Using eDNA to assess the effects of Sierra Nevada meadow restoration on invasive species and sensitive amphibians

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Introduction/Background

Meadow restoration methods:

- Pond-and-plug[4]
- Pervious impoundment[5]
- Channel fill[6]

Ecological goal of Sierra Nevada meadow restoration:

- Improve habitat for species of conservation concern[1]

Non-ecological goals:

- Water storage/filtration[2]
- Flood attenuation[3]

Restoration projects may facilitate invasive American bullfrogs[6,7] meaning that the ecological goal will not be met .

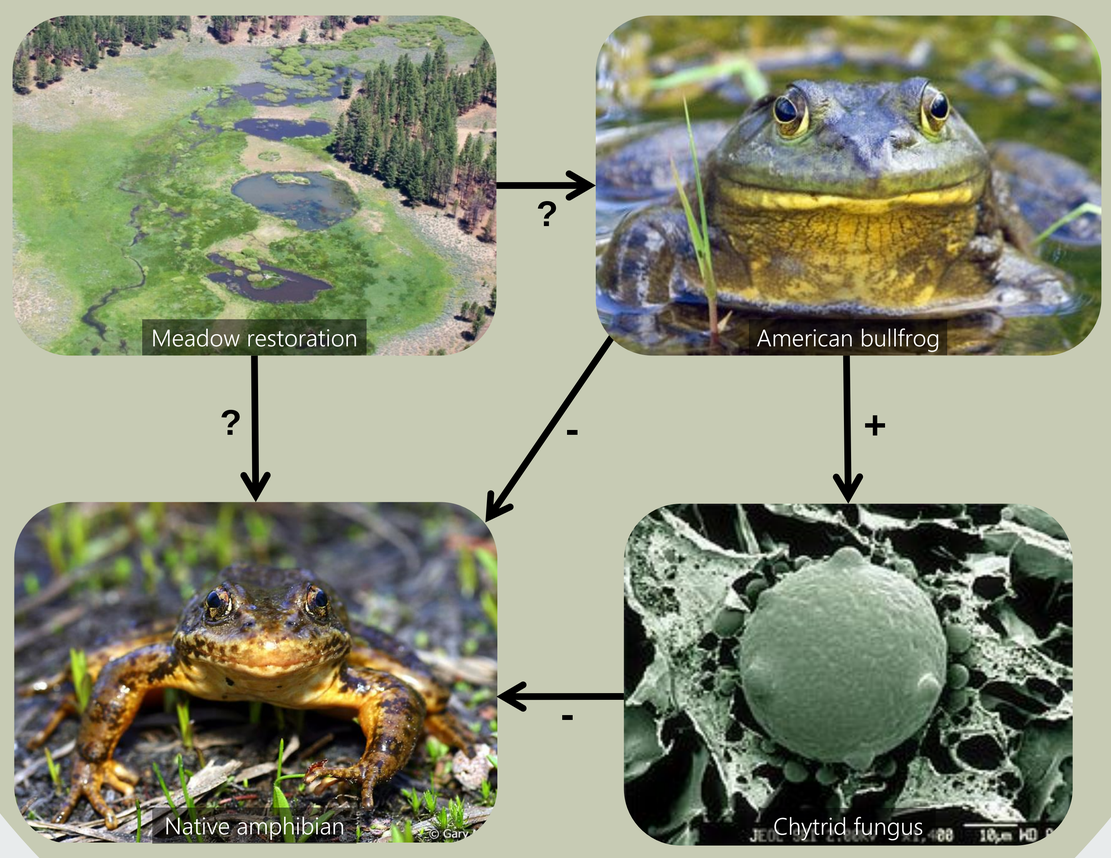
Aim: use environmental DNA (eDNA) to compare occupancy of sensitive amphibians, American bullfrogs, and chytrid fungus between restored and similar unrestored meadows.

Hypotheses:

- Sensitive native amphibians are positively influenced by restoration.
- American bullfrog occupancy is positively influenced by restoration methods that create lentic habitat.
- Chytrid occupancy is positively influenced by bullfrog presence.

Potential drawbacks of meadow restoration:

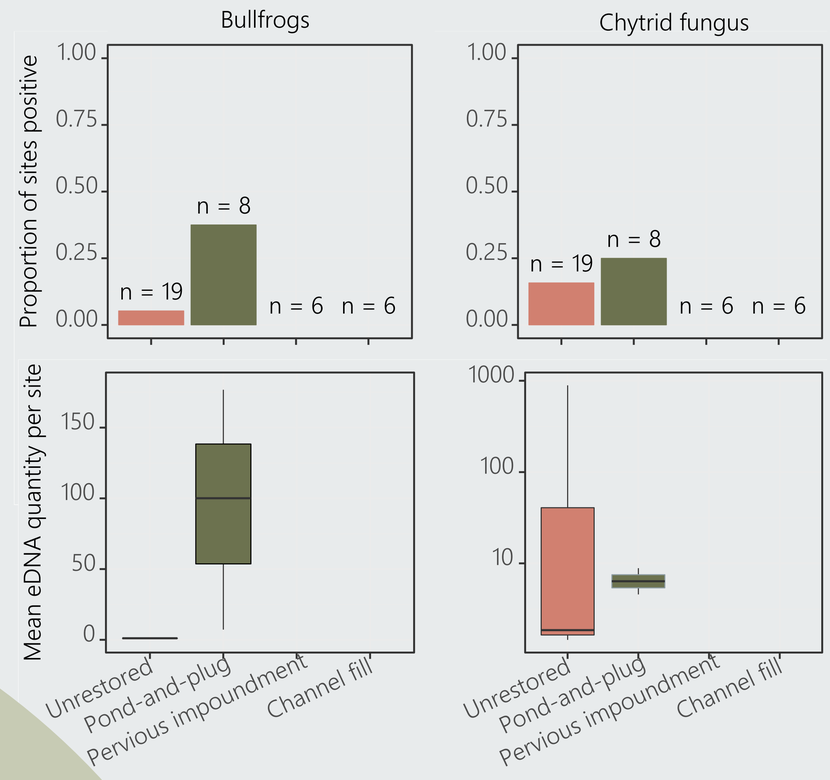
Sierra Nevada meadow restoration projects may facilitate invasive American bullfrogs[6,7]. Bullfrogs predate on native amphibians and compete for habitat and resources[8]. They can also carry the deadly amphibian chytrid fungus[9].



Our study suggests that certain types of meadow restoration in the Sierra Nevada may exacerbate the negative impacts of American bullfrogs and chytrid fungus on sensitive native amphibians.

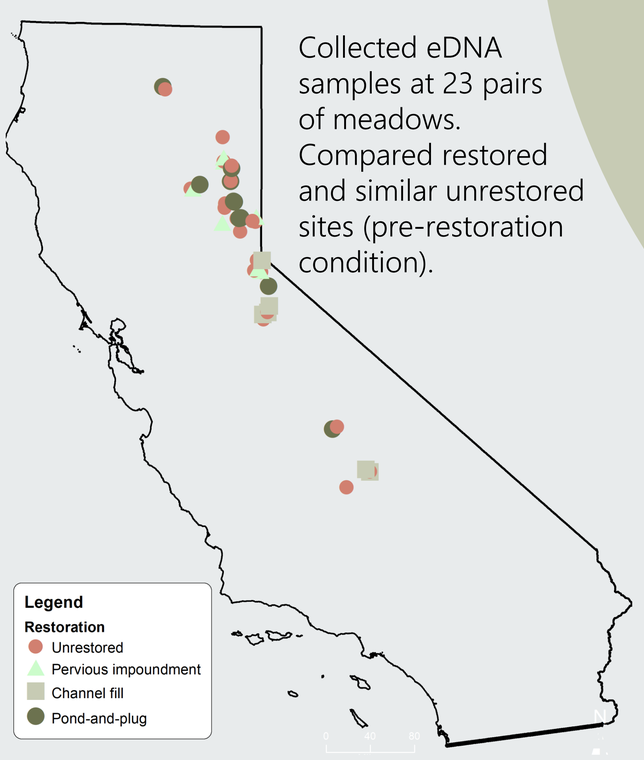
Preliminary results (2018 data only)

- Bullfrogs and chytrid were not detected at pervious impoundment or channel fill sites.
- Bullfrogs were the most prevalent at pond-and-plug restored sites.
- No sensitive native amphibians were detected.



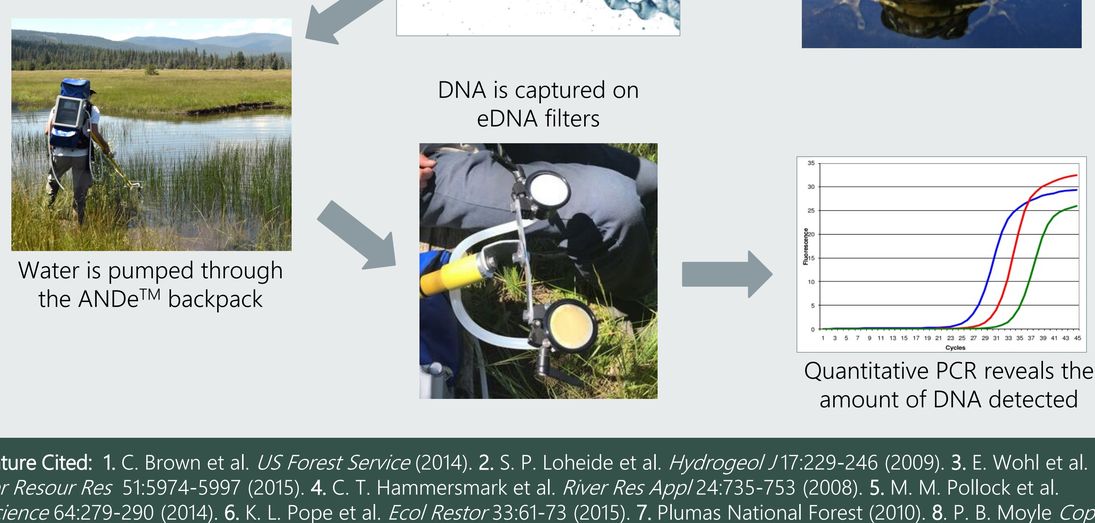
- Chytrid fungus was the most prevalent at pond-and plug restored sites.
- Chytrid and bullfrogs were only detected together at pond-and-plug sites.

Methods



Collected eDNA samples at 23 pairs of meadows. Compared restored and similar unrestored sites (pre-restoration condition).

Collecting and quantifying eDNA:



Preliminary conclusions

Meadow restoration may not be directly benefiting sensitive Sierra Nevada amphibians.

- No sensitive amphibians detected.
- Potential association between bullfrogs and pond-and-plug restoration.
  - Pond-and-plug restoration results in novel pond habitat suitable for bullfrogs.
- Potential association between chytrid and bullfrogs.

Future Directions

Run PCR on 2019 samples (some native amphibian detections expected).

Species-specific multi-scale occupancy models:

- Probability of presence per site
- Detection probability per site
- Effects of environmental factors on species occupancy

Examine the spread of bullfrogs in California

- Key drivers of historic spread
- Potential spread with climate change

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Literature Cited: **1.** C. Brown et al. *US Forest Service* (2014). **2.** S. P. Loheide et al. *Hydrogeol J* 17:229-246 (2009). **3.** E. Wohl et al. *Water Resour Res* 51:5974-5997 (2015). **4.** C. T. Hammersmark et al. *River Res Appl* 24:735-753 (2008). **5.** M. M. Pollock et al. *BioScience* 64:279-290 (2014). **6.** K. L. Pope et al. *Ecol Restor* 33:61-73 (2015). **7.** Plumas National Forest (2010). **8.** P. B. Moyle *Copeia* 1973:18-22 (1973). **9.** C. Miaud et al. *Biol Invasions* 18:2299-2308 (2016).

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