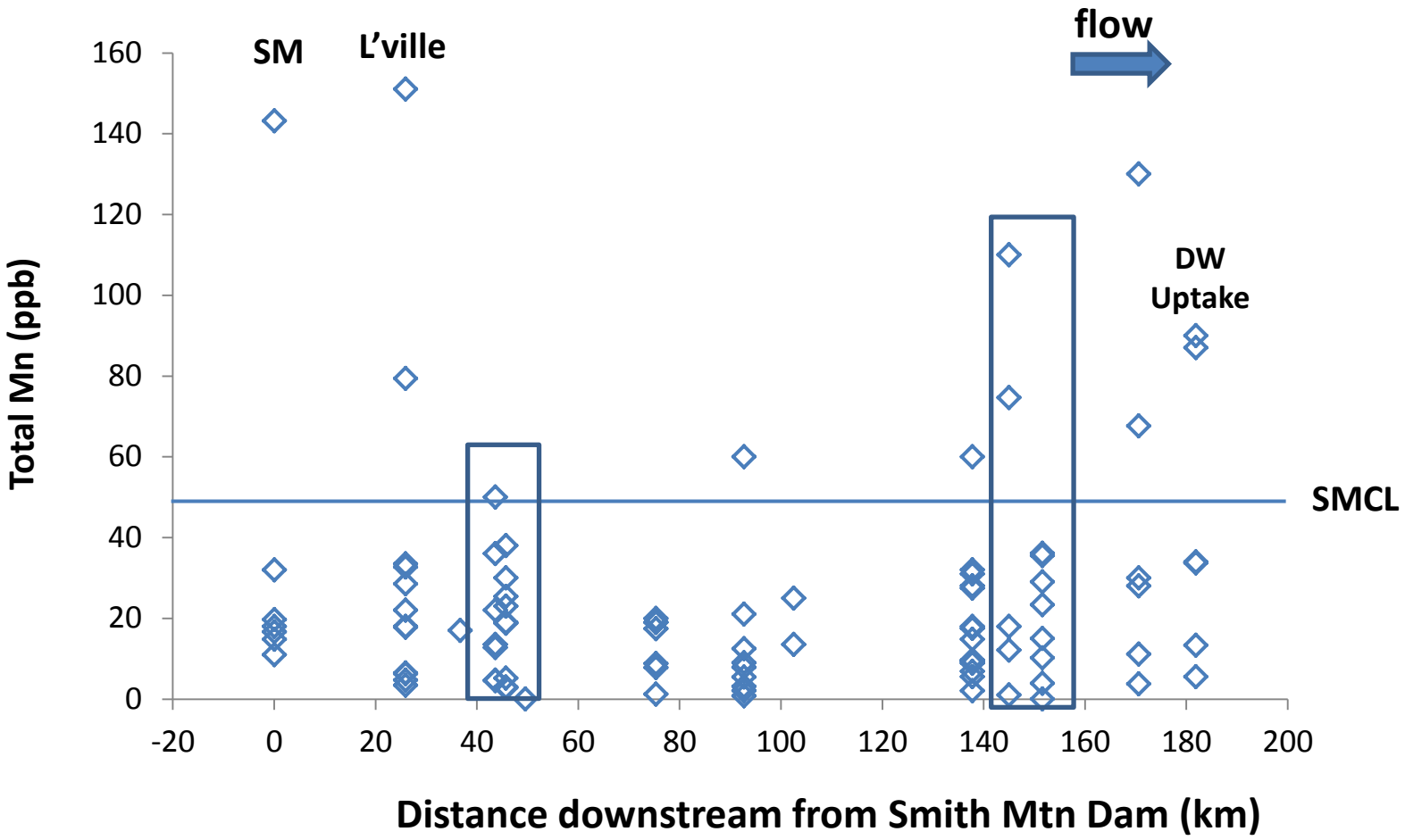
- **Monitoring period: Fall 2012-Fall 2014 (quarterly plus additional)**
- **13 sampling sites on the Roanoke; 1 on Dan**
- **Collect samples using a depth integrated sampler (DH-81) by wading or with kayak**
- **Measure field parameters (DO, T, SC, pH)**
- **Analyze samples for total and filtered Mn and Fe, filtered major cations and anions, DOC, TSS. Filter size 0.45 μm.**
- **Measure continuous (15 min) SC/T using loggers at 4 sites**

Monitoring sites along the Roanoke



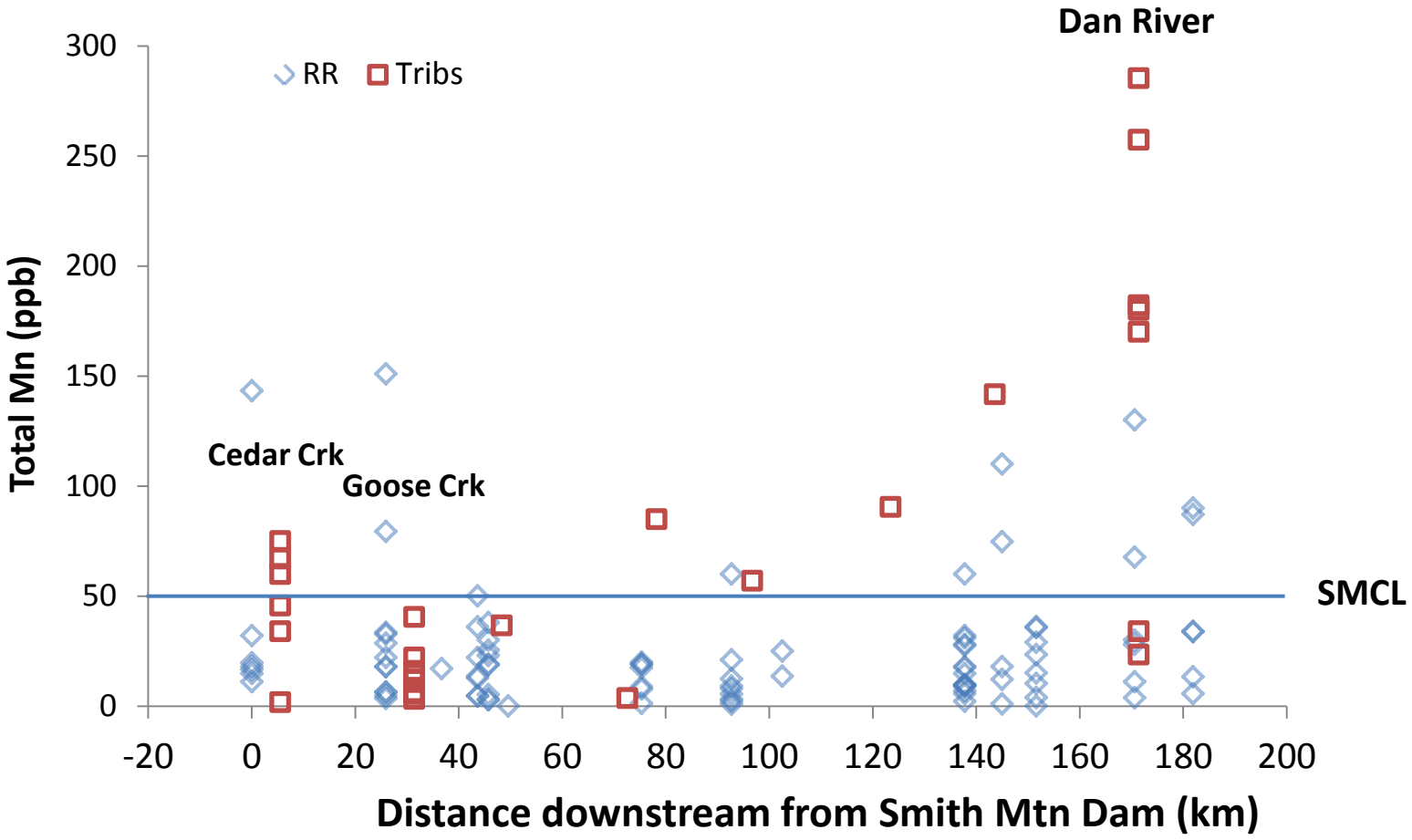
RR01 = Smith Mountain tailrace; RR03 = Leesville tailrace

Results: Manganese concentrations in the Roanoke River are spatially and temporally variable

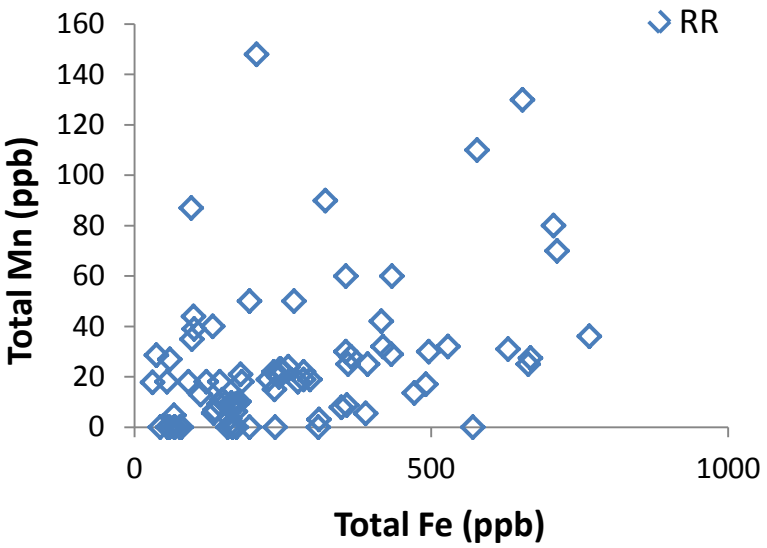


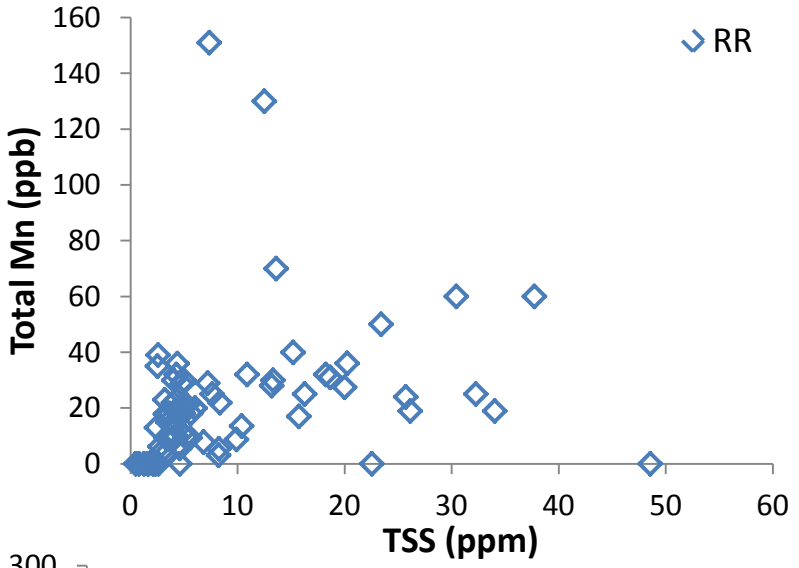
22% of our Roanoke River samples > 50 ppb Total Mn

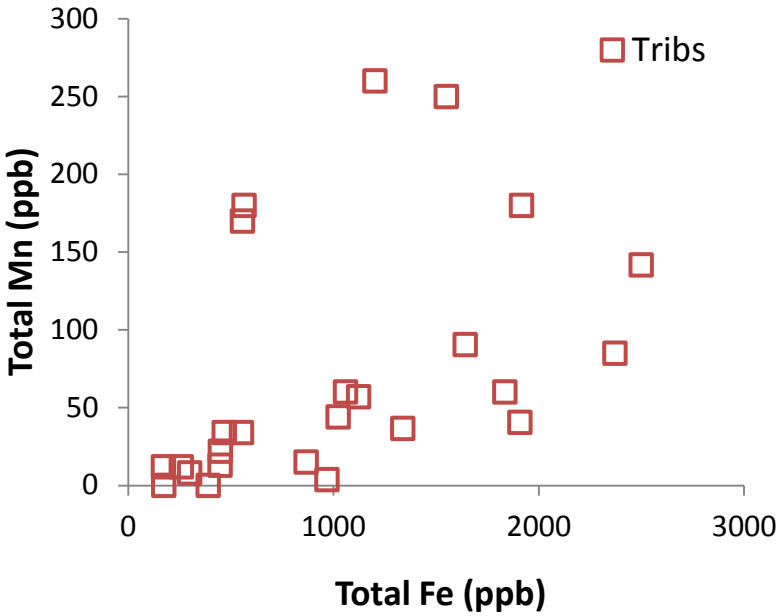
Results: Manganese concentrations in tributaries are also spatially and temporally variable

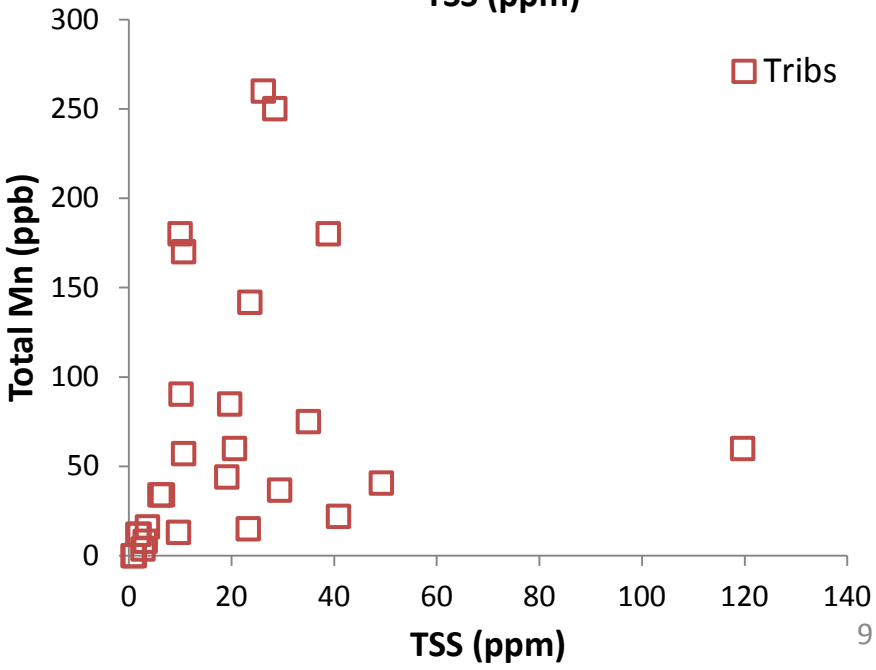


Results: Manganese is correlated with Fe and TSS



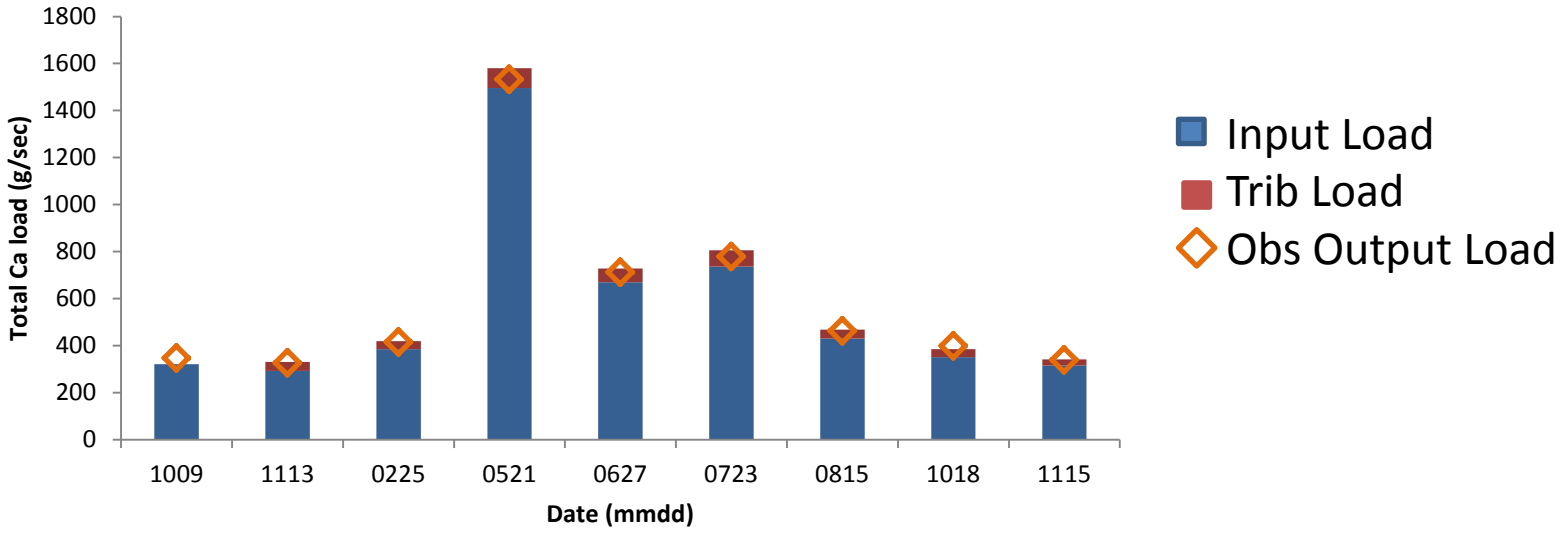




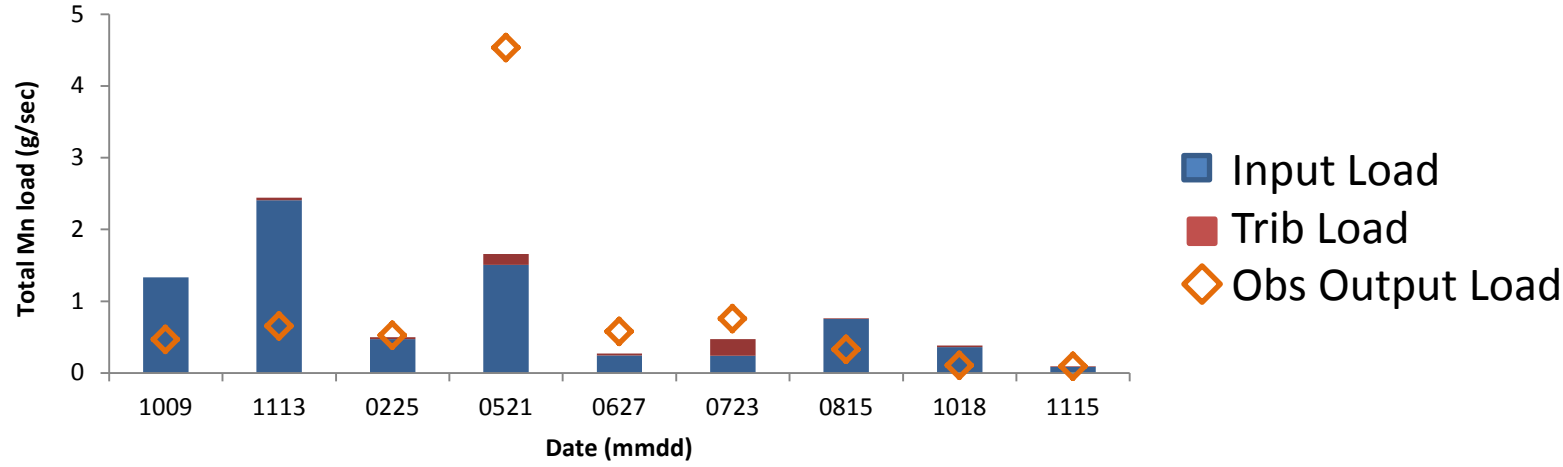


Mass balance results show Ca behaves conservatively; Mn does not – reflects gains and losses

Ca

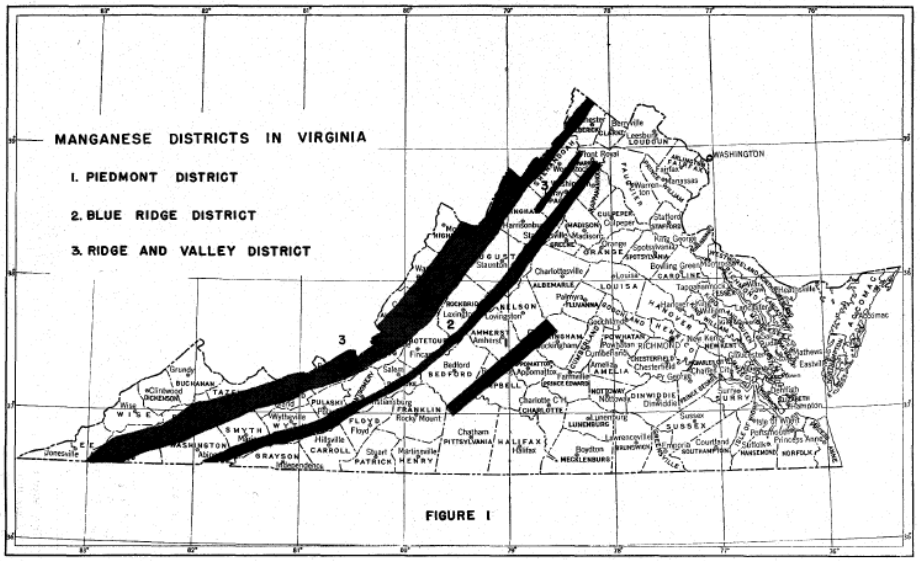


Mn



Our second project is to examine sources of Mn within the watershed

- Literature review
- Identify locations of historic Mn mines
- Geologic maps
- Field work
- Retrieve groundwater Mn data from NURE
- Examine spatial and statistical relationships

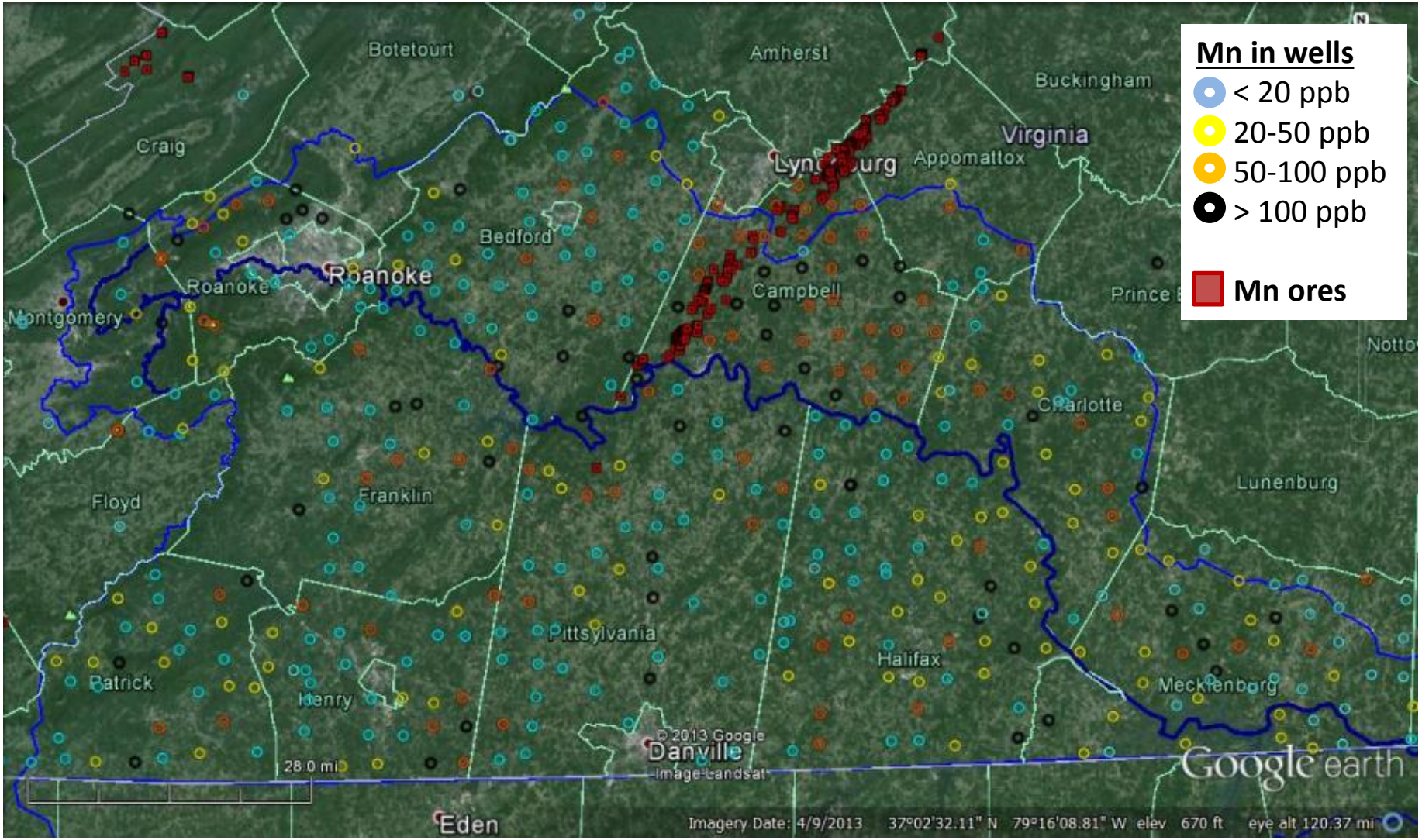


Gooch 1955

Mn-cemented breccia

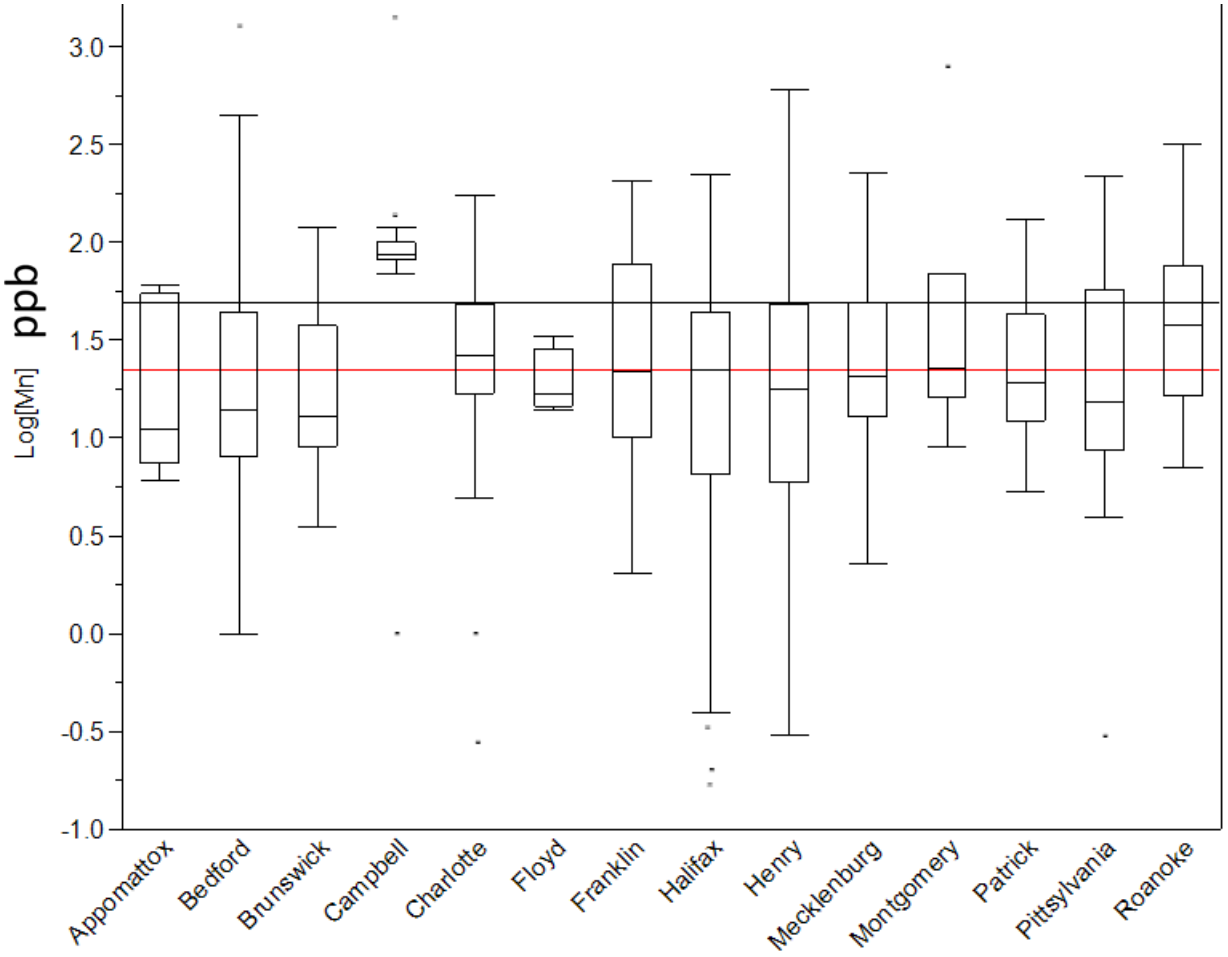
Soil pit, Altavista

Manganese concentrations in groundwater are spatially variable



Groundwater data from NURE; Locations of Mn mines from DMME

Campbell Co. has consistently highest Mn; other regions more variable



SMCL 50 ppb

Watershed mean 22 ppb

Manganese project summary to date

Monitoring:

- Total Mn concentrations in Roanoke River between Leesville and Clarksville *can* exceed the 50 ppb SMCL, but are spatially and temporally variable
- Total Mn correlates with Total Fe and TSS
- Mass balance suggests that Mn does not behave conservatively; can be gained and lost through physico-chemical reactions

Manganese sources:

- Mn is present in concentrated ores in watershed
- Mn is elevated in groundwater in the watershed; spatially variable but see cluster in Campbell Co near historic mines

Continuing work

- Attention to seasonality (stratification) and to storm events
- Filtration experiments – is filtered Mn really “dissolved”?
- Connections between rock type and groundwater/surface water Mn

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- **DMME: Joshua Rubenstein**