Status of Ecological Restoration in California Meadows: Current practices and Performance

Karen Pope

USDA Forest Service, Pacific Southwest Research Station

Restoration Science is Young

- We are yet to equal nature (not just floodplains and meadows)
  - "**Recovery Debt**" – ~50% organismal abundance, ~30% species diversity, ~35% C cycling, ~35% N cycling (Moreno-Mateos et al. 2017, Nature Communications)
  - Rey Benayas et al. 2009, Bernhardt and Palmer 2011, Moreno-Mateos et al. 2012, Pope et al. 2015
- Work to do to improve restoration outcomes
  - Science
  - Practice
  - Regulation

Goal

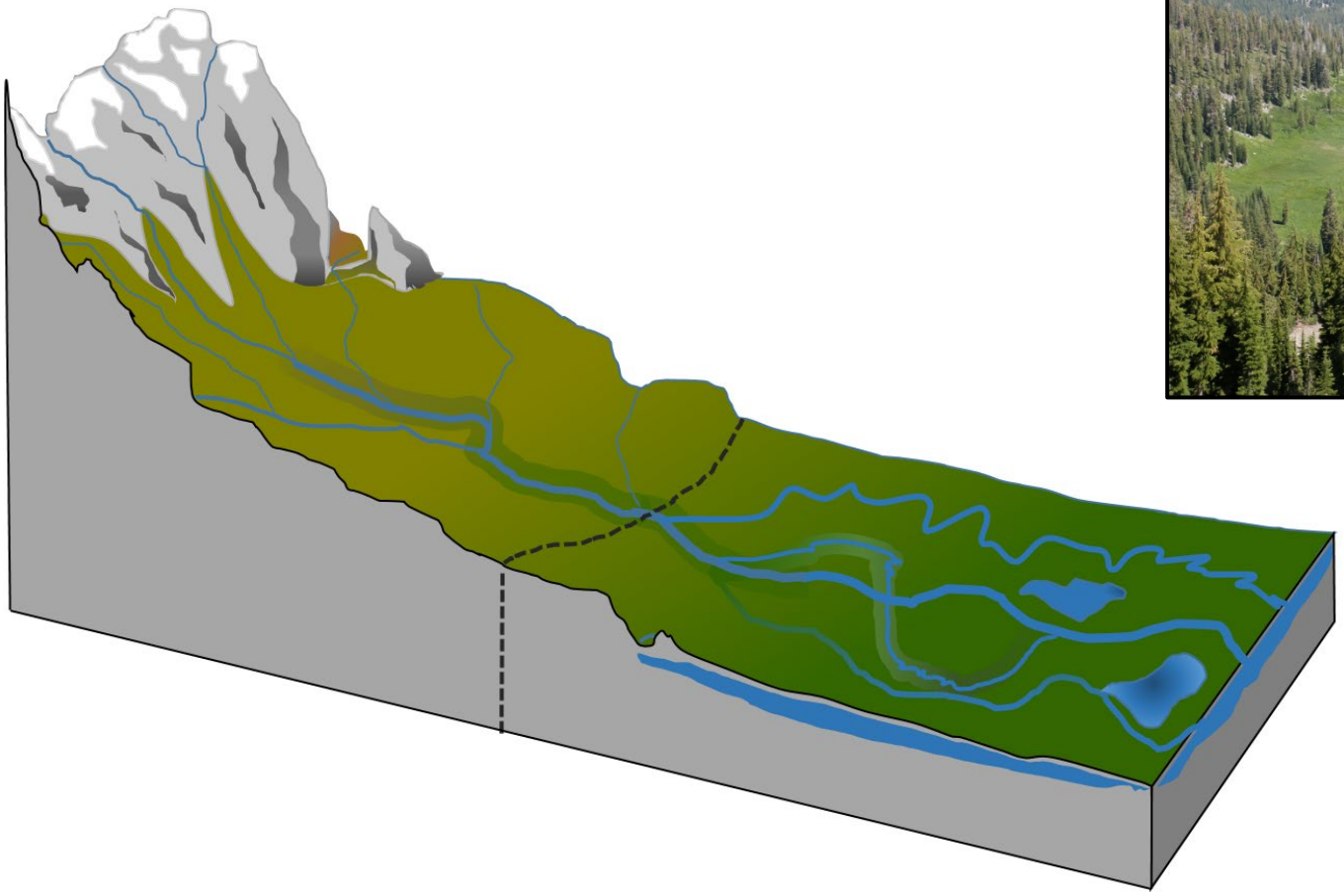
Highlight needed improvements to meadow restoration in California and show how ecological restoration approaches may help provide solutions

Brian Cluer

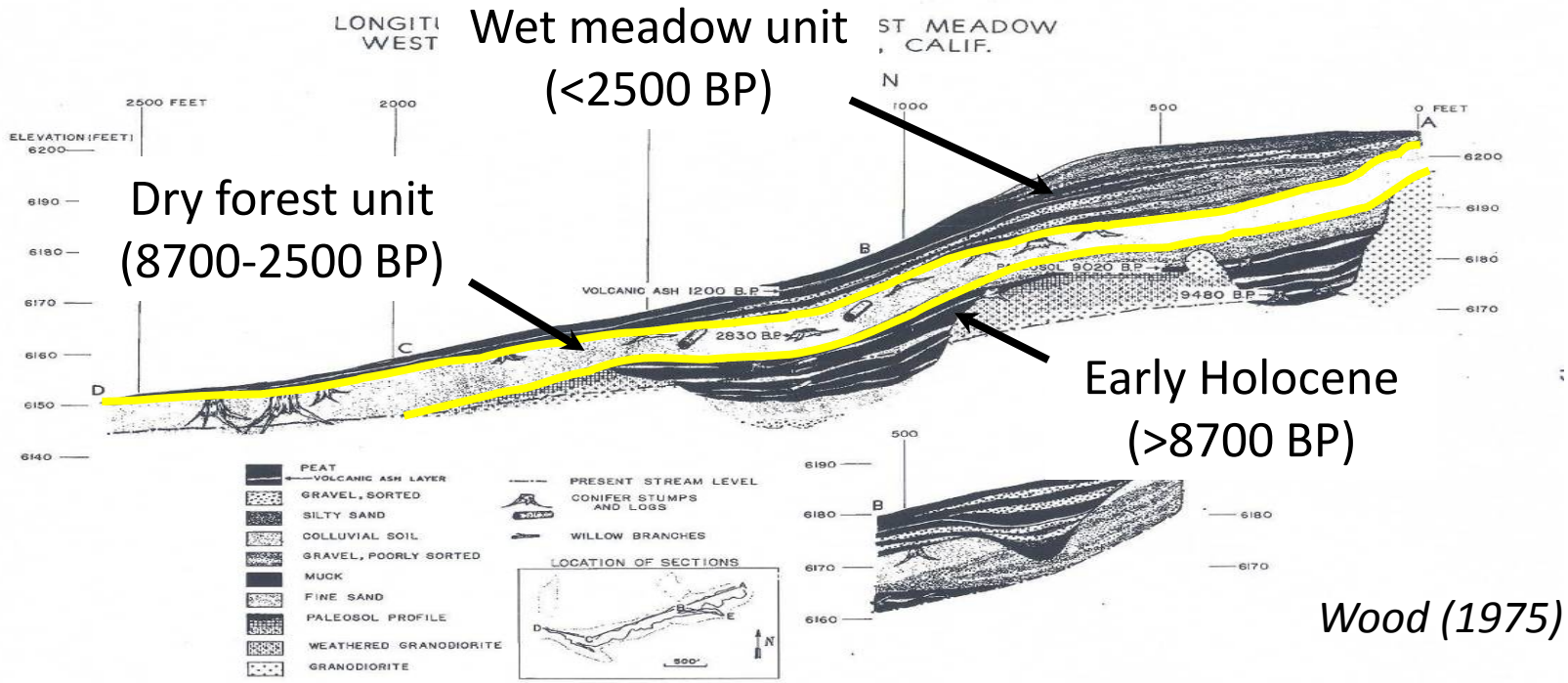
Definitions

- ***Ecological Restoration*** - Recover self-sustaining ecological systems, including the organisms, and ecosystems and dynamic processes that support them (Palmer & Ruhl 2015).
- ***Process-based Restoration*** - Correct anthropogenic disruptions to stream-floodplain processes, such that ecosystem recovery progresses along a recovery trajectory with minimal corrective intervention (Beechie et al. 2010).

What is a montane meadow?



Meadow Stratigraphy



Wood (1975)

Why are meadows important?

Pacific Forest Trust 2017

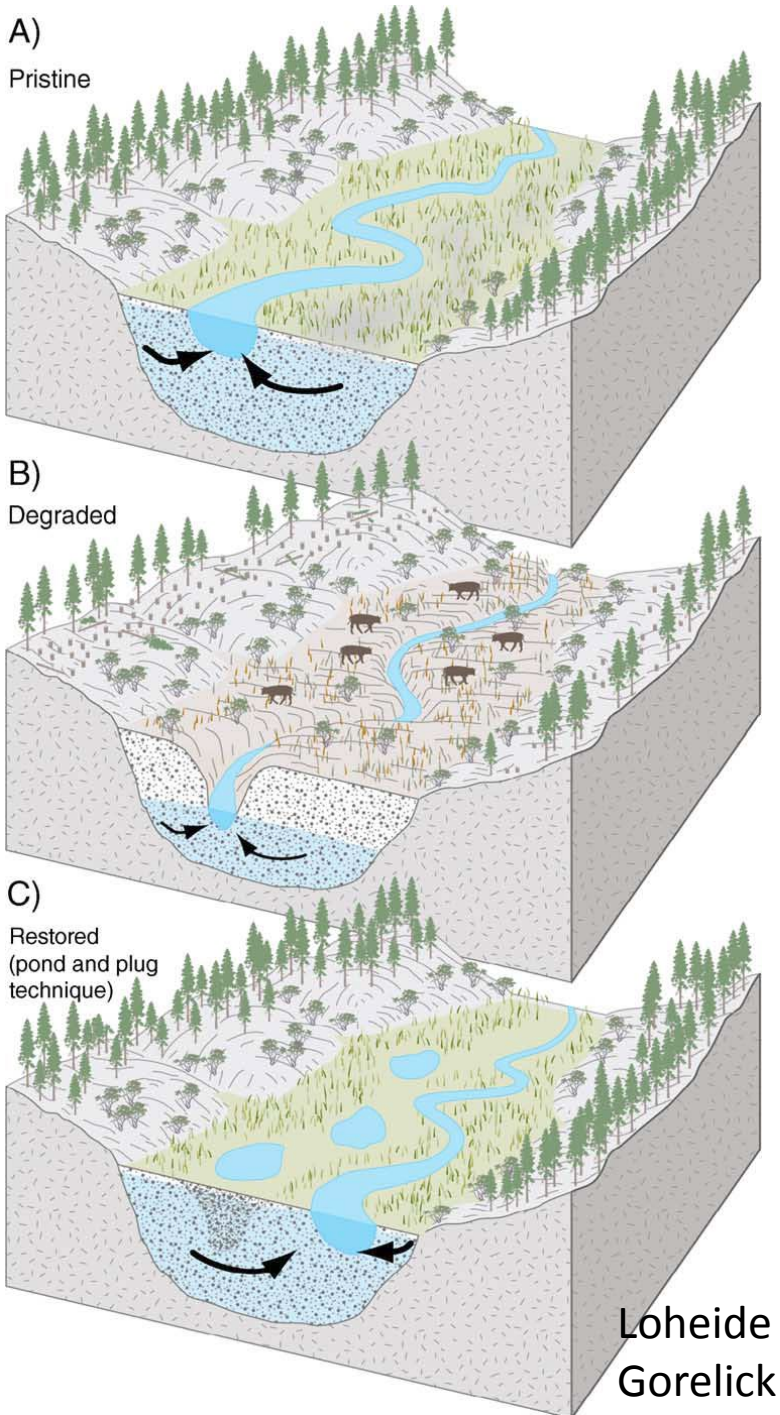
- "Over 90% of wet and dry meadow area are in need of restoration"
- Restoring natural source water infrastructure is a "least-cost" approach to increasing water supply reliability and quality

Early Interventions

Restoration Methods

Pond-and-Plug

- Excavate and fill incised channel
- Redirect water to channels on historic floodplain
- Results in:
  - Raised water table
  - Reconnected floodplain
  - Series of ponds and dams

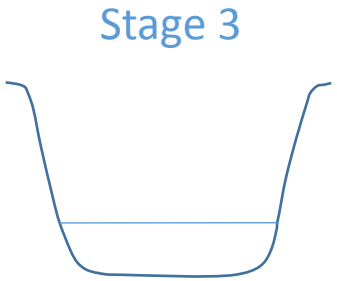


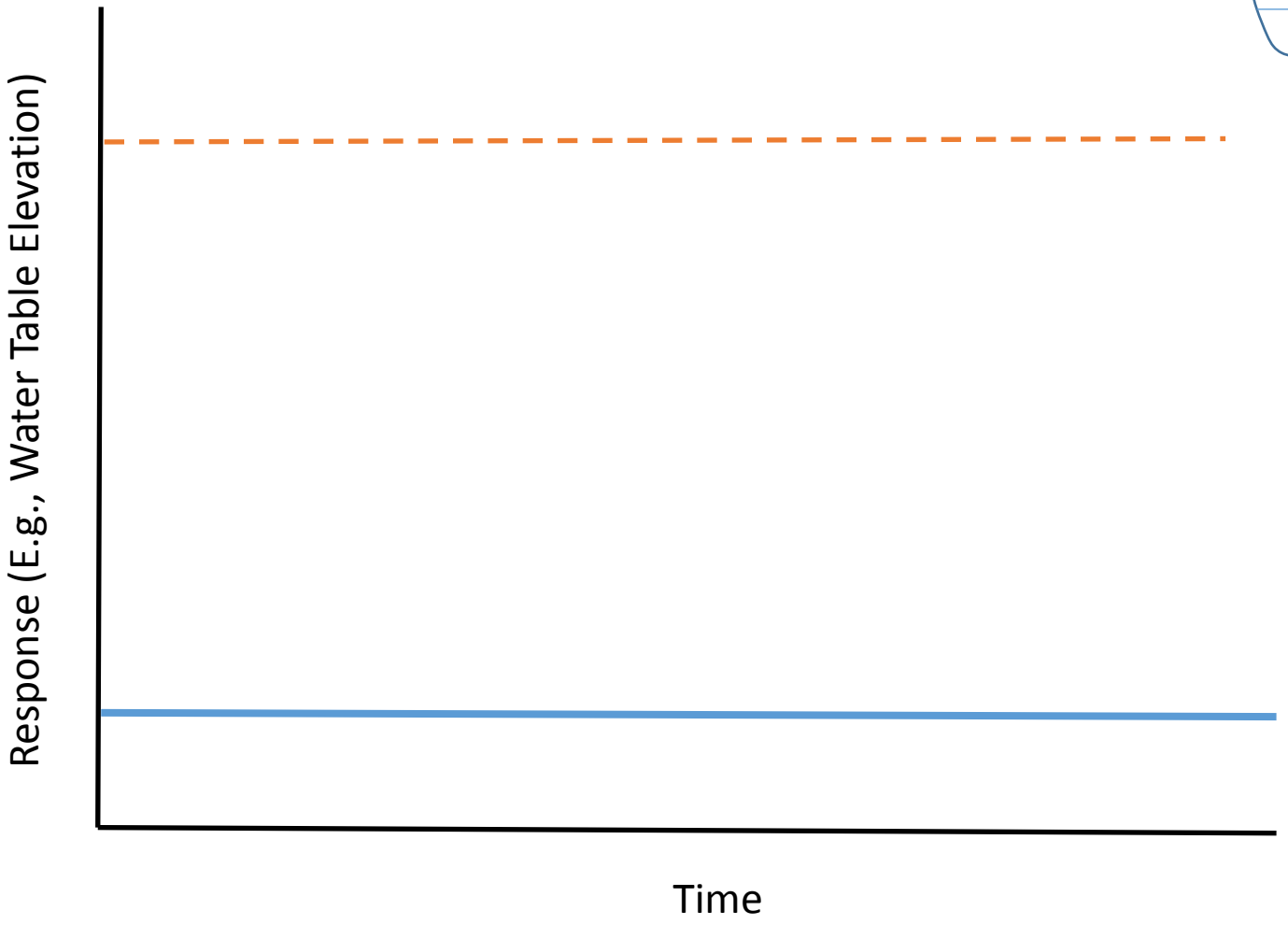
Loheide & Gorelick 2005

Ecological Restoration

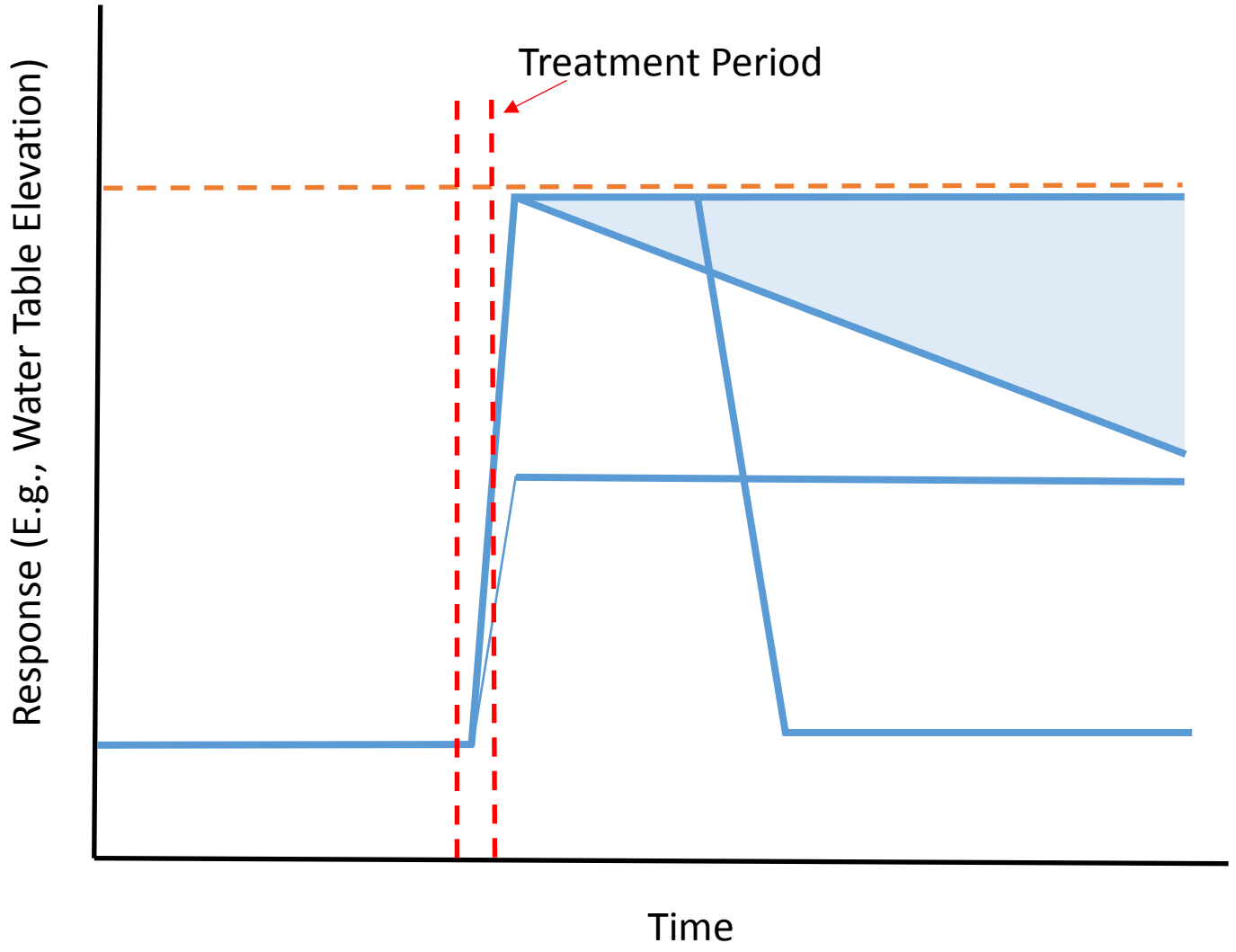
1. Address the root causes of degradation
2. Use the intrinsic energy of a site
3. Use minimally invasive procedures first

The Hydrological Problem

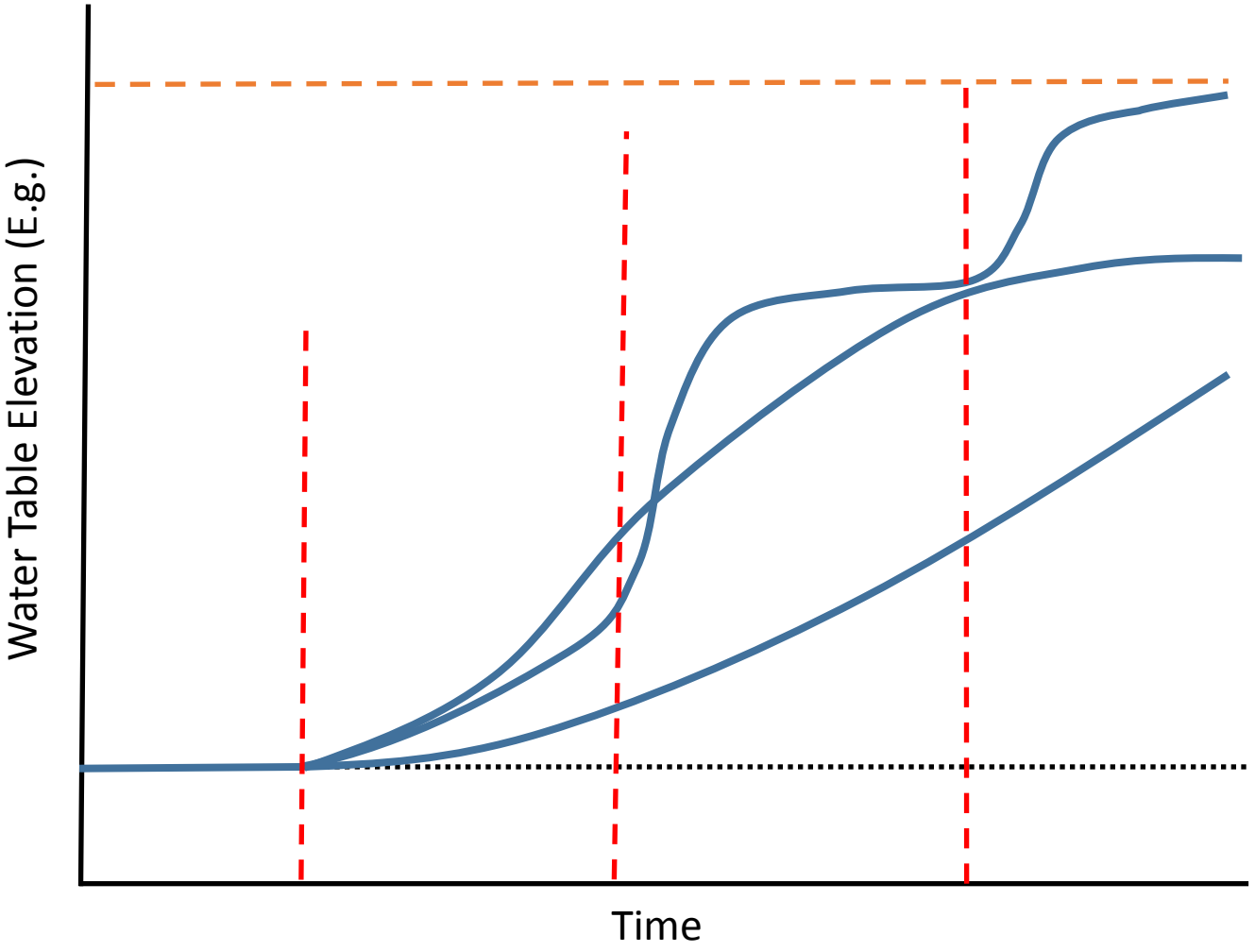




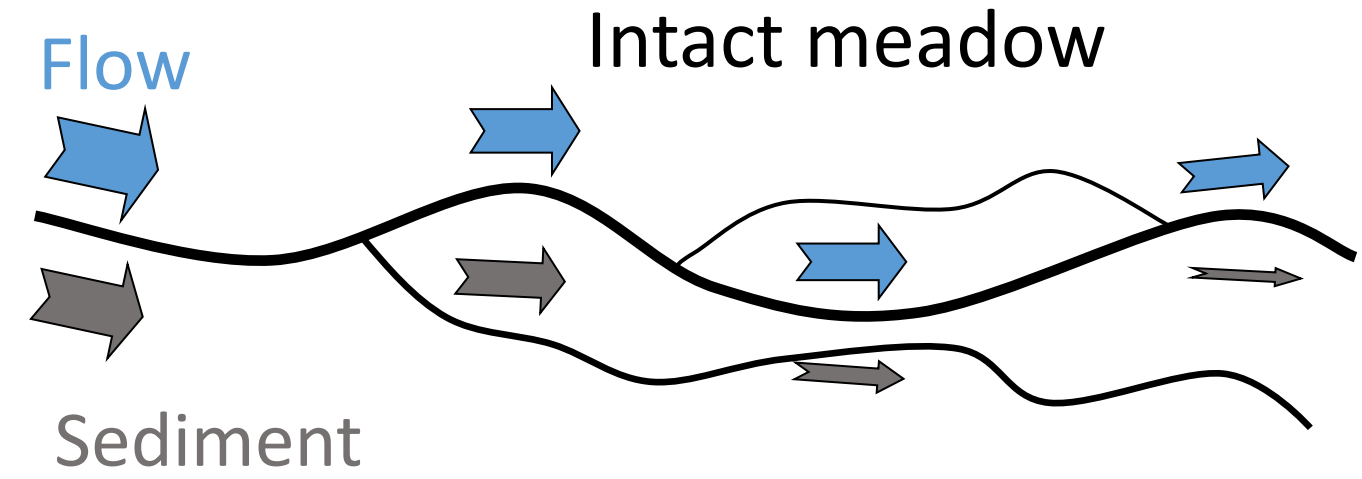
“Rewatering” Solution

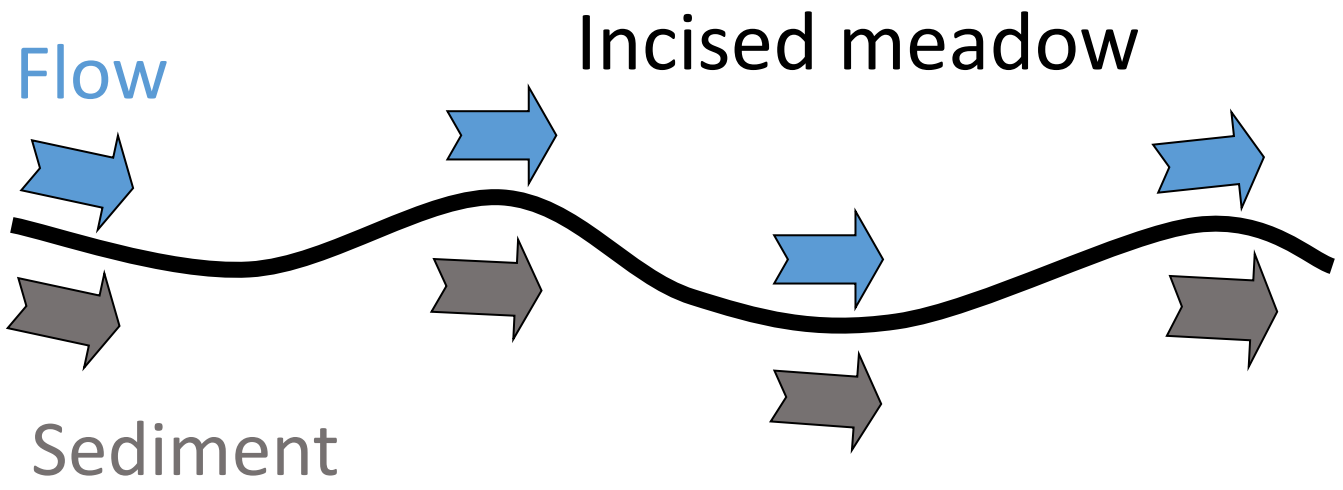


Ecological Process Solution

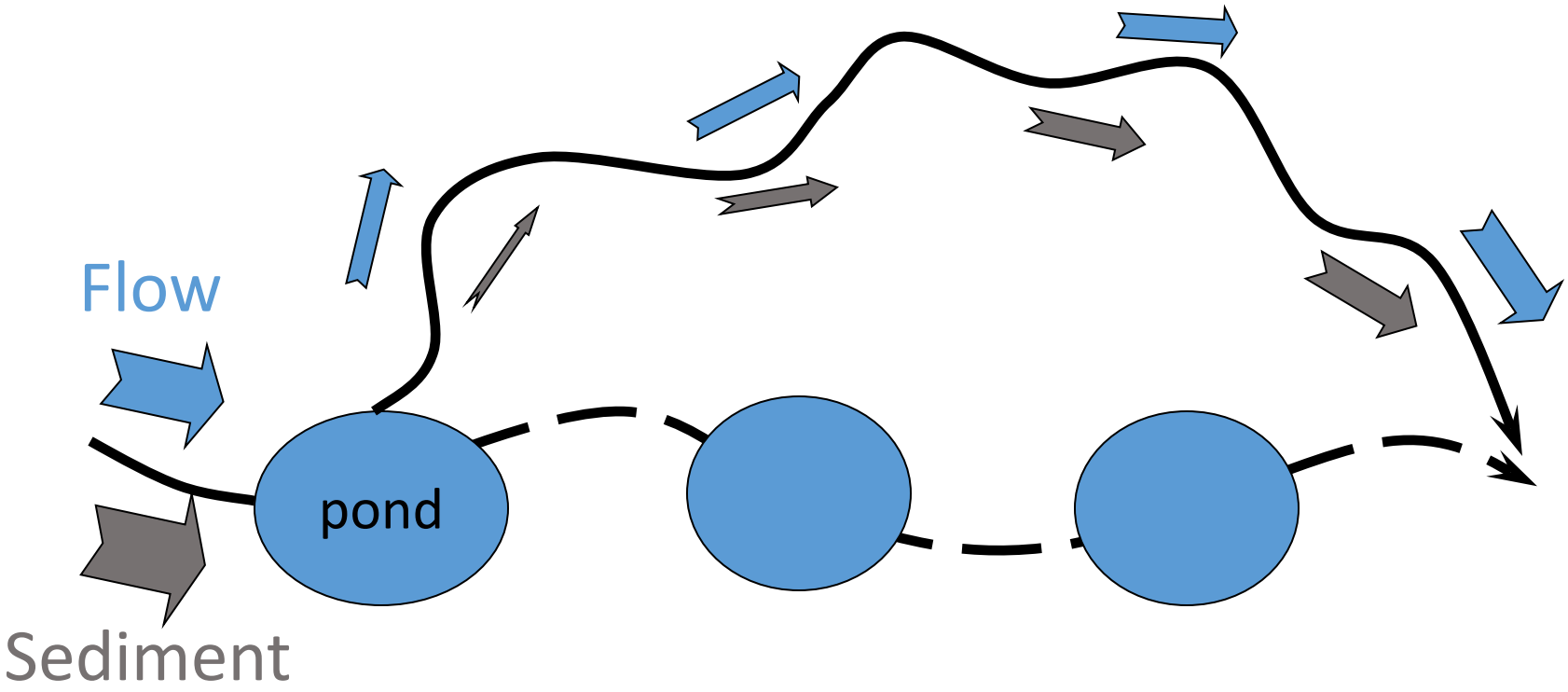


Sediment Problem



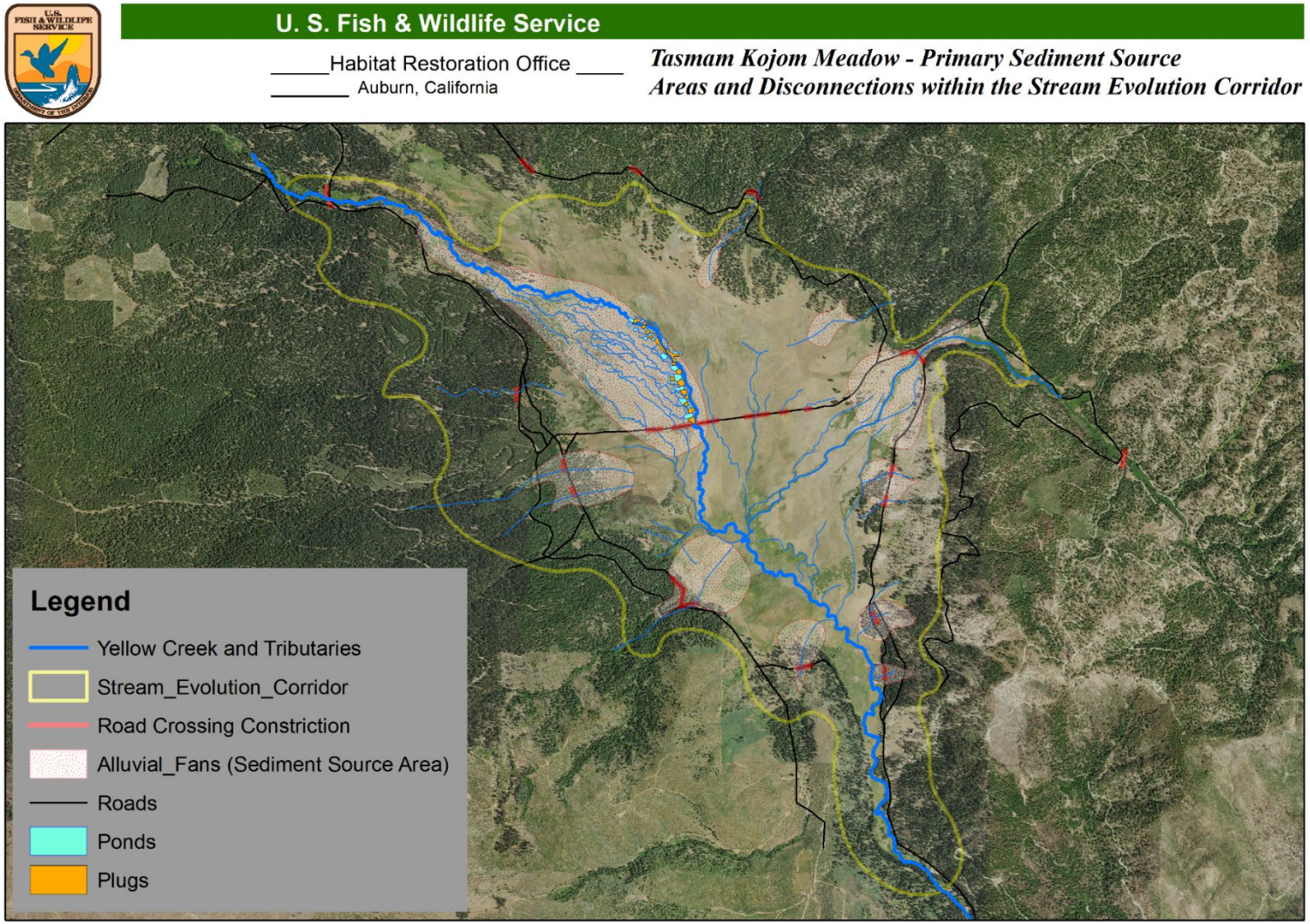


Pond-and-Plug Solution




Google earth
N
400 ft

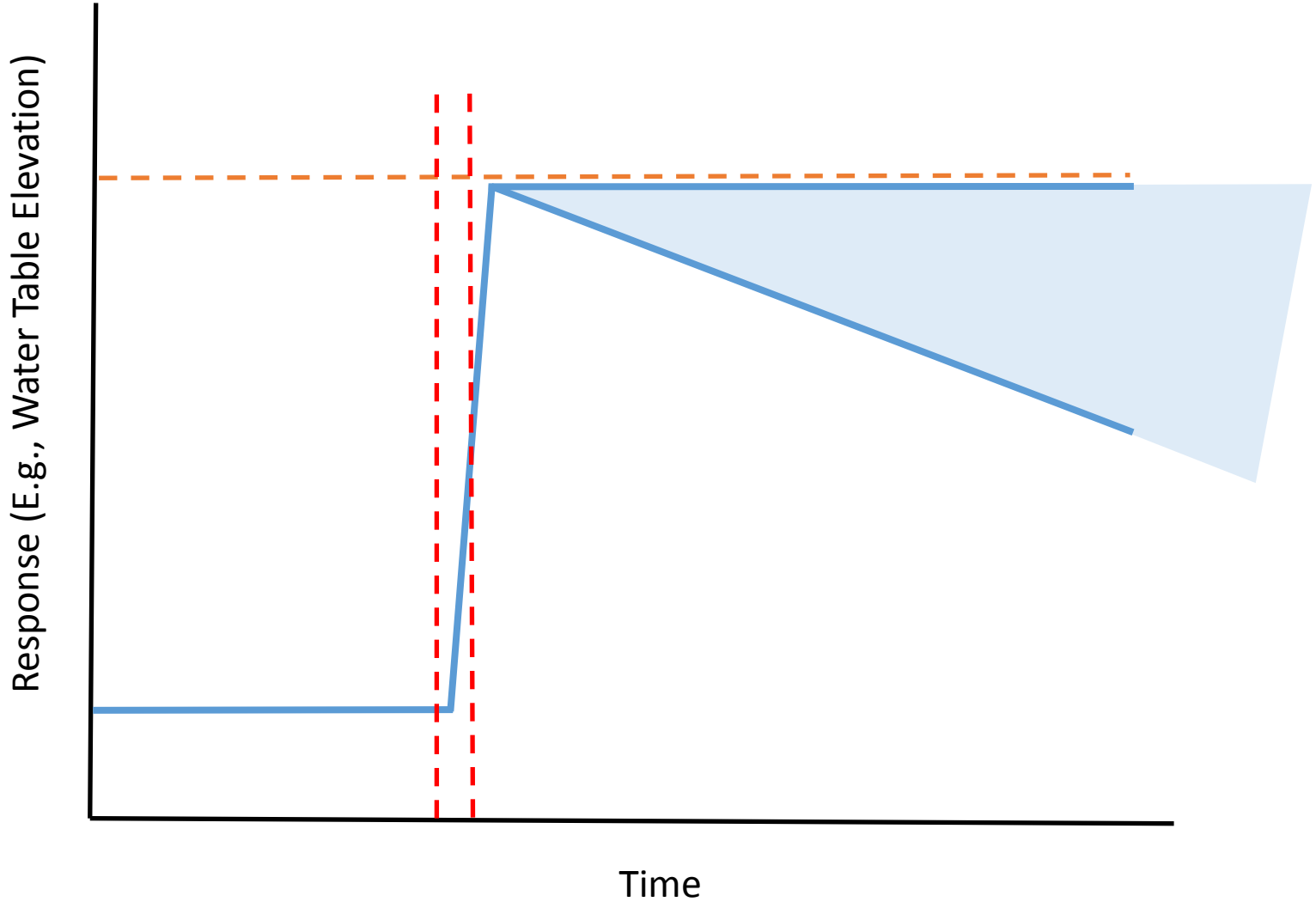
Process Solution



Biological Problem

Conifer encroachment???

Re-watering Solution

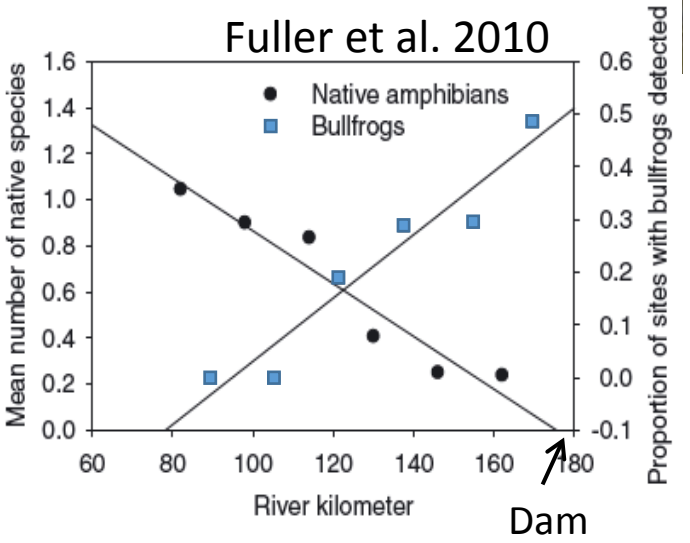


Vegetative Response

But….

American Bullfrog (*Lithobates catesbeianus*)

- Native to eastern North America
- “Eats everything”
- 2-year larval stage
- Defined breeding habitat:
  - Still, deep water
  - Rooted floating vegetation
  - Reservoirs, tailing ponds, cattle ponds, borrow pits



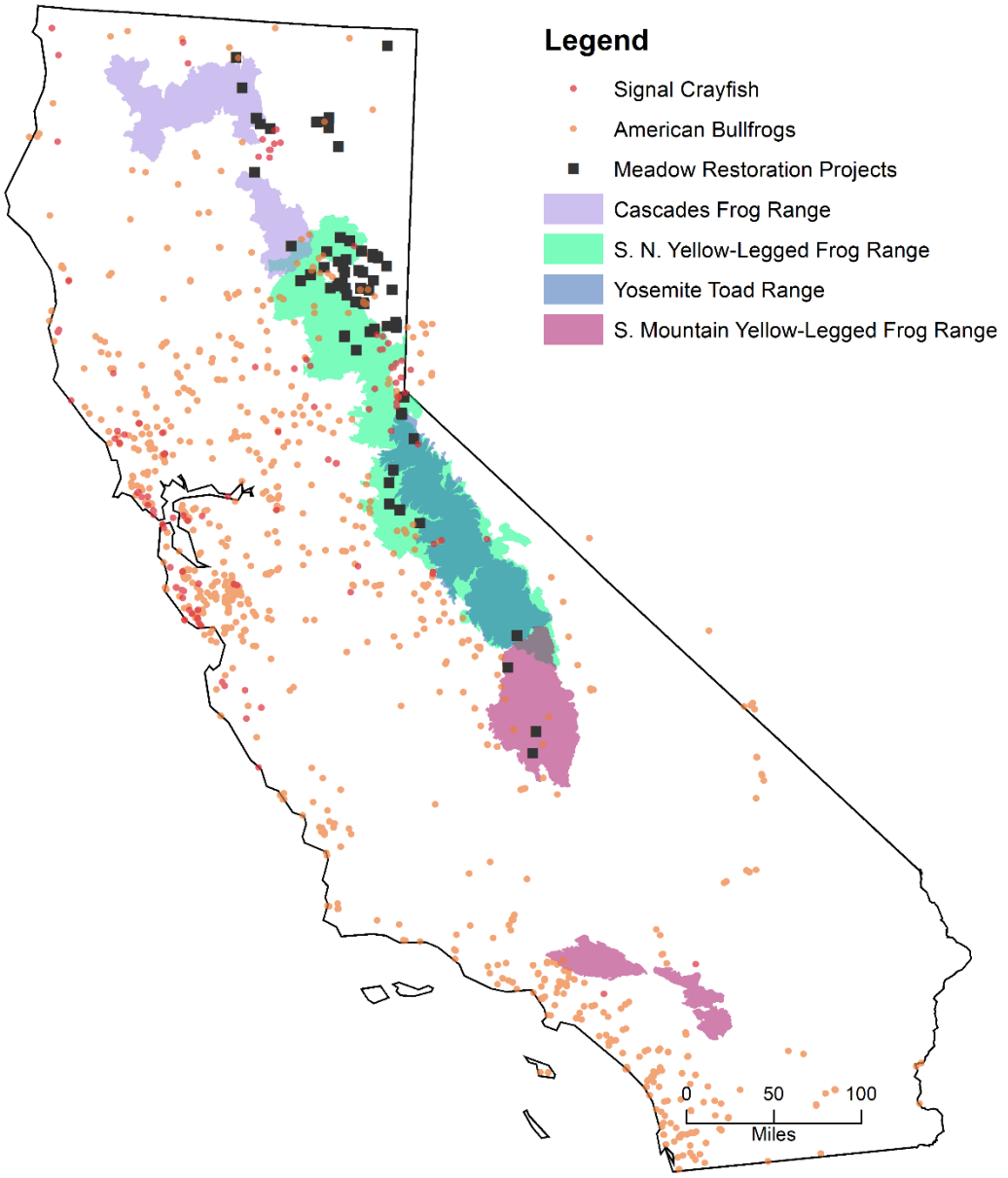

Carman-Kuth
Carman Creek
Google

Process Approach

- Consider those species that evolved with natural meadow processes

Photo: Spencer Riffle

Ranges of California's sensitive mountain amphibians



Biological Characteristics
(*Rana sierra, R. muscosa, R. cascadae*)







What Meadow Conditions support Native Amphibians (RASI, RAMU, RACA)?

a) Water throughout the year
   - With specific conditions for breeding & overwintering

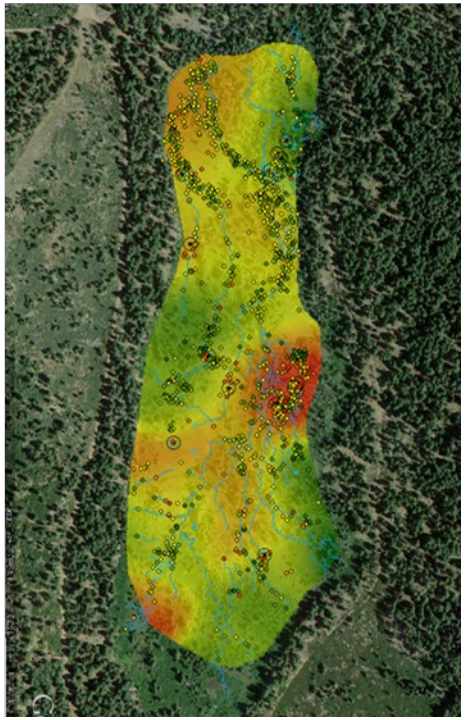
b) Ability to access food and refuge

c) Basking sites

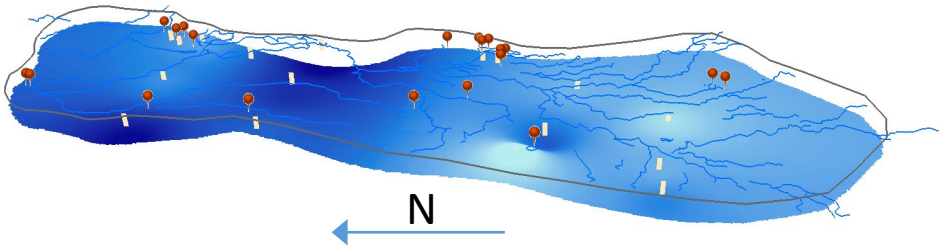
Meadow Hydrology and Frog Distribution

Stream flow and breeding sites

Water temperature and frog locations

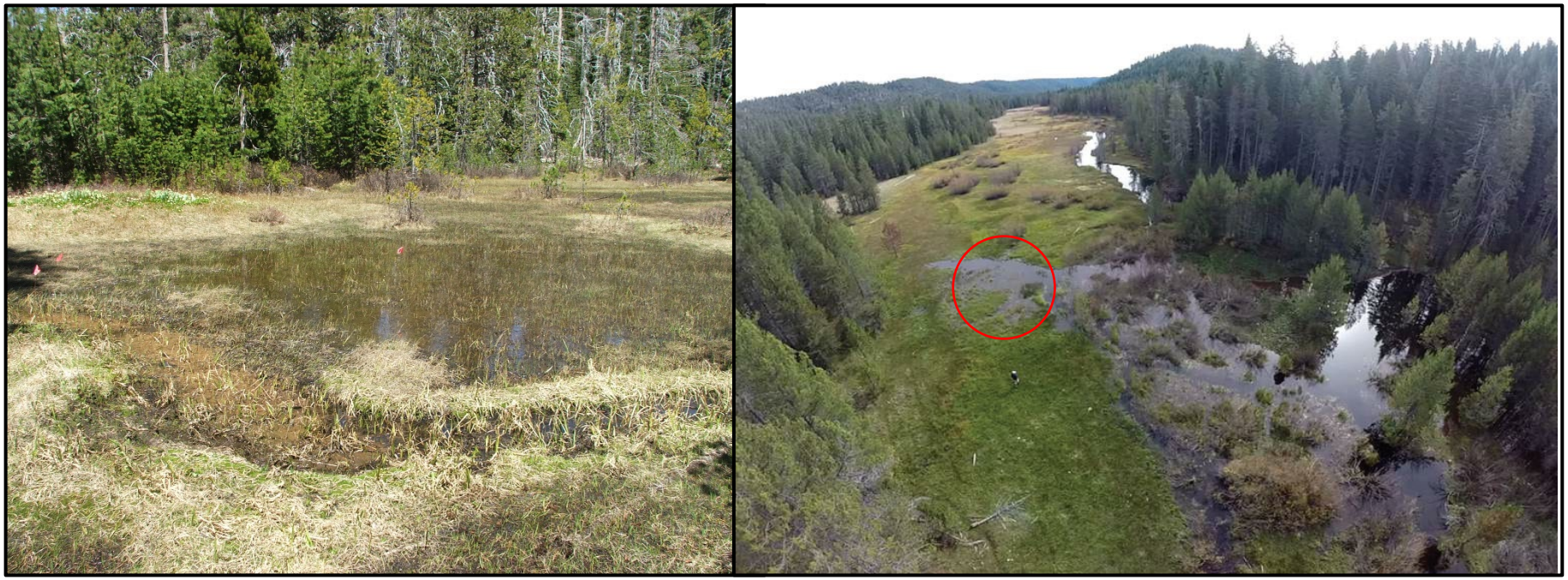


Ground water and breeding sites



NFWF

Breeding Habitat (RACA)



Summer Needs

- Ability to access food, refuge, and sun

How are appropriate conditions created and maintained?

- Different from mountain lakes
- Local disturbances necessary
- Hydrologic processes
  - Sediment transport – deposition and scour
- Biological processes
  - Ecosystem engineers
  - Vegetation change

Restoration Objectives for Native Frogs

- Retain surface water – increase hydroperiod
- Provide a range of aquatic habitat conditions for different life stage needs
- Protect and enhance habitat associated with groundwater springs
- Retain/encourage natural disturbance processes

Conclusions

When we initiate restoration, remember the interacting processes that create and maintain the habitat.

- **Incorporate all of those natural processes**
- **Remember the importance of natural disturbance**
- **Increase hydrogeomorphic complexity**

Resulting in:

- **Improved water storage**
- **Better water quality**
- **Carbon sequestration**
- **Increased biodiversity**

Acknowledgements

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