Selected USGS Data Collection and Analysis Products, Difficult Run Watershed, Fairfax Co, Virginia, 1979 - 2018

Materials prepared for presentation at the 2023 Metropolitan Washington Council of Governments Water Summit Series: COG's Freshwater Salinization Monitoring Program Update Webinar

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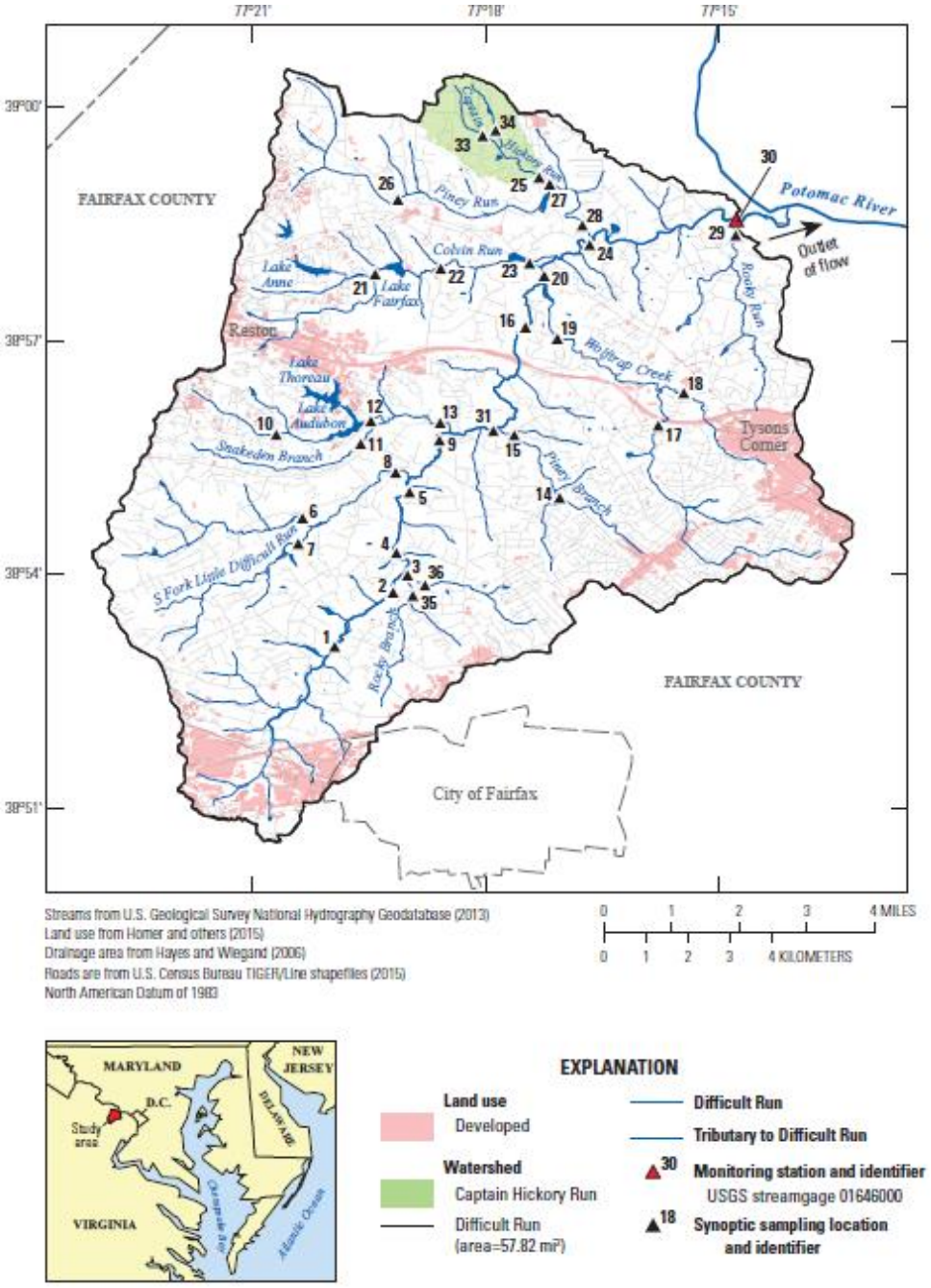
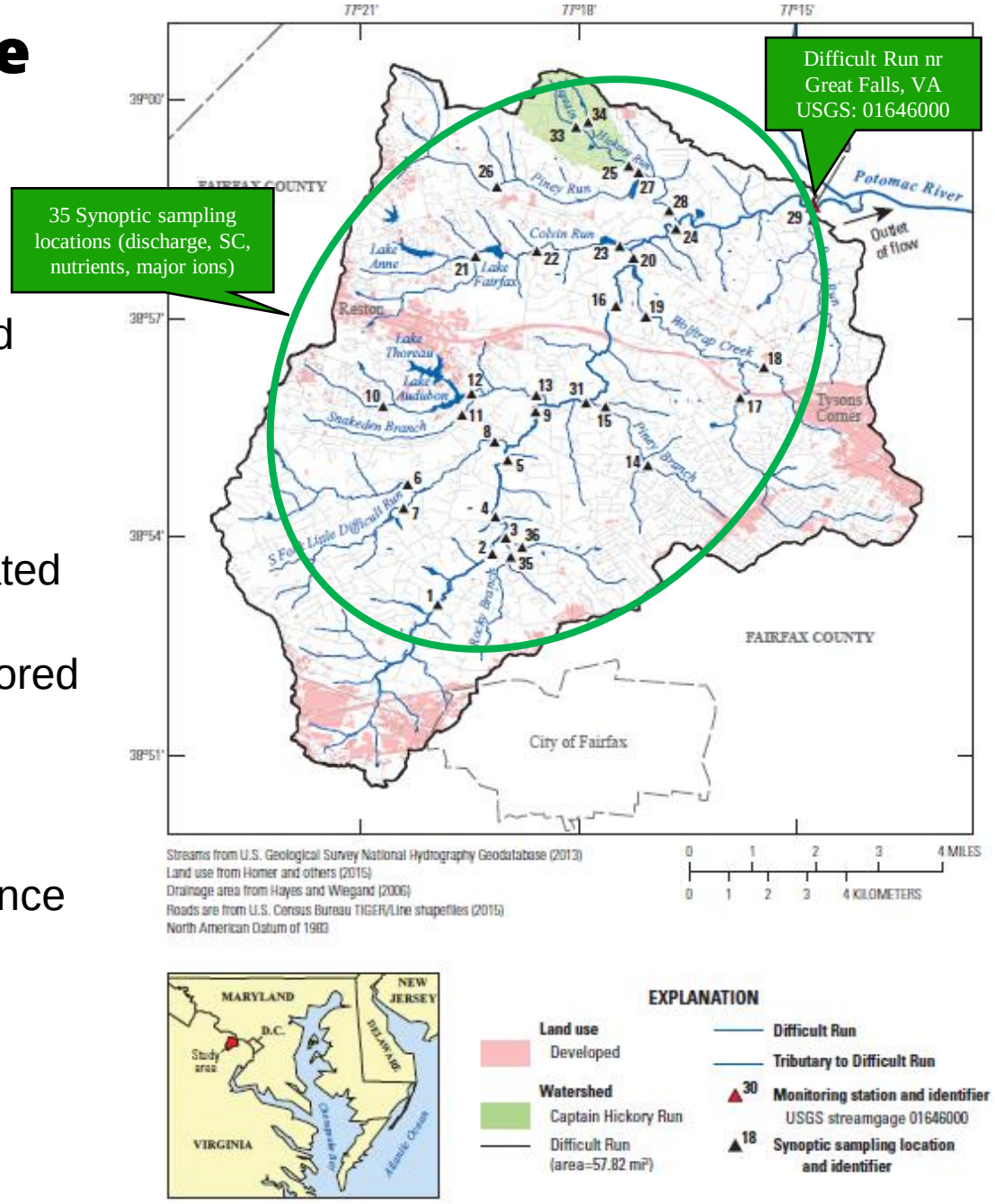


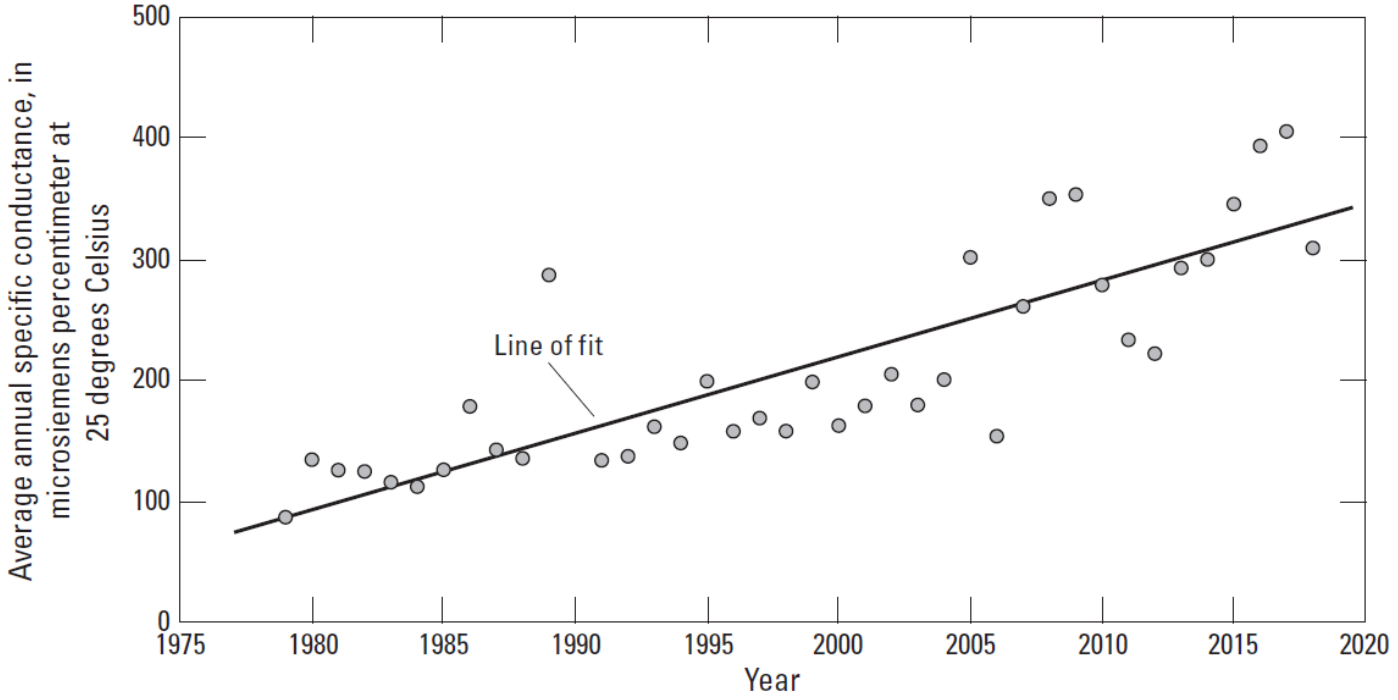
USGS data collection and analysis in the Difficult Run watershed is leading to insights on salinization

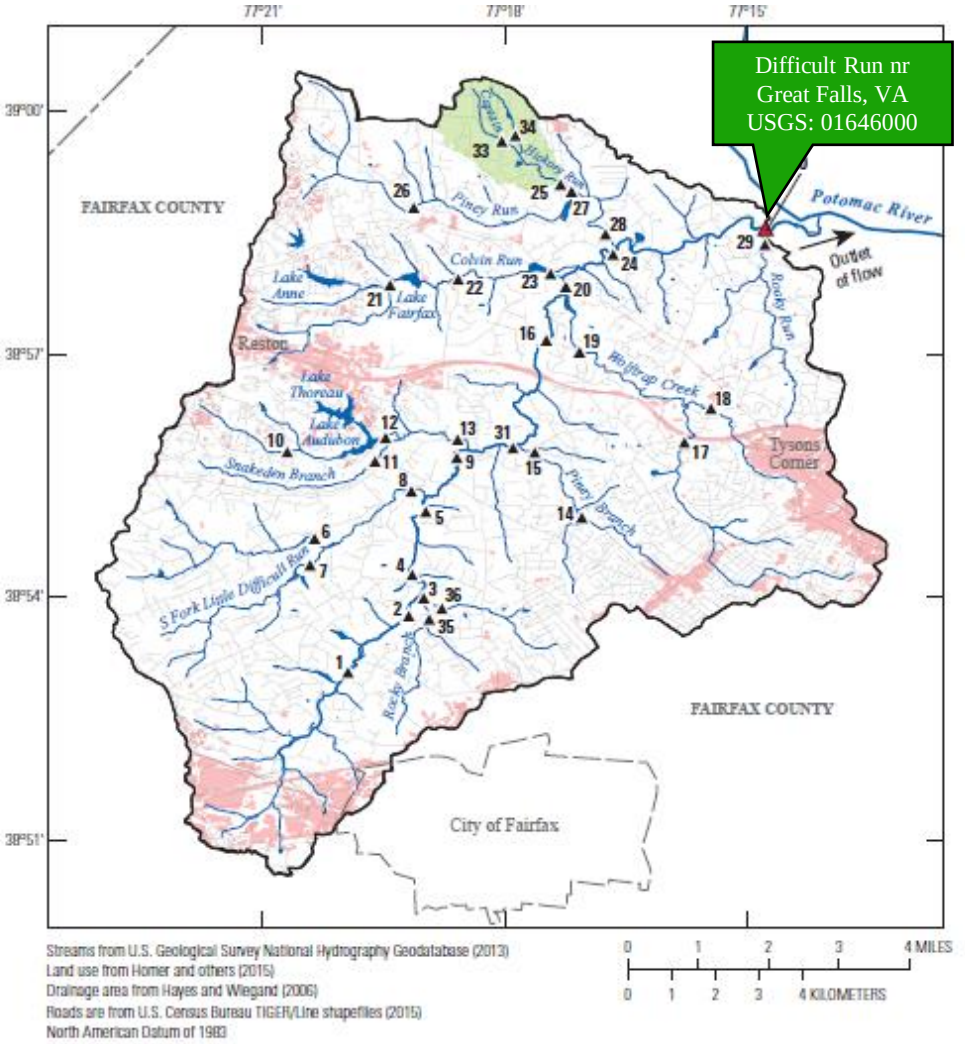
- Difficult Run is the largest Fairfax County watershed (58 mi^2) and contains a mixture of urban land (residential, commercial, and industrial area).
- Sampling strategies
  - ***USGS gage at Great Falls:*** A stream-gage has been operated at the outlet of the watershed since 1935. Water-quality has been collected since 1985. Difficult Run is one of 123 monitored watersheds in the Chesapeake Bay Non-tidal Monitoring Network.
  - ***Synoptic:*** USGS has collected dry-weather discharge and water-quality samples throughout the watershed annually since the early 2010's.

What are we learning?



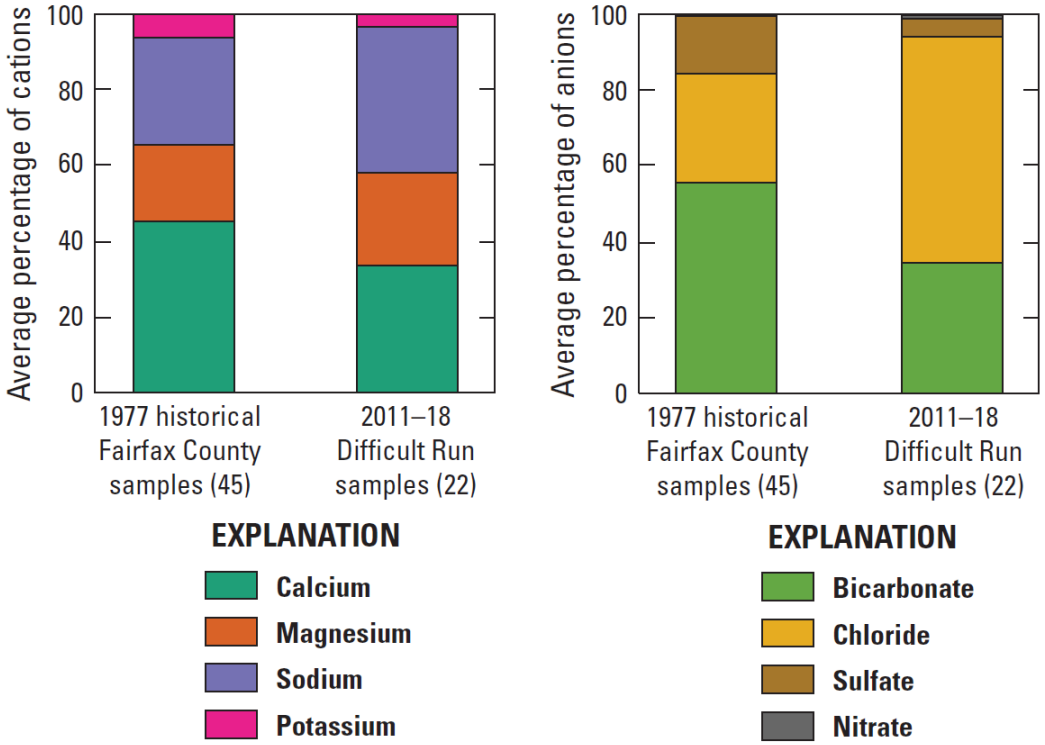
Specific conductance increased at the Difficult Run streamgage

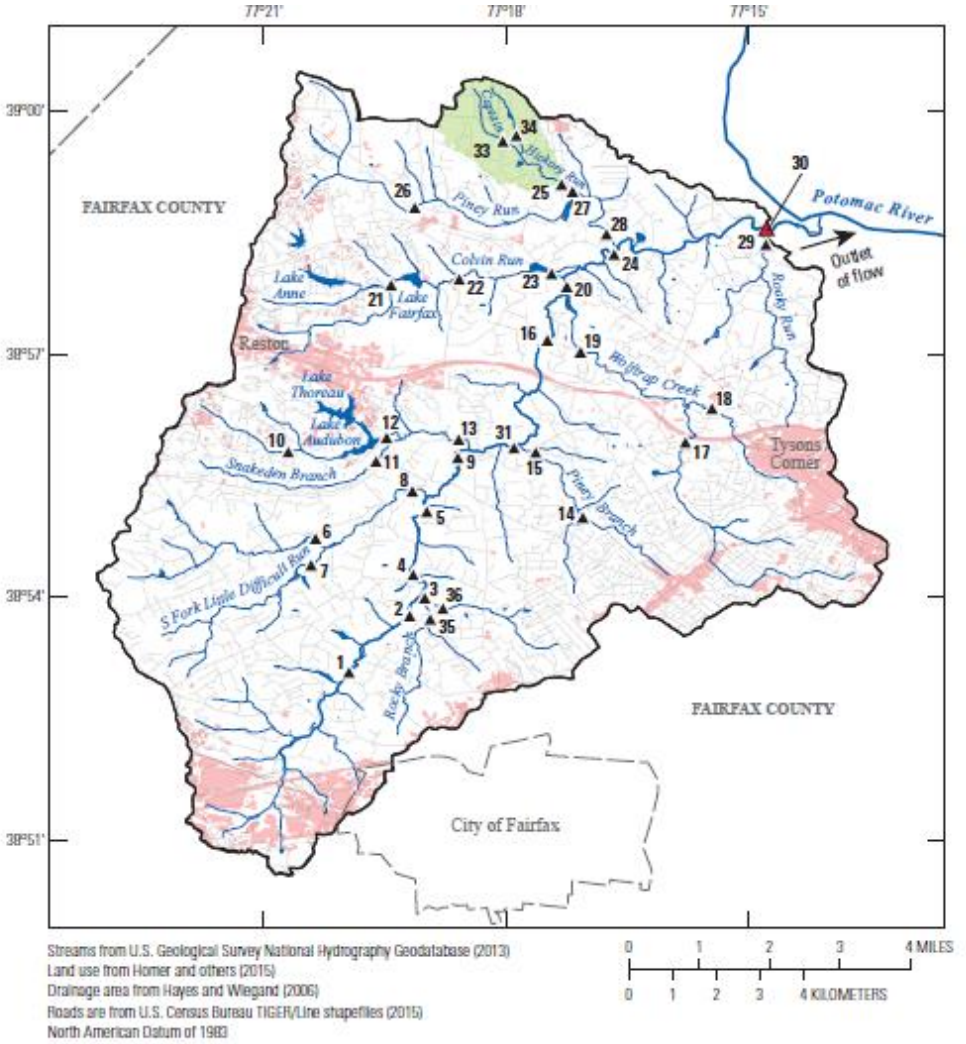




Average annual specific conductance values tripled at the Difficult Run stream-gage since the early 1980s, from about 100 uS/cm to more than 300 uS/cm.

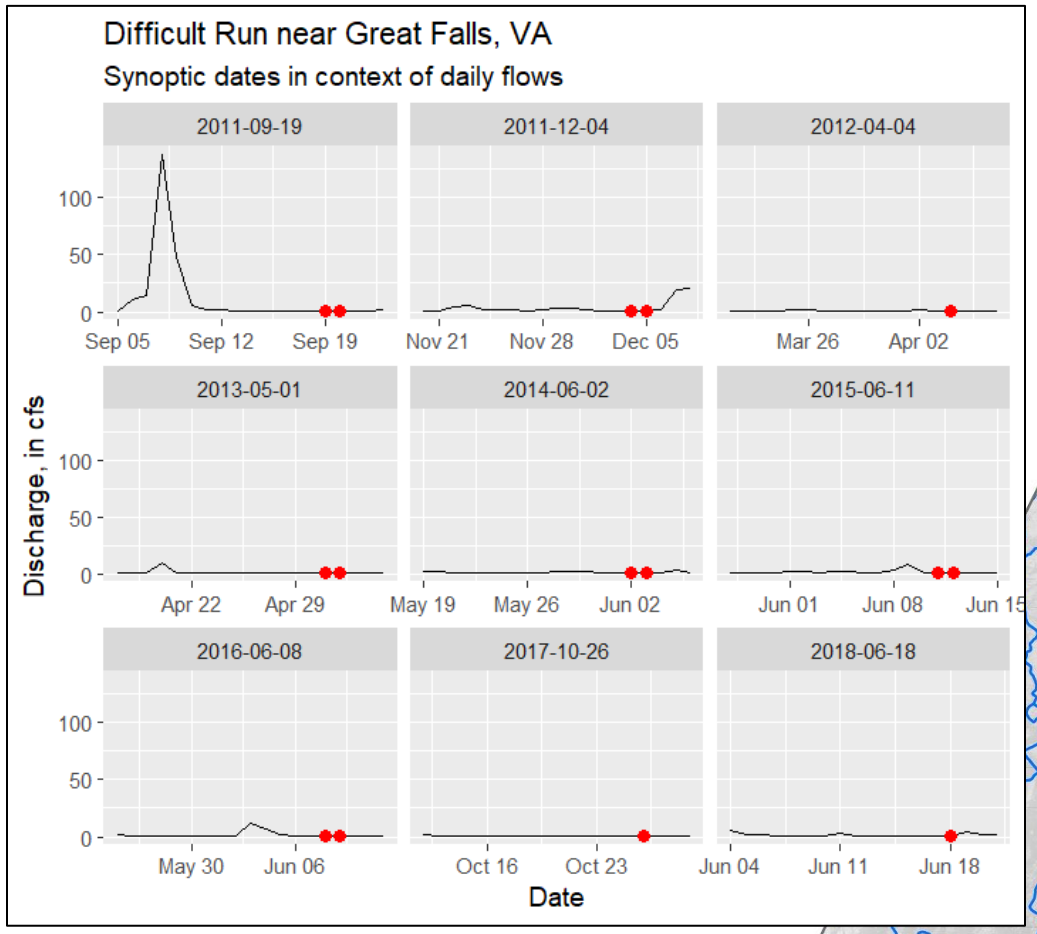
Increases in specific conductance result from increases in Na^+ and Cl^-





On average, calcium and bicarbonate were the most prevalent ions in the 1977 Fairfax County samples, whereas sodium and chloride were the most prevalent ions in the 2011-2018 Difficult Run samples.

Dry-weather synoptic sampling of specific conductance in Difficult Run streams



35 synoptic sampling locations (discharge, SC, nutrients, major ions)

Season	# events
Winter	1
Spring	2
Summer	4
Fall	2

Constituents
Nutrients
Sediment
Major ions
$\delta^{18}O$, $\delta^{15}N$

Reston

Tysons Corner

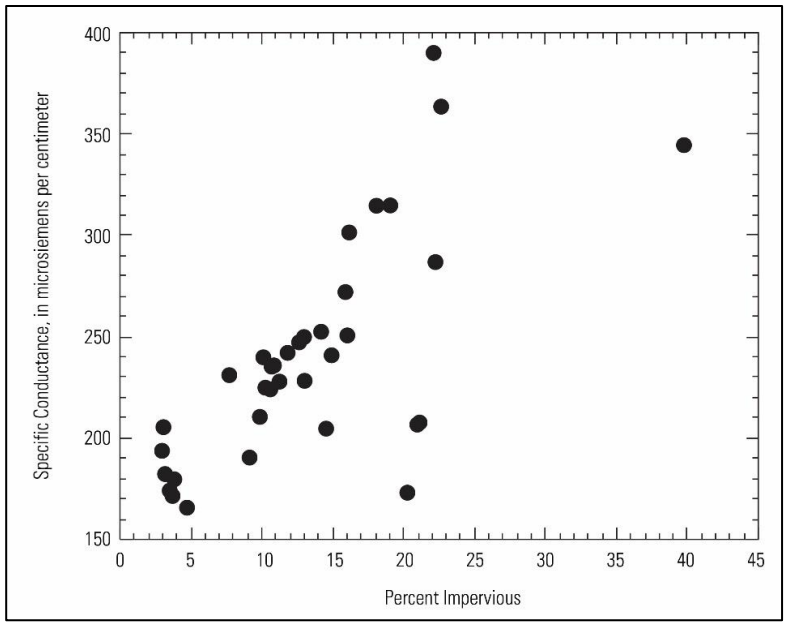
Fairfax City

Specific Conductance, in µS/cm
- 165 – 210
- 211 – 255
- 256 – 300
- 301 – 345
- 346 – 390

Two analytical perspectives on synoptic specific conductance in Difficult Run streams

1. Map sampled concentrations (shown at right)

High values of specific conductance are in watershed areas immediately downstream of Fairfax City, Tysons Corner, and Reston.



35 synoptic sampling locations (discharge, SC, nutrients, major ions)

Reston

Tysons Corner

Fairfax City

Percent Impervious
1 → 100

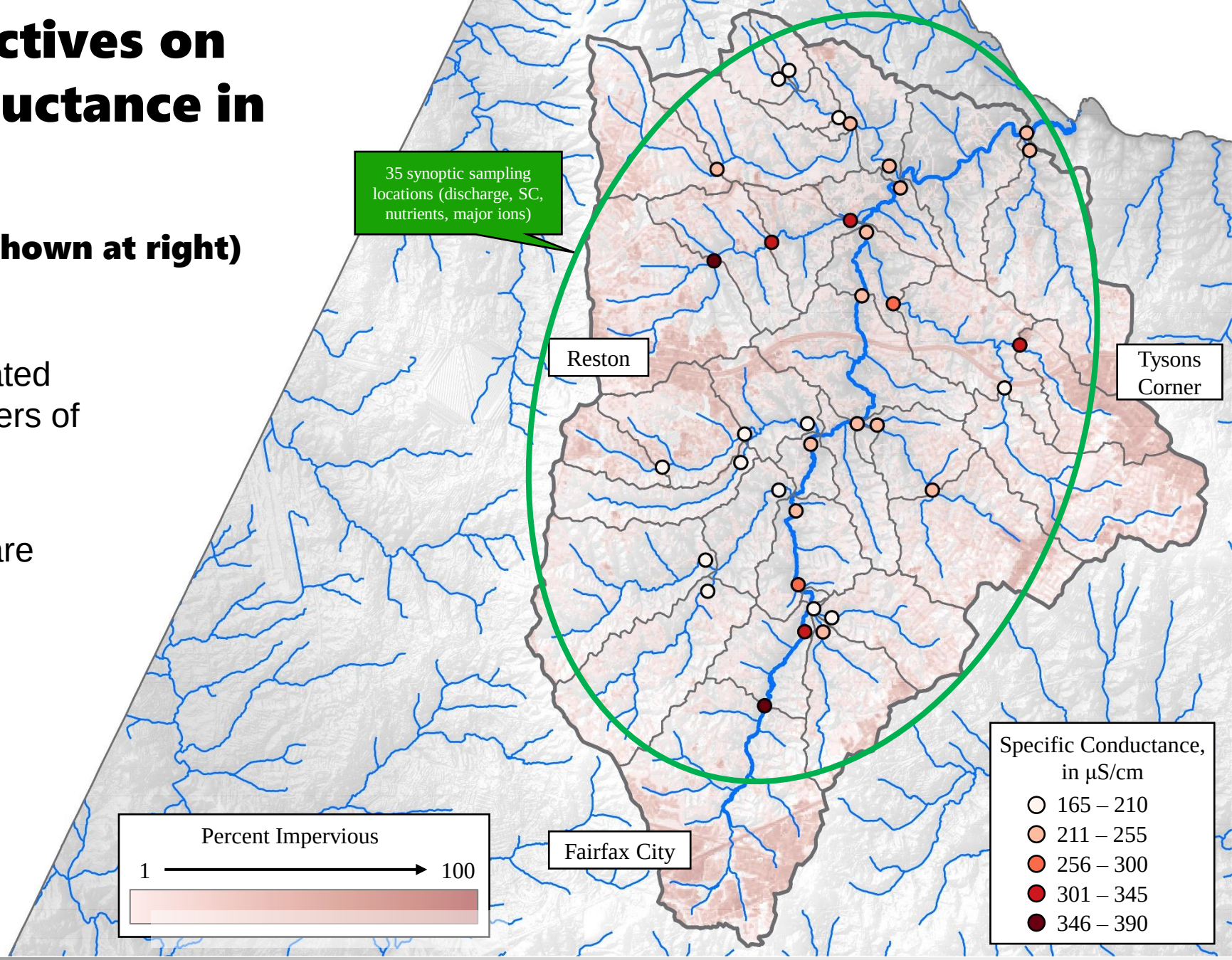
Specific Conductance, in µS/cm
165 – 210
211 – 255
256 – 300
301 – 345
346 – 390

Two analytical perspectives on synoptic specific conductance in Difficult Run streams

1. Map sampled concentrations (shown at right)

Limitations:

- Upstream contributing area associated with each sample varies over 2 orders of magnitude.
- In-stream observations violate regression assumptions (samples are not independent).
- More difficult to explicitly locate problematic impervious areas as sampled watershed size increases.



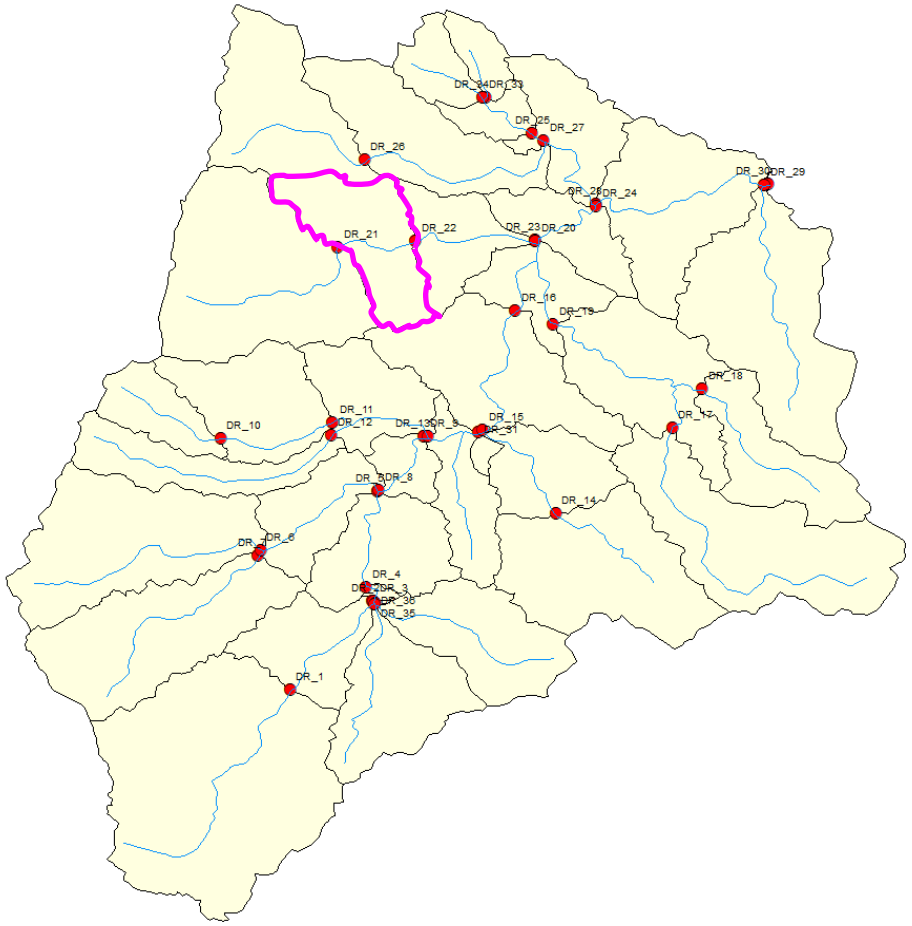
Two analytical perspectives on synoptic specific conductance in Difficult Run streams

2. Alternately, **consider the incremental sub-watersheds which contribute to each synoptic sampling location** (small area between nearest upstream and downstream sampling location).

   - Close coupled H_20/conservative solute mass balance over entire sampling domain.
   - Knowing the incremental discharge between sampling points, pose question as:

     For each incremental watersheds' contribution to streamflow volume, what must the local concentration have been to lead to the observed in-stream concentration, considering the role of upstream inputs?

   - This approach improves our ability to pinpoint problematic source areas.



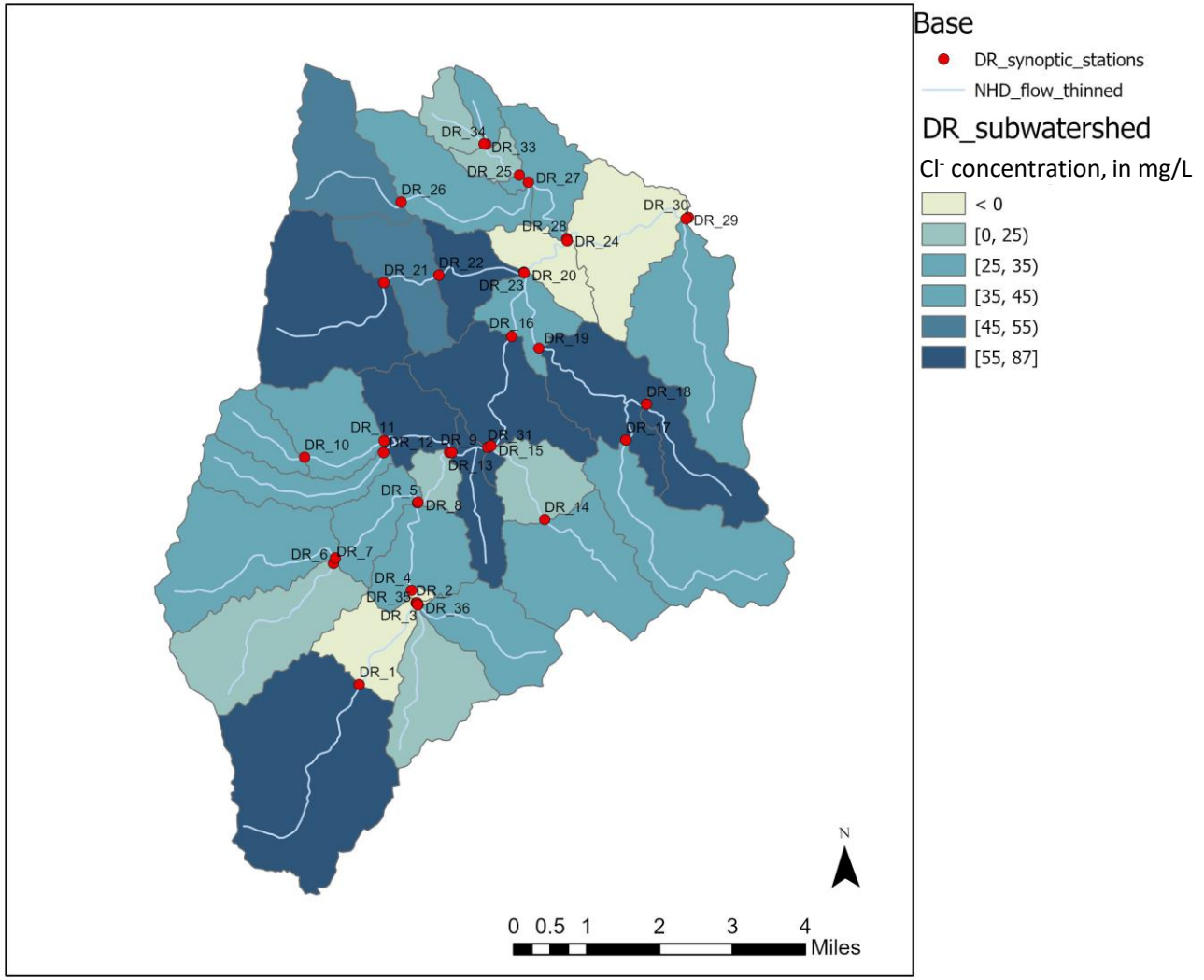
$$Q_{inc} = Q_{dns} - Q_{ups}$$

$$C_{inc} \cdot Q_{inc} = C_{dns} \cdot Q_{dns} - C_{ups} \cdot Q_{ups}$$

Two analytical perspectives on synoptic specific conductance in Difficult Run streams

2. Alternately, **consider the incremental sub-watersheds which contribute to each synoptic sampling location** (small area between nearest upstream and downstream sampling location).

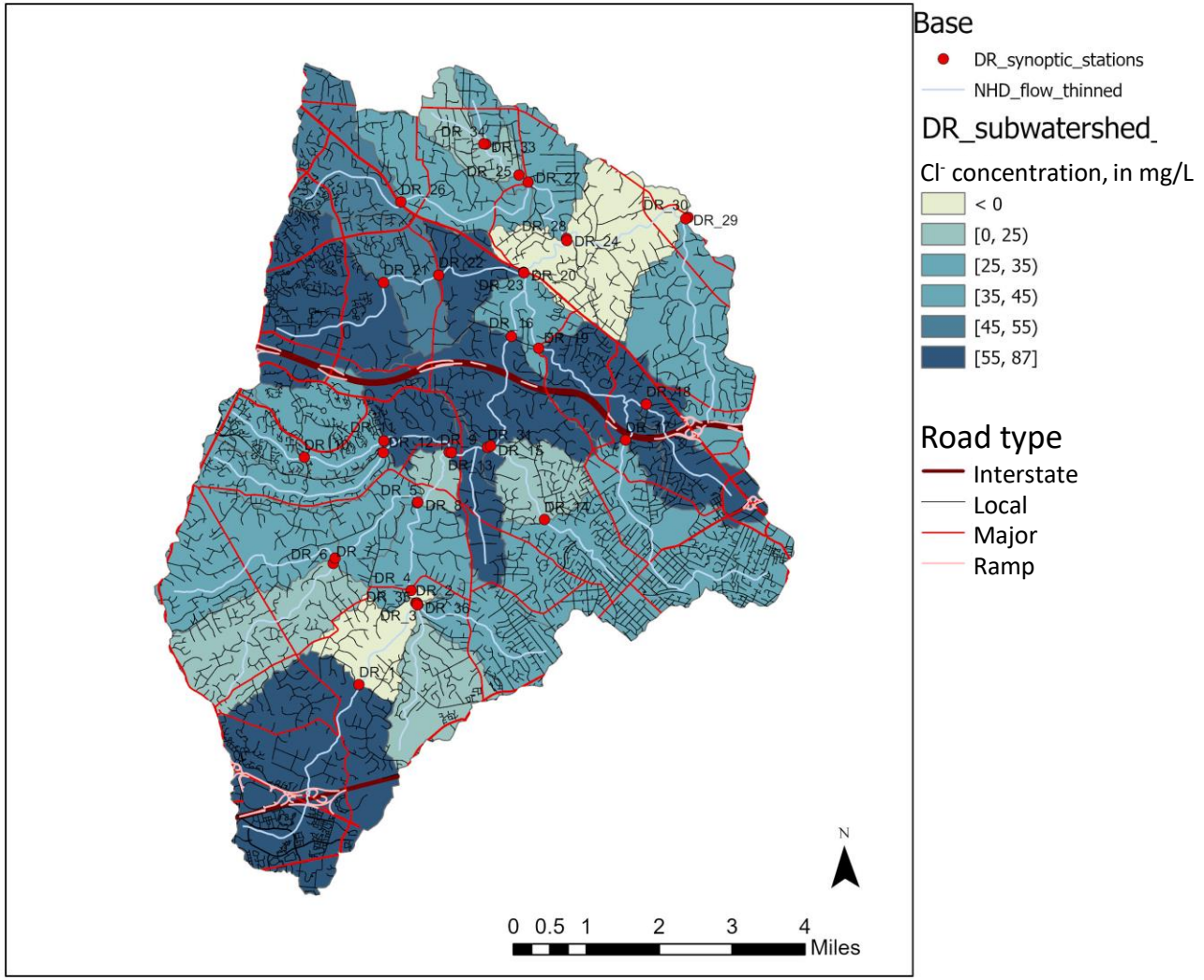
   - A map of **estimated chloride concentration of incremental channel inflow, April 4, 2012**
   - Pattern revealed suggests the significance of connected areas



Two analytical perspectives on synoptic specific conductance in Difficult Run streams

2. Alternately, **consider the incremental sub-watersheds which contribute to each synoptic sampling location** (small area between nearest upstream and downstream sampling location).

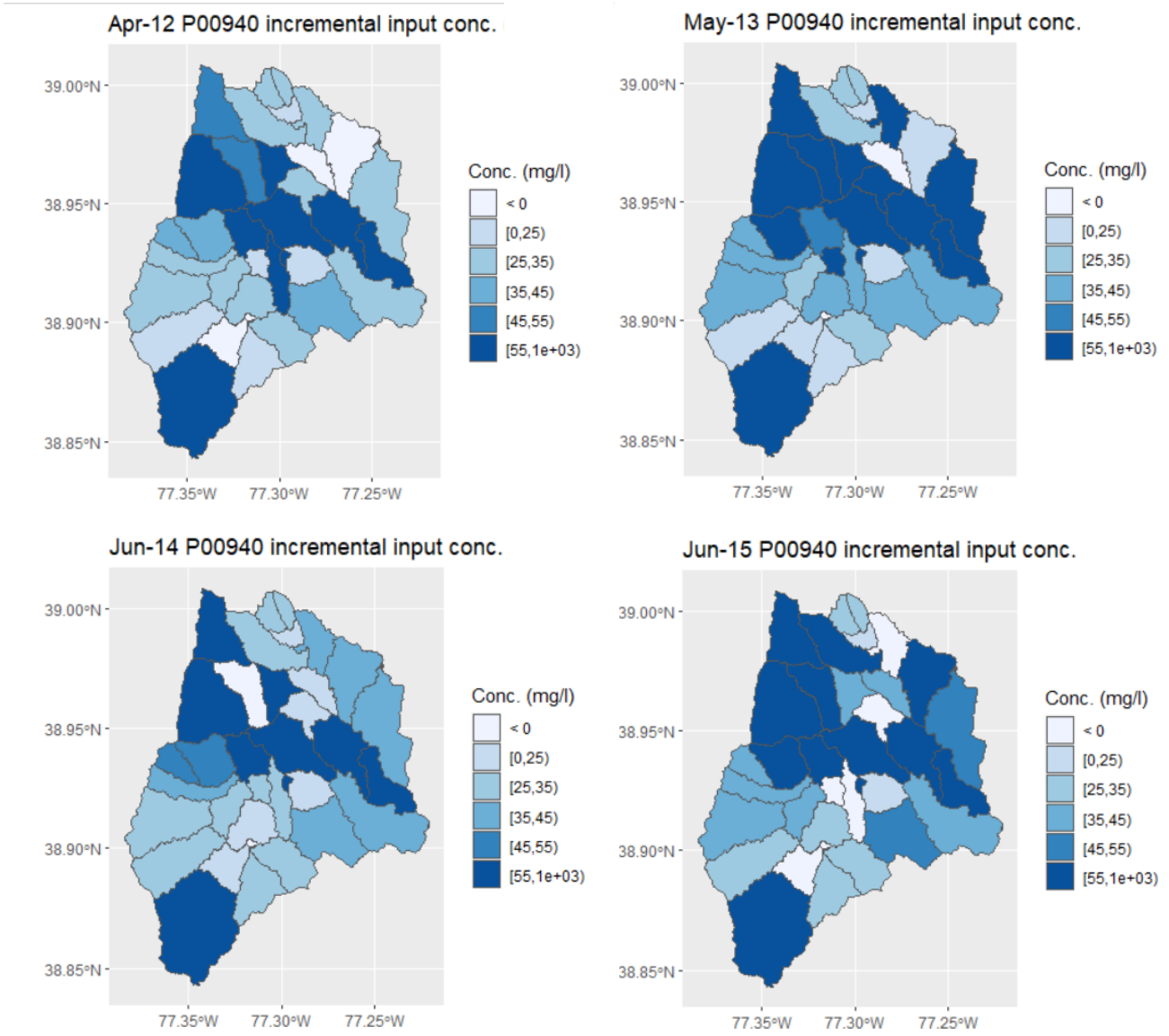
   - A map of **estimated chloride concentration of incremental channel inflow, April 4, 2012**
   - Pattern revealed suggests the significance of connected areas
   - Overlay associates pattern with **interstate roads and/or co-located impervious area**



Two analytical perspectives on synoptic specific conductance in Difficult Run streams

2. Alternately, **consider the incremental sub-watersheds which contribute to each synoptic sampling location** (small area between nearest upstream and downstream sampling location).

   - Pattern revealed suggests the significance of connected areas
   - This appears to be a **stable dry-weather pattern in Difficult Run**
   - Next steps:
     - Explain these patterns by including spatially explicit predictors such as lithology, % impervious, length of all roads, length of major roads, etc.



Thank you!

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