Groundwater quality in the Portneuf Aquifer: expanding research on nitrate and emerging contaminants

Jenna Dohman[1]*, Courtney Ohr[1]*, Sarah Godsey[1], John Welhan[2], Kathleen Lohse[1], James Stoutenborough[1], Donna Lybecker[1], Rebecca Hale[1], Danelle Larson[1]

* Co-authors, 1 Idaho State University, 2 Idaho Geological Survey

Overview

- Both municipal and private wells in Pocatello and Chubbuck draw their drinking water from the Portneuf aquifer
- Ohr (2016)[1] found nitrate and pharmaceutical and personal care products (PPCPs) in private wells supplied by the Portneuf aquifer
  - Nitrates and PPCPs have known associated ecological and human health risks[2,3]
- Perceived risk of pharmaceutical contamination was an important factor driving actions to improve water quality
- **There is a strong need to identify contaminant sources in order to:**
  - implement effective water restoration and management practices in this region
  - guide urban planning for other small cities
- There is a need to understand the public's risk perception of their drinking water in order to:
  - define the specific concepts that should be covered in a new public education campaign
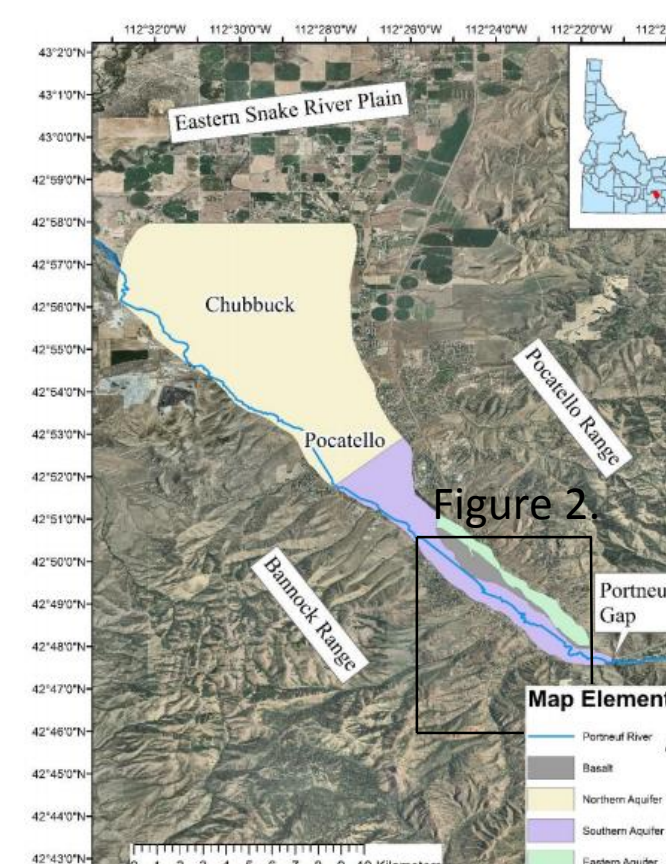 - target priority areas for education about groundwater contamination and water testing

Figure 1. Study area and aquifer locations within the LPRV. NAIP imagery distributed by the Land Processes. http://lpdaac.usgs.gov.

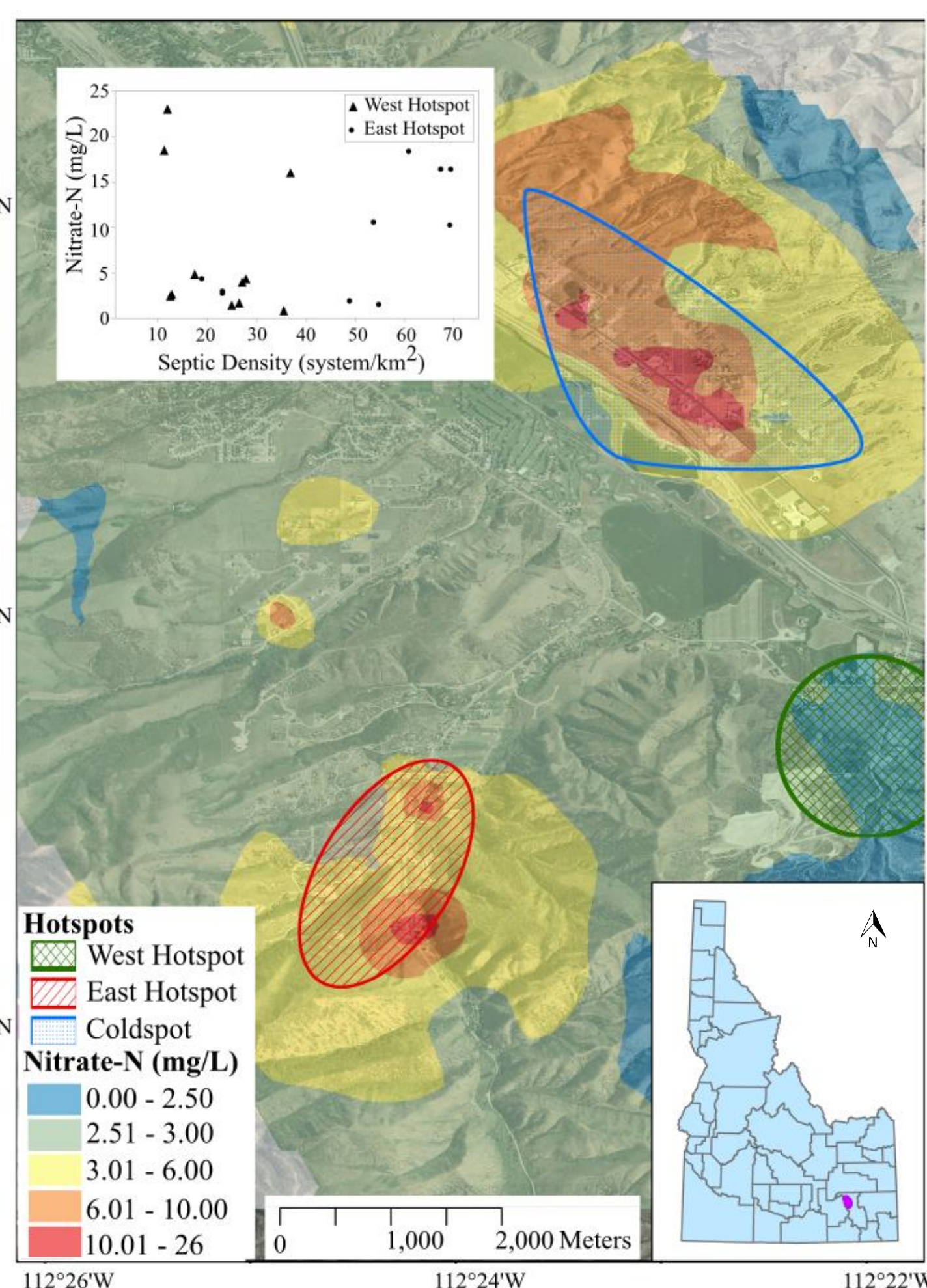## Nitrate Hotspots in the LPRV and the Presence of PPCPs

Figure 2. Predicted nitrate-N across the Lower Portneuf River Valley (LPRV) with ordinary kriging.

- Two nitrate-N hotspots exist in the Lower Portneuf River Valley (LPRV)
- Nitrates were not correlated with septic density
- Higher nitrate-N concentrations were identified where PPCPs were detected, implying that these were derived from anthropogenic sources
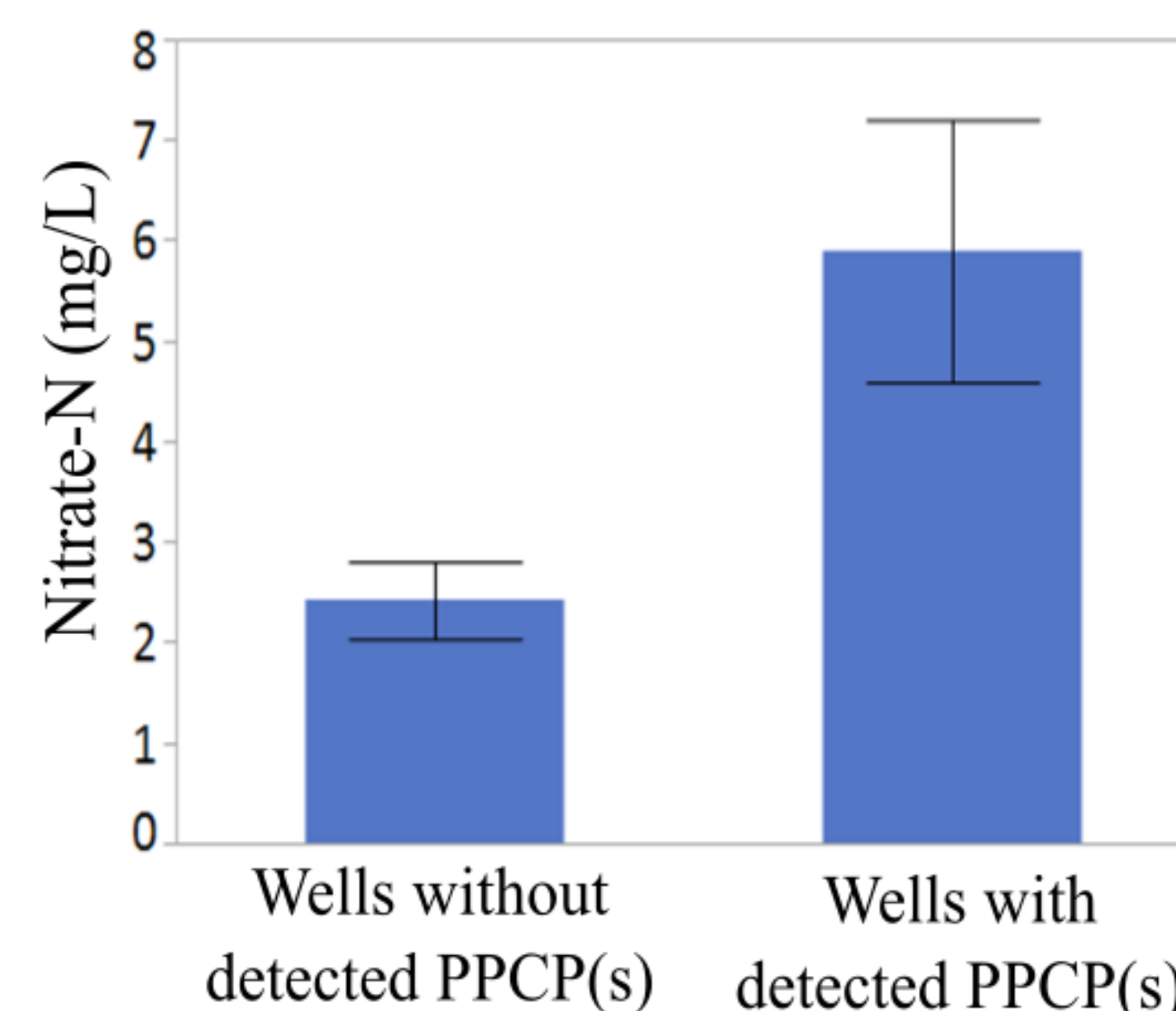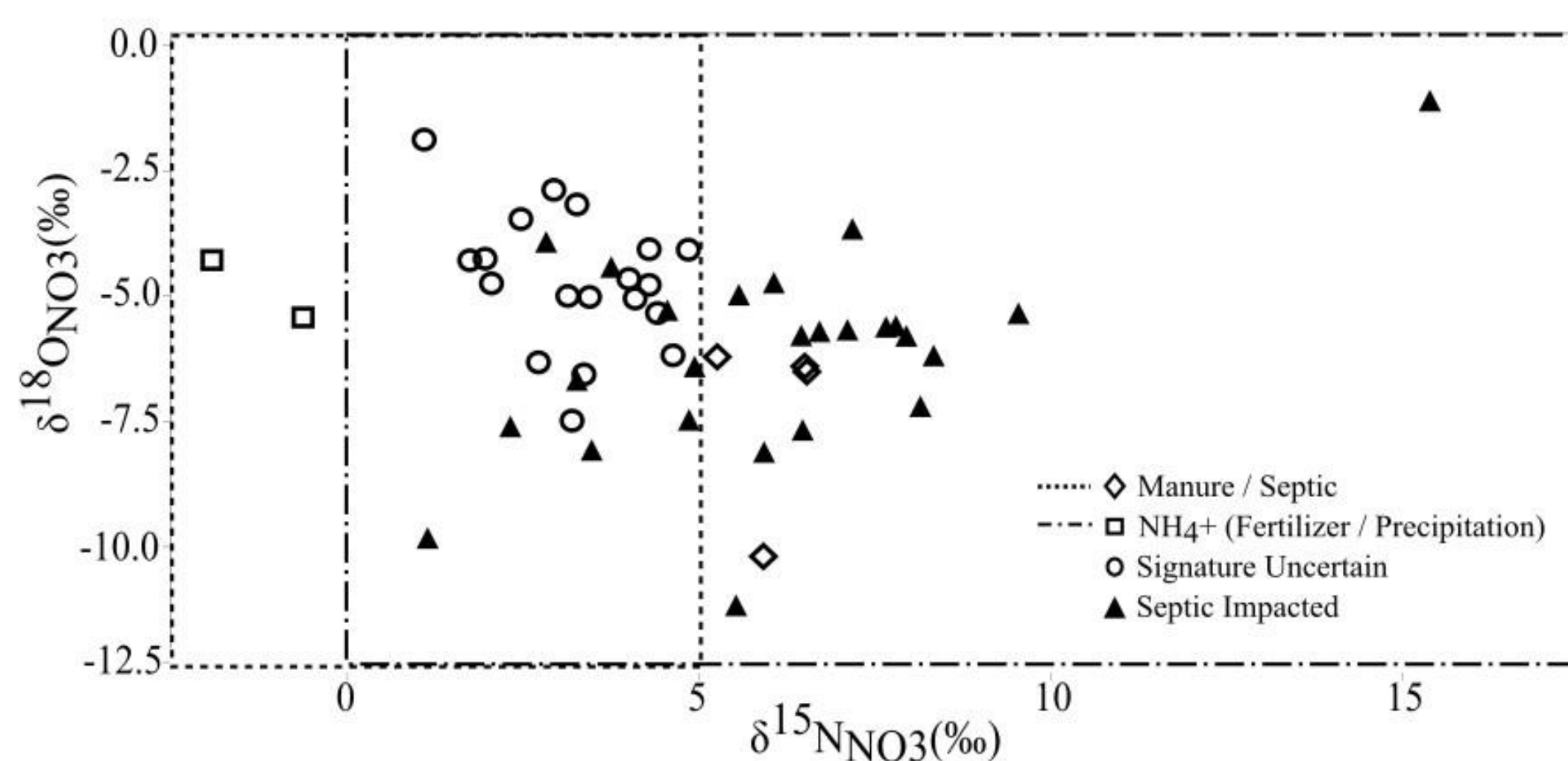- Nitrates were also present in the absence of detectable PPCPs

Figure 3 (above). Wells where PPCPs were detected had significantly higher nitrate-N concentrations than wells without any PPCPs detected.

Figure 4 (left). $\delta^{15}N_{NO3-N}$ (‰) vs. $\delta^{18}O_{NO3-N}$ (‰) with $\delta^{15}N_{NO3-N}$ corrected for $\Delta^{17}O$ (adapted from Kendall 1998). Symbol shape indicates likely sources. Closed triangles indicate wells identified as septic impacted.

How Risk Perception Influences Actions Towards Drinking Water

- Risk perceptions can influence behaviors or actions that may change drinking water
  - Actions included softening, filtering, testing, treating, and buying bottled water
- Actions were highly correlated with demographics, type of primary H_2O sources and concern about pharmaceuticals
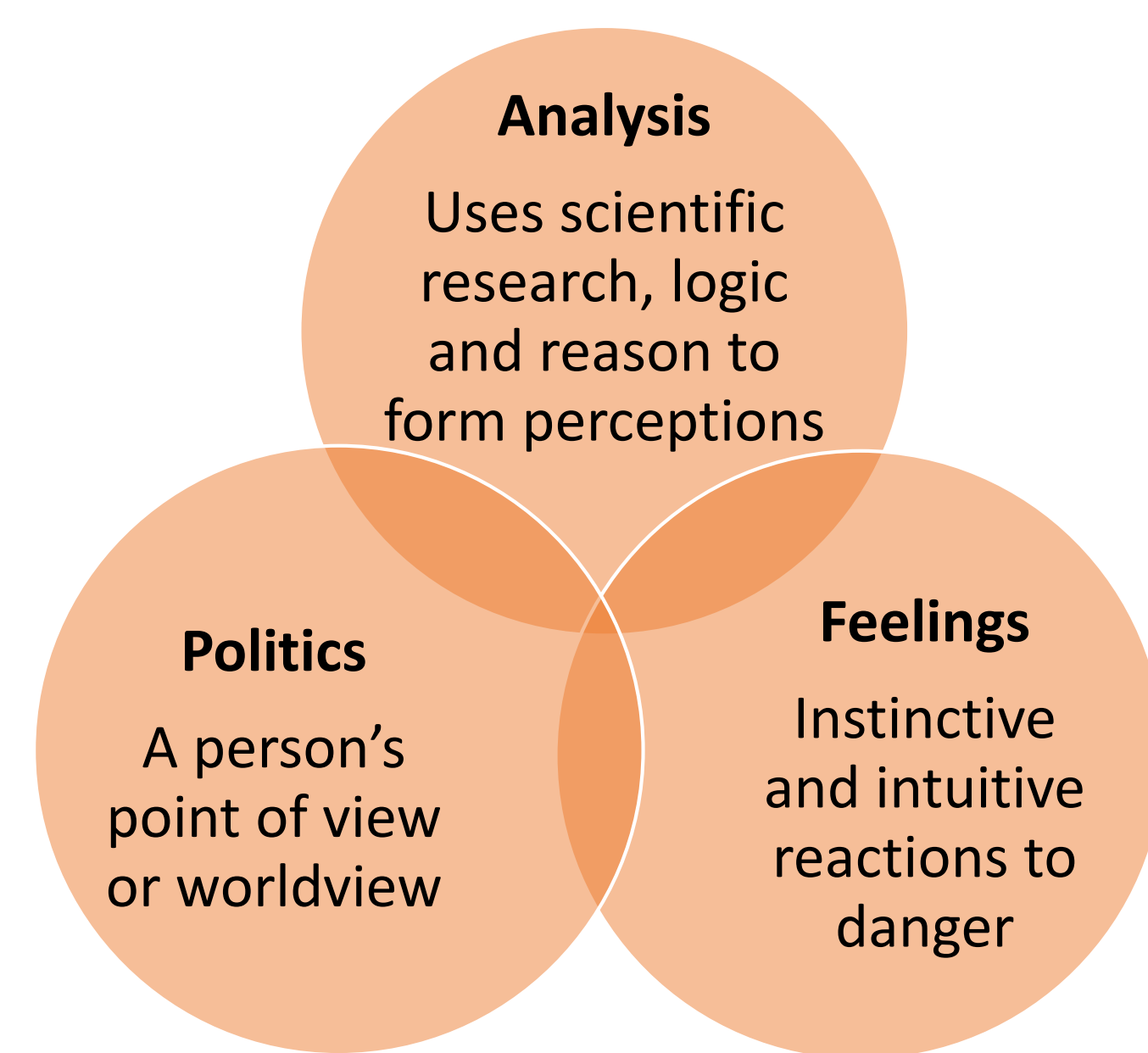- Water treatment actions were not correlated with level of local contamination

Figure 5. Risk perceptions were characterized by three typologies.

Analysis — Uses scientific research, logic and reason to form perceptions

Politics — A person's point of view or worldview

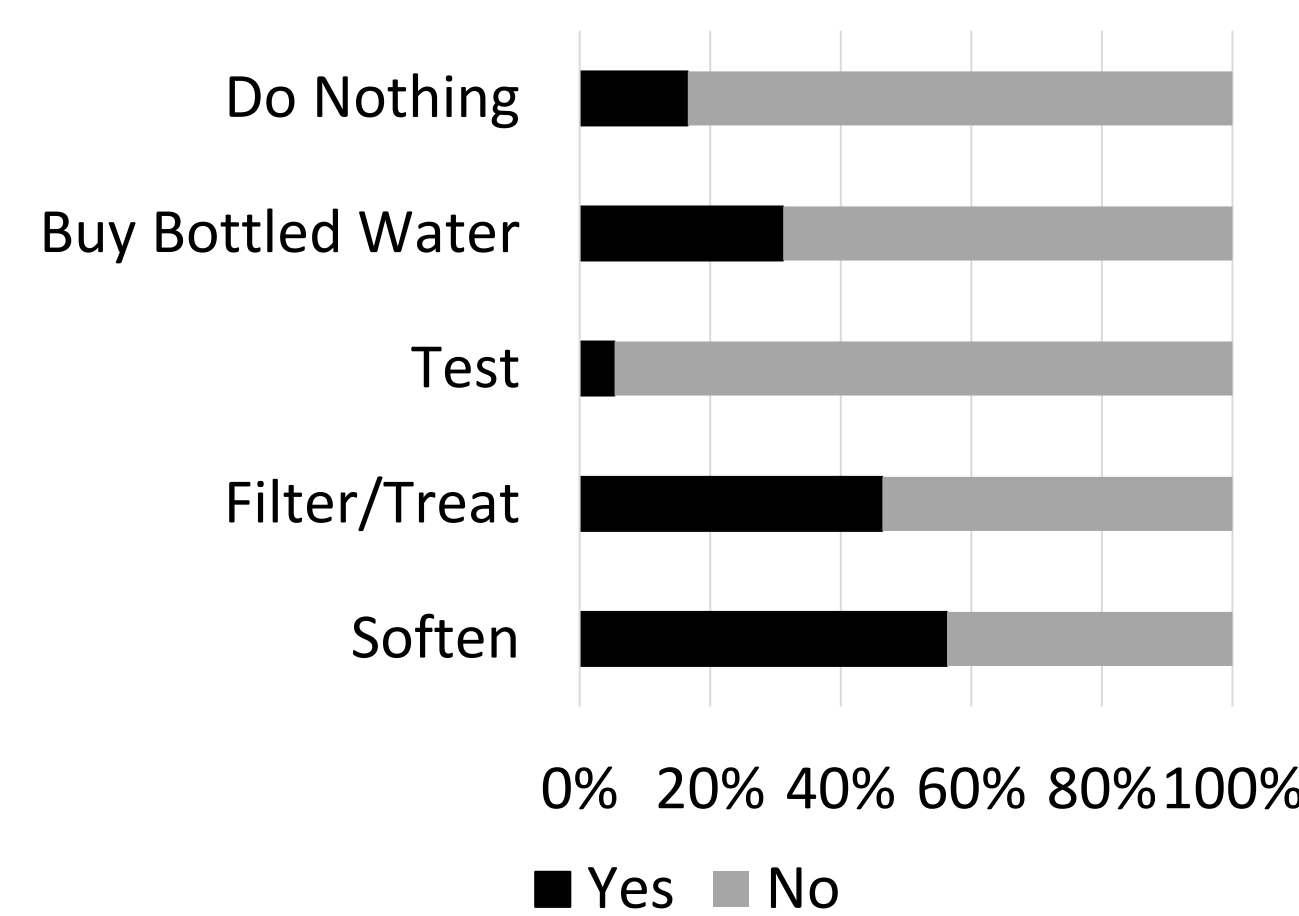**Feelings** — Instinctive and intuitive reactions to danger

Figure 6. Actions taken in response to concern about water quality as indicated by survey answers. Totals may not sum to 100% because respondents may select multiple actions that they take to improve their water quality.

GAPS IN UNDERSTANDING:

No municipal wells were tested in the previous study.

No surveys were conducted in the nitrate-N hotspots.

Questions Guiding Future Research in the Portneuf Aquifer

Test municipal wells

- Which regions have the highest concentrations of contaminants?
  - Urban areas – Municipal wells
    - Perhaps higher concentrations in aquifer used by city because of recharge from both rings
  - Ex-urban areas – Private wells
    - Perhaps higher, more localized concentrations in "inner ring" with well-established moderate populations on dense septic systems
  - No significant differences in contamination
    - Perhaps more complex controls on spatial distribution of contaminants in the aquifer
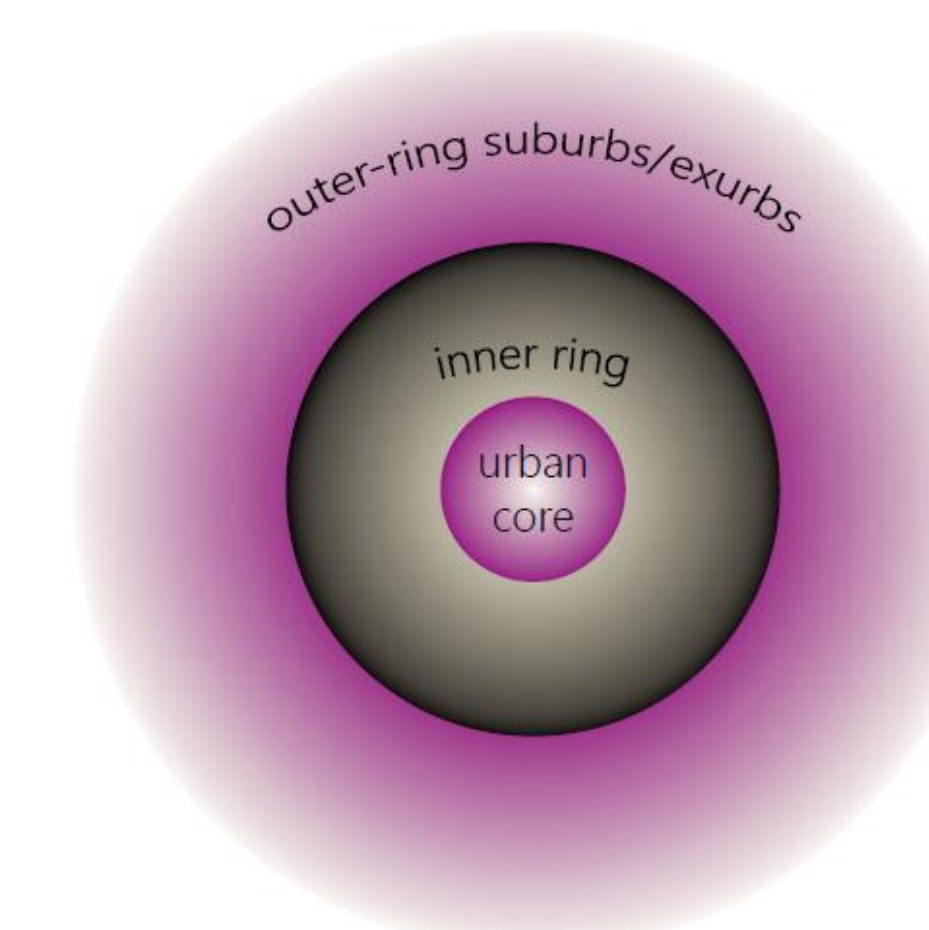- Are the sources of contamination in the municipal wells similar or different to those identified in private wells?

Figure 7. In the "donut model" population decreases with distance from the urban core.[5] The urban core represents the population on city wells, with the inner and outer ring representing the population on private wells. The inner ring is the area predicted to be most susceptible due to the lower level of infrastructure paired with moderate populations.

Expand surveys to include those in nitrate-N hotspots

- Are residents within the nitrate-N hotspots more or less concerned about their water quality than residents outside of the hotspots?
  - If these residents are concerned, is it based on knowledge of contamination?
  - If not, this might help target education measures focused on water quality testing
- Does an increased risk perception result in taking more actions to treat their drinking water more than other residents?
  - If not, further education measures about types of water treatment may be useful
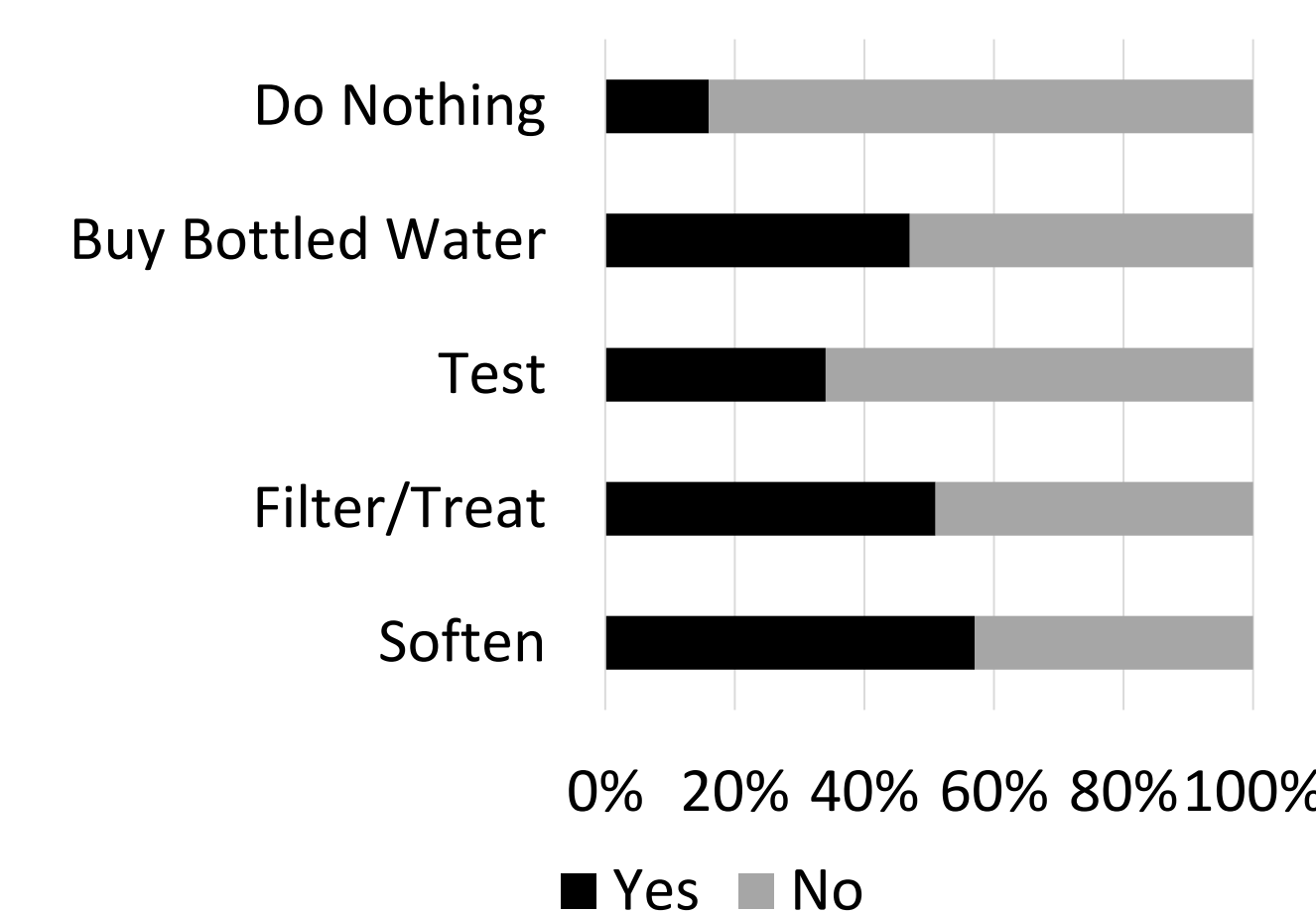

Figure 8. In nitrate-N hotspots, concern about water quality may increase some actions taken towards drinking water (relative to Figure 6). Totals may not sum to 100% because respondents may select multiple actions that they take to improve their water quality.

References and Acknowledgements

[1] Ohr, C. 2016, "Sources and Public Perceptions of Contaminants in the Lower Portneuf River Valley: A Case Study for Nitrates and Personal Care Products and Pharmaceuticals."
[2] Verhoeven et al. (2006) *Trends in Ecology and Evolution* doi:10.1016/j.tree.2005.11.015.
[3] Ward et al. (2010) *Epidemiology* doi:1097/EDE.0b13e3181d201d.
[4] Kendall (1998) *Elsevier* doi:10.1016/B978-0-444-81546-0.50023-9
[5] Juday L.J., "The Changing Shape of American Cities". coopercenter.org/demographics