Assessment of surface water chloride and conductivity trends in areas of unconventional oil and gas development – Why existing national data sets cannot tell us what we would like to know

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Briefing Outline

- Background and issues
- Objectives
- Approach and methods
- Results
- Publications
- Questions and discussion

Background and Issues

- Unconventional oil and gas are key to the projected U.S. energy supply mix
- Hydraulic fracturing is typically required to access unconventional oil and gas resources
- Increased interest in potential effects of hydraulic fracturing on water resources
- Very little credible scientific information available
- In 2010 an average of 2,814 oil, gas, and dry wells were drilled per month in the U.S.
- Logical role for USGS… Powell Center Proposal

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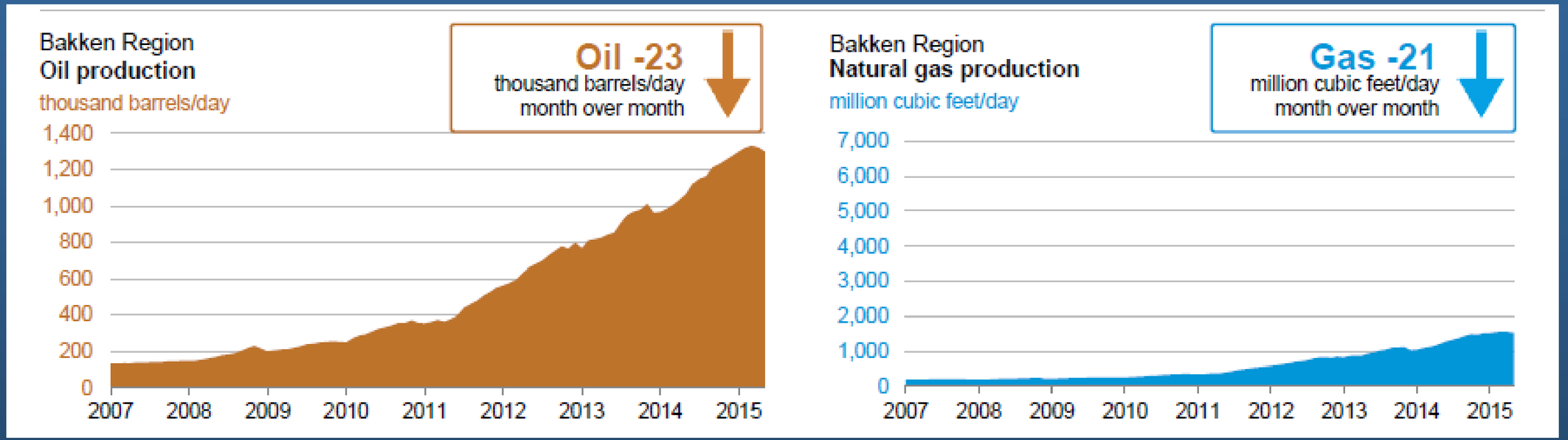
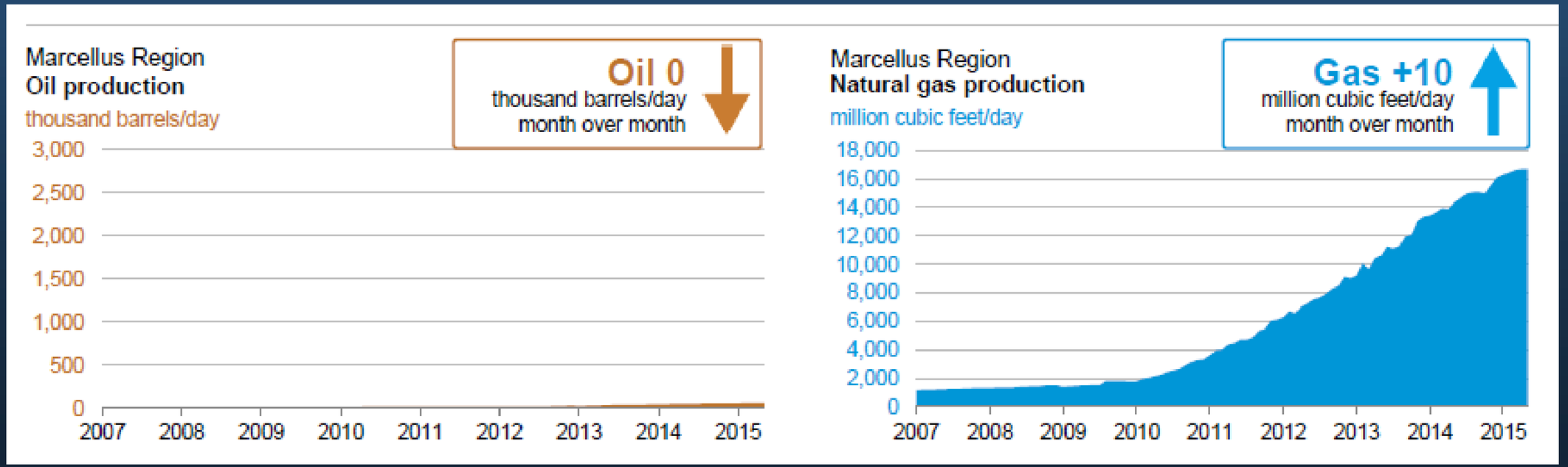
Unconventional Oil and Gas Production





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EIA, April 2015 Drilling Productivity Report

Objectives

Utilize existing National databases to:

- Better understand hydraulic fracturing in the U.S.
- Assess the quality of both surface water and groundwater in areas of oil and gas production
- Evaluate potential changes in water quality over time
- Establish current baseline concentrations of major ions in surface water and groundwater
- Identify data gaps and research needs

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Approach and Methods

- Developed a new map for unconventional oil and gas resource potential areas in the U.S. and identified watersheds in these areas
- Quantified hydraulic fracturing activity in the U.S. from 1900-2010 and summarized by watersheds
- Retrieved 11,401,883 results from over 110,000 sites for surface water and ground water quality from NWIS and STORET in watersheds in areas with unconventional oil and gas resources
- Analyzed watershed trends in number of hydraulically fractured wells and trends in chloride and specific conductance from 1970-2010

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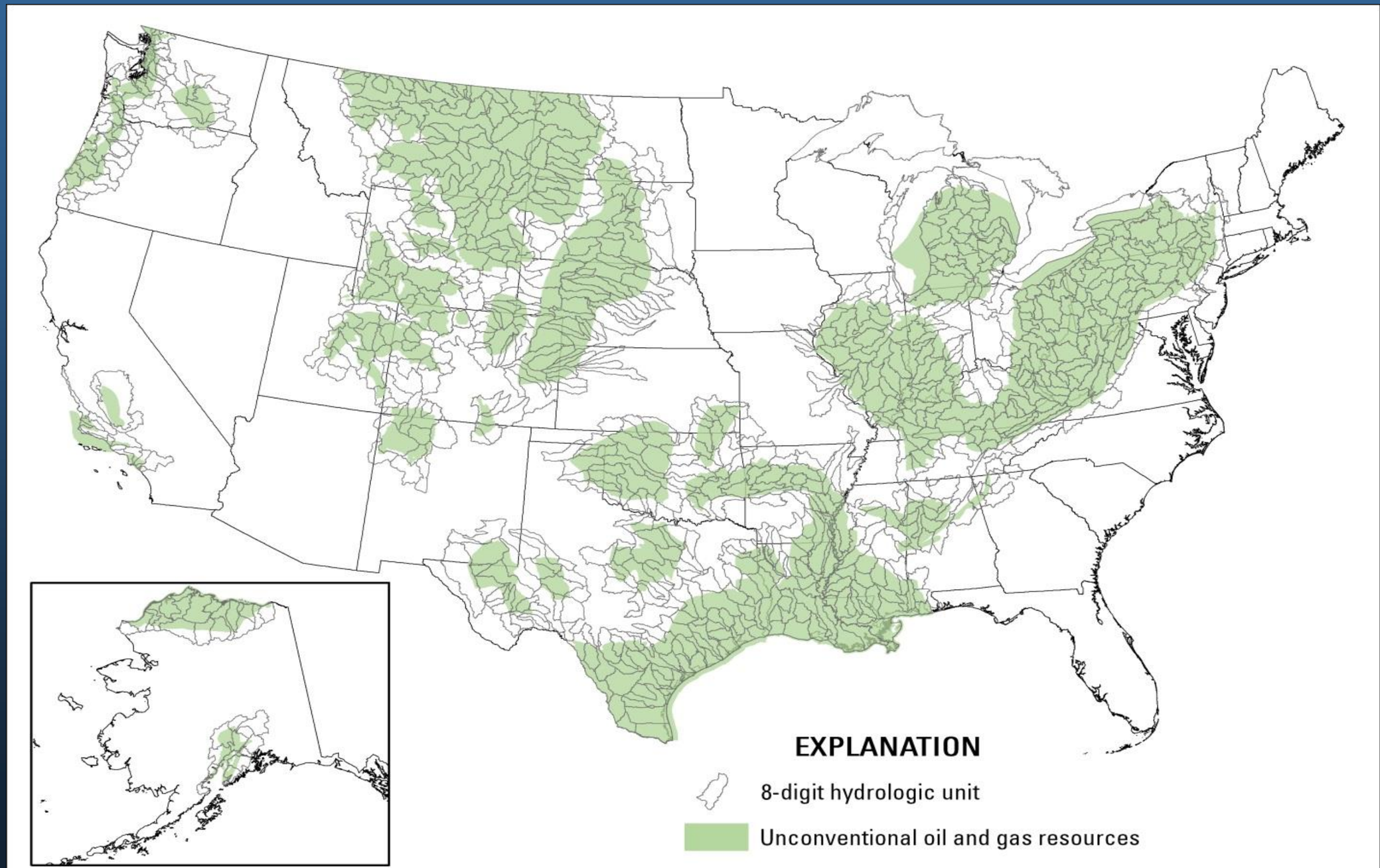
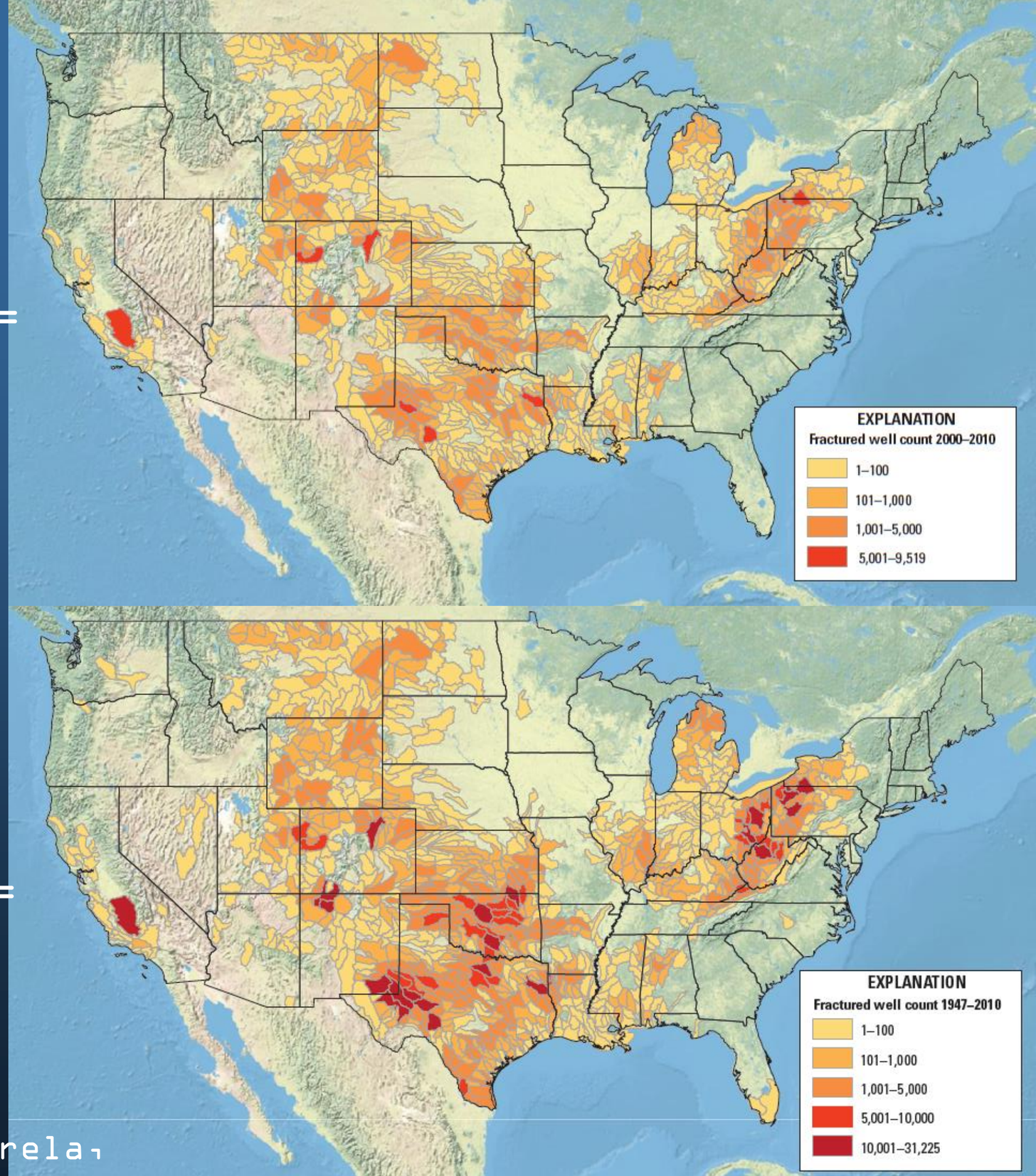
Areas of Unconventional Oil and Gas Potential and Watersheds



Fractured Well Counts

2000 - 2010 N = 278,000



1947 - 2010 N = 986,600

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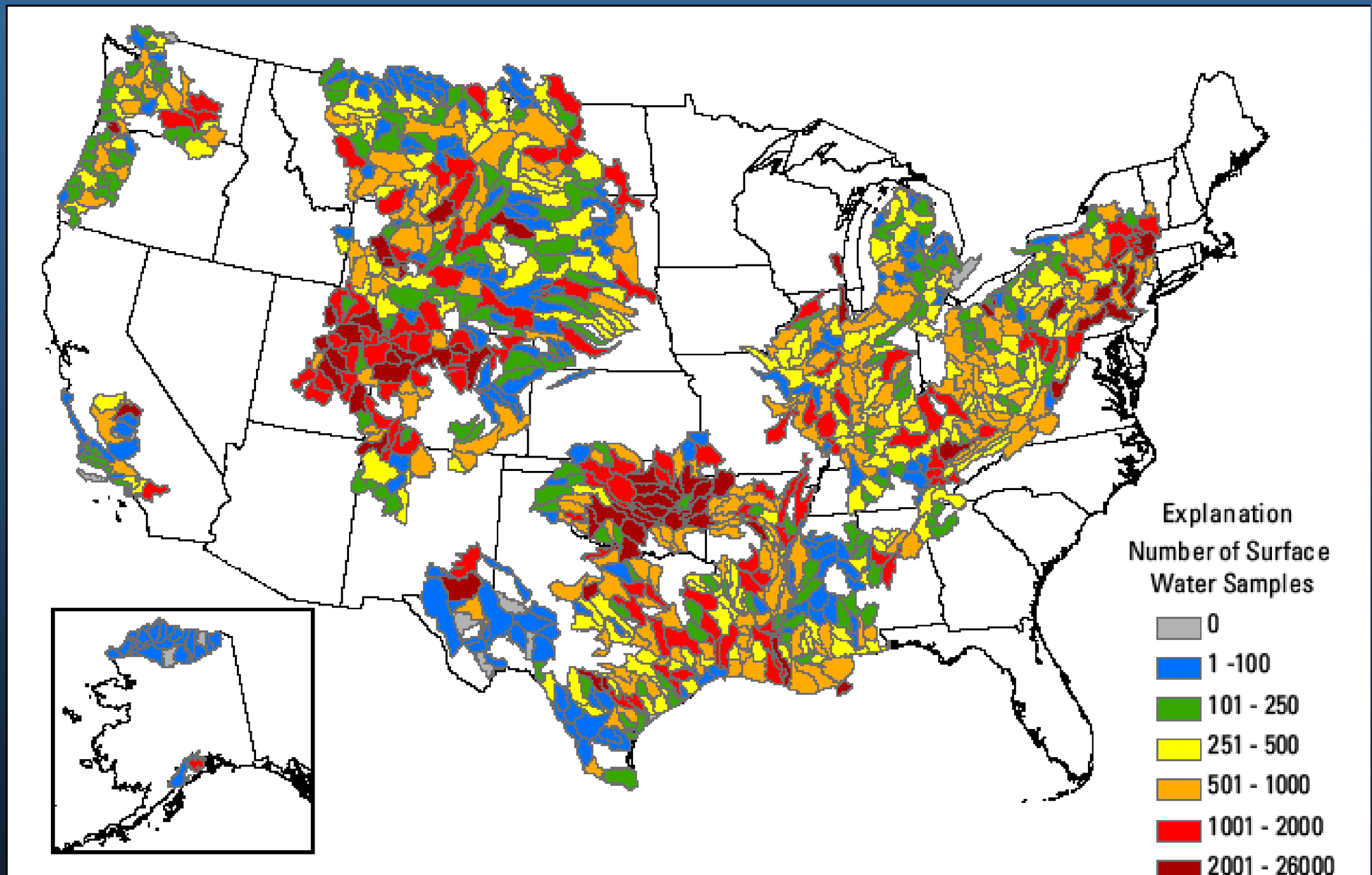
(Gallegos, T.J., and Varela,

Surface Water Sample Results



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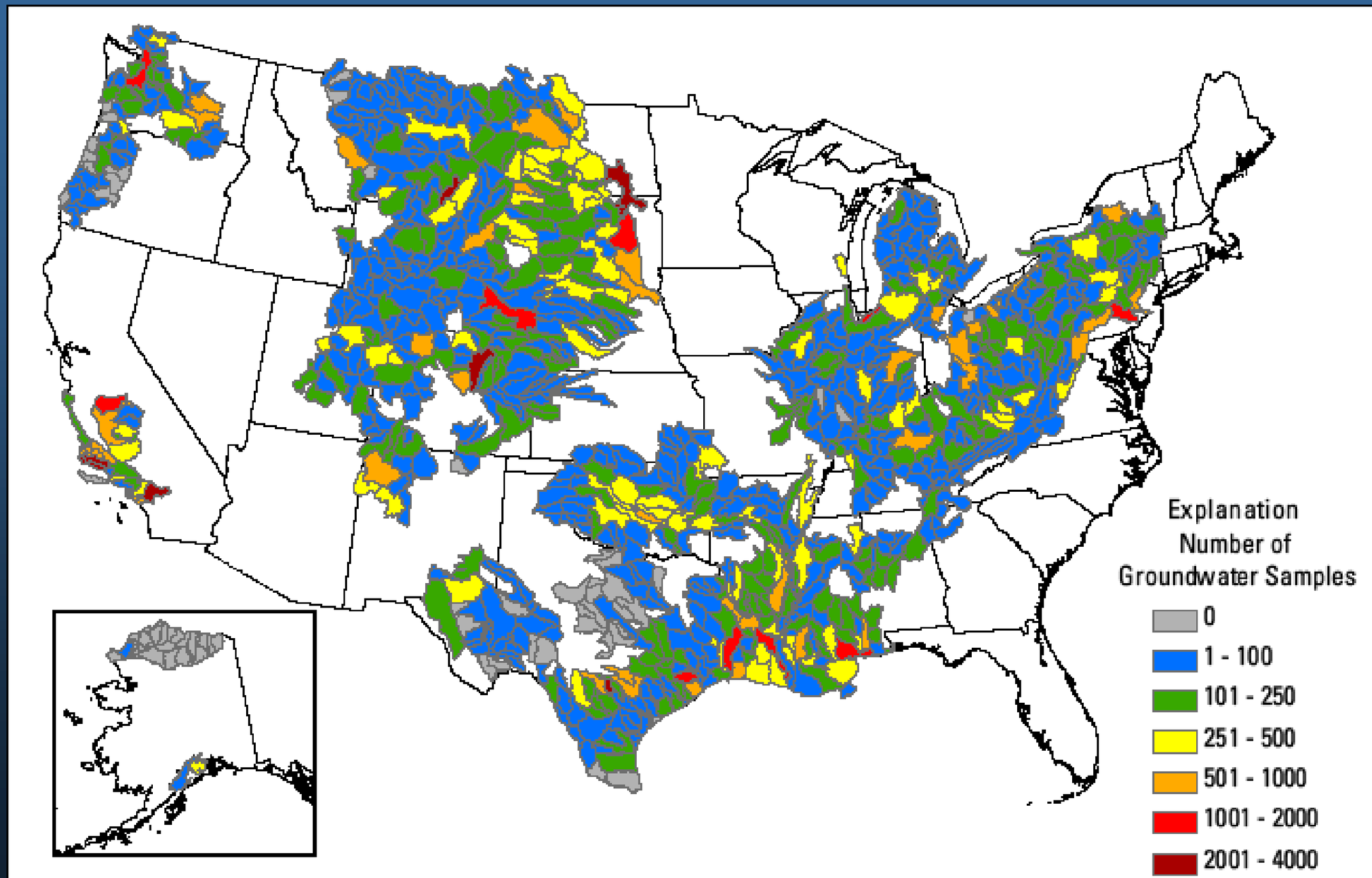
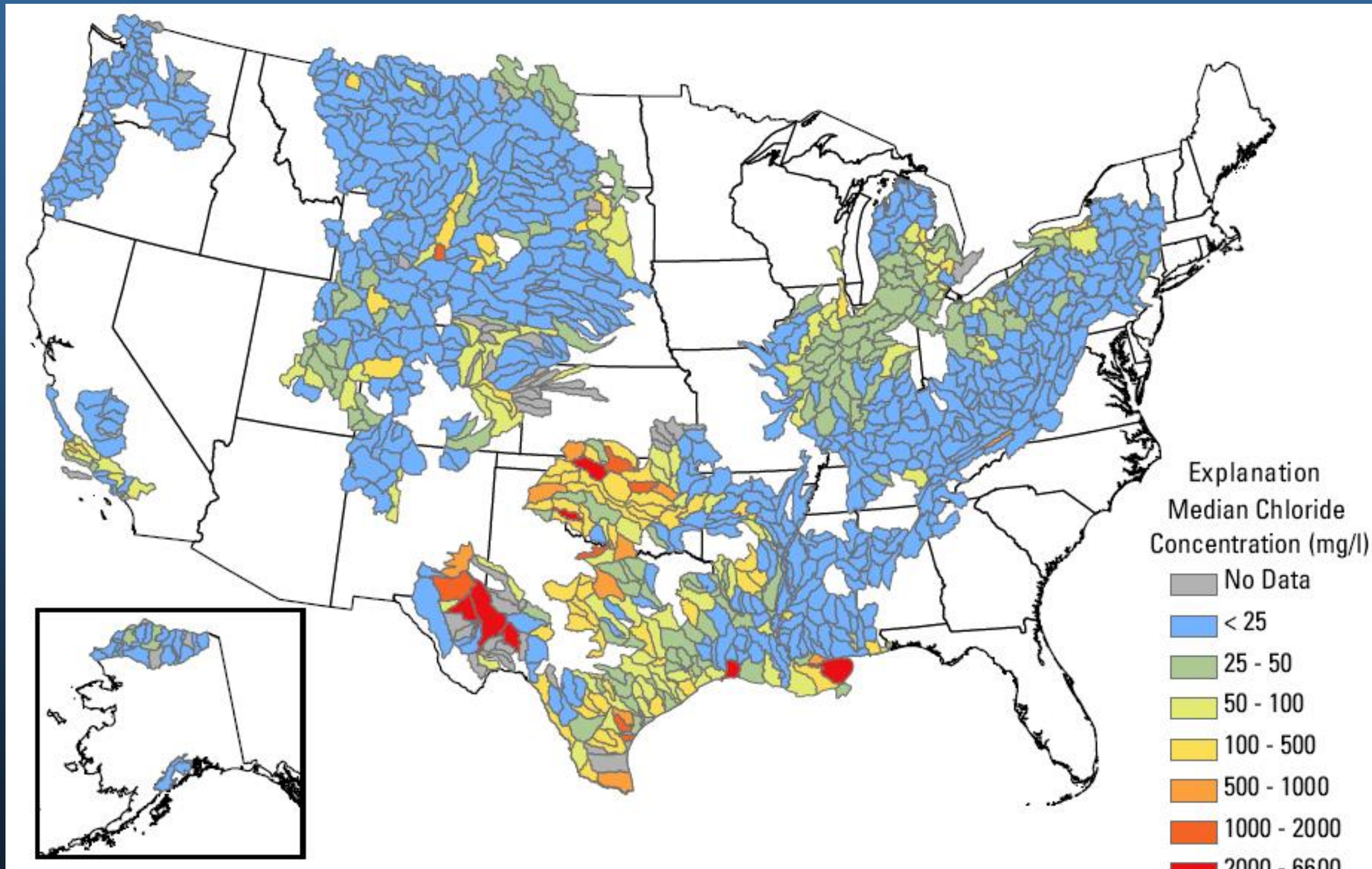
Ground Water Sample Results



Chloride in Surface Water



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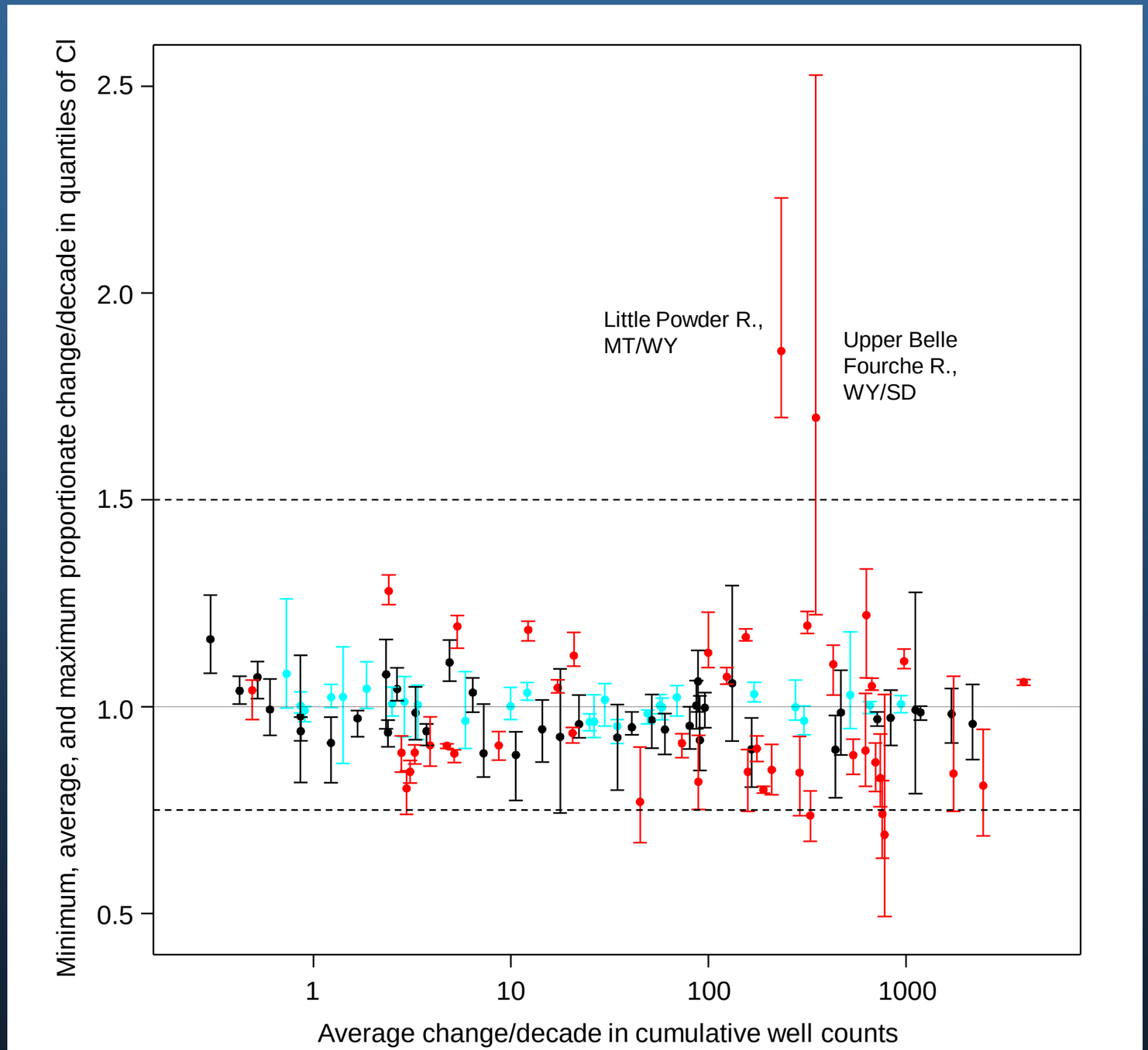
Min., average, and max. change in quantiles of chloride for 107 HUCs with changes in unconventional oil/gas wells, 1970-2010.



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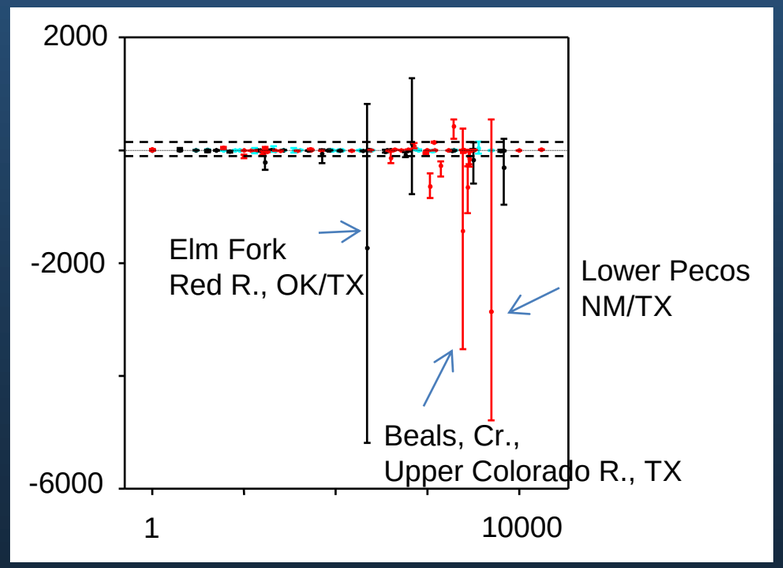
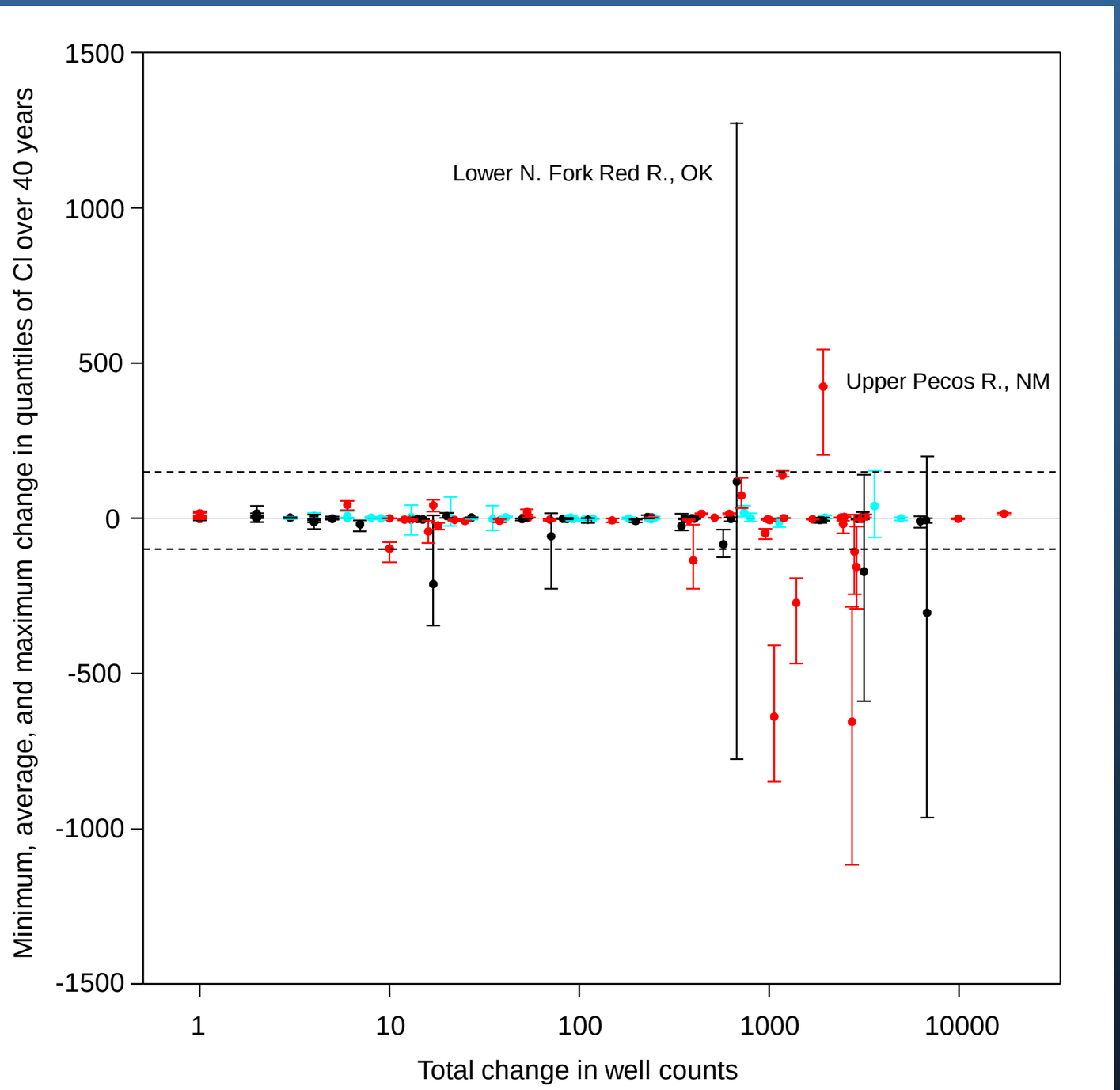
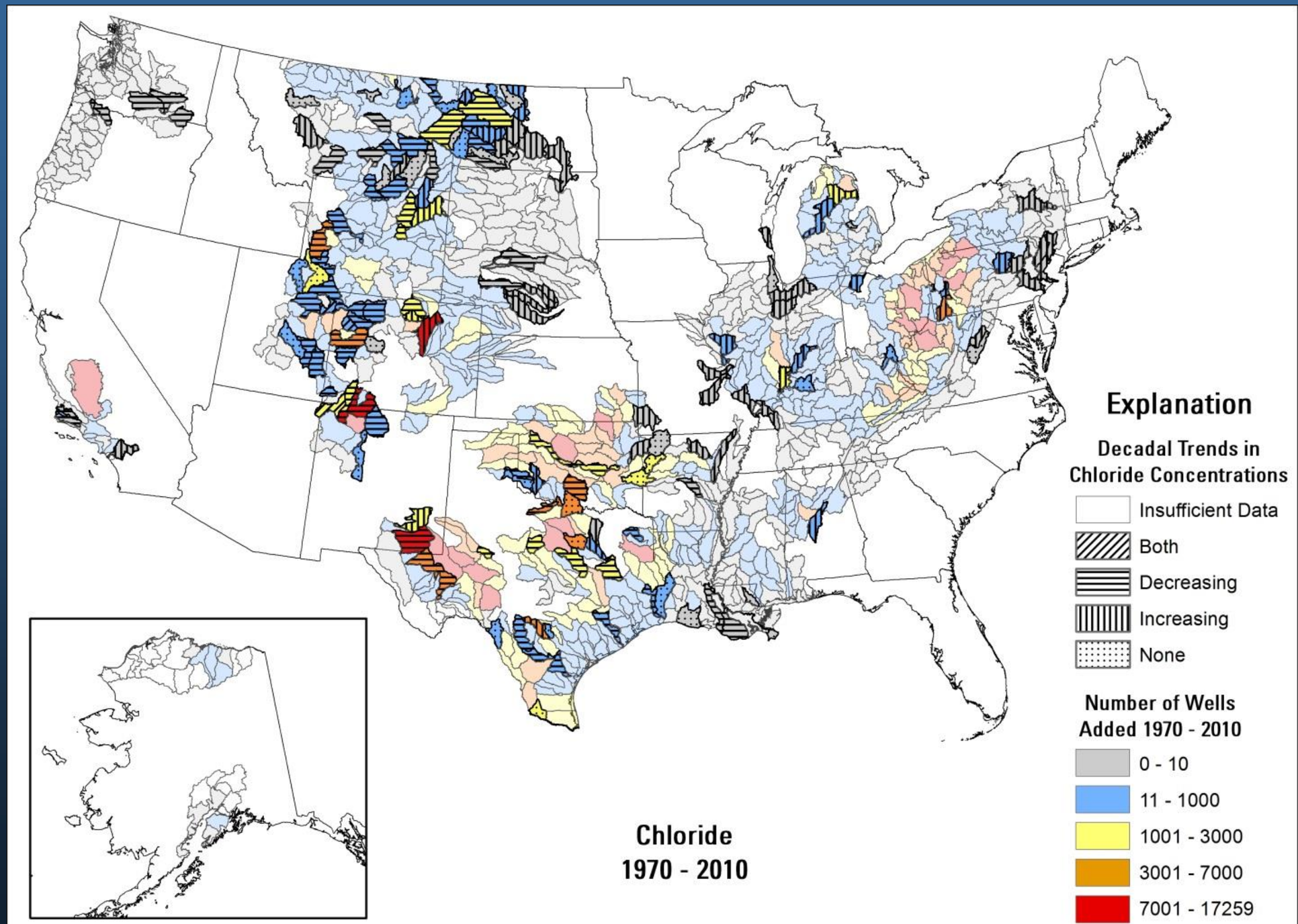
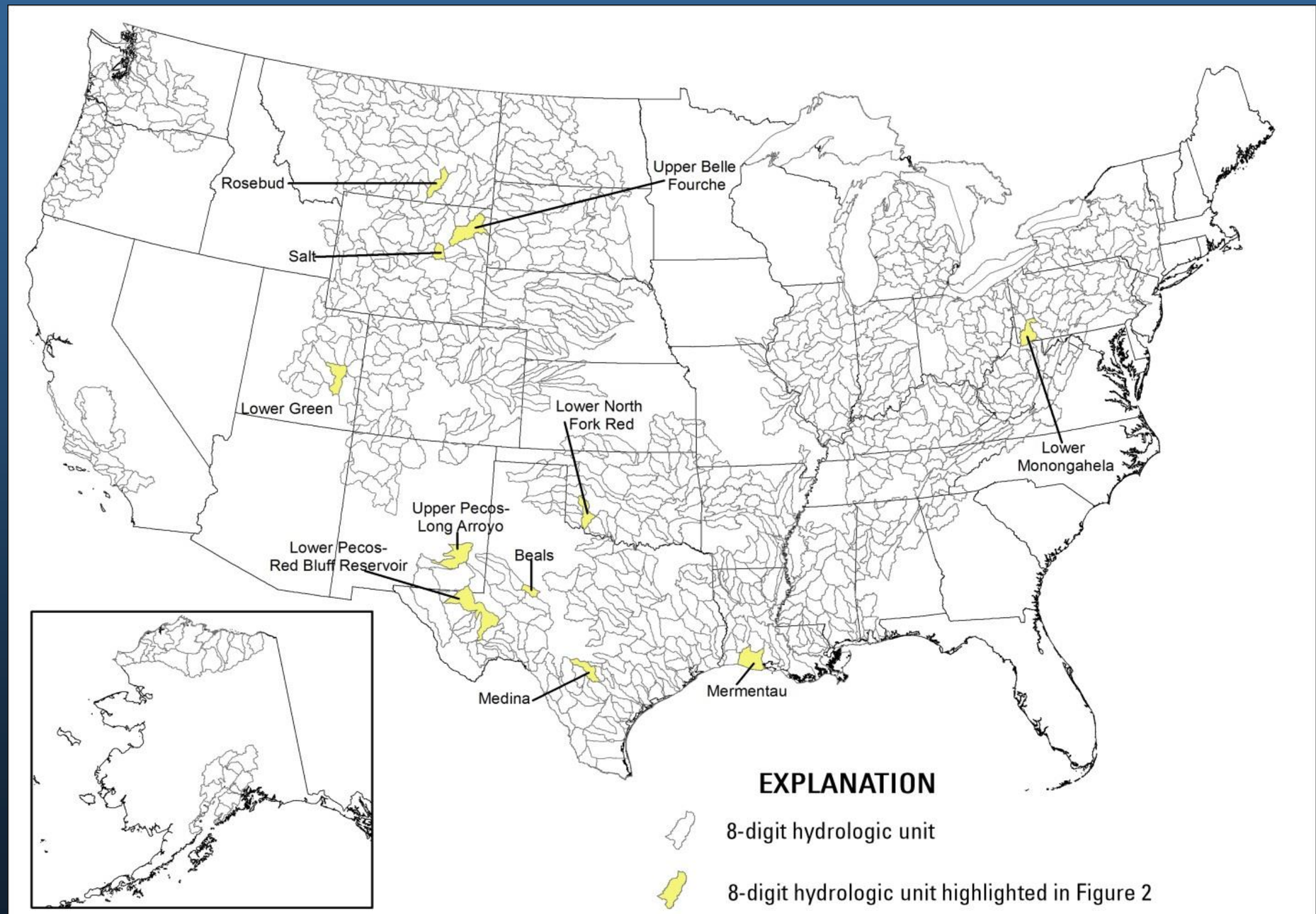




Decadal Trends in Cl^- and Wells Added



Watersheds with Relatively Large Trends in Water Quality



Summary

- National water quality databases were mined to assess trends in oil and gas areas

- No widespread trends in Cl- and SC noted in areas with increases in number of unconventional oil and gas wells

- Available analytes, spatial distribution, and frequency of water quality samples are limiting in national data sets

- Data limitations hamper rigorous regional or national assessment of potential linkages between UOG development and water quality

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Publications

AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE

10.1002/2014WR016382

Assessment of surface water chloride and conductivity trends in areas of unconventional oil and gas development—Why existing national data sets cannot tell us what we would like to know

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Key Points:
- We mined national water databases to assess trends in unconventional oil and gas areas
- No widespread trends in Cl- and SC noted in areas with increased oil and gas wells
- Analytes, spatial distribution, and frequency of samples are limiting in national data

Supporting Information:
- Supporting Information S1

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Abstract Heightened concern regarding the potential effects of unconventional oil and gas development on regional water quality has emerged, but the few studies on this topic are limited in geographic scope. Here we evaluate the potential utility of national and publicly available water-quality data sets for addressing questions regarding unconventional oil and gas development. We used existing U.S. Geological Survey and U.S. Environmental Protection Agency data sets to increase understanding of the spatial distribution of unconventional oil and gas development in the U.S. and broadly assess surface water quality trends in these areas. Based on sample size limitations, we were able to estimate trends in specific conductance (SC) and chloride (Cl^-) from 1970 to 2010 in 16% ($n = 155$) of the watersheds with unconventional oil and gas resources. We assessed these trends relative to spatiotemporal distributions of hydraulically fractured wells. Results from this limited analysis suggest no consistent and widespread trends in surface water quality for SC and Cl^- in areas with increasing unconventional oil and gas development and highlight limitations of existing national databases for addressing questions regarding unconventional oil and gas development and water quality.

1. Introduction

The United States (U.S.) is forecast to remain one of the world's largest oil and gas producers in the coming decades, with projected growth largely from the development of unconventional oil and gas resources, including shale gas, shale oil, tight-gas sands, and coal-bed gas [*International Energy Agency*, 2012]. Unlike conventional structural or stratigraphic oil and gas reservoirs, unconventional oil and gas resources are characterized by large areal extents of low-permeability accumulations, and are self-sourced or in close proximity to the source rock. Development of unconventional oil and gas resources typically requires advanced drilling and well-completion methods, including directional or horizontal drilling in conjunction with hydraulic fracturing (HF). From 2000 to 2010, at least 749,000 HF treatments were reported in the U.S. [*Gallegos and Varela*, 2015a, 2015b]. As use of HF for producing domestic oil and gas has increased during the last decade, so has public concern about its potential effects on surface water and groundwater resources.

Many of the chemicals used in hydraulic fracturing fluids are known to have direct or indirect effects on human and ecosystem health [*Colborn et al.*, 2011; *U.S. Environmental Protection Agency*, 2004]. Interaction

Bowen, Z. H., et al. (2015), Assessment of surface water chloride and conductivity trends in areas of unconventional oil and gas development—Why existing national data sets cannot tell us what we would like to know, Water Resour. Res., 51, 704–715, doi:10.1002/2014WR016382.

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Trends in Hydraulic Fracturing Distributions and Treatment Fluids, Additives, Proppants, and Water Volumes Applied to Wells Drilled in the United States from 1947 through 2010—Data Analysis and Comparison to the Literature

Scientific Investigations Report 2014–5131

U.S. Department of the Interior
U.S. Geological Survey

Gallegos, T.J., and Varela, B.A., 2015, Trends in hydraulic fracturing distributions and treatment fluids, additives, proppants, and water volumes applied to wells drilled in the United States from 1947 through 2010—Data analysis and comparison to the literature: U.S. Geological Survey Scientific

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Data Regarding Hydraulic Fracturing Distributions and Treatment Fluids, Additives, Proppants, and Water Volumes Applied to Wells Drilled in the United States from 1947 through 2010

Data Series 868

U.S. Department of the Interior
U.S. Geological Survey

Gallegos, T.J., and Varela, B.A., 2015, Data regarding hydraulic fracturing distributions and treatment fluids, additives, proppants, and water volumes applied to wells drilled in the United States from 1947 through 2010: U.S. Geological Survey Data Series 44, 11 p.

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In Progress - UOG Citation Tracker

- Searchable citation database for UOG and environmental effects
- Actively maintained with searches run quarterly
- Short-term use with ongoing USGS work; will expand to include EPA and DOE input