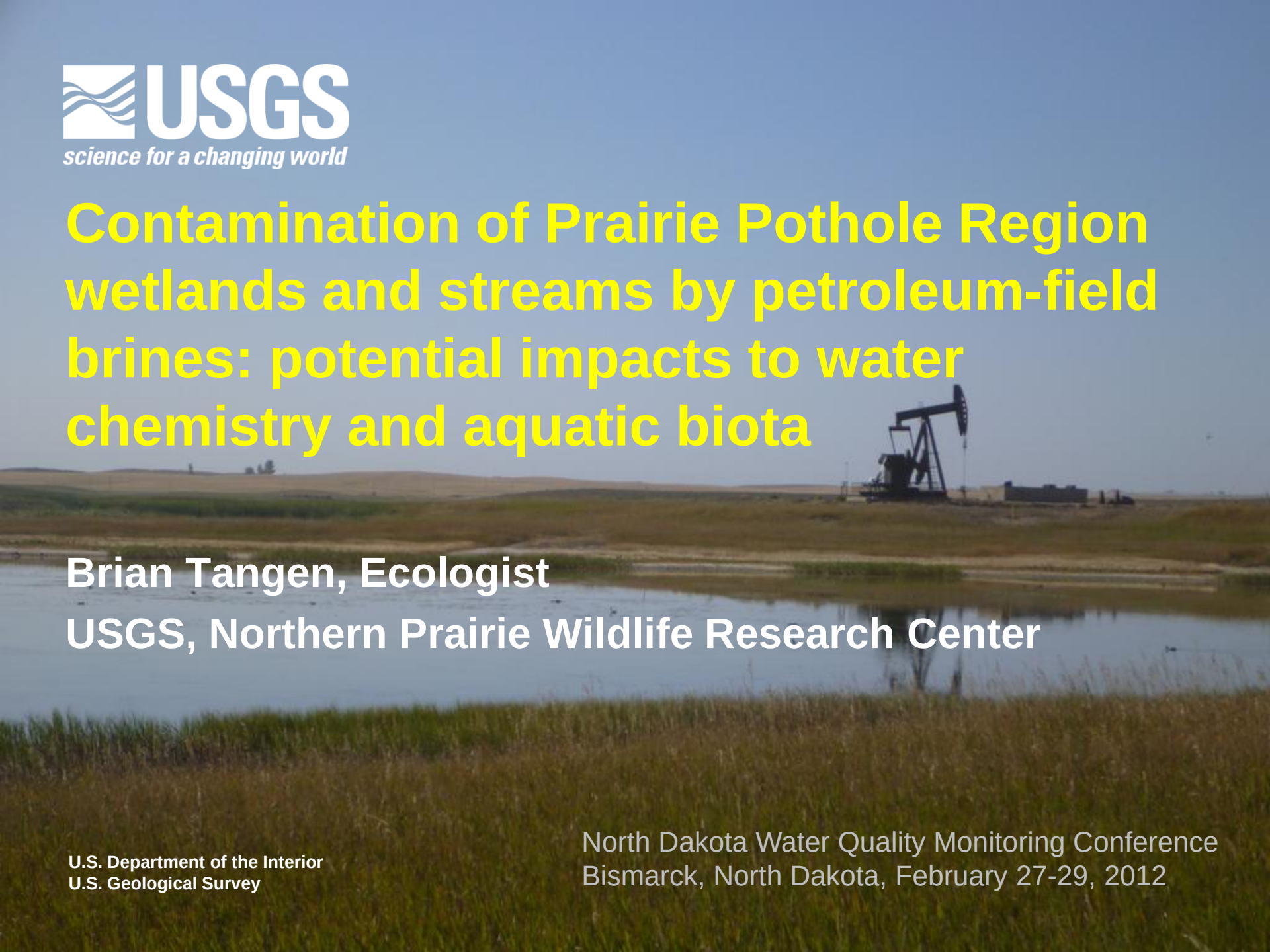

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science for a changing world

Contamination of Prairie Pothole Region wetlands and streams by petroleum-field brines: potential impacts to water chemistry and aquatic biota

Brian Tangen, Ecologist

USGS, Northern Prairie Wildlife Research Center

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

North Dakota Water Quality Monitoring Conference
Bismarck, North Dakota, February 27-29, 2012

Brine Contamination from Energy Development in the Williston Basin

USGS Northern Prairie Wildlife Research Center

- Robert Gleason, Max Post van der Burg, Brian Tangen

USGS Montana Water Science Center

- Joanna Thamke

USGS Crustal Geophysics and Geochemistry Science Center

- Bruce Smith

USGS Northern Rocky Mountain Science Center

- Todd Preston
- Tara Chesley-Preston

- USGS Fact Sheet: http://pubs.usgs.gov/fs/2011/3047/
- USGS Professional Paper forthcoming (2012)

Project web site: http://steppe.cr.usgs.gov/

USGS

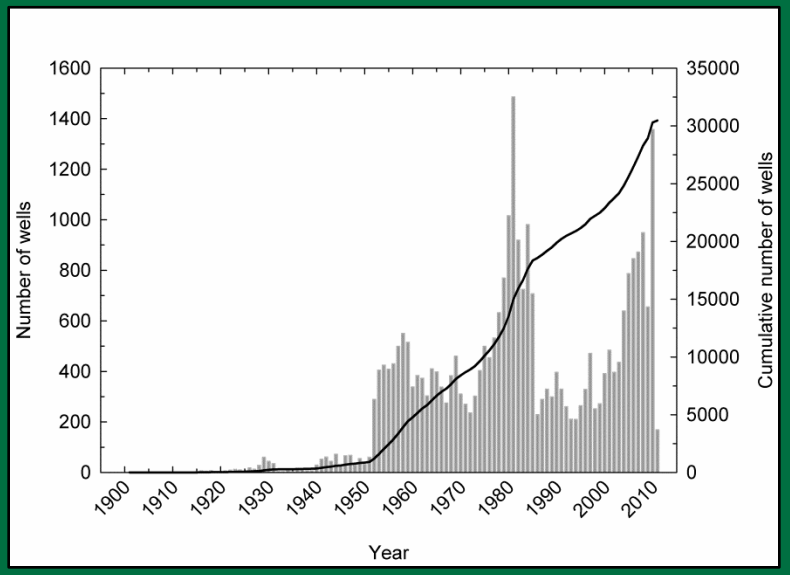
Overview

Williston Basin

- Mont., N. Dak., S. Dak.
- Leading domestic oil-producing region for more than half a century

Bakken “oil boom”

- Large reserve
- USGS assessment
  http://pubs.usgs.gov/fs/2008/3021/
- Technological advances
- Oil prices



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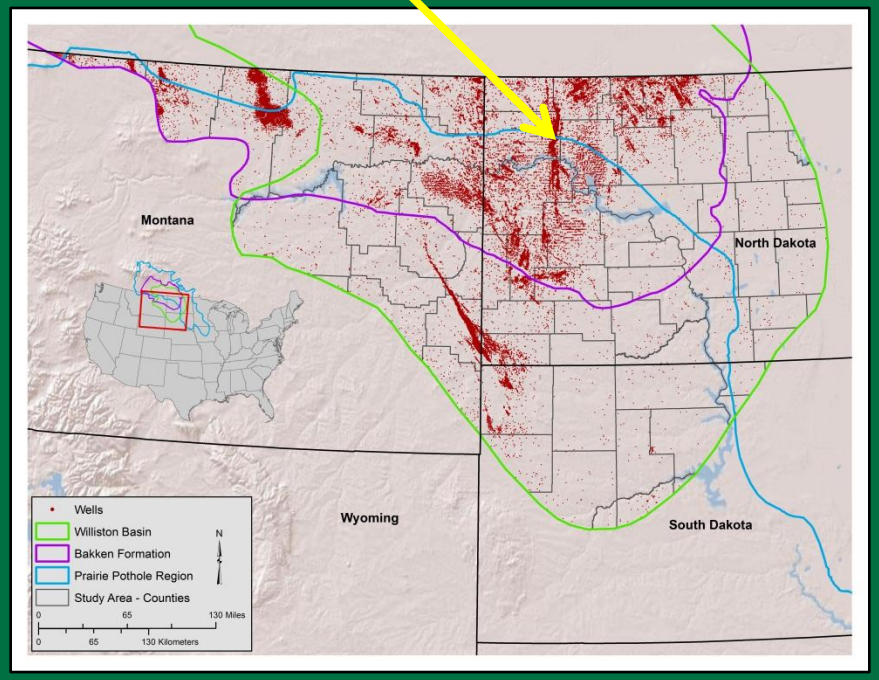
Overview

Prairie Pothole Region



- Pothole wetlands
- Environmental concerns
  - Spills
  - Habitat
  - Disturbance/wildlife
- Brine contamination
  - Surface waters
  - Groundwater/aquifers
- Implications to ecosystems?

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Aquatic resources

- Pothole wetlands
- Streams
- Stock ponds

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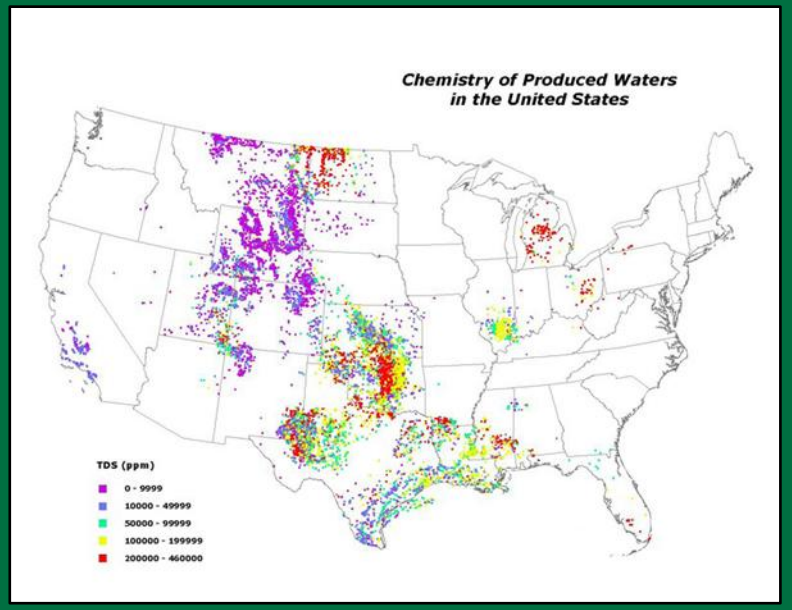
Brine

- Co-produced with oil
- TDS >35,000 mg/L
- 10 bbl brine / bbl oil
  - Varies by age
- TDS of Williston Basin brines among highest in U.S.



Otton, 2006

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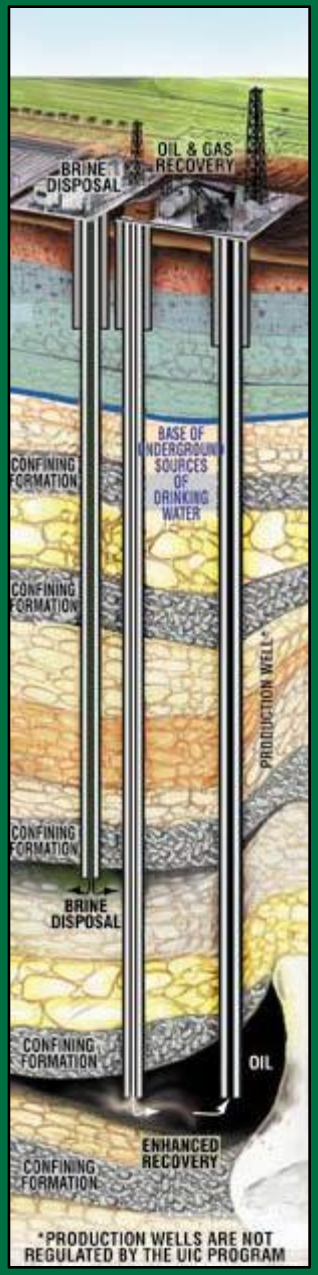
Disposal

- Injection wells
- Evaporation pits
  - Unlined prior to the 1970s



http://water.epa.gov/type/groundwater/uic/class2/index.cfm

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Sources of brine contamination

- Pits
  - Seepage
  - Migration
- Transport
  - Pipelines
  - Tanker trucks
- Infrastructure failure
  - Well bore
  - Tank batteries

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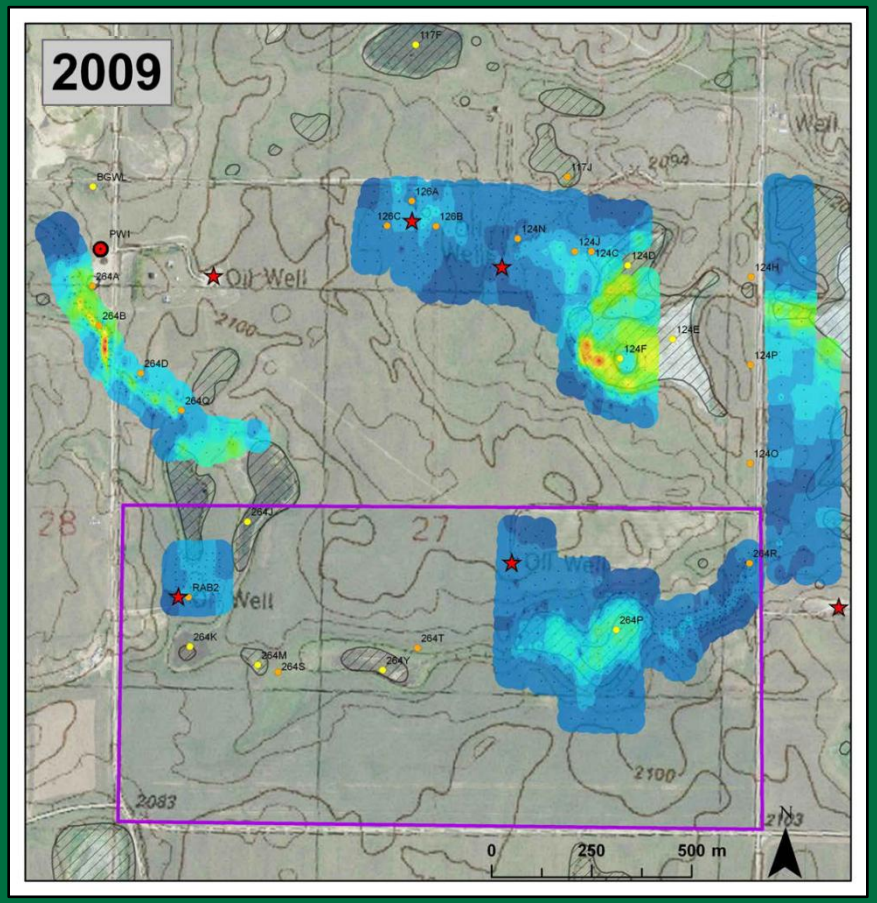
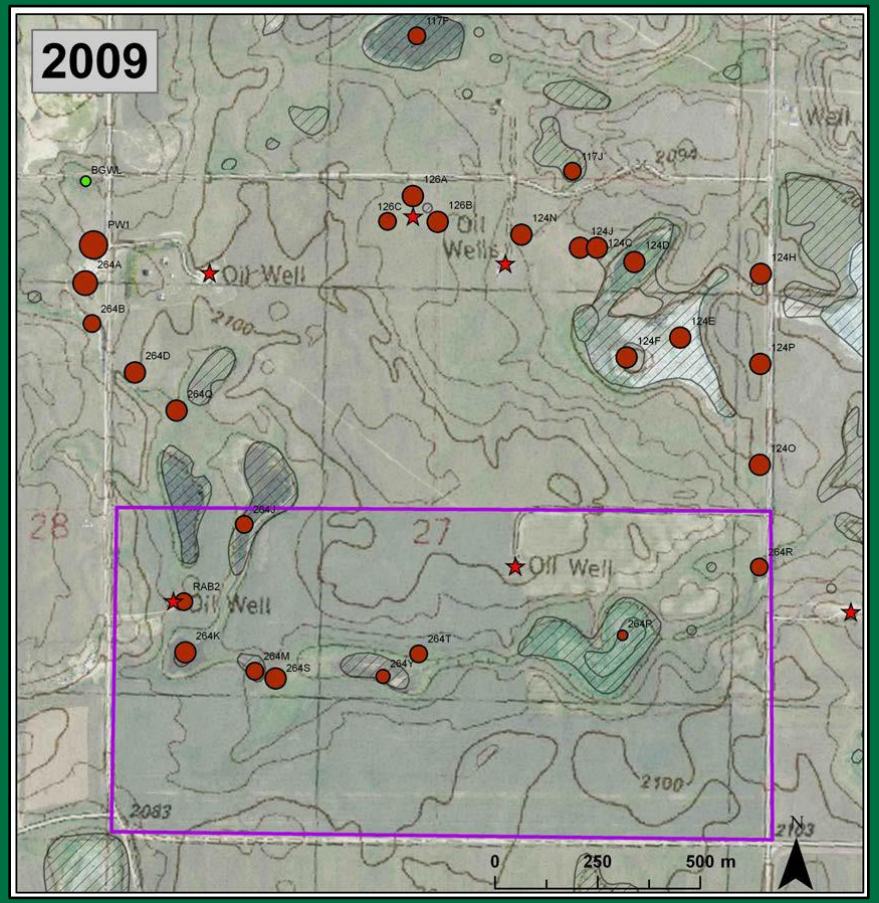
Example: subsurface brine migration





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So what?

Chemistry

Wetlands & streams:

Salinity

- >70,000 µS/cm (99,575 mg/L)
- Typically <10,000 mg/L

Ions

- Na, Mg, SO_4, and HCO_3

WB Brines:

Salinity

- 100,000 to >500,000 mg/L

Ions

- Na and Cl

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Brine contamination

Potential to:

- Raise salinity levels and alter ionic composition
- Impact biotic communities
- Make the water unsuitable for domestic livestock

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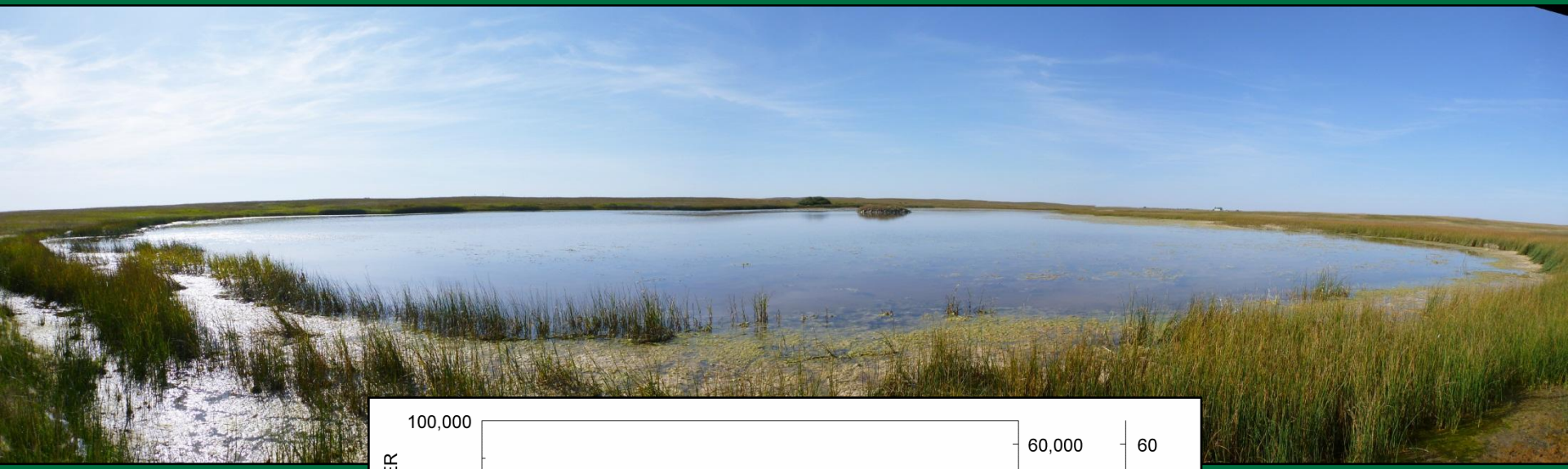
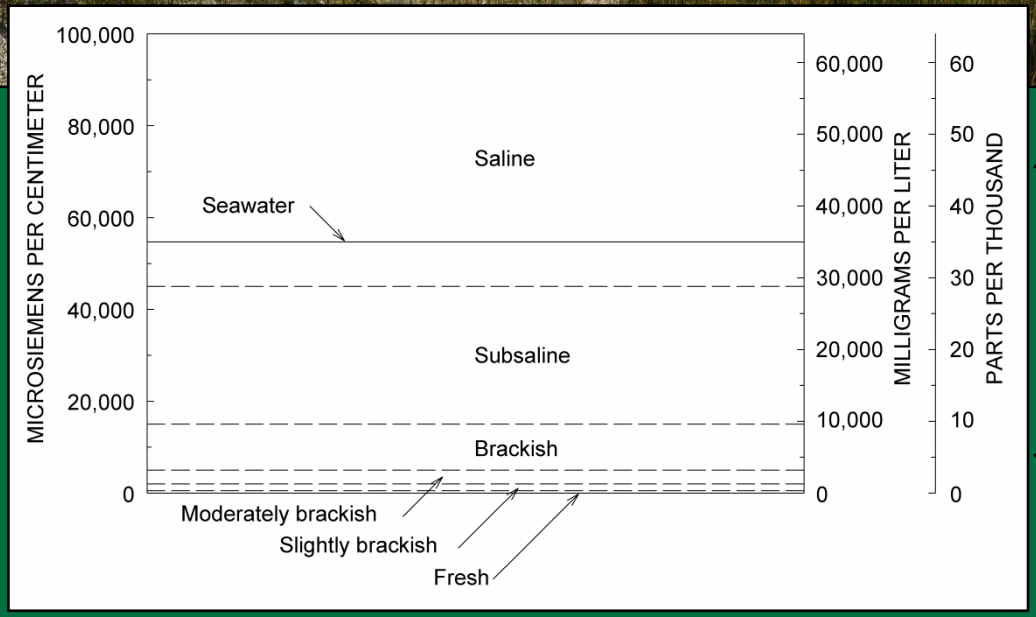
Wetland Classifications





Biota

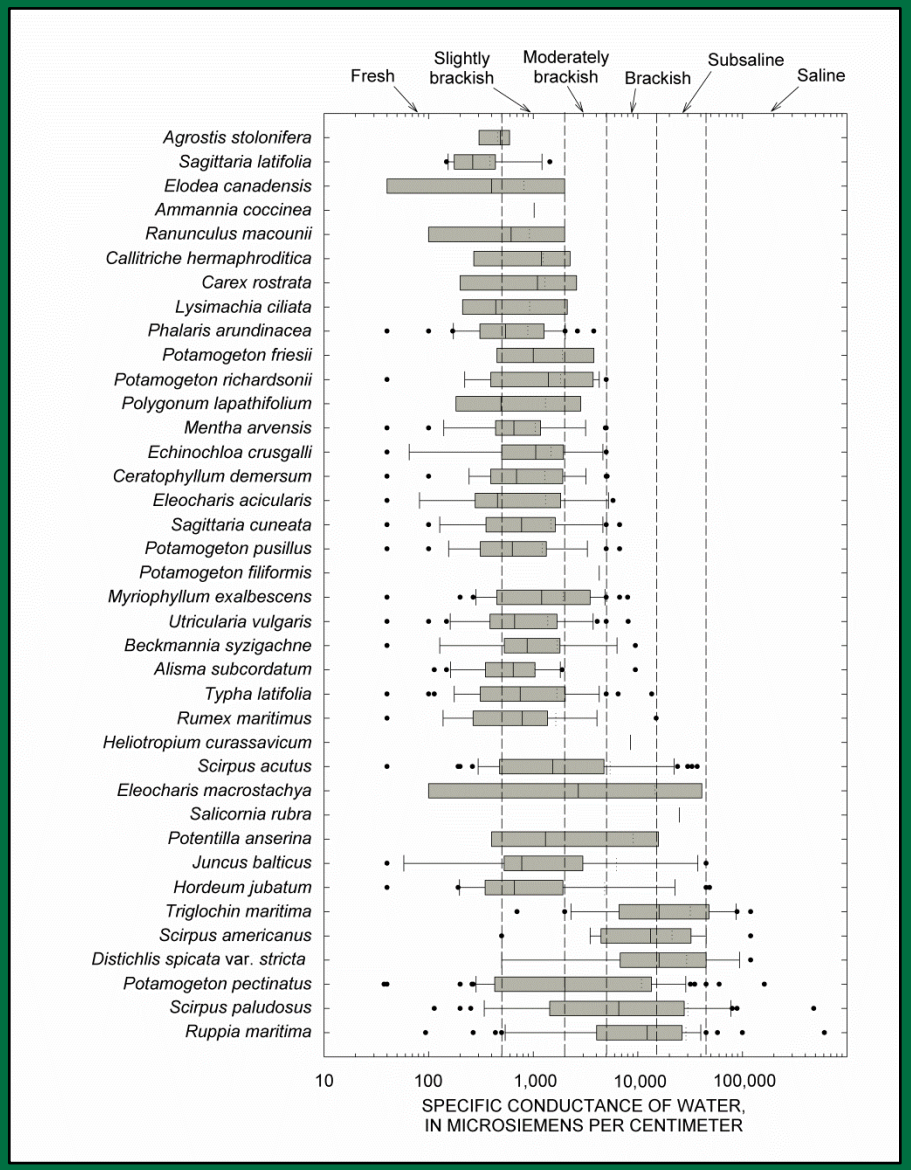
USGS

Gleason et al., 2009

Plants & salinity

NaCl:

- **~3,000–100,000 mg/L**
- **Germination rates of halophytes**
- **75-100% → ~10%**
- *Baskin and Baskin, 1998*



Gleason et al., 2009

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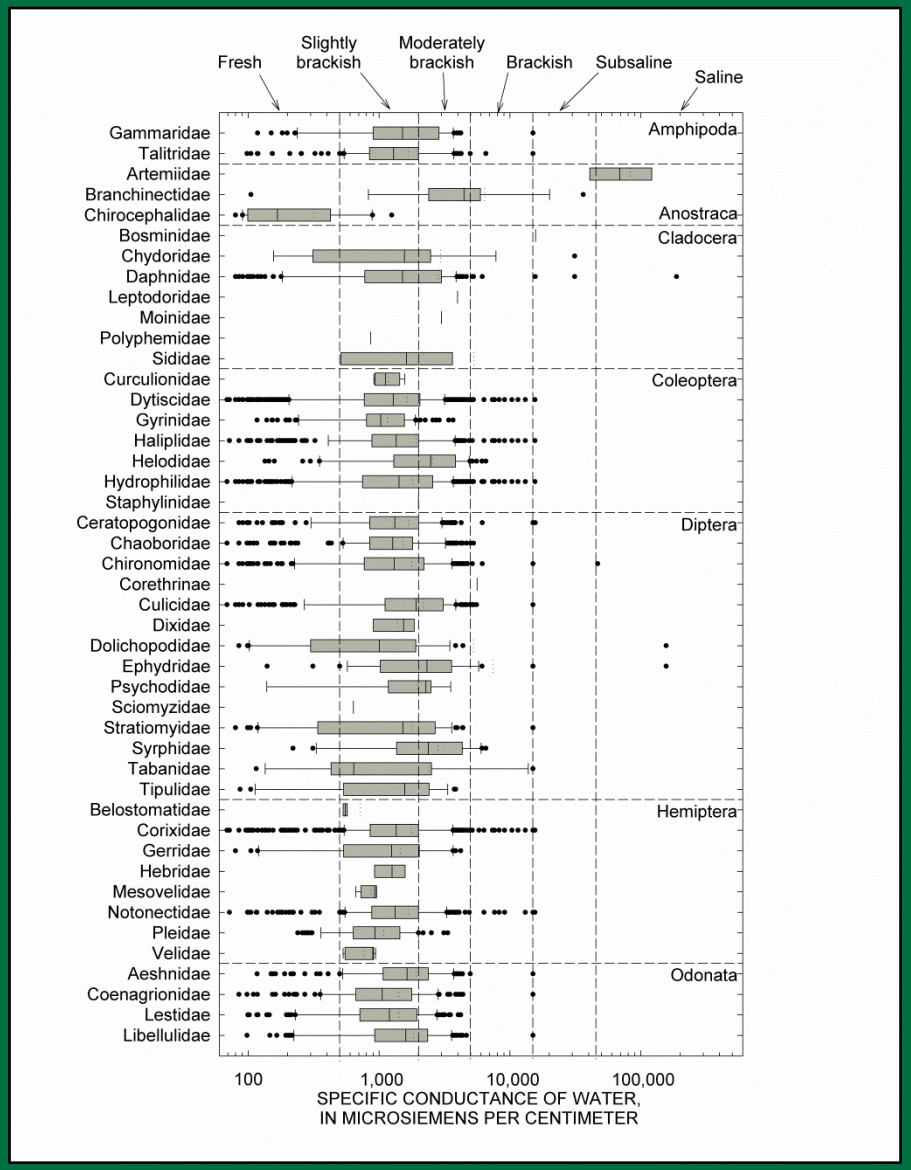
Inverts & salinity

http://www.npwrc.usgs.gov/about/factsheet/wetlands.htm



Gleason et al., 2009

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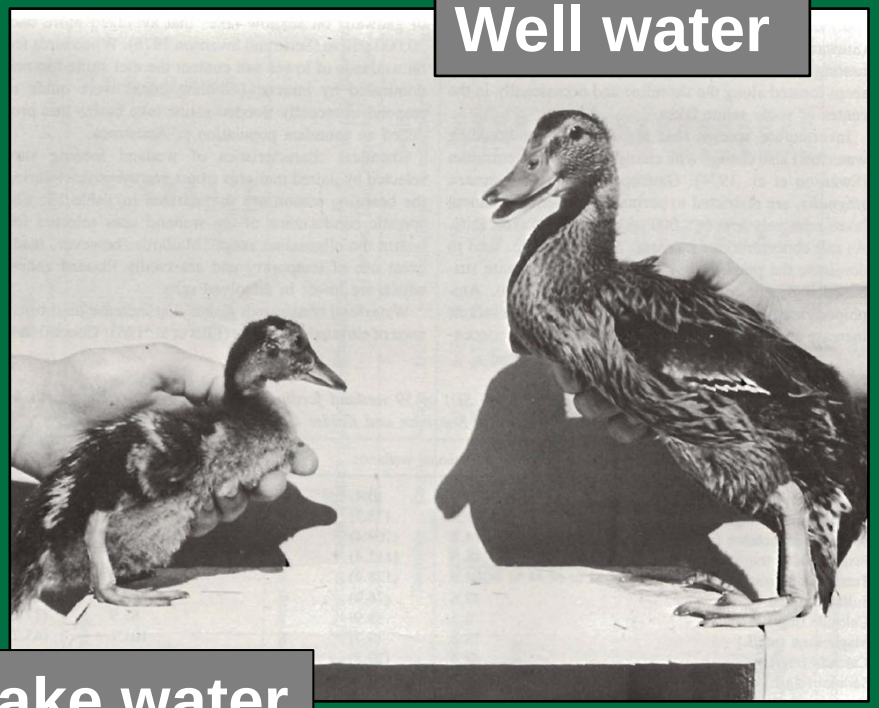
Waterfowl & salinity

- Ducklings
  - Growth/Mortality
- Food resources
  - Plants/inverts
  - Drinking water



Swanson et al., 1988

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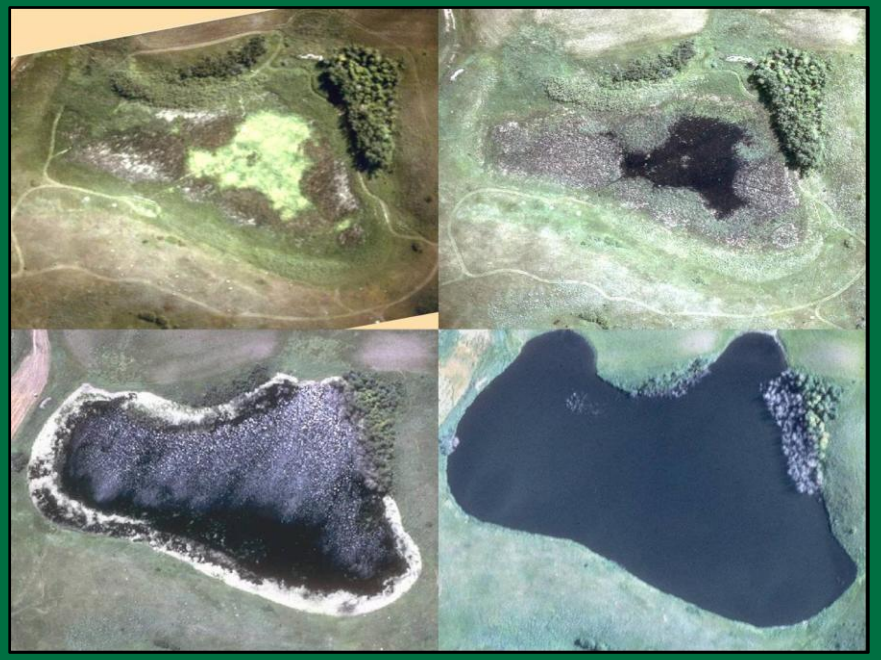
How much?

Impacts depend on:

- Volume
  - Wetland, Brine
- Wetland salinity
- Biotic communities
- Climate
  - Dilution
  - Concentration
- Wetland “type”



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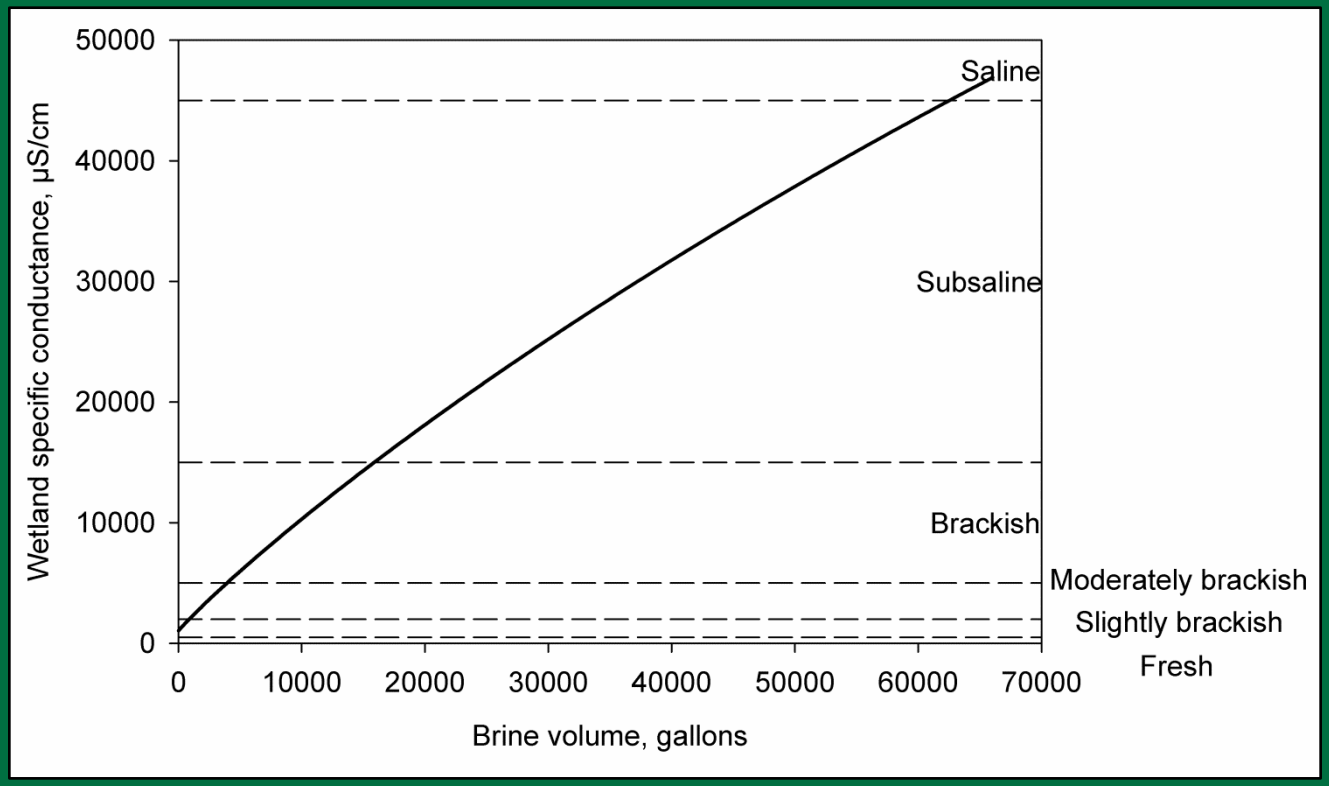
Static example, seasonal wetland:

- Area = 0.5 ha, Volume = 0.15 ha/m (~388,000 gal.)
- EC = 1,000 µS/cm (TDS~636 mg/L)
- Brine: TDS = 300,000 mg/L



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Summary

- Documented brine contamination to aquatic resources
- Brines differ from “natural” waters
- Potential to impact chemistry and biota
- A lot of factors/variability to consider when assessing impacts
- Currently, more questions than answers

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Research needs / information gaps

- **Baseline data**
  - Extent and magnitude of contamination
- **Brine spills**
  - Frequency
  - Typical spill characteristics
- **Impacts of brine**
  - Ecosystems
    - Water quality, community composition
  - Aquatic biota of PPR
    - Lethality, growth impacts, etc.

USGS


Questions?
http://steppe.cr.usgs.gov/
USGS