Stream Conductivity Monitoring at State Roads in Maryland

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Salts Workshop
April 1,2019

Research Questions

- Does salt application to any SHA roads contribute measurably to stream conductivity?
- Is stream conductivity higher downstream from a road crossing than upstream?
    - During base flow?
    - After road salt application?
- What is the ionic composition of streams before, during, and after a snow event?
- What is the relationship between road salt application (lbs/lane mile/inch of snow) and stream conductivity?
- Are biological conditions downstream of a road crossing different than upstream?

Study Design

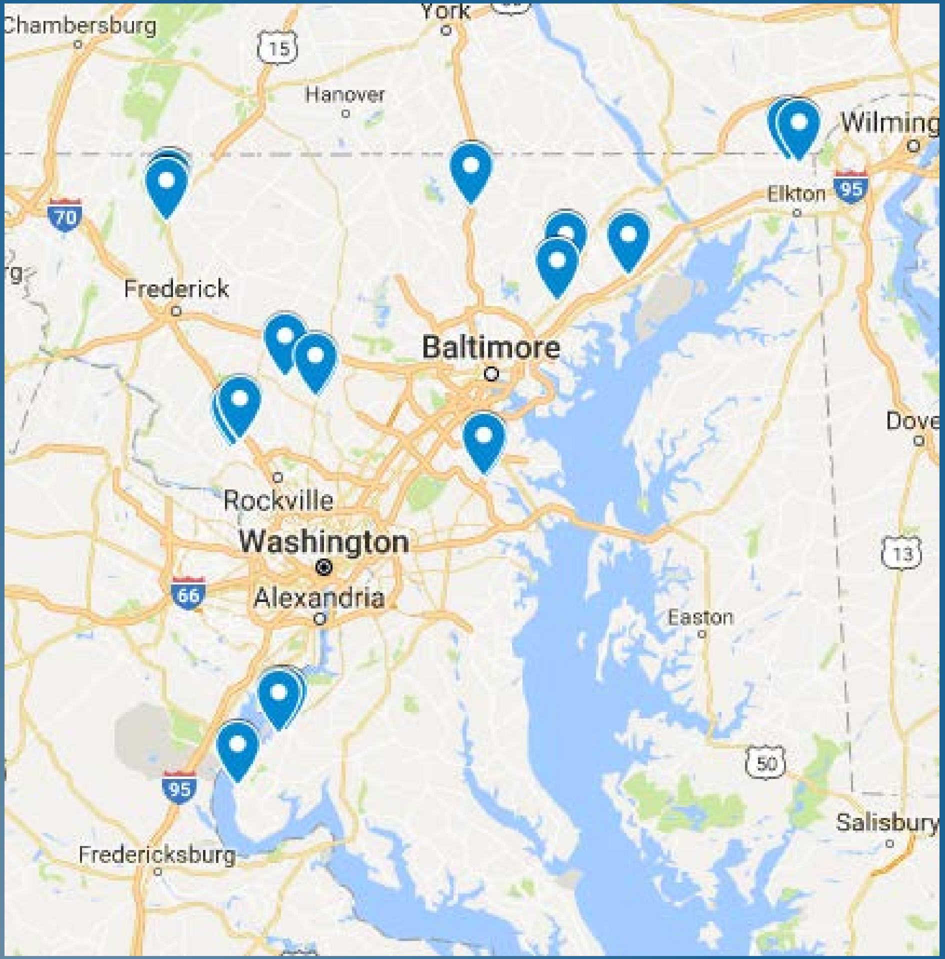
- SHA-maintained roads on DNR lands in MS4 Counties

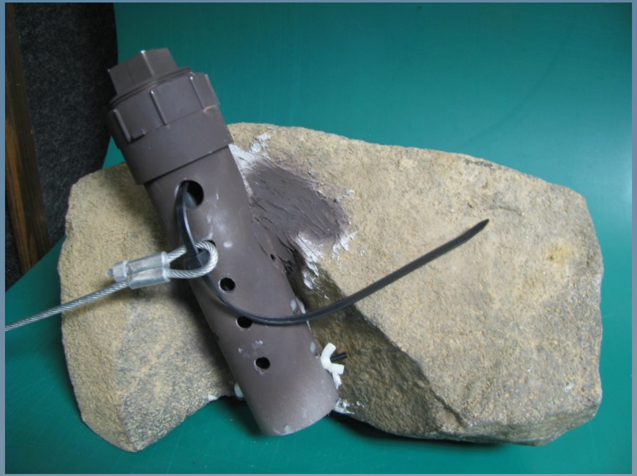
- No influence of other local confounding factors
    - Other roads (county, etc..)
    - Parking lots
    - Tributaries

- Representative sample of conditions in the state
    - Physiographic province
    - Stream size
    - Environmental setting (rural and urban)

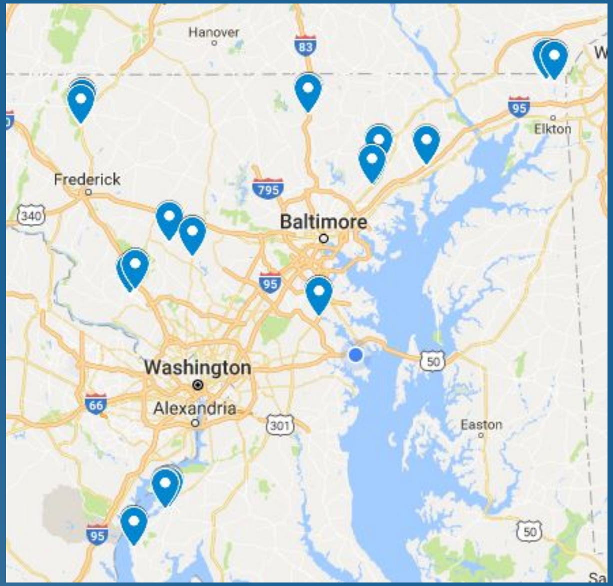
Study Design

- 19 road crossings selected for study
- Loggers deployed – one upstream, one downstream
- Sites located in:
    - Cecil
    - Harford
    - Baltimore
    - Anne Arundel
    - Howard
    - Charles
    - Montgomery
    - Frederick





Conductivity Logger Deployment/Downloads

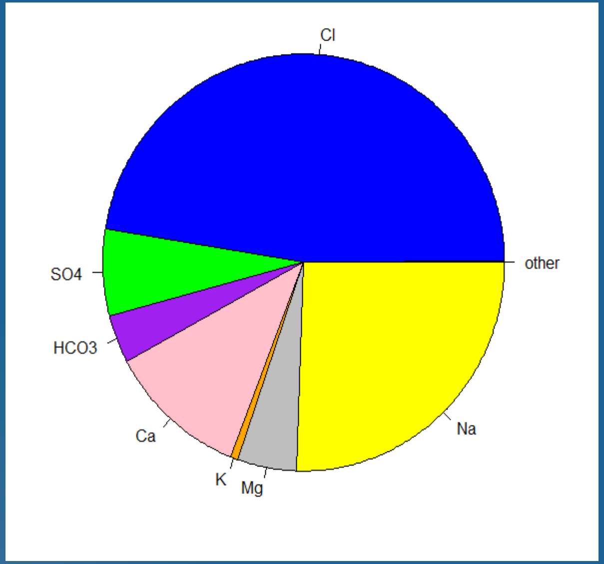


- Hourly conductivity monitoring since November 2016
- Over 532,000 conductivity measurements as of Sept.2018
- Maximum conductivity measured during the study = 3,377 µS/cm
- Minimum conductivity measured during the study = 7.3 µS/cm

Ion Matrix Sampling

- Characterized ionic composition of study streams
  - Pre-salt application baseline: collected in fall of each year
  - Post-salt application baseline collected in spring of each year
  - Snow storm event: collected at times of elevated (above baseline) conductivity levels during snow events

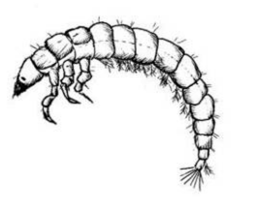
Ion Matrix Sampling



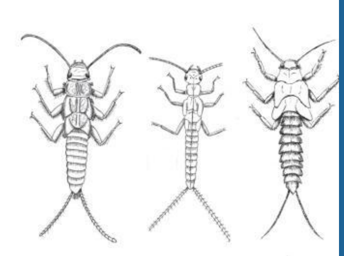
- 215 ion samples collected as of November 2018
- All samples analyzed at UMCES Appalachian Laboratory
- Ions measured: Chloride, Bromide, Nitrate, Sodium, Magnesium, Calcium, Potassium, Bicarbonate, Sulfate, Ammonia, as well as pH, ANC, Alkalinity

Biological Monitoring

- Biological monitoring has been conducted at all road crossings
  - Benthic macroinvertebrate sampling conducted upstream and downstream in spring 2017 and 2018



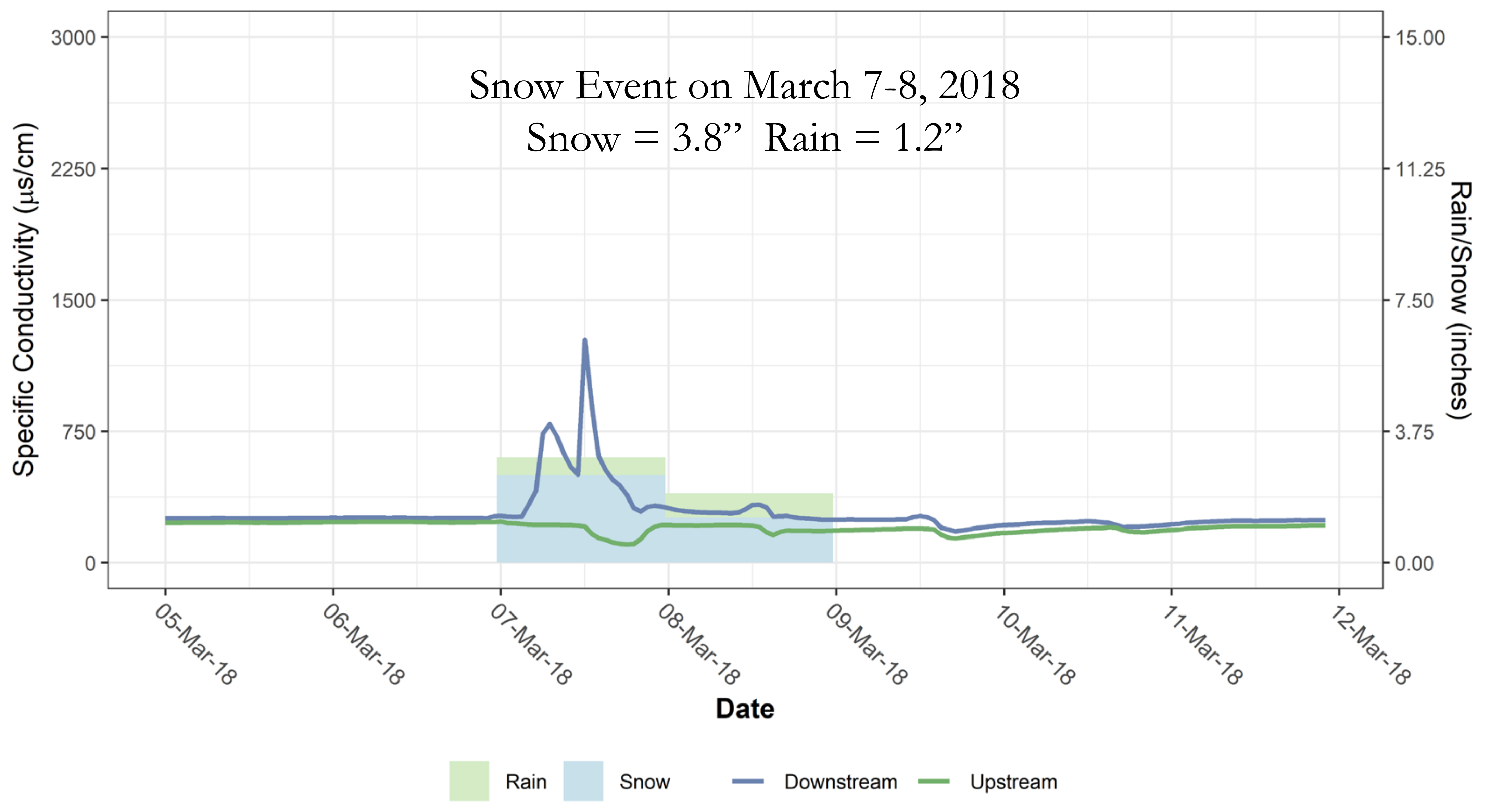
  - Fish sampling conducted at four select road crossings in 2017 and 2018
- Physical habitat quality assessed upstream and downstream at all crossings



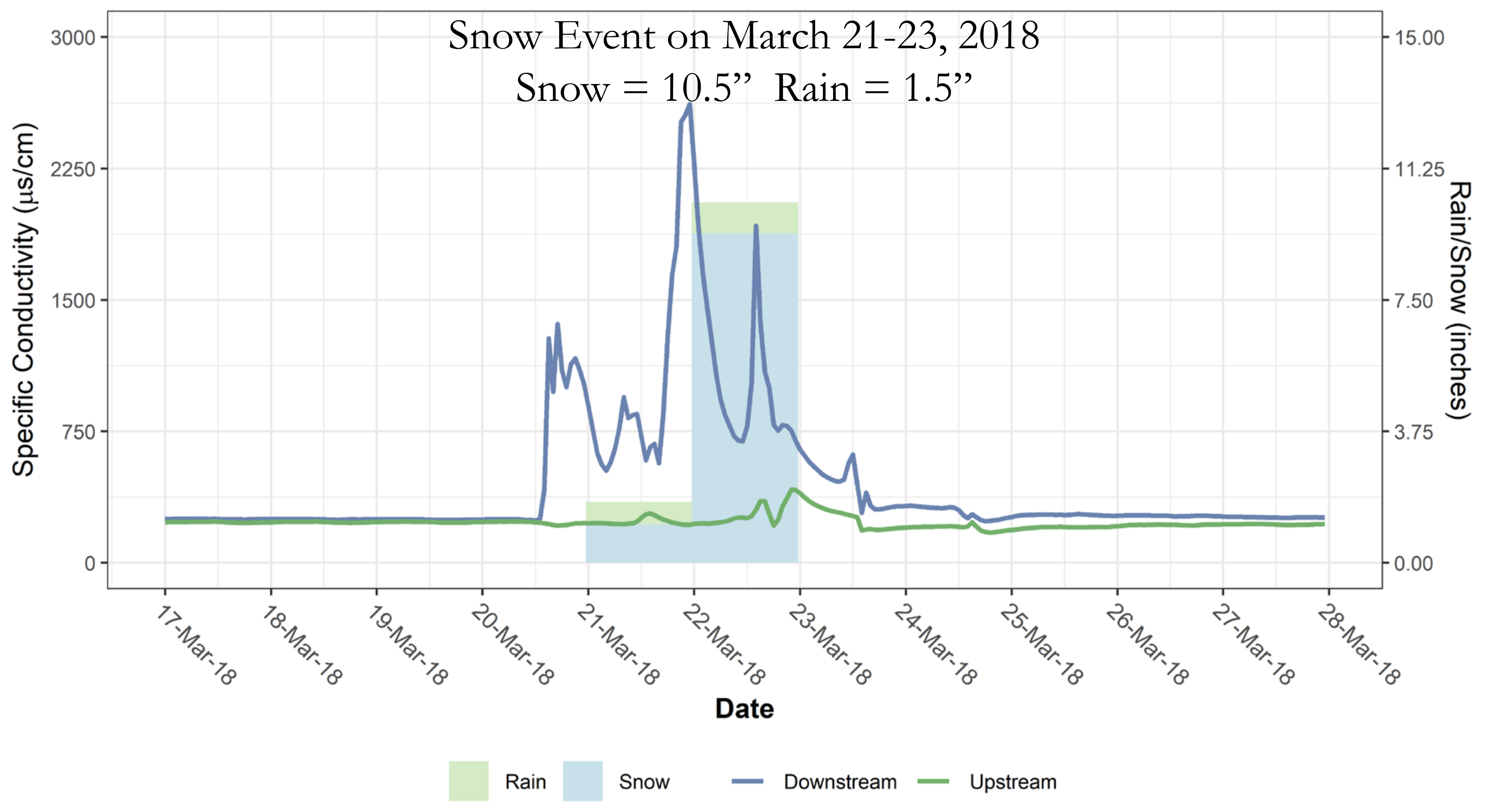
Provisional Results - Conductivity Monitoring

- Documented increased conductivity downstream compared to upstream during snow events at some road crossings
    - Response varied by snow event

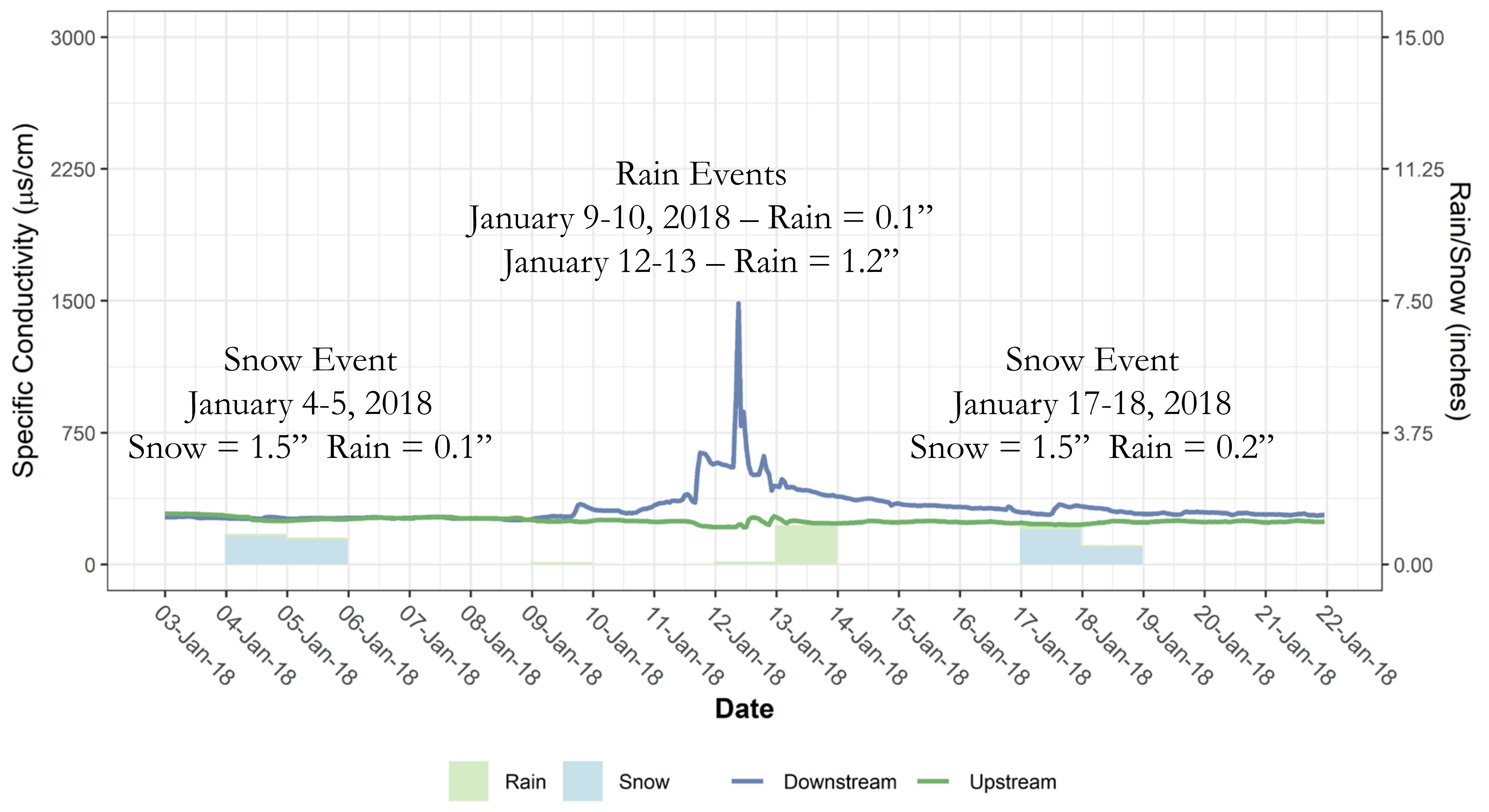
Gramies Run @ MD 273 (Telegraph Road)



Gramies Run @ MD 273 (Telegraph Road)



Gramies Run @ MD 273 (Telegraph Road)



Rain Events
January 9-10, 2018 – Rain = 0.1”
January 12-13 – Rain = 1.2”

Snow Event
January 4-5, 2018
Snow = 1.5” Rain = 0.1”

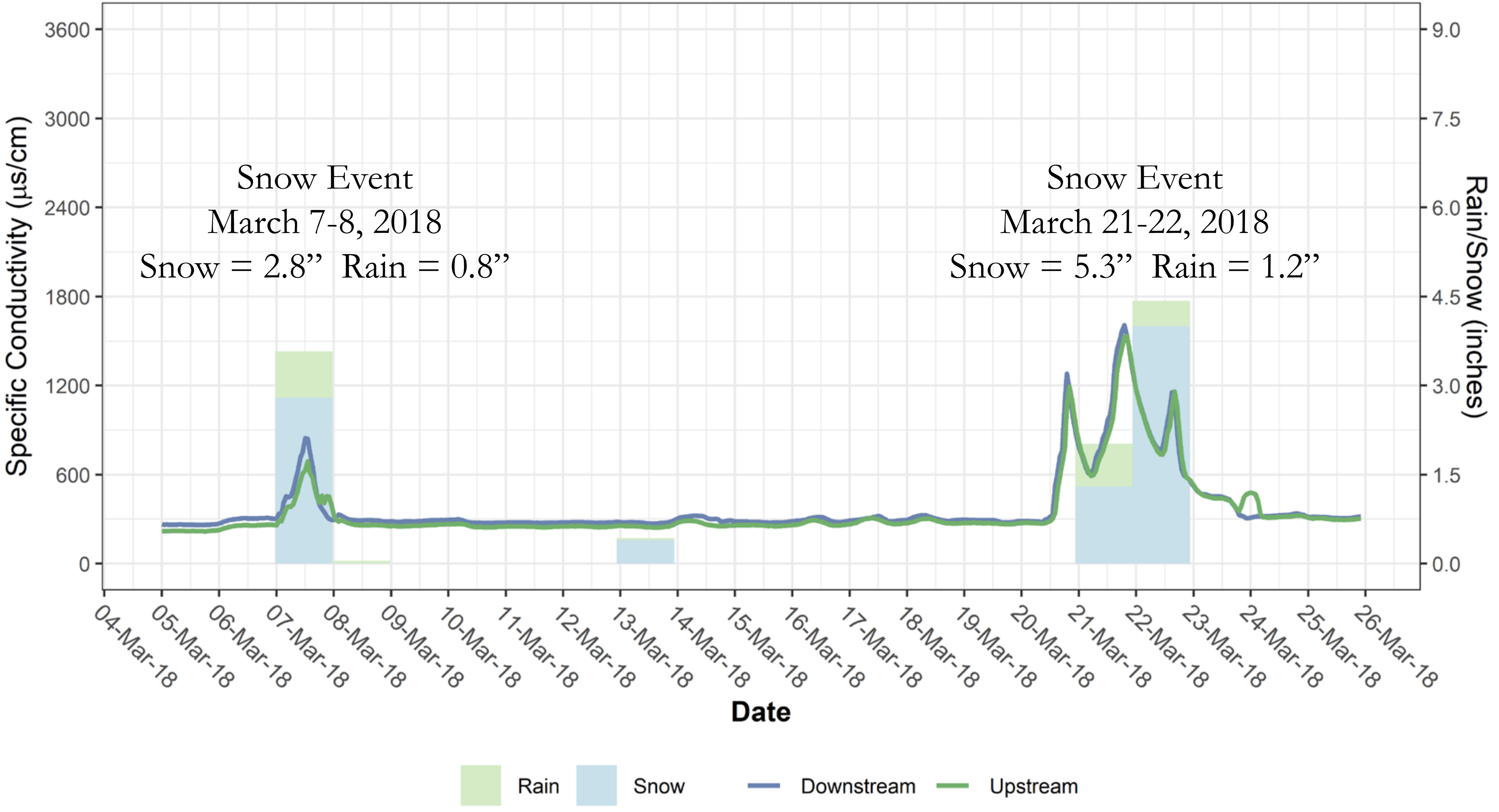
Snow Event
January 17-18, 2018
Snow = 1.5” Rain = 0.2”

Provisional Results - Conductivity Monitoring

- Documented increased conductivity during snow events downstream of some road crossings
    - Response varied by snow event

- Documented increased conductivities upstream and downstream of some road crossings – especially in larger watersheds

James Run@ MD 7 (Old Philadelphia Road)



Snow Event
March 7-8, 2018
Snow = 2.8” Rain = 0.8”

Snow Event
March 21-22, 2018
Snow = 5.3” Rain = 1.2”

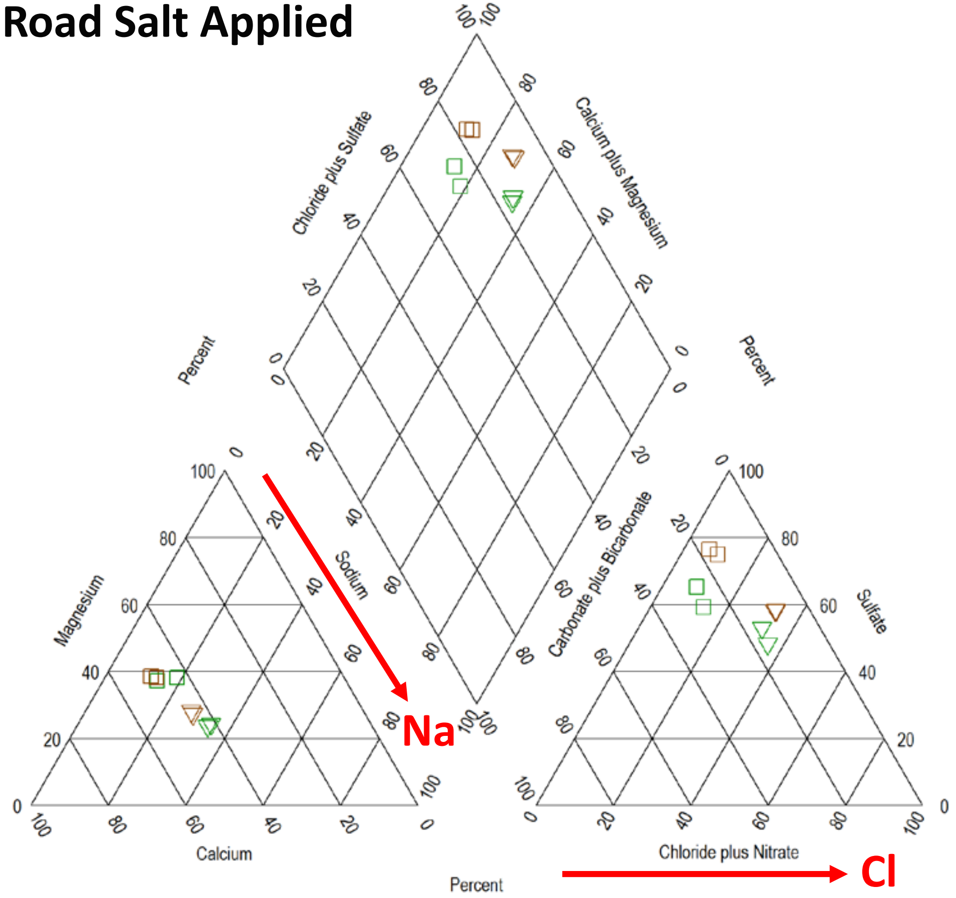
Provisional Results - Ion Composition Monitoring

UT Muddy Run @ US 15

- ▽ Downstream
- □ Upstream
- 🟫 Fall pre-application baseline
- 🟩 Spring post-application baseline
- 🟦 Snow event

Fall and Spring baseline (2017,2018)

No Road Salt Applied

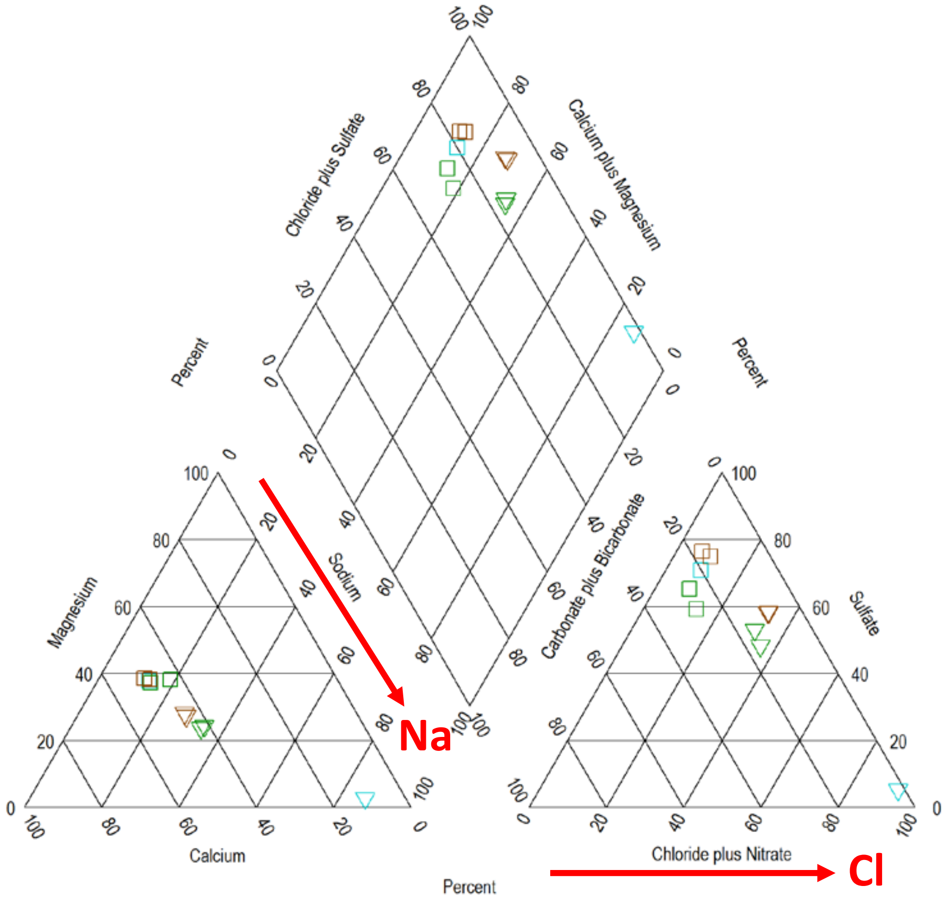


Provisional Results - Ion Composition Monitoring

UT Muddy Run @ US 15

- ▽ **Downstream**
- □ **Upstream**
- 🟫 **Fall pre-application baseline**
- 🟩 **Spring post-application baseline**
- 🟦 **Snow event**

March 15,2018 Snow Event



Downstream *in situ* = 797 uS/cm

Upstream *in situ* = 45 uS/cm

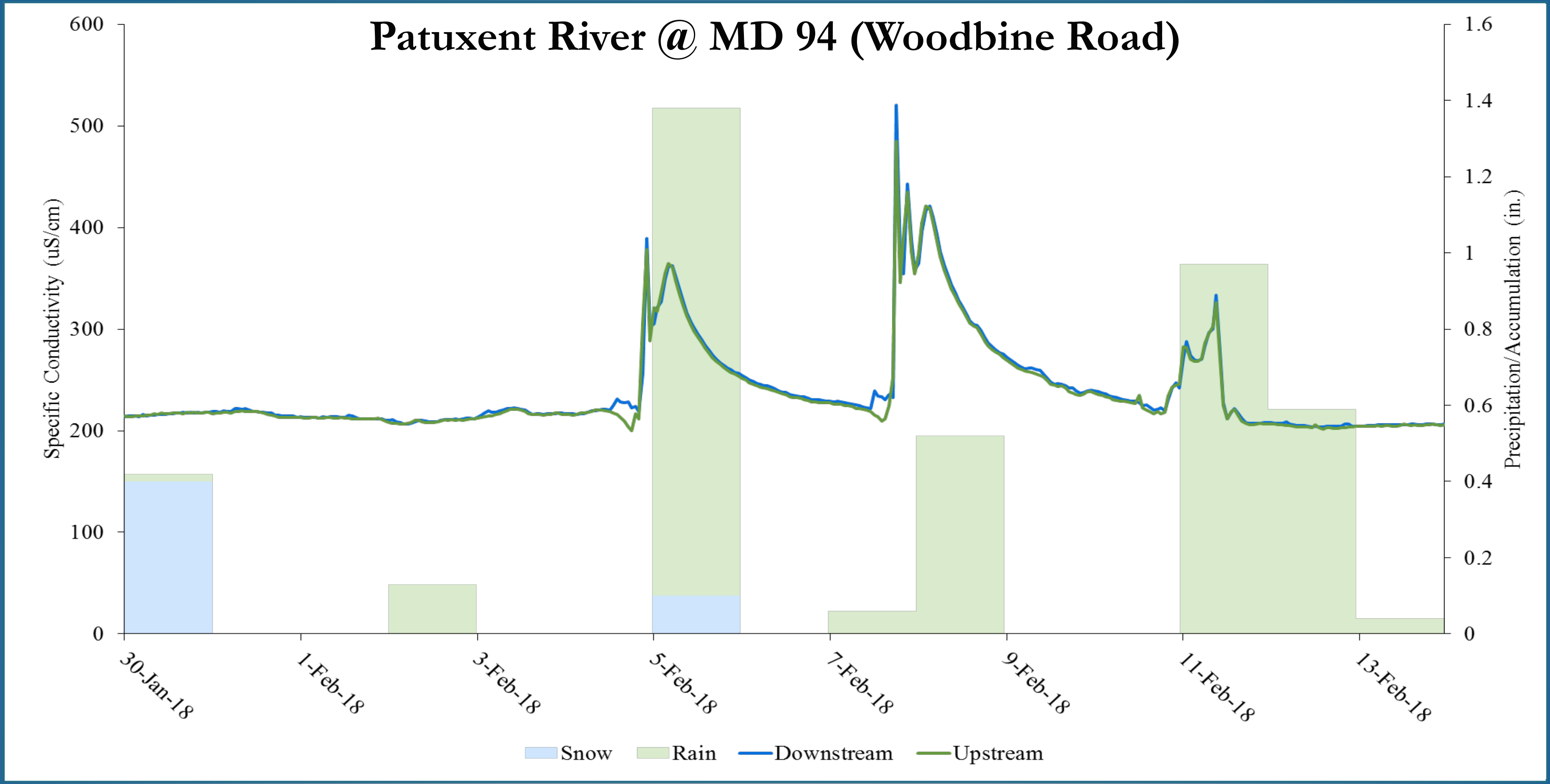
Provisional Results - Biological Monitoring

Benthic Macroinvertebrate Index of Biotic Integrity Scores from 2017 (0 (poor) – 5 (good) scale)

Road Crossing	Downstream	Between	Upstream
Gramies Run @ MD 273	3.67	----	2.67
Big Elk Creek @ MD 273	3.67	----	3.67
James Run @ MD 7	3.00	----	3.33
Little Gunpowder @ MD 147	4.67	----	4.00
Gunpowder Falls @ US 1	2.33	----	2.33
Gunpowder Falls @ I-83 & MD 45	4.67	4.67	4.33
Severn Run @ I-97 & MD 5461	4.14	----	4.14
UT Mattawoman Creek @ MD 224	4.71	----	5.00
Marbury Run @ MD 224	4.71	----	4.71
UT Mallows Bay @ MD 224	5.00	----	4.71
Patuxent River @ MD 97	4.67	----	3.67
Patuxent River @ MD 94	3.33	----	3.67
Long Draught Branch @ MD 119	2.25	----	2.25
Great Seneca Creek @ MD 119	2.25	----	2.50
Great Seneca Creek @ MD 117	2.00	----	2.75
UT Muddy Run @ US 15	3.00	----	3.25
Little Hunting Creek @ US 15 & MD 806	3.25	4.00	4.25

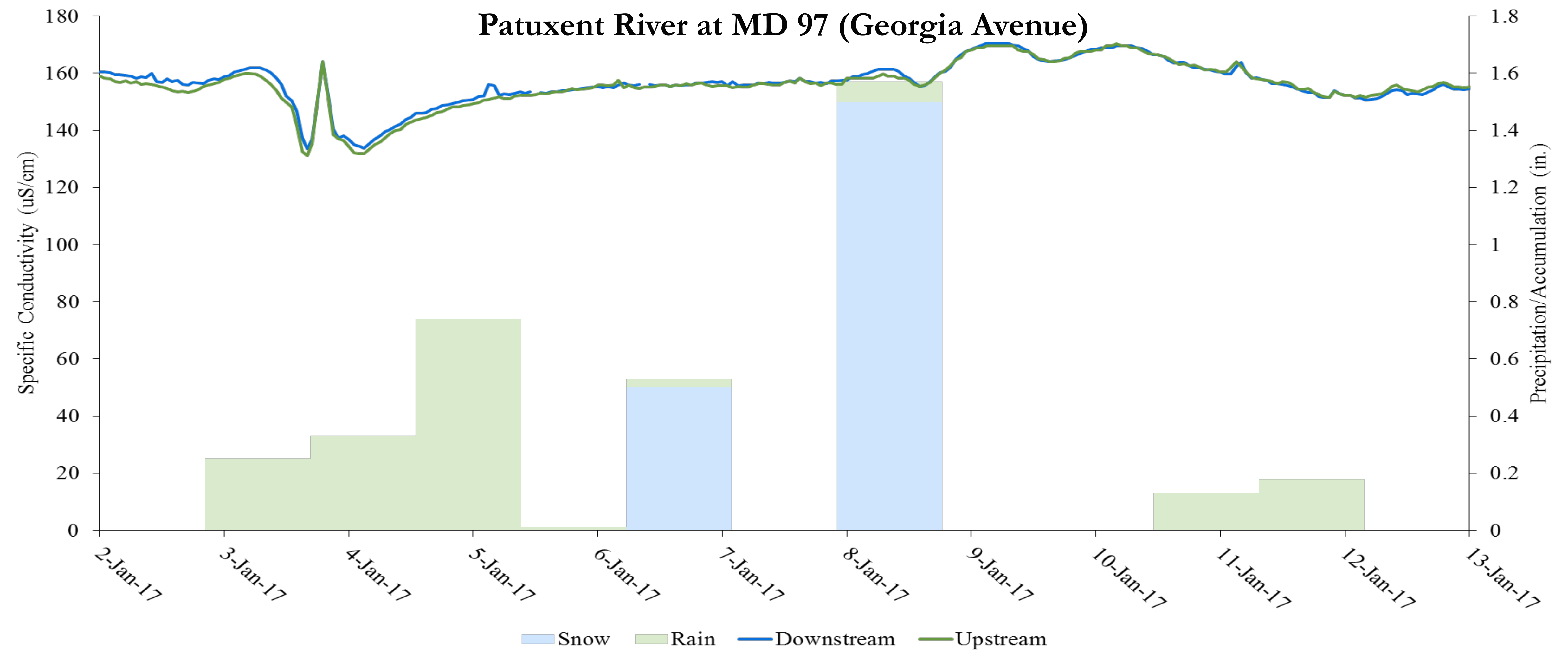
What is next?

- Why do we see different timing of response at the same road crossings? i.e., what roles do application technique and timing, temperature, precipitation play?



What is next?

- What other factors influence conductivity at each site?



Potential variables influencing results?

Environmental Setting:

- Land use
- Stream size (Upstream catchment area)
- Physiography
- Stream gradient

Site-scale Factors:

- Road size
- Run-off catchment (area of road draining to stream)
- Valley width
- Valley slope
- Soils/geology
- Hydrology

Event Factors:

- Amount of precipitation
- Salt application technique
- Salt application timing
- Ambient temperatures
- Duration and timing of thaw

Any Questions?

Potential sources of variability :

- Hobo instrument error
- In situ meter instrument error
- Correction faction/equation error (i.e., converting from raw conductivity to Specific Conductance)
- Biofouling correction
- Temporal variability (e.g., time lag error related to logger measurement vs. in-situ measurement)
- Spatial variability

Other DNR Conductivity Monitoring

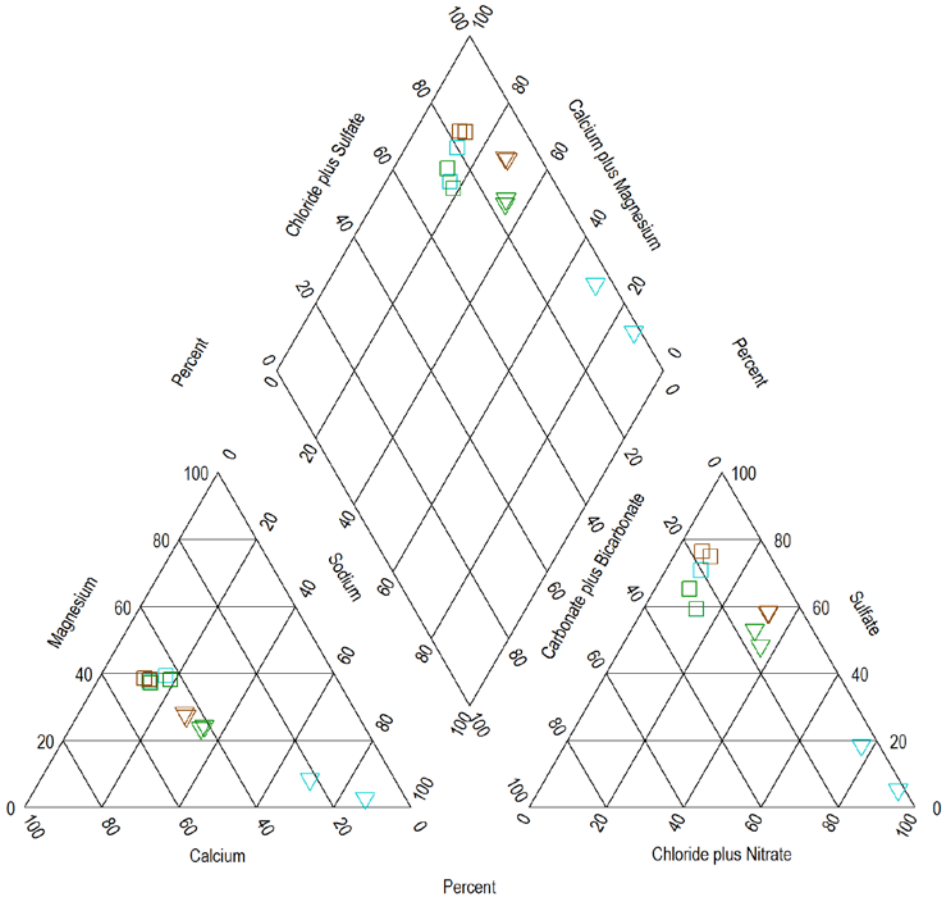
- Core Trend (Long-term monitoring at fixed stations)
- Sentinel Site Network (long-term monitoring at minimally-impacted, ‘reference’ sites)
- Stream Restoration
- Natural Trout Waters

Provisional Results - Ion Composition Monitoring

UT Muddy Run @ US 15

- ▽ **Downstream**
- ☐ **Upstream**
- 🟫 **Fall pre-application baseline**
- 🟩 **Spring post-application baseline**
- 🟦 **Snow event**

February 5, 2018 Snow Event



Downstream *in situ* = 242 uS/cm
Upstream *in situ* = 33 uS/cm

Provisional Results - Ion Composition Monitoring

UT Muddy Run @ US 15

▽ Downstream

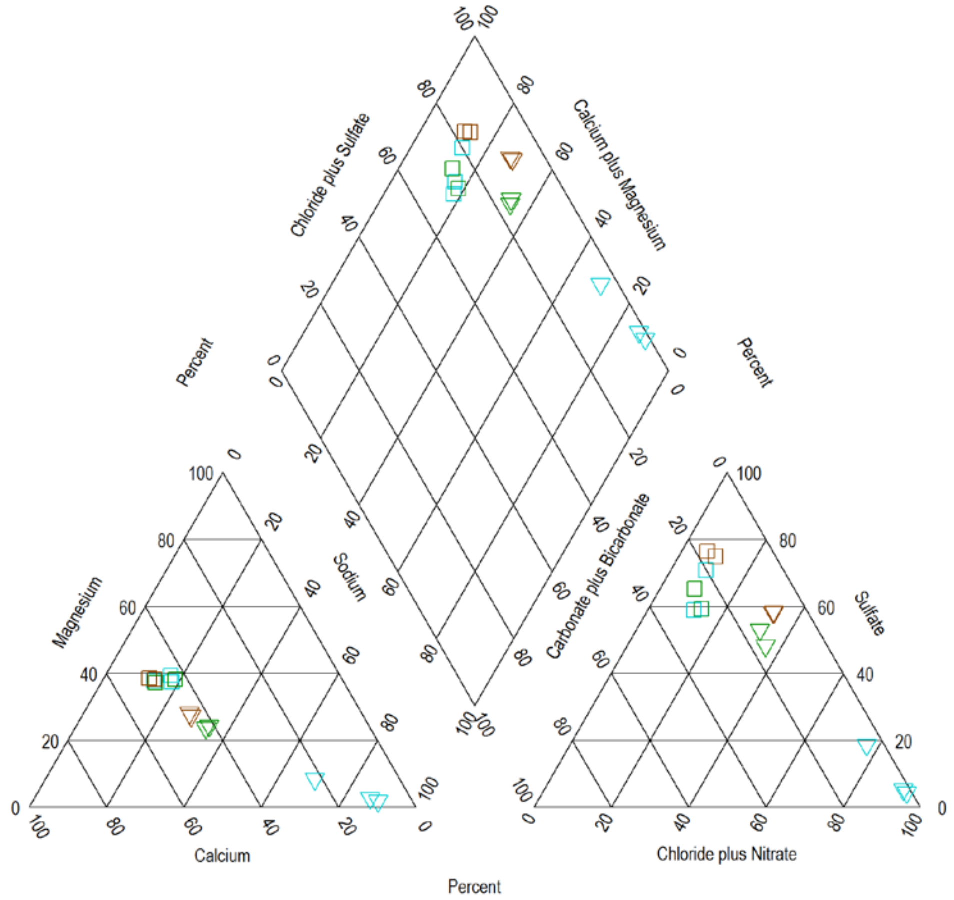
□ Upstream

🟫 Fall pre-application baseline

🟩 Spring post-application baseline

🟦 Snow event

February 7, 2018 Snow Event



Downstream *in situ* = 1,776 uS/cm
Upstream *in situ* = 36 uS/cm

Provisional Results - Ion Composition Monitoring

UT Muddy Run @ US 15

▽ **Downstream**

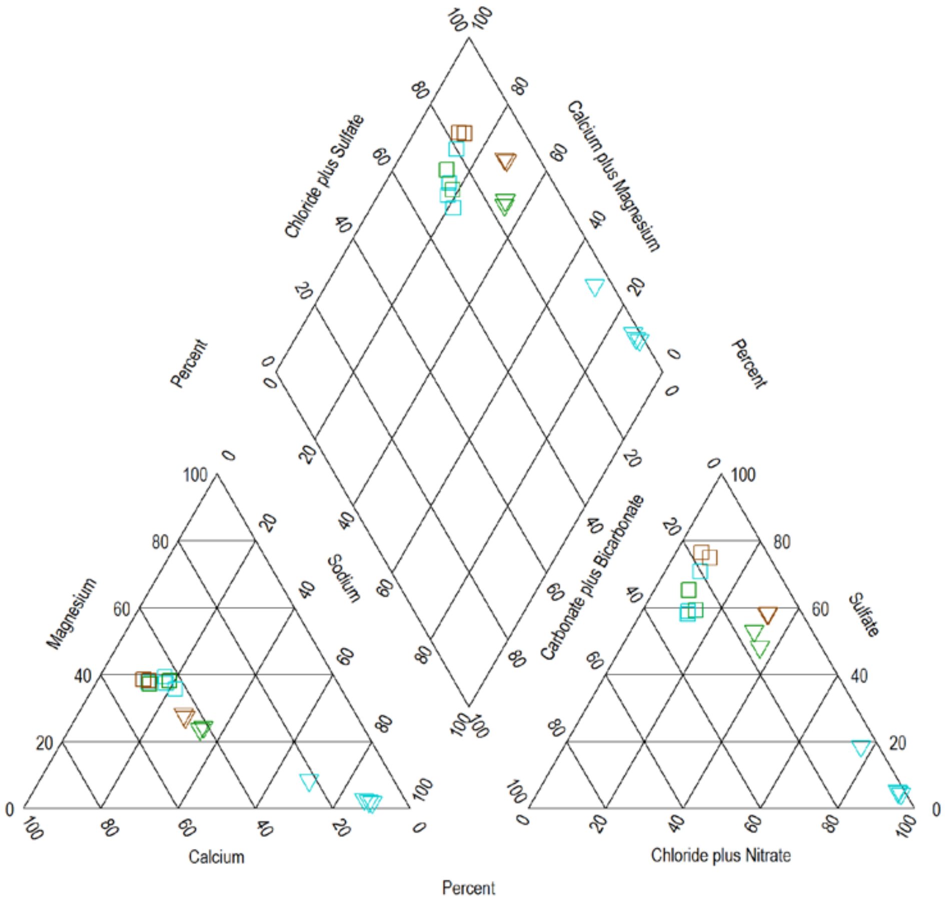
□ **Upstream**

🟫 **Fall pre-application baseline**

🟩 **Spring post-application baseline**

🟦 **Snow event**

March 22, 2018 Snow Event



Downstream *in situ* = 960 uS/cm
Upstream *in situ* = 29 uS/cm

Spatial Variability

Big Gunpowder Falls @ US 1

In situ measurements of conductivity taken within 15 minutes of each other following March 14-15, 2017 snow event (approx. 4.5 inches accumulation)