Preliminary Results from Stream Methane Monitoring in the Marcellus Shale Region of the Susquehanna River Basin

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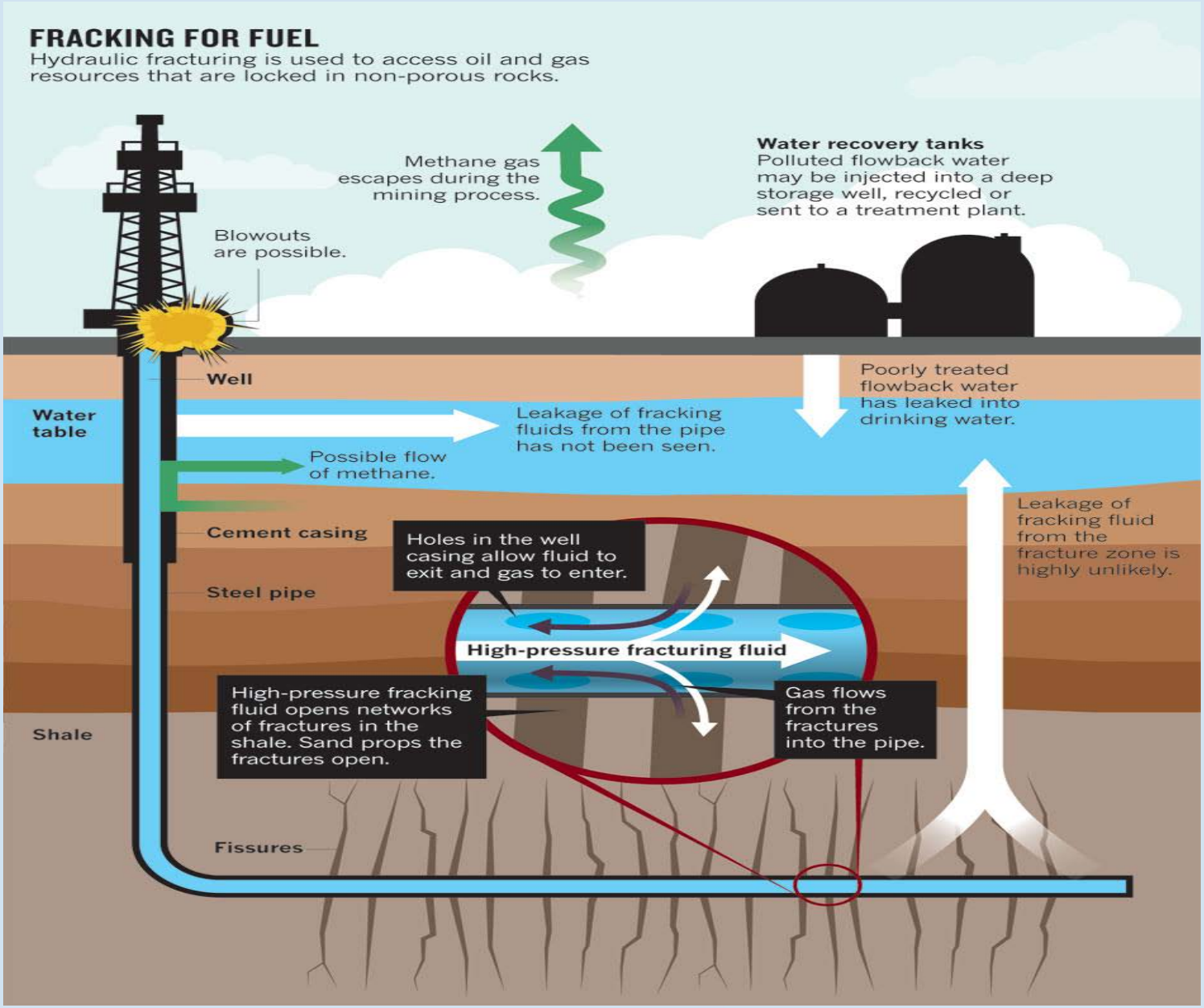
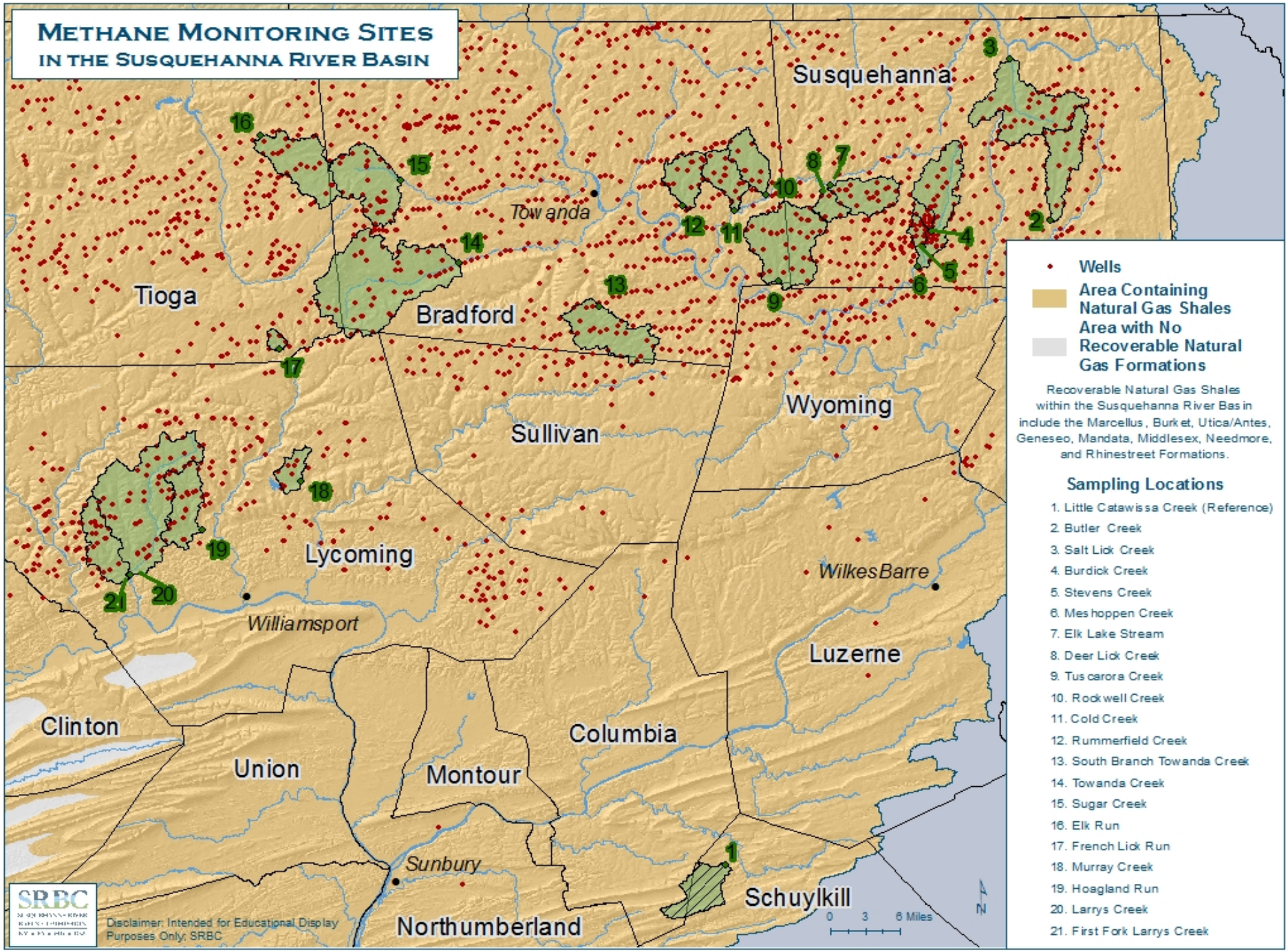
General Overview

- USGS reported on results from monitoring methane concentrations in surface water as potential indicator of Marcellus source methane in groundwater
  - Surface water easier to sample
  - Exploratory/screening type data collection done fairly inexpensively
- Targeted small streams with high gas well density
  - 20 stream sites
  - July and October 2016
- Analyzed for dissolved methane concentration and isotopic fractionation
- Isotopes of CH_4
  - ratio of $^{13}C/^{12}C$
  - ratio of $^{2}H/^{1}H$
  - looking at these ratios can provide source tracking information


FRACKING FOR FUEL
Hydraulic fracturing is used to access oil and gas resources that are locked in non-porous rocks.
Methane gas escapes during the mining process.
Blowouts are possible.
Water recovery tanks
Polluted flowback water may be injected into a deep storage well, recycled or sent to a treatment plant.
Well
Water table
Leakage of fracking fluids from the pipe has not been seen.
Possible flow of methane.
Poorly treated flowback water has leaked into drinking water.
Cement casing
Steel pipe
Holes in the well casing allow fluid to exit and gas to enter.
Leakage of fracking fluid from the fracture zone is highly unlikely.
High-pressure fracturing fluid
High-pressure fracking fluid opens networks of fractures in the shale. Sand props the fractures open.
Gas flows from the fractures into the pipe.
Shale
Fissures

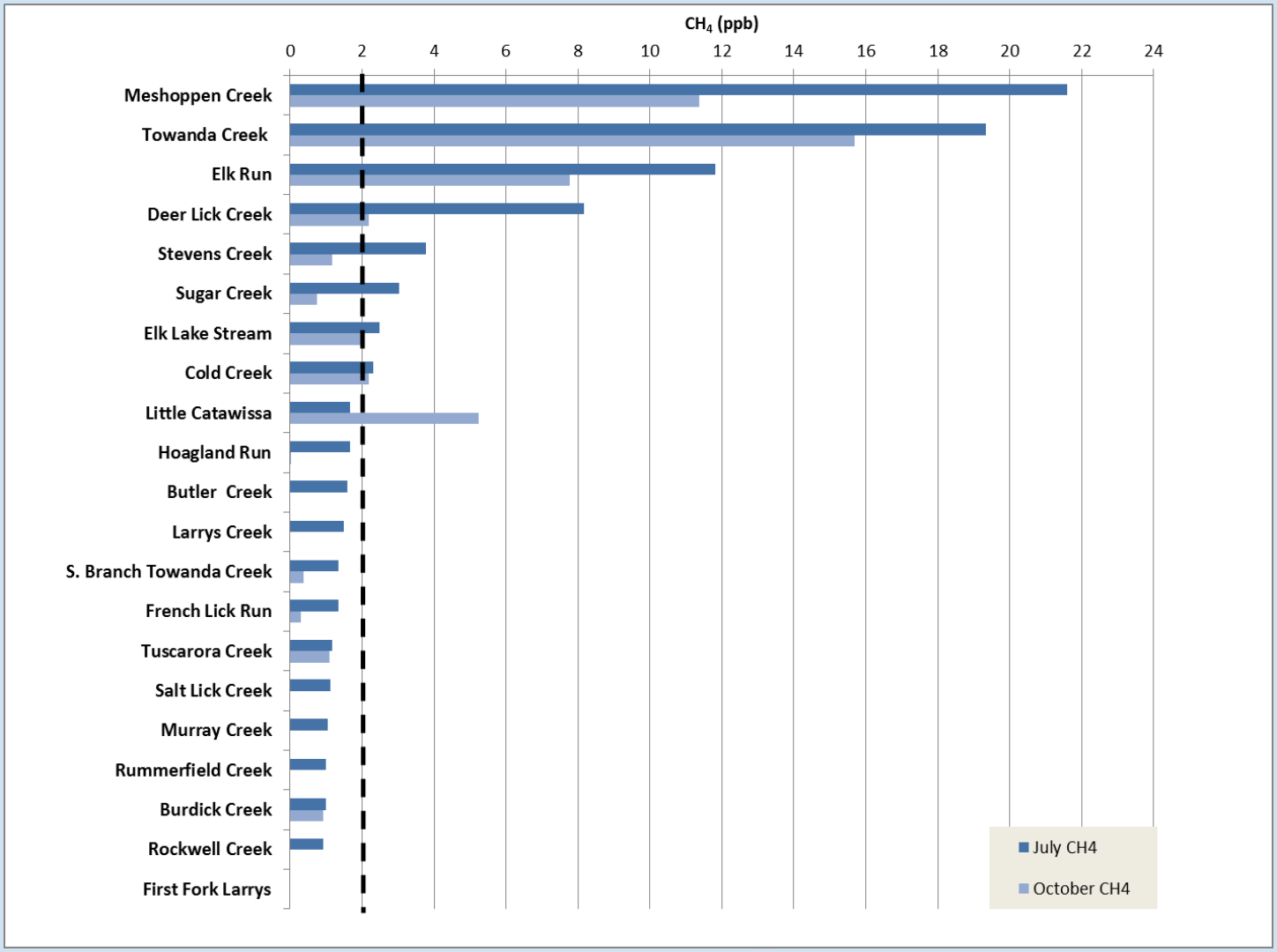
Caveats and Disclaimers

- Exploratory Monitoring
- Non-regulatory
- Implementation of USGS research methods
- NOT pointing to any specific well or company
- We recognize we are working with very low concentrations so the results must be interpreted with caution

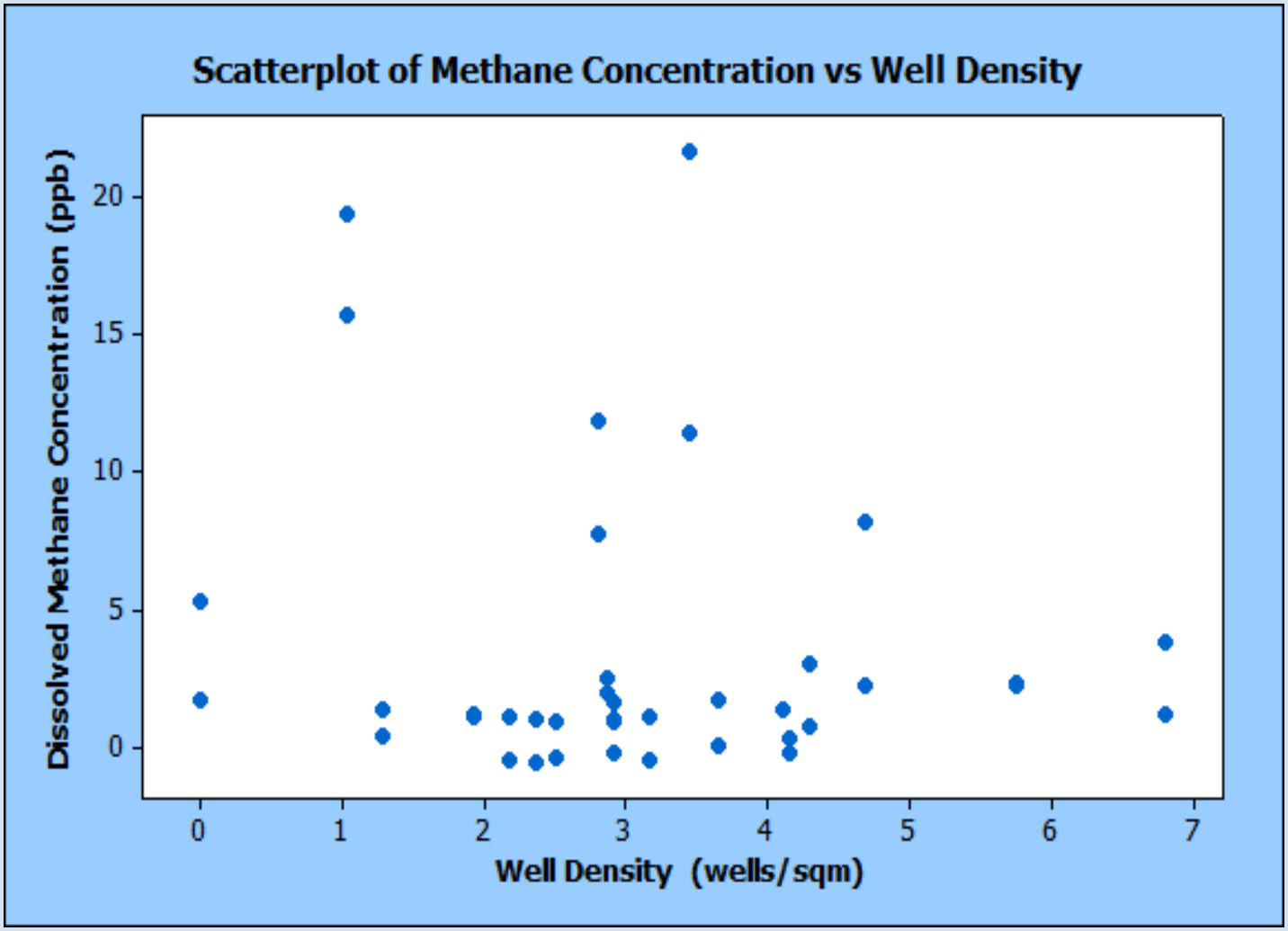

Methane Monitoring Sites
in the Susquehanna River Basin
Susquehanna
Towanda
Tioga
Bradford
Sullivan
Wyoming
Lycoming
Williamsport
WilkesBarre
Luzerne
Clinton
Union
Montour
Columbia
Sunbury
Schuylkill
Northumberland
Wells
Area Containing Natural Gas Shales
Area with No Recoverable Natural Gas Formations
Recoverable Natural Gas Shales within the Susquehanna River Basin include the Marcellus, Burket, Utica/Antes, Geneseo, Mandata, Middlesex, Needmore, and Rhinestreet Formations.
Sampling Locations
1. Little Catawissa Creek (Reference)
2. Butler Creek
3. Salt Lick Creek
4. Burdick Creek
5. Stevens Creek
6. Meshoppen Creek
7. Elk Lake Stream
8. Deer Lick Creek
9. Tuscarora Creek
10. Rockwell Creek
11. Cold Creek
12. Rummerfield Creek
13. South Branch Towanda Creek
14. Towanda Creek
15. Sugar Creek
16. Elk Run
17. French Lick Run
18. Murray Creek
19. Hoagland Run
20. Larrys Creek
21. First Fork Larrys Creek
SRBC
Disclaimer: Intended for Educational Display Purposes Only; SRBC
0 3 6 Miles
N

Stream	WBD 12 Name	Latitude	Longitude	Drainage Area (sqm)	Size class (sqm)	Well density (wells/sqm)
Stevens Creek	Thomas Creek-Meshoppen Creek	41.69666	-75.89069	4	<10	6.8
Cold Creek	Cold Creek - Wyalusing Creek	41.74771	-76.20762	12	10-20	5.75
Deer Lick Creek	Deer Lick Creek - E. Branch Wyalusing Creek	41.77499	-76.05931	7	<10	4.69
Sugar Creek	South Branch Sugar Creek	41.78982	-76.77577	29	20-40	4.3
First Fork Larrys Creek	First Fork Larrys Creek	41.26730	-77.23529	18	10-20	4.15
French Lick Run	Roaring Branch	41.55994	-76.98014	3	<10	4.1
Hoagland Run	Hoagland Run	41.32709	-77.11620	19	10-20	3.65
Meshoppen Creek	Thomas Creek - Meshoppen Creek	41.68280	-75.88721	31	20-40	3.44
Murray Creek	Wallis Run	41.39128	-76.94614	8	<10	3.17
Burdick Creek	Thomas Creek-Meshoppen Creek	41.71754	-75.87267	3	<10	2.92
Butler Creek	Butler Creek	41.72926	-75.67472	21	20-40	2.92
Elk Lake Stream	Lake Stream	41.78005	-76.04555	16	10-20	2.87
Elk Run	Gaffers Creek - Elk Run	41.84806	-77.01227	28	20-40	2.81
Rockwell Creek	Rockwell Creek - Wyalusing Creek	41.76815	-76.15558	13	10-20	2.5
Rummerfield Creek	Rummerfield Creek - Susquehanna River	41.74542	-76.30876	14	10-20	2.37
Salt Lick Creek	Salt Lick Creek	41.94494	-75.73761	40	20-40	2.17
Tuscarora Creek	Tuscarora Creek	41.65316	-76.13534	39	20-40	1.93
Larrys Creek	Larrys Creek	41.26859	-77.23291	62	40+	1.6
S. Branch Towanda Creek	South Branch Towanda Creek	41.62711	-76.43413	29	20-40	1.29
Towanda Creek	Headwaters Towanda Creek	41.69248	-76.62909	79	40+	1.04
Little Catawissa Creek	Little Catawissa Creek	40.889945	-76.209143	17	10-20	0

Dissolved Methane Concentrations



Methane Concentration vs. Well Density

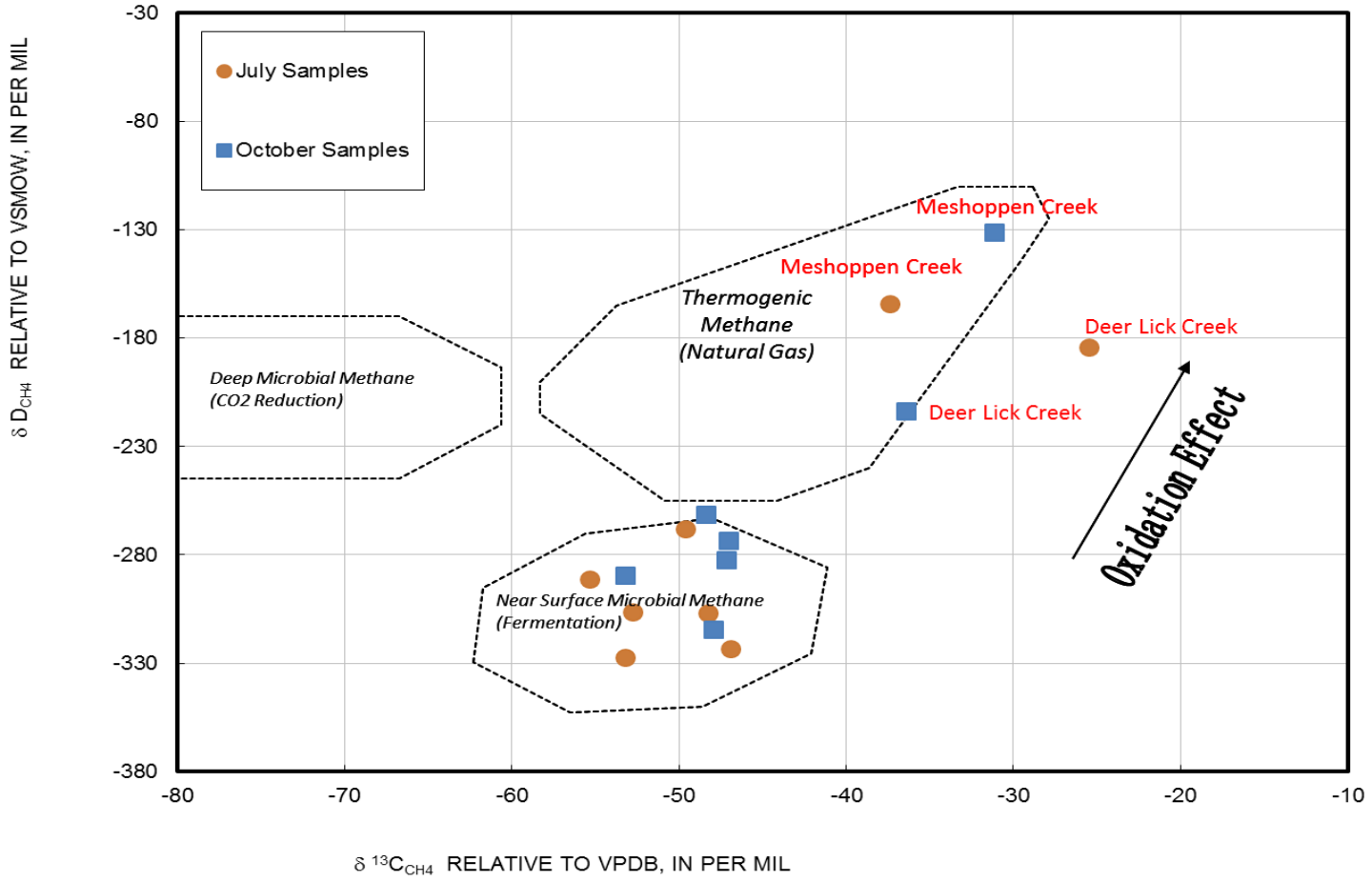


Well density includes both conventional and unconventional wells.

Acknowledge surface and ground water don't follow same boundaries.

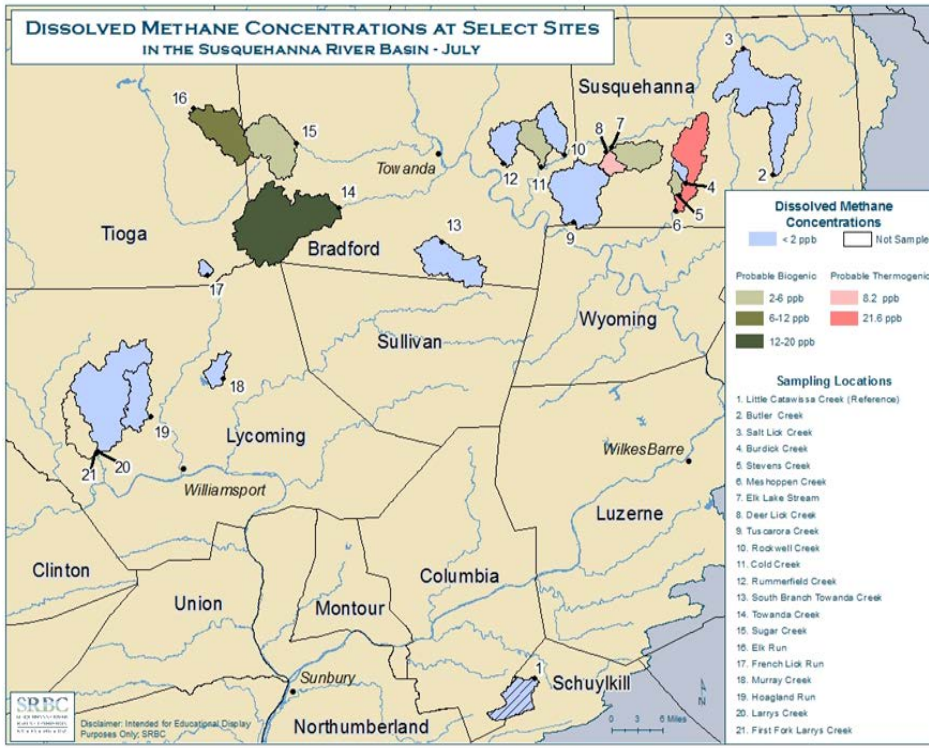
No significant correlation between well density and CH4 concentration.

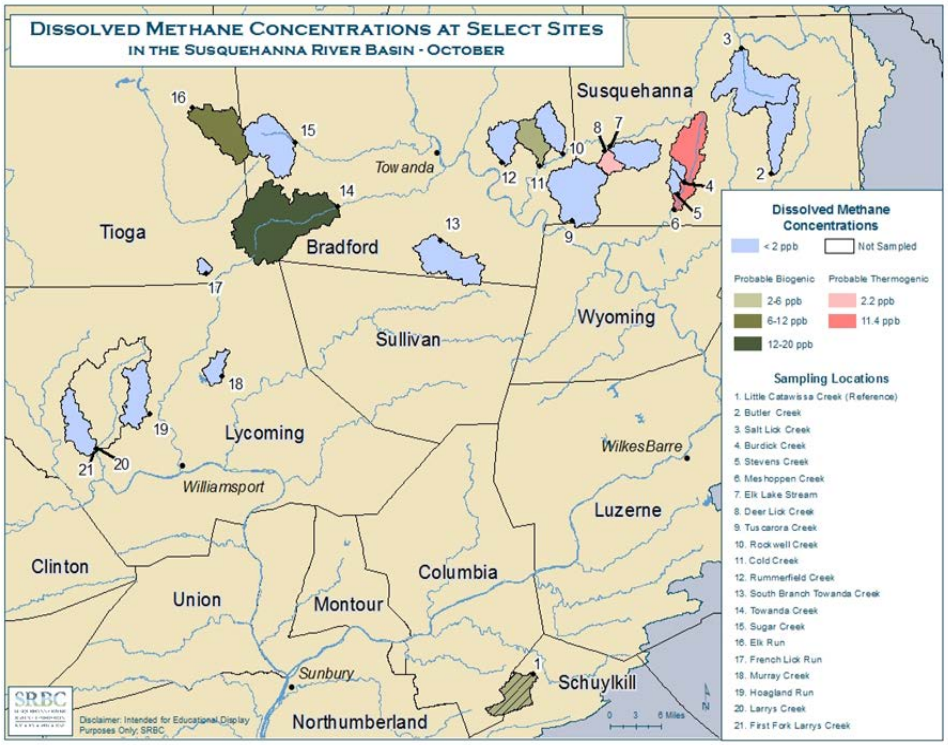
Interpreting Isotope Data



Schoell 1980

Spatial Distribution





What does this all mean?

- Initial results point toward a possible signal of thermogenic methane in two watersheds
- High well density areas
- Very low methane concentrations
- Need to do more intensive sampling, compile more lines of evidence
- Results were promising enough to warrant additional internal SRBC funding

Next Steps

- Focus on Deer Lick and Meshoppen Creeks
  - validate thermogenic methane isotopic signatures
- Evaluate seasonal/flow differences
  - sample in 3 different flows
- Document extent and duration
  - sample at intervals upstream and downstream of original sampling point
- Additional lines of evidence
  - methane/ethane ratio

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Questions?
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