Thank you for funding from National Science Foundation, CUAHSI, Penn State Institutes of Energy and Environment, Penn State Earth and Environmental Systems Institute; Univ of Pittsburgh. Thank you for organizational help from PA DEP

Welcome to 5th Shale Network Workshop

Science and Cooperation around Water Quality Data and Legacy Wells

Susan L. Brantley, on behalf of the Shale Network team including Radisav Vidic, Matt Gonzales, Liza Brazil, Anna Wendt, Todd Sowers, Jennifer Williams, Patryk Soika, Dave Yoxtheimer, Jon Pollak, Kathy Brasier, Julie Vastine, Candy Wilderman, Debbie Lambert, others

Penn State, University of Pittsburgh, Dickinson College, Consortium of Universities for the Advancement of Hydrologic Sciences Inc.

This talk

(15 minute talk, 4 minutes questions, 1 minute speaker change)

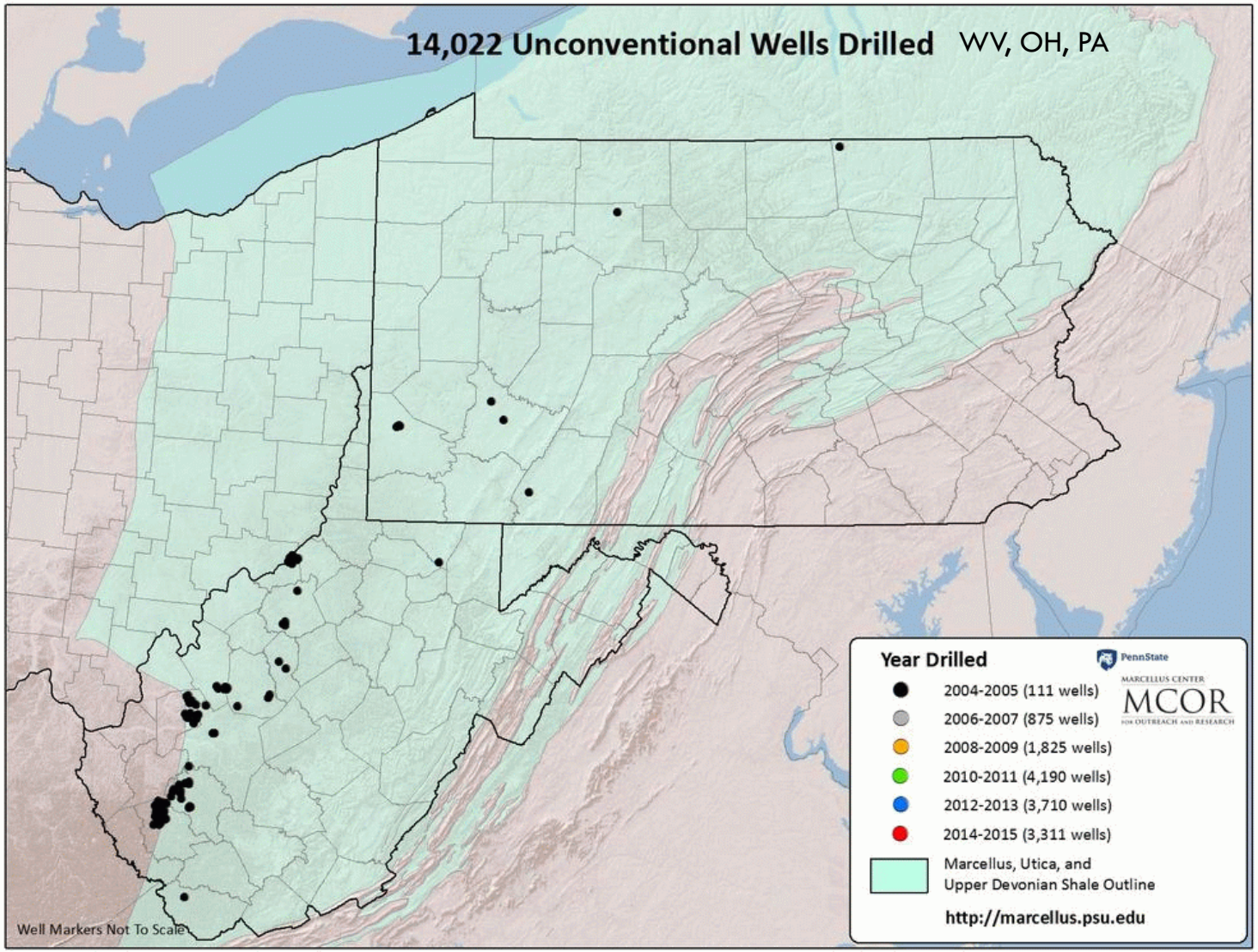
- Welcome
- Introductions (Volunteers, Academics, Gas Industry, Environmental Industry, Government Entities, Other)
- Introduction to Shale Network

Speakers please upload your talks in the correct room at least by the last break before your talk!

Remember

- Today we host nonscientists and scientists: remember that we want to try to speak jargon-free and to maintain open communication so everyone can understand and feel comfortable in the conversation

Drilled shale-gas wells since 2004



Shale Network Hypothesis

An online, shared compilation of water quality and quantity data collected by citizen scientists, government agencies, industry, nonprofit corporations and university personnel in areas of shale gas production will pull people together and provide the understanding needed to make good decisions.

PENNSTATE 1855

UNIVERSITY OF PITTSBURGH VERITAS 1787 VIRTUS

ALLARM Alliance for Aquatic Resource Monitoring est. 1986

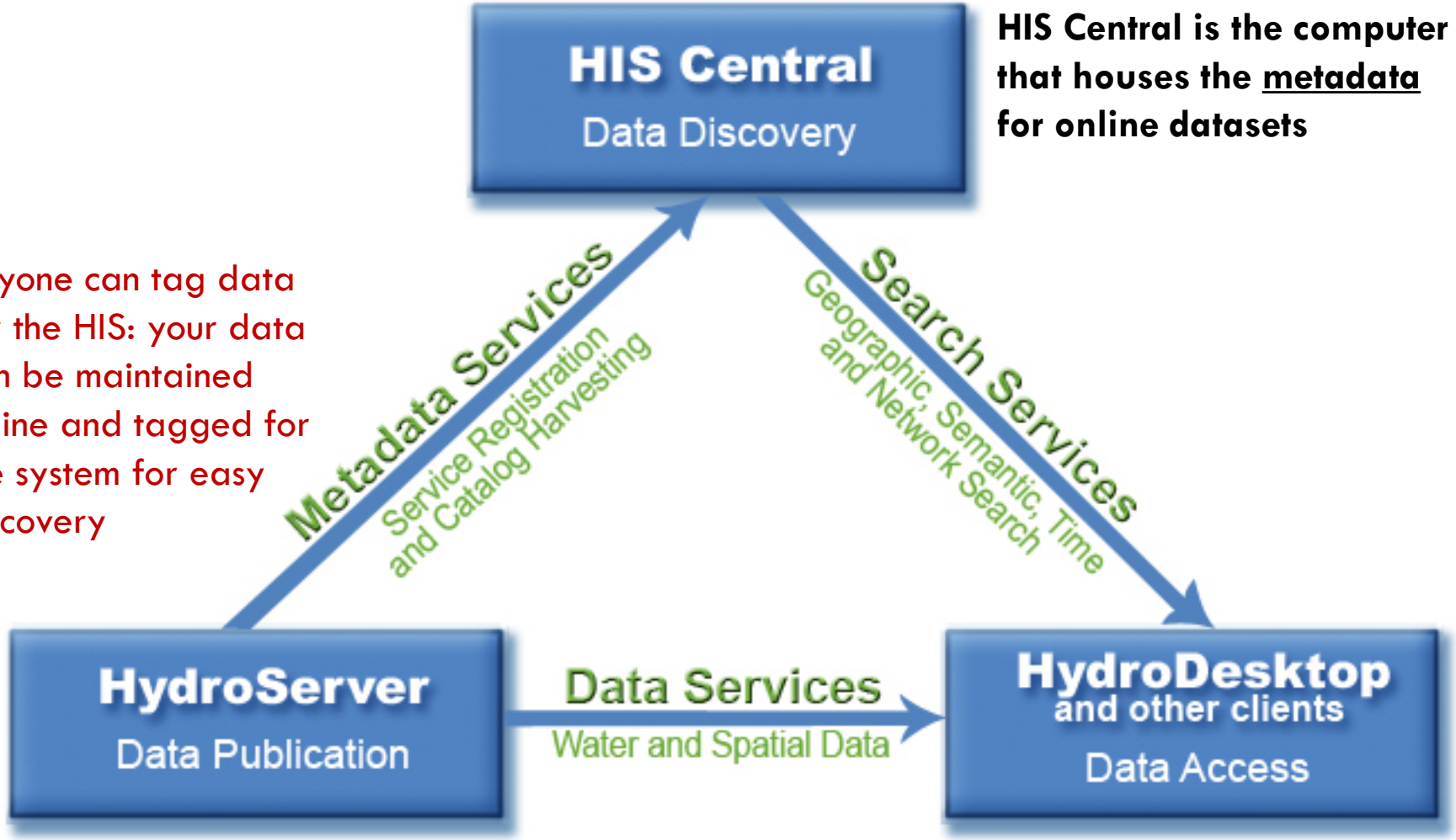
Educate. Engage. Empower.

DICKINSON COLLEGE

CUAHSI HIS

Sharing hydrologic data

What is the Hydrologic Information System?



HIS Central is the computer that houses the <u>metadata</u> for online datasets

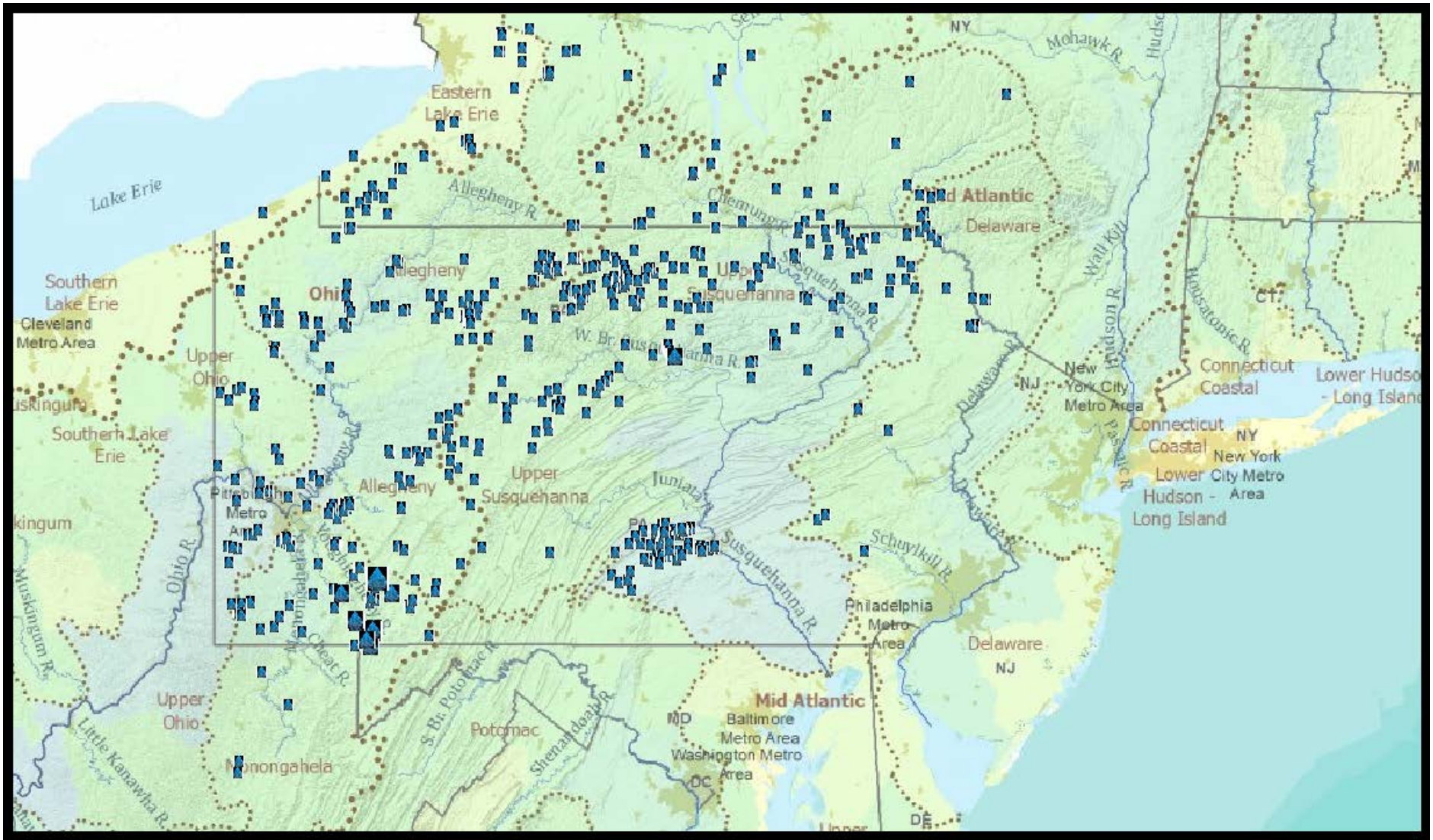
Anyone can tag data for the HIS: your data can be maintained online and tagged for the system for easy discovery

Hydroservers are computers around world that post <u>online data</u>

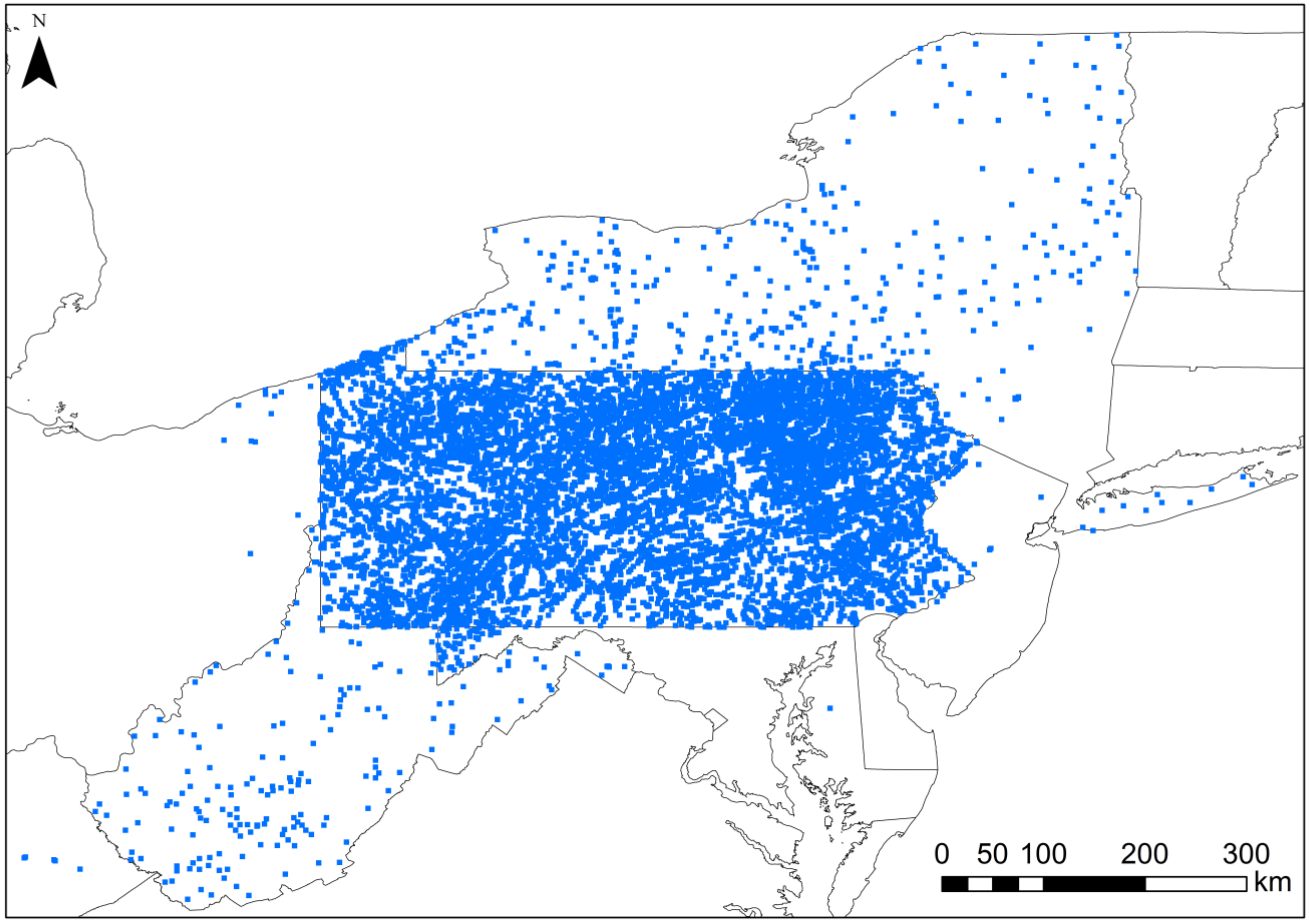
CUAHSI
universities allied for water research

HydroDesktop or HydroClient is a tool that allows you to find water data and work with it on your computer

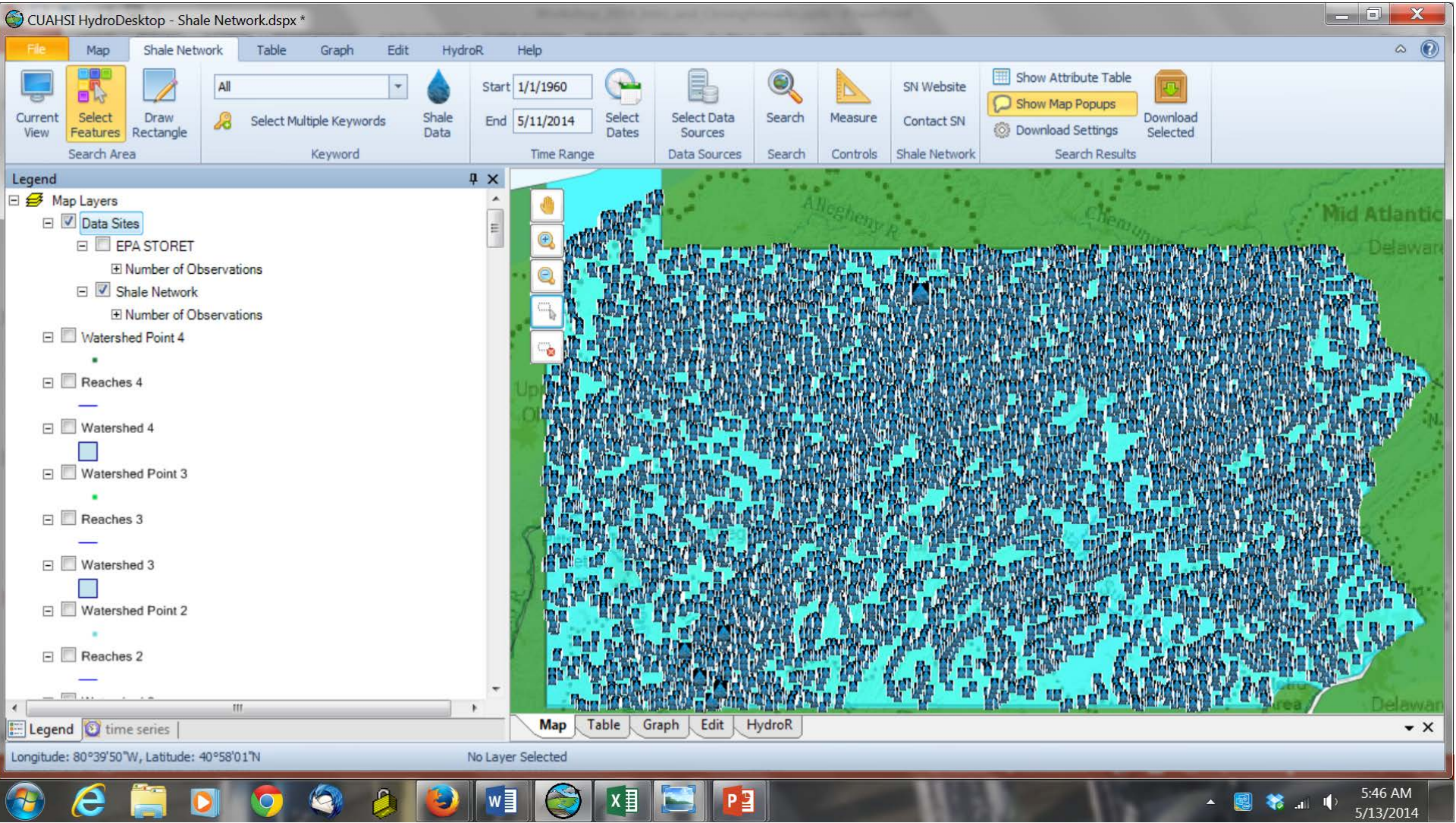
All data uploaded by Shale Network (started 10/11) as of December 2012: about 500 sites



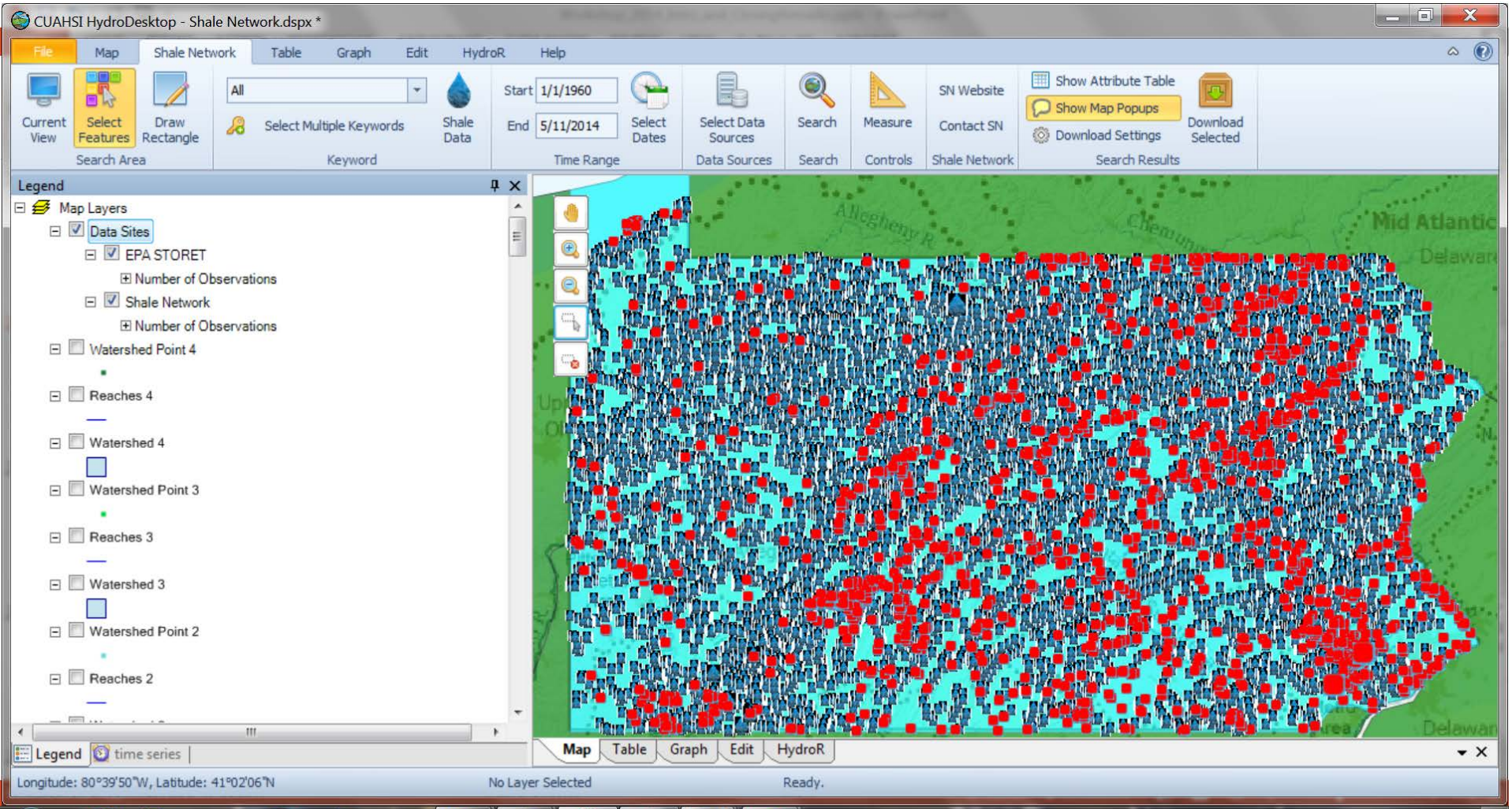
All data uploaded by Shale Network as of April 2016: 26,984 sites



Why we use HIS: Data in ShaleNetwork can be found along with EPA, USGS and other tagged data



All locations with Shale Network (blue) and EPA (red) data as of May 2014



What data types are in the database?

Data Types

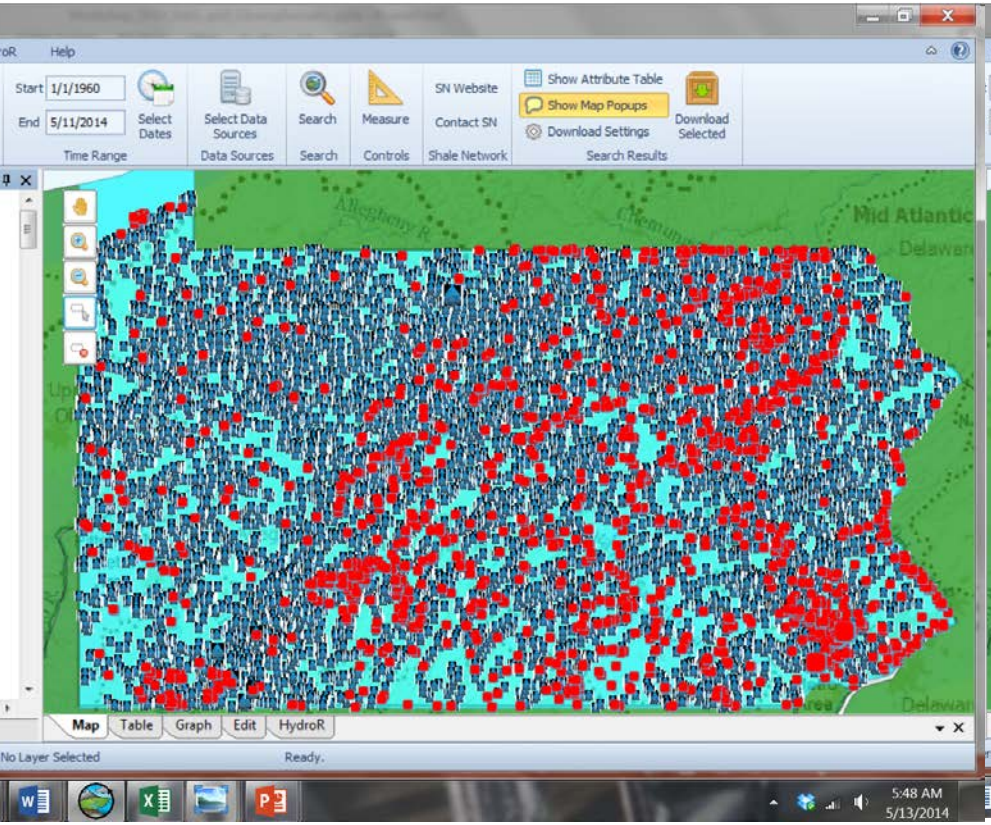
- Water quantity: discharge rates or stage height, etc
- Sensor data (water quantity, water quality)
- Chemical analyses on grab samples
- Samples collected on sporadic or regular basis

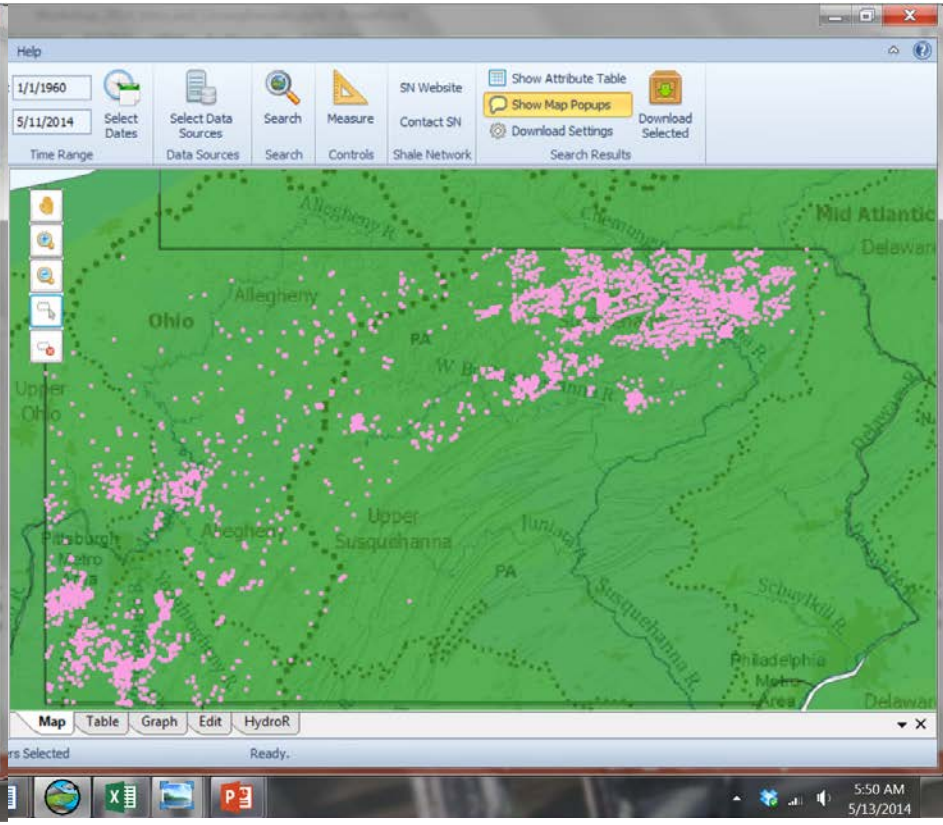
Water Types

- Surface water
- Ground water
- Flowback water
- Production water

What have we learned from publicly available data?

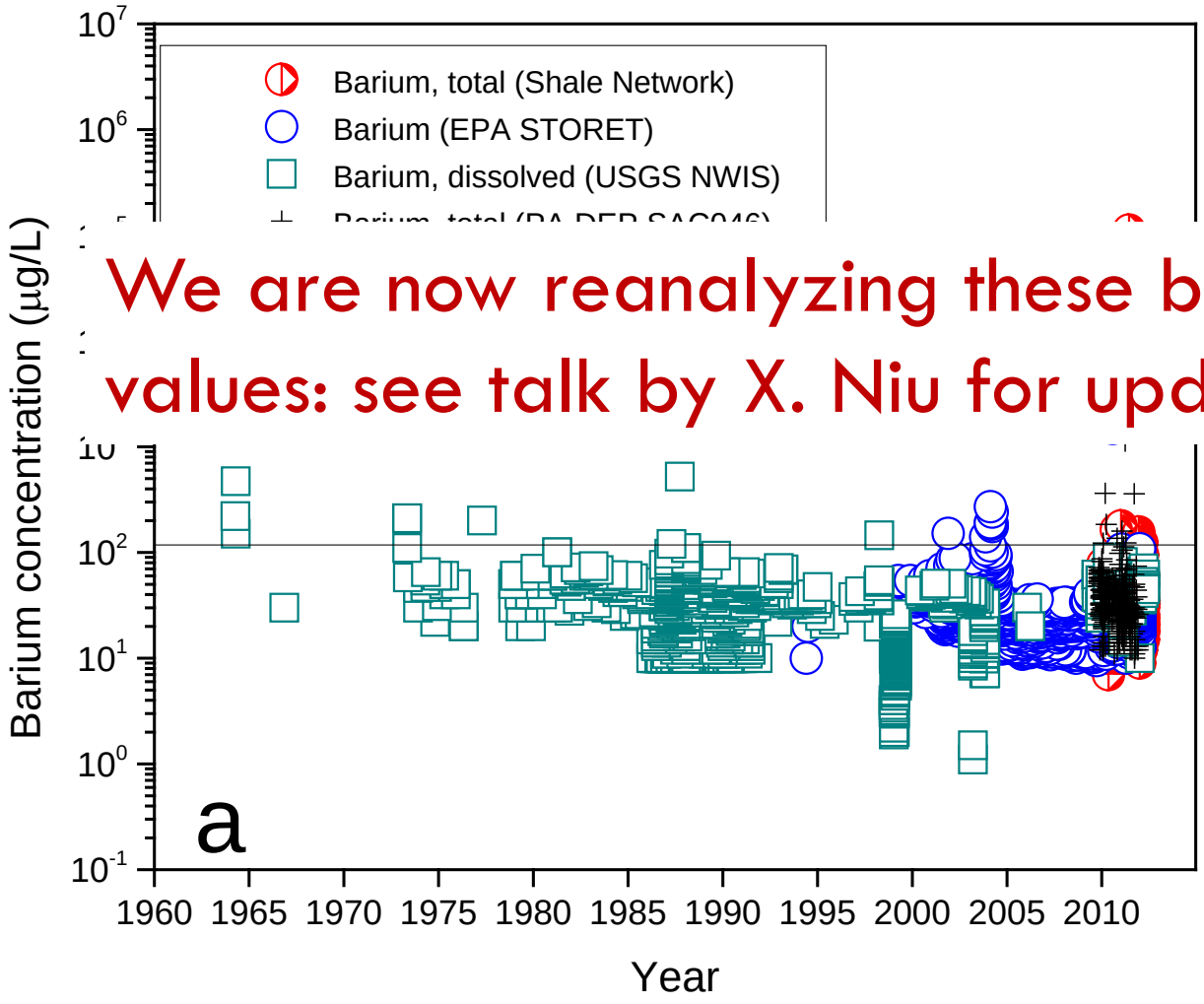
Conclusions about impacts are limited because data are not made public for enough monitoring stations located at appropriate sites with the appropriate analytes measured at the appropriate times over appropriate durations.





See talks by Anna Wendt, X Niu

Barium in surface water versus time for all 40 PA counties with Marcellus drilling



High concentrations since 2003 were generally in areas with

We are now reanalyzing these background values: see talk by X. Niu for update

1960-2003 for USGS data. Detection limit = 10ug/L. EPA MCL = 2000 ug/L

Includes data from EPA Storet, USGS NWIS, SRBC, Appal. Hydrogeo. Enviro. Consulting, ALLARM, PA DEP

Vidic, Brantley, Vandenbossche, Yoxtheimer, Abad, Science 2013

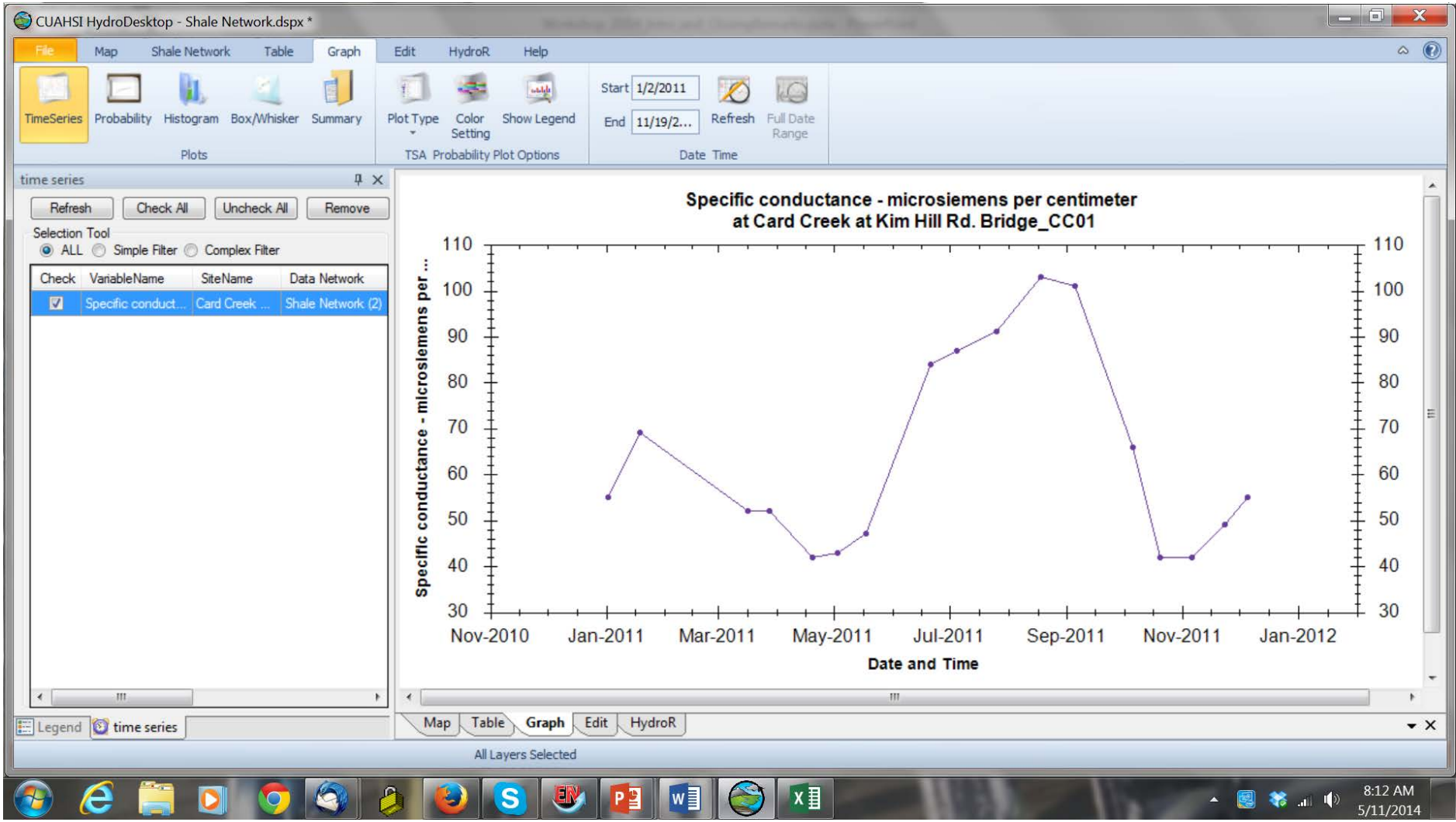
Lessons Learned in the NE Area of Shale Gas: Water Issues

- Relatively few impacts have been noted in public data collections compared to the number of shale gas wells -- but confidence in this observation is limited because of the sparseness of data.
- Due to the low incidence rate of problems, the story of contamination that can be read in publicly available data is a story of outliers.
- Problems have included: spills, subsurface leakage of injected fluids at shallow to intermediate depths, natural gas migration out of wells, natural gas and/or brine migration out of local environments, erosional incidents, and leakage of natural gas from old wells.
- Most or all of the water quality problems related to unconventional shale gas wells have been observed previously with conventional oil/gas wells.
- Most commonly reported contaminant in DEP reports of ground water issues related to oil/gas is methane.

Lessons Learned in the NE Area of Shale Gas: Data Issues

- Conclusions about impacts are limited because there are not enough monitoring stations at appropriate sites where analytes have been measured at the appropriate times over appropriate durations.
- Many challenges are present in measuring and interpreting water quality and quantity data in areas of shale gas development, ranging from problems in sensing/sampling to cyberinfrastructure. Comparatively little funding is available to overcome these challenges.
- Given the geological heterogeneity, the previous water quality impacts, and the high density of streams in the northeast, the sampling or sensor density required to detect contamination incidents is extremely high.
- Decision making about sensor placement or sampling site tends to be *ad hoc* and choice of analyte and monitoring site has varied over the years. We have found little evidence of coordination in collection, collation, analysis, and standardization of water quality data in the northeastern area of shale gas development.
- All relevant entities (academia, government, industry, watershed groups, NGOs) tend to be resistant or slow in data sharing.
- Data from *bona fide* problem sites are especially unlikely to be released.

Volunteer data: collected for Card Creek in Potter County by Cork Sauve of GC Trout Unlimited



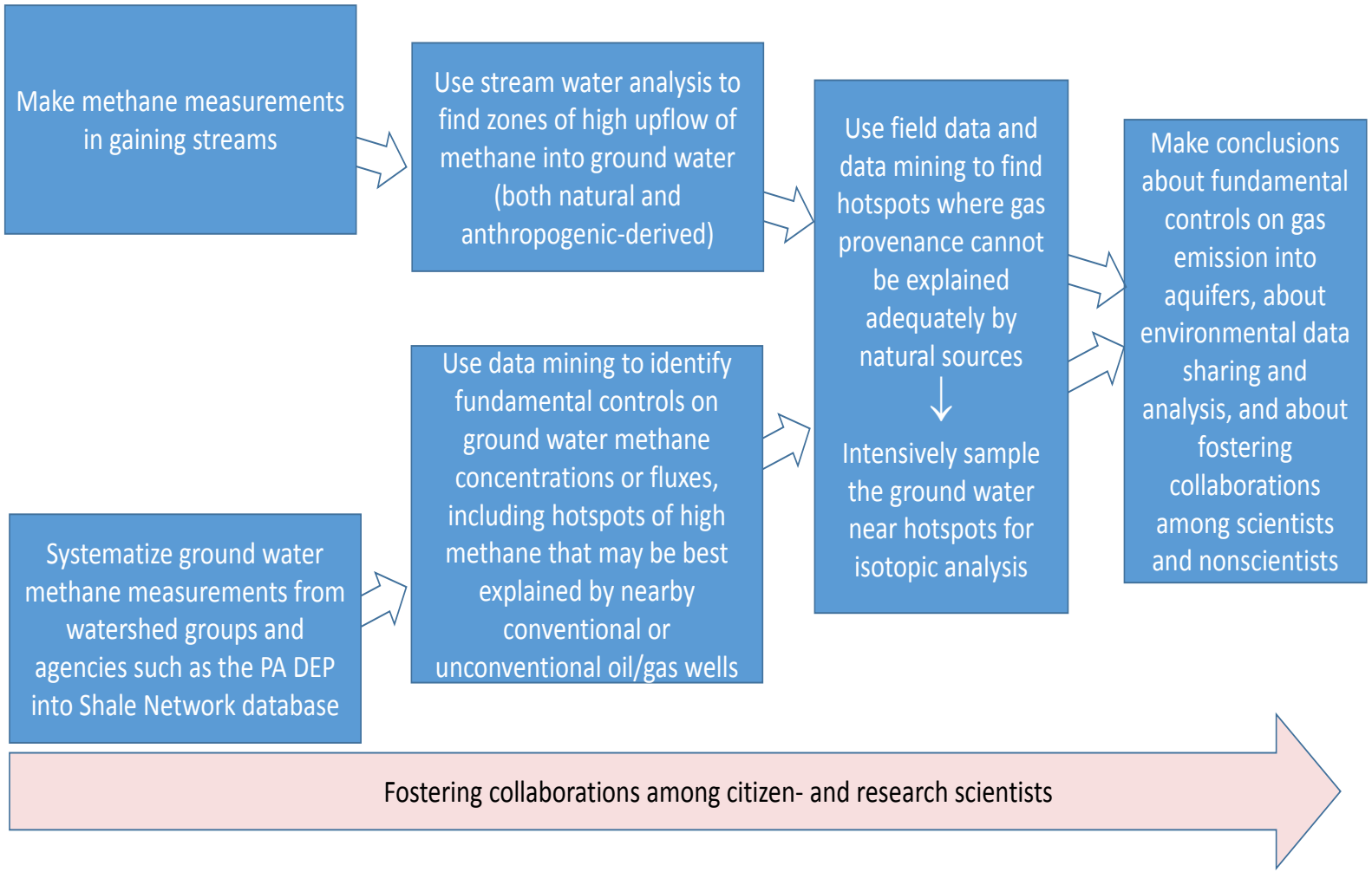
What about data quality?

- Shale Network includes data from any group using established data protocols -- from industry sources, government sources, university sources, nonprofits, citizen scientists
- SN philosophy is that even published peer-reviewed or gov't data has problems, so as much as possible we want to put data online with appropriate metadata for researchers to assess…THE BEST WAY TO ASSURE DATA QUALITY IS TO PUT IT ONLINE FOR SCRUTINY
- The metadata includes some information about data quality
- If problems are found in data we can remove data

Some Thoughts about What is Needed

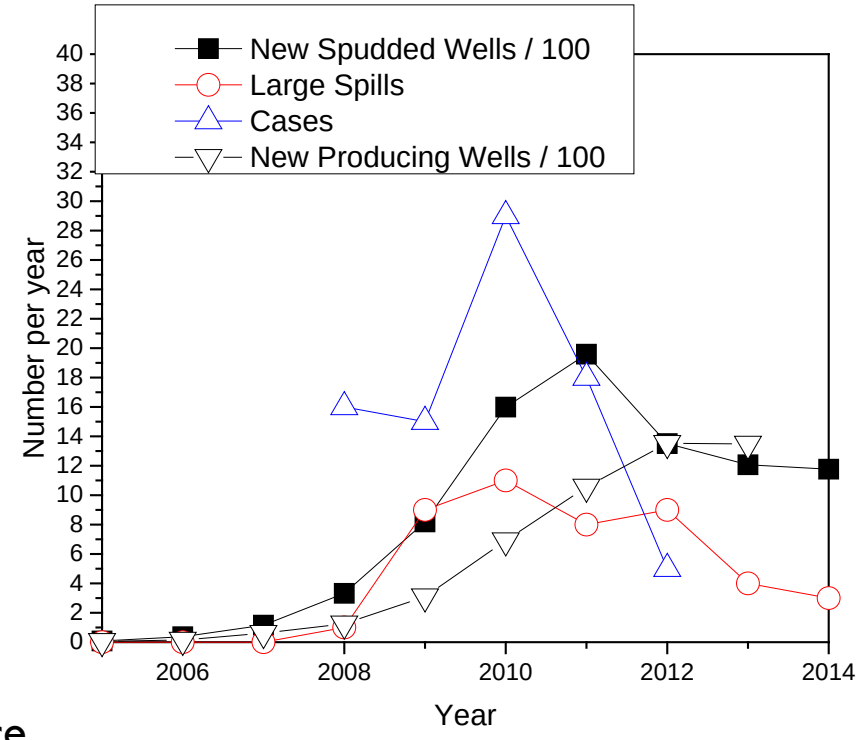
- Public data is a requirement for public confidence in any activity that is related to water quality. Data sharing, even at litigated sites, should be promoted.
- Perhaps the most important goal of monitoring should be *to assess background conditions* over extended durations of time: this is what we want to protect.
- With 10,000 shale gas wells and 300,000 conventional wells, we need methods to look over broad areas for problems and then focus on specific sites.
- Data tagging and cyberinfrastructure standards are needed to promote the use of data from all entities: government, industry, citizen science, academia, NGOs.
- Citizen science has a role to play to assess background values: "background" is what we are trying to protect.
- Research is needed to i) find leakage from old wells; ii) determine potential problems related to radioactive elements; iii) assess background values of water quality; iv) maintain and improve well integrity; v) replace the use of toxic by nontoxic compounds; vi) improve cyberinfrastructures for data sharing; vii) learn how to promote data standardization and sharing.

Conceptual model for a way forward?



The five top water issues related to oil/gas in northeast

- Methane migration due to relatively rare well integrity issues
- Spills or leaks
- Brine disposal over the long term
- Old wells or shallow/intermediate depth fractures acting as potential transport pathways
- Low-concentration radioactive contaminants in wastes: a longer term problem, or no problem?



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Observations about data sharing

- All entities have reasons not to share data
- Many entities want to build their own data models or cyberinfrastructure to house their own data
- The multiplicity of data models, data standards, and data cyberinfrastructures impedes understanding
- Building a cyberinfrastructure that is robust and efficient to use is difficult -- it takes resources over a sustained time (commercial products are pricey; nonprofit products can be simplistic or glitchey)
- Without access to publicly available data that can be easily inspected, the public loses faith in the process and the social license for an activity can be lost