

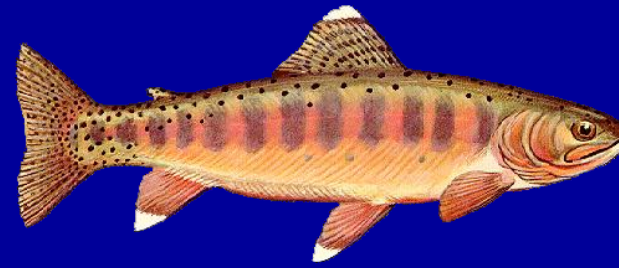


California golden trout: can their warming streams handle cattle grazing and climate change?

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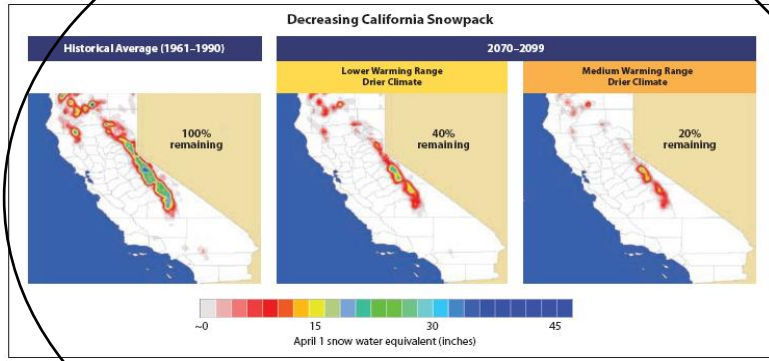
California Golden Trout

- California's state fish; one of few native fish >8000 ft; inhabits high elevation meadow streams in the southern Sierra
- Native to South Fork Kern River and Golden Trout Creek; not native to lakes
- Most of its native range now within Golden Trout Wilderness



Golden Trout
Wilderness
encompasses
most of the
subalpine
meadows of the
Kern Plateau—
all meadows
grazed since the
1800s



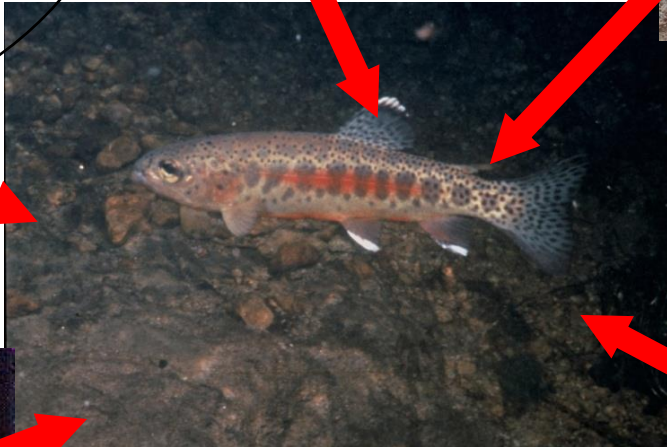


Climate warming

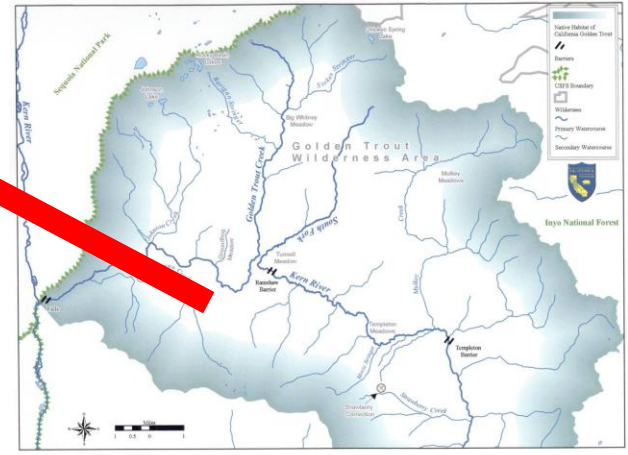
Loss of genetic diversity



Degraded habitat from cattle grazing



Non-native trout



Can Golden Trout handle another stressor?
 Limited distribution and in headwaters

Climate change: some factors that may influence golden trout and their habitat

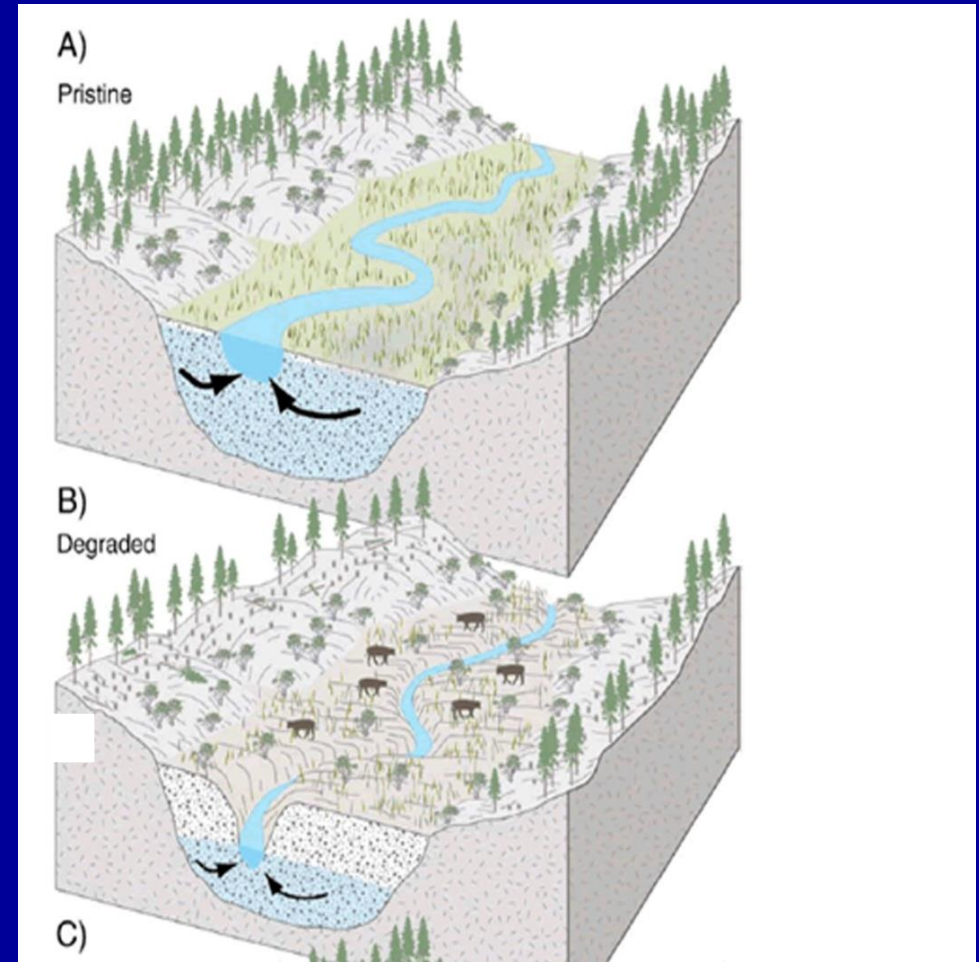
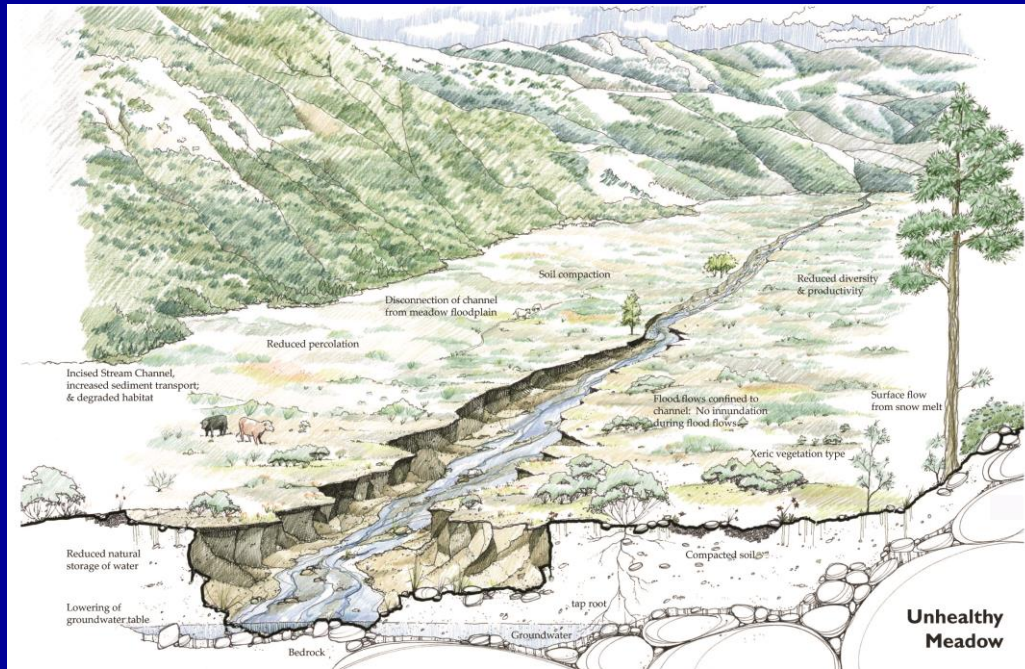
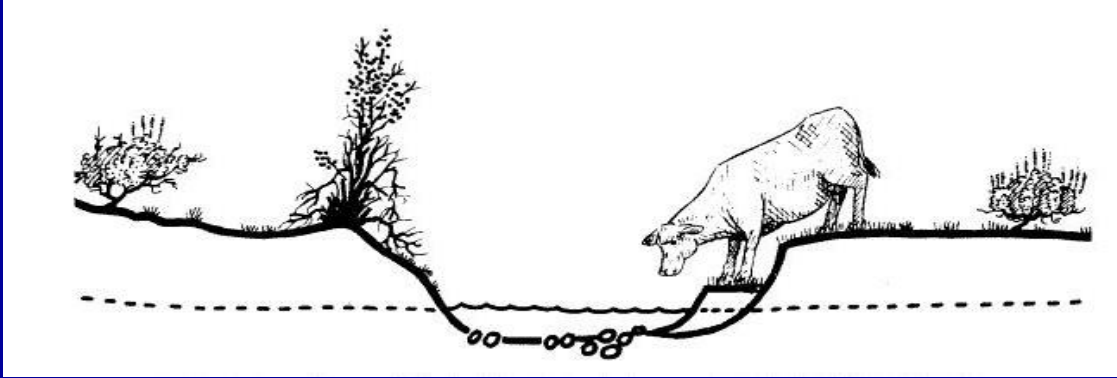
- Decreased snowpack—may be more dramatic at lower elevation (<9000 ft)
- Earlier snowmelt some year-round mountain streams going dry by summer
- More sediment scouring from increased precipitation
- Increasing water and air temperatures- 2-5°C over next 100 years

How are they doing??



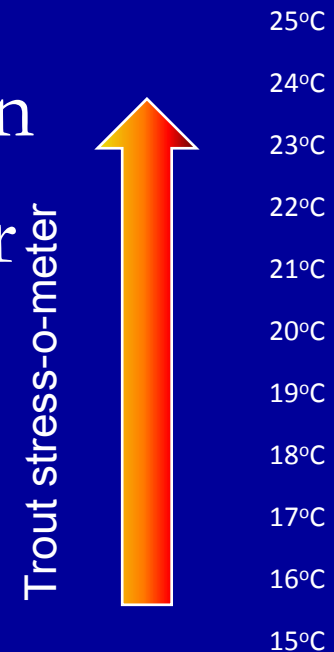
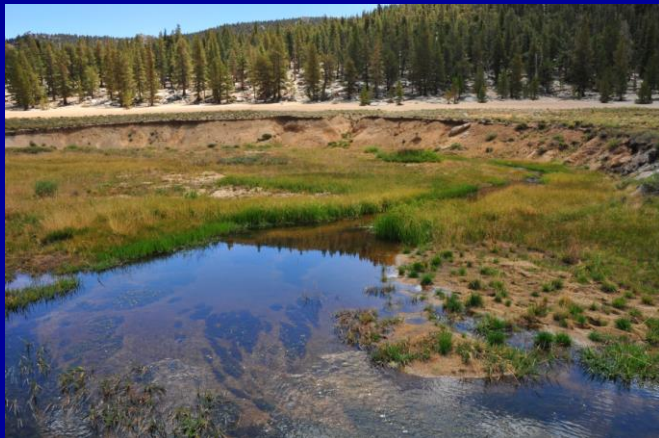
- Were threatened by exotic trout
- Genetic integrity imperiled
- Very dense, stunted populations
- Stream habitat degraded
- Water temperatures are high
- Limited distribution & at the headwaters

Cows and Meadow streams- all of the GTW streams have been grazed



What happens to trout with warmer ($>21^{\circ}\text{C}$) water temperature?

- Increased metabolism/decreased growth
- Increased susceptibility to disease/fungal infections
- Decreased survival/low condition
- Dissolved oxygen becomes lower



Climate change and cattle grazing—similar stressors to aquatic systems

Predicted climate change effects	Known effects of cattle grazing	Combined—double whammy??
Increasing water and air temperatures- 2-7°C	Reduced streamside vegetation and widened/shallow streams lead to higher water temperatures	Lethal water temperatures for salmonids
Reduced snowpack, less water availability, reduced vegetation growth	Reduced streamside vegetation from grazing and subsequent bank instability	Inability to keep to stream cool--lethal water temperature and reduced dissolved oxygen
What can we do? Climate adaptation	Current condition	Action
Need resilient stream ecosystems to adapt to future warming	Low resiliency to future warming and little opportunity for recovery	Beschta et al. (2013) recommend eliminating grazing (especially in wilderness) to ensure stream habitats can tolerate future warming

Golden Trout Wilderness temperature vulnerability assessment



90 temperature probes record data
every 20 minutes

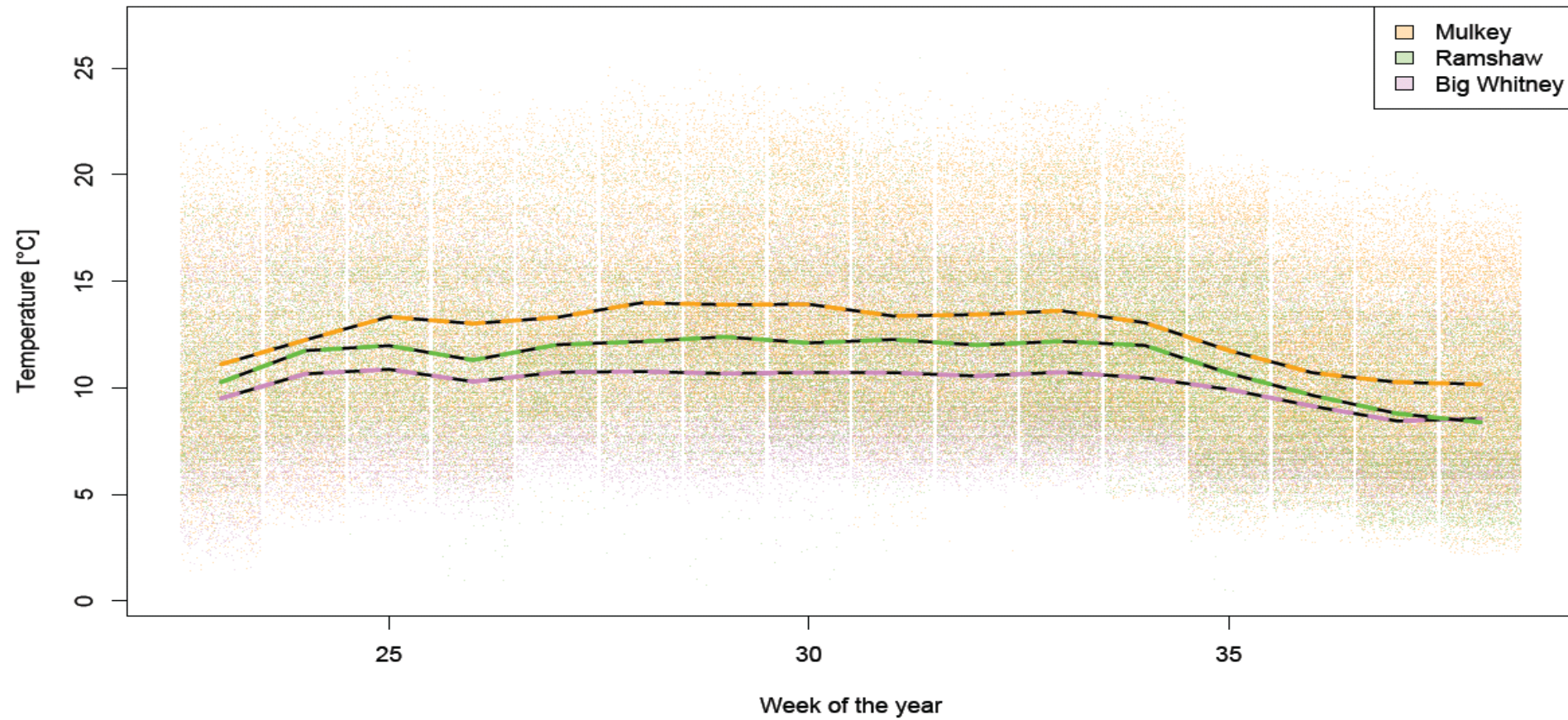
Quantified stream water temperatures, shading &
dissolved oxygen (DO) in three meadows: Mulkey,
Ramshaw, and Big Whitney

Preliminary findings/concerns from 2008-2013

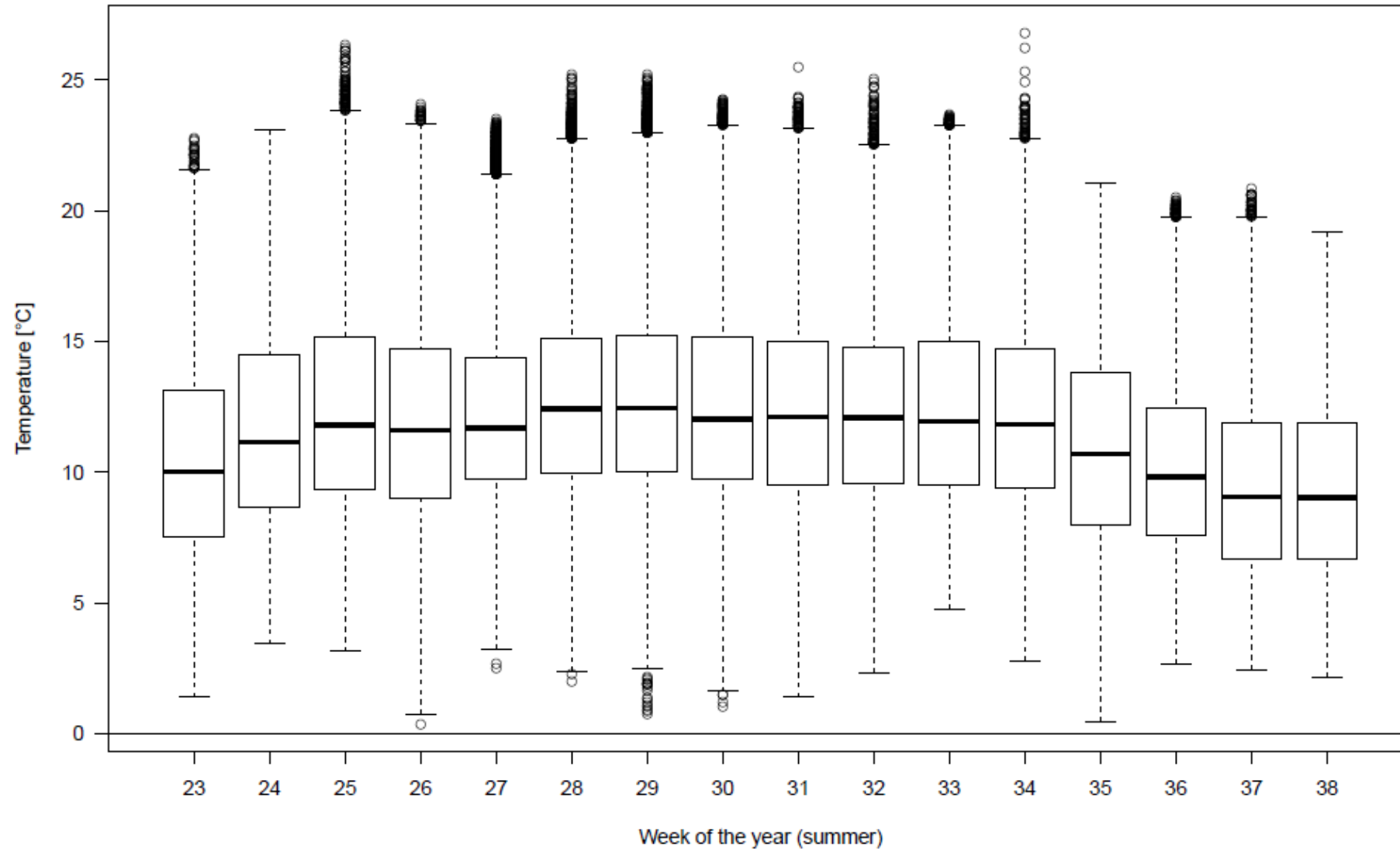
- Maximum temperatures in summer reach 26°C, up to 55 days w/water temperature exceeding 20°C
- Diel (24 hr) fluctuations range up to 15°C
- Stressful combination of high temperature and low shading
- Streams don't have resilience to future warming
- CGT are in the headwaters, no place to go

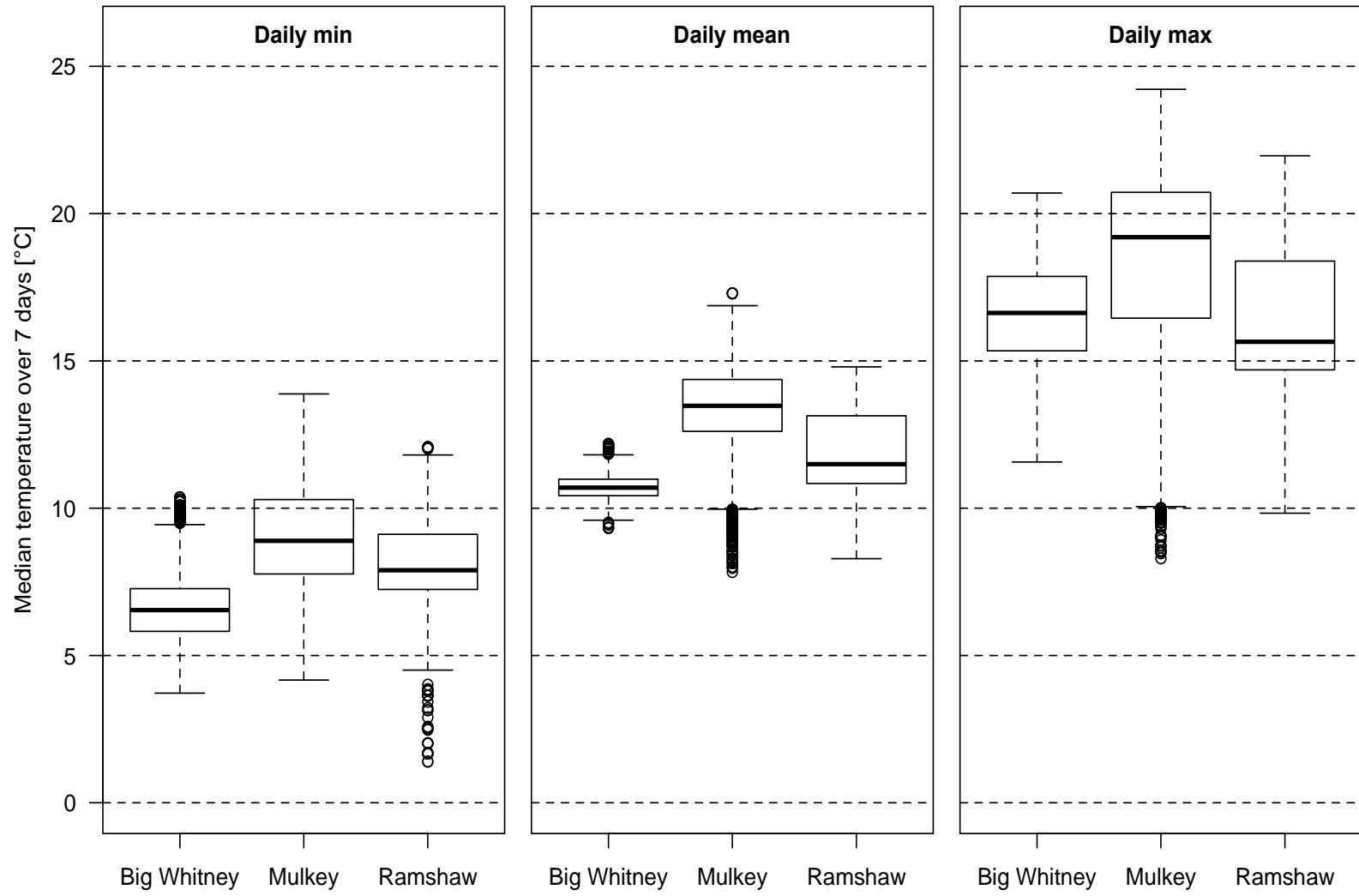


Summer mean water temperatures-Mulkey, Ramshaw & Big Whitney

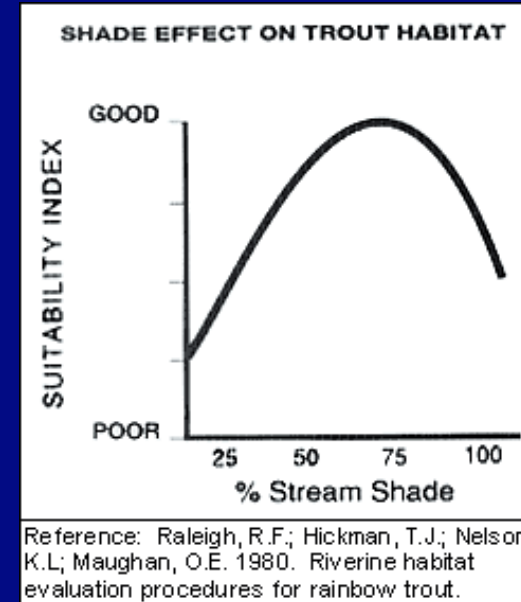
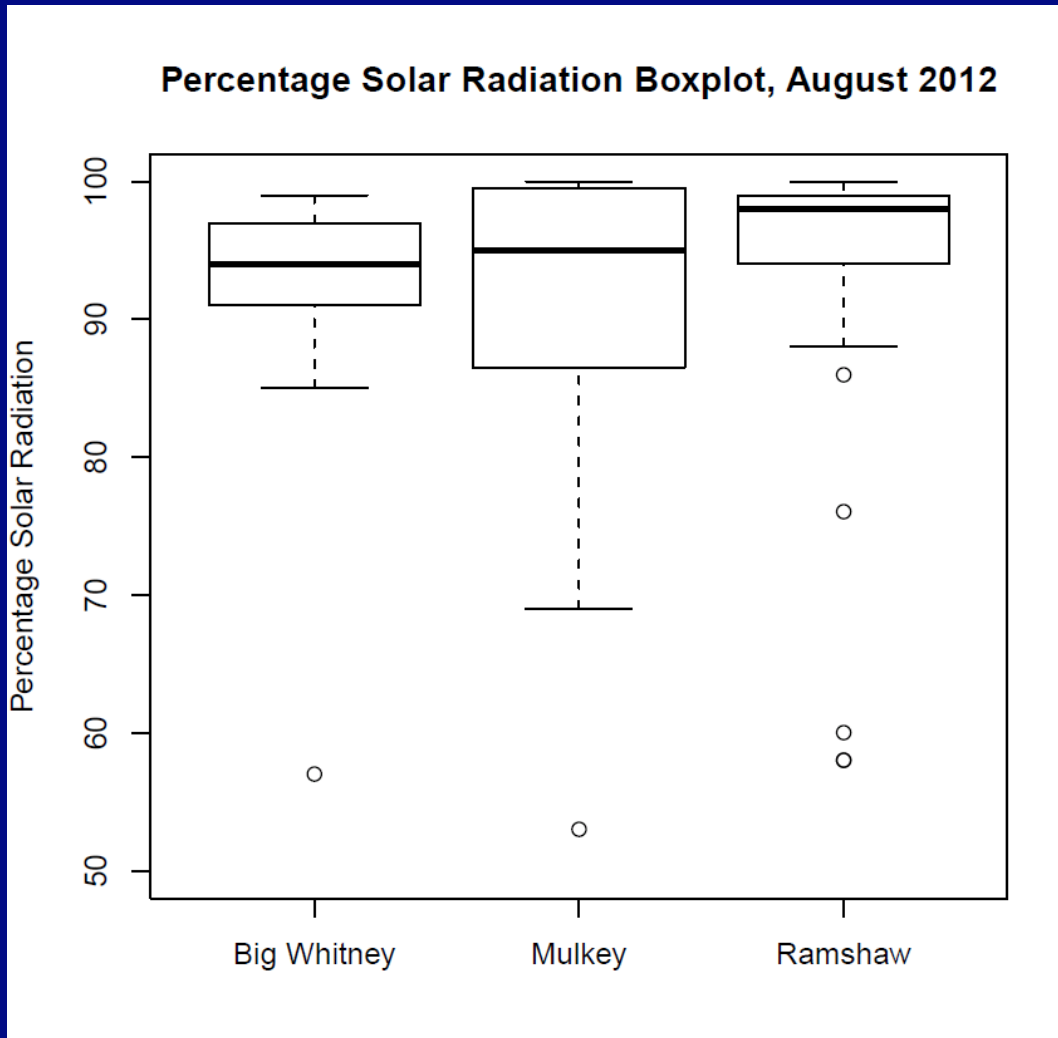


Summer range of water temperatures—all 3 meadows



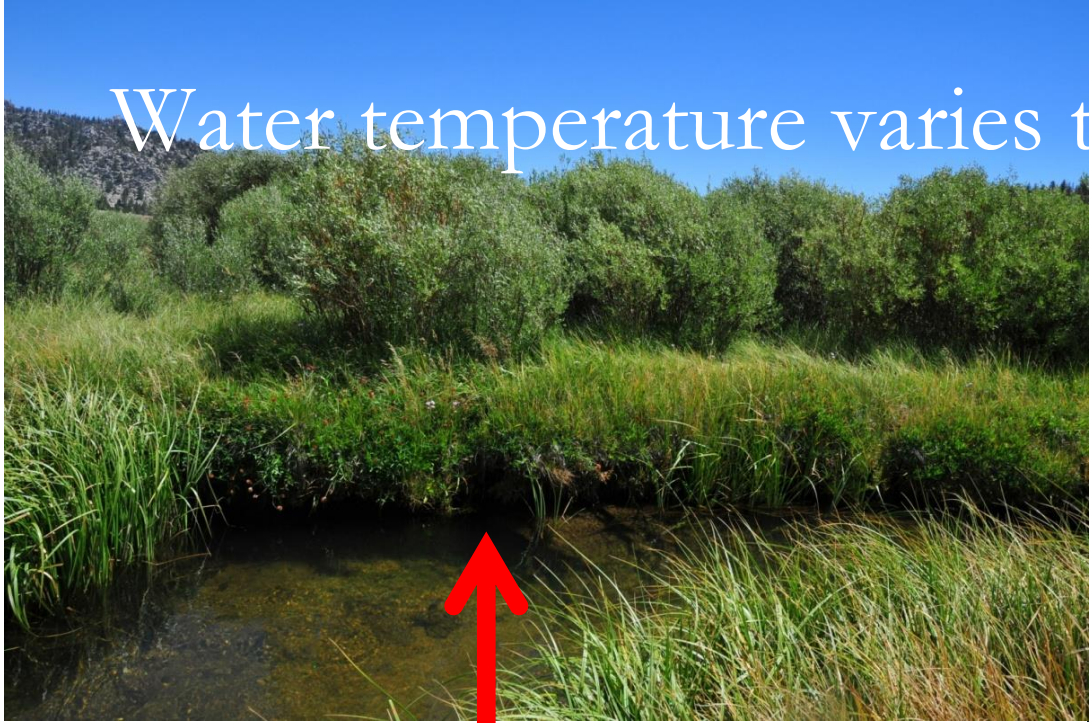


Solar input high ($>90\%$) & shading low ($<10\%$)



50-80% shading considered good

Water temperature varies throughout stream

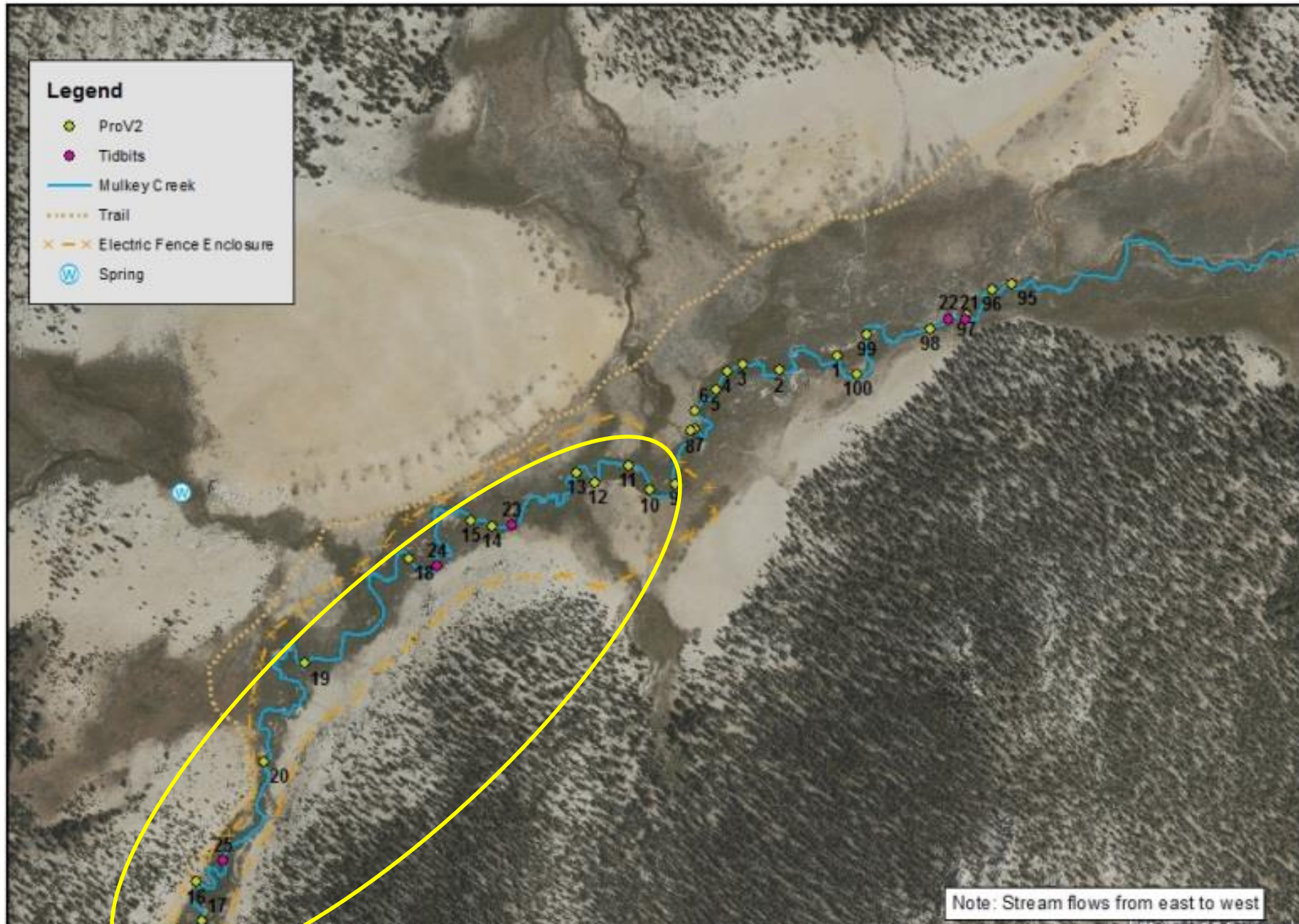


- Shaded undercut bank, 1 m deep
- Coolest temperatures found here



- Open to solar radiation, .2 m deep
- Highest temperatures found here

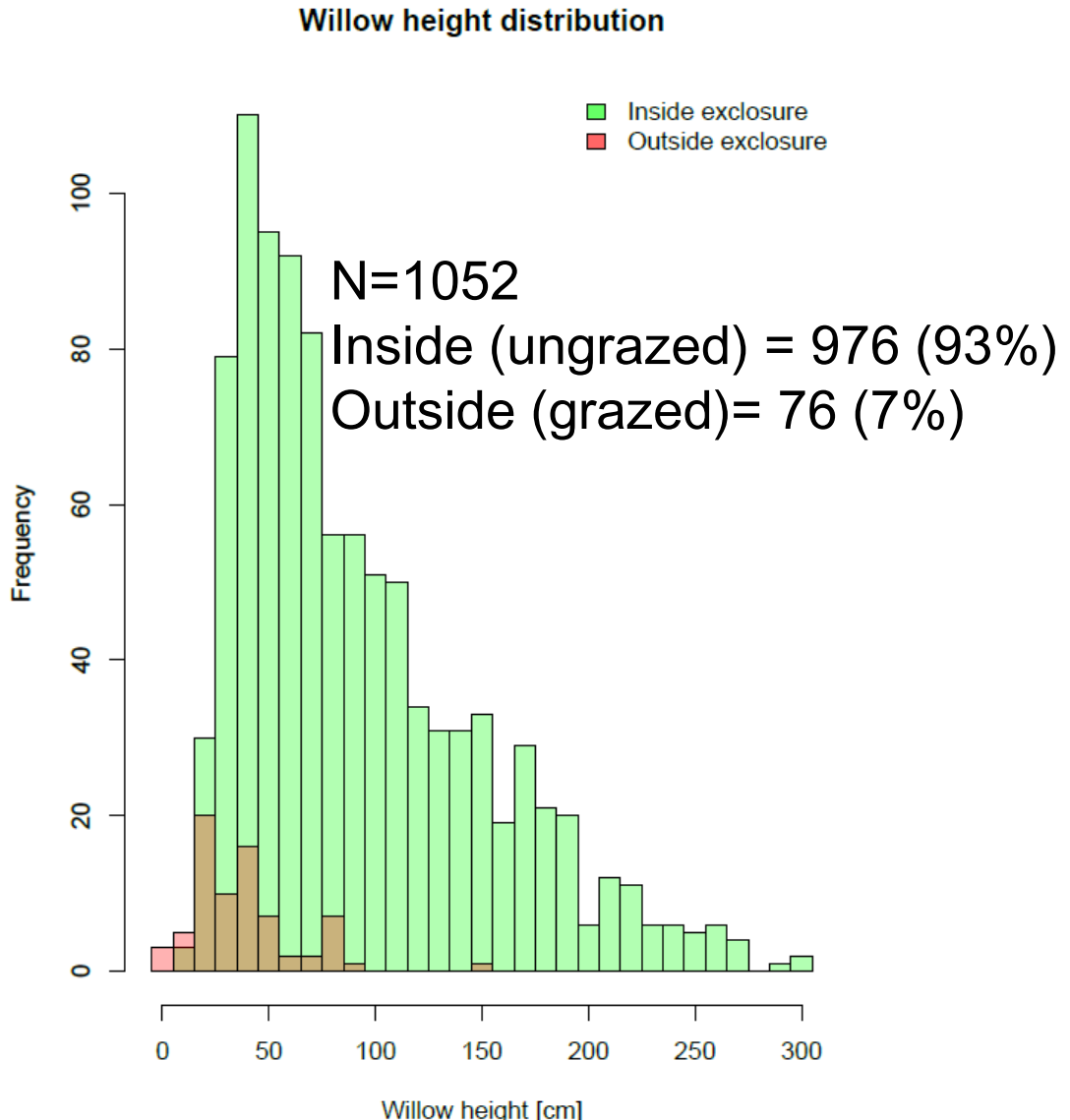
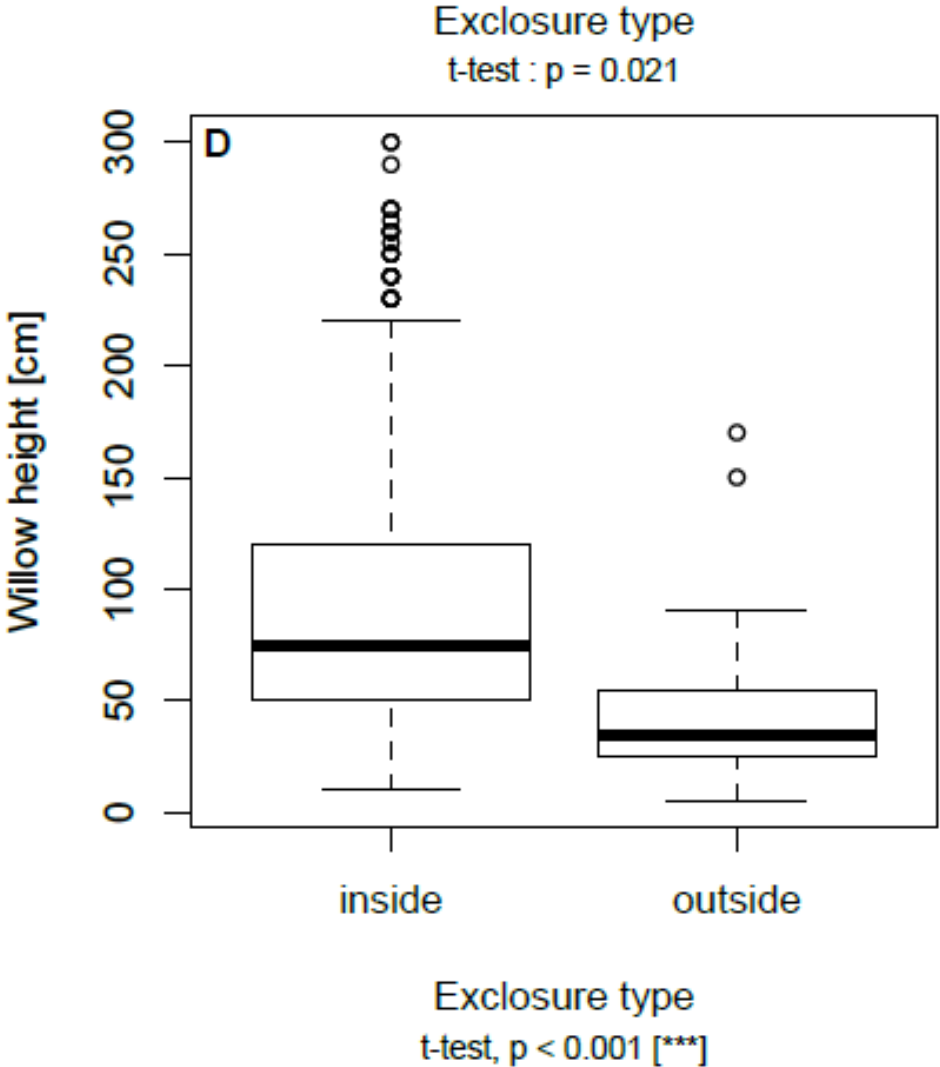
Mulkey Meadow Probe Locations



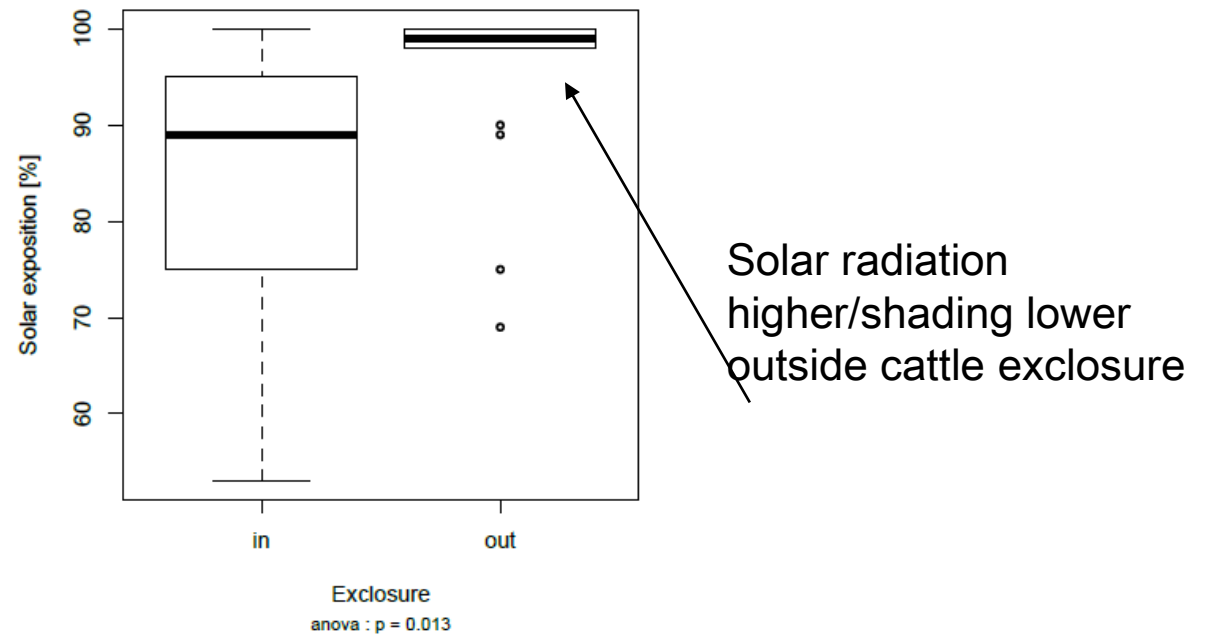
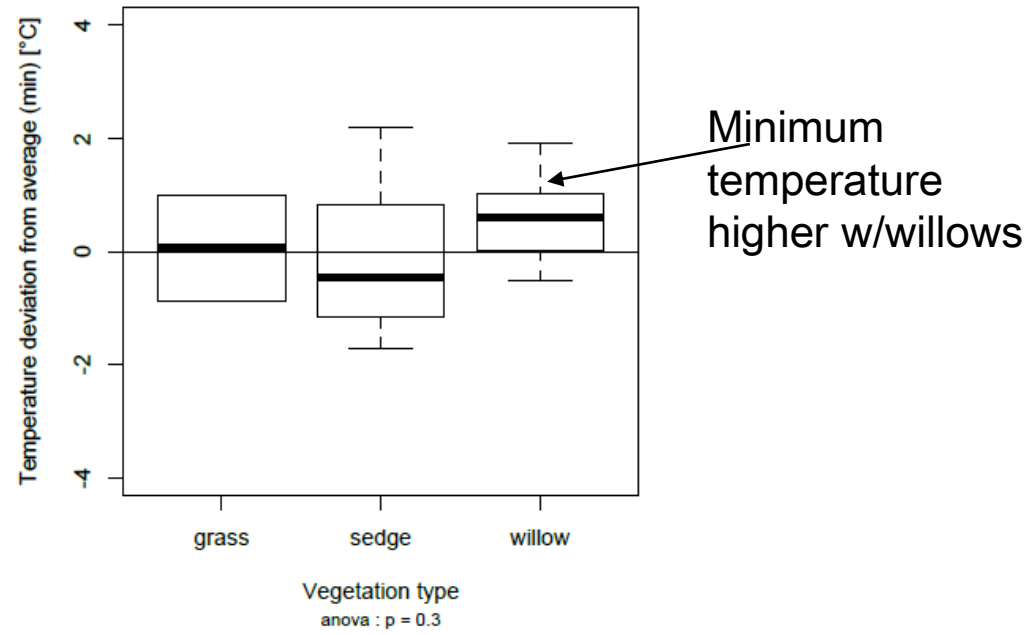
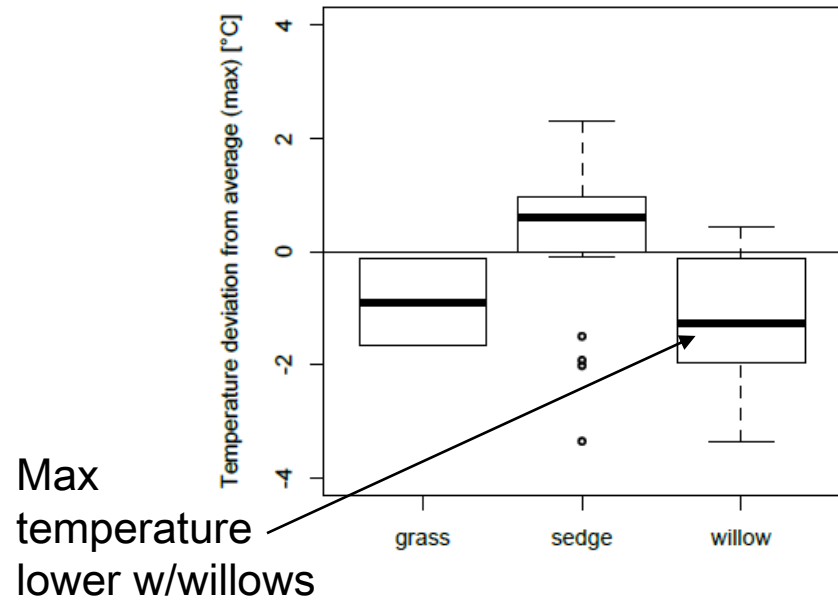




Willow numbers and heights inside and outside Mulkey cattle exclosures



Mulkey (2837 M)

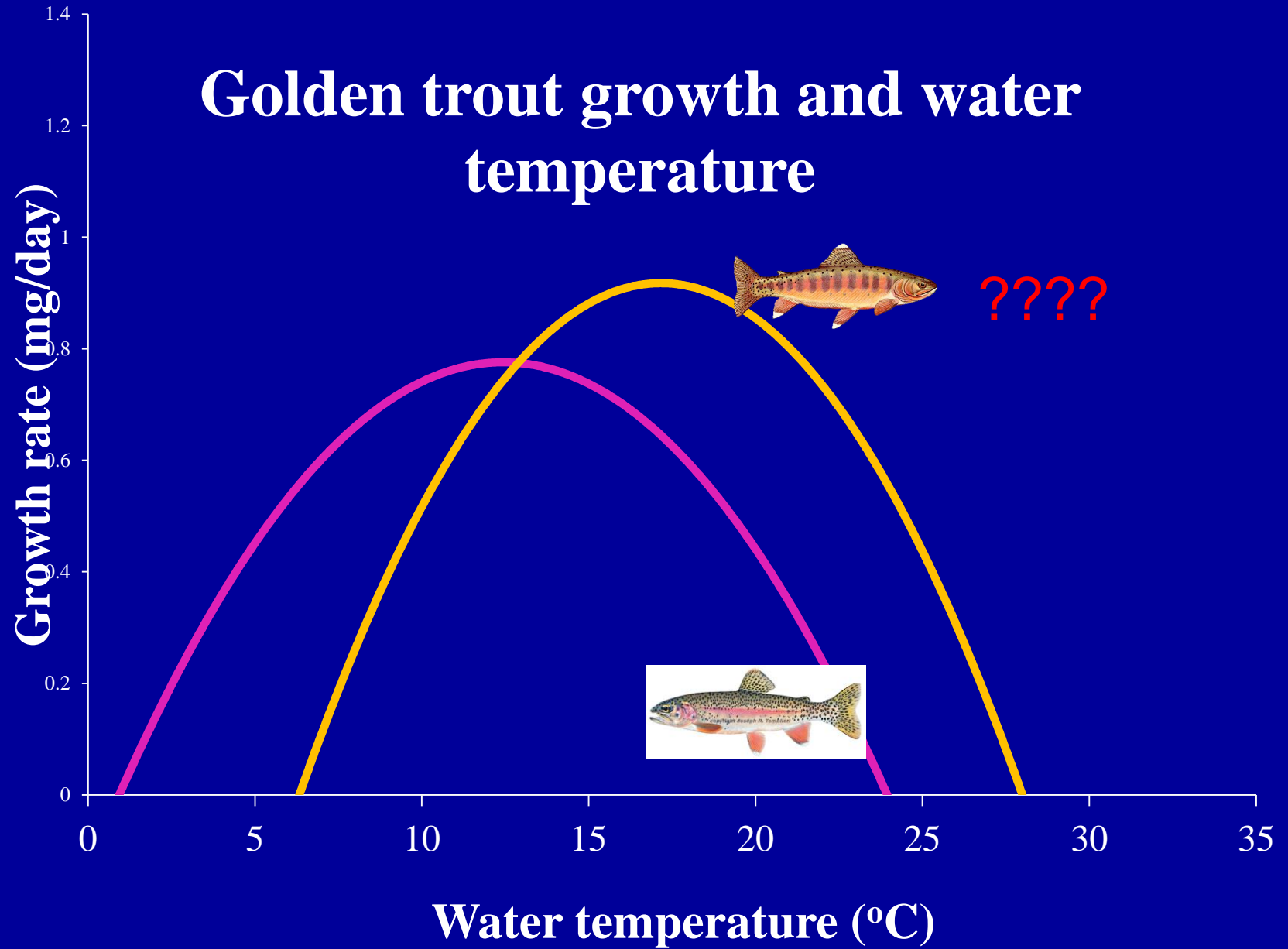


What is thermally “suitable habitat” for golden trout?

- For most trout, upper tolerance is 20-24°C
- Nothing is known regarding temperature tolerances for golden trout

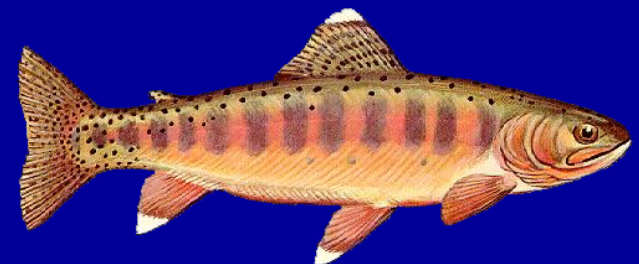


Golden trout growth and water temperature



Is CGT stream habitat resilient to climate warming?

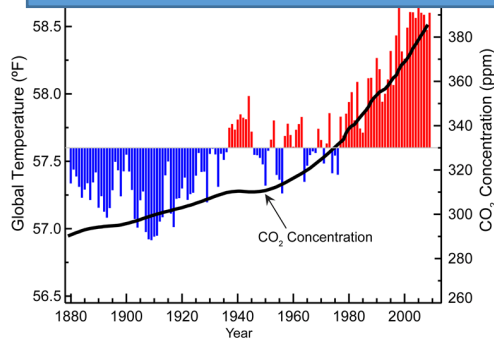
- No! None of the streams withstand increased warming
- Interim thresholds for conservation??
- Restoration should prioritize keeping streams cool



Can Golden Trout handle both stressors??

Climate change

Warmer temperature & reduced snowpack predicted to increase water temperatures



Cattle grazing

Reduced streamside vegetation and widened streams have led to increased water temperatures

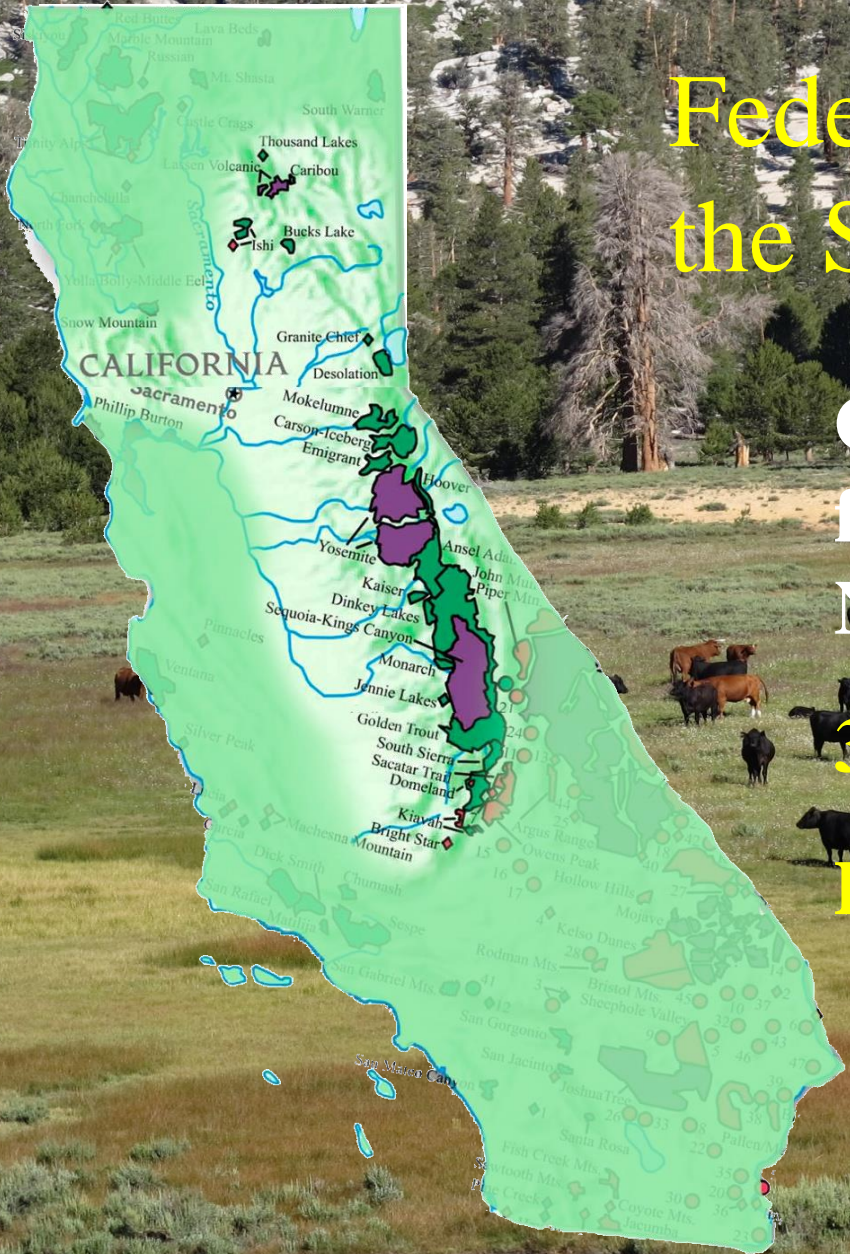


???

Federal Wilderness in the Sierra Nevada

Of the 12 million acres of federal land in the Sierra Nevada

3.7 million acres (30 %) are Designated Wilderness



Wilderness Act of 1964

“An area of wilderness is further defined...to mean an area of Federal land **retaining its primeval character and influence**...which is generally protected and managed **to preserve its natural conditions** and which generally appears to have been affected primarily by forces of nature, with the imprints of man’s work substantially unnoticeable”



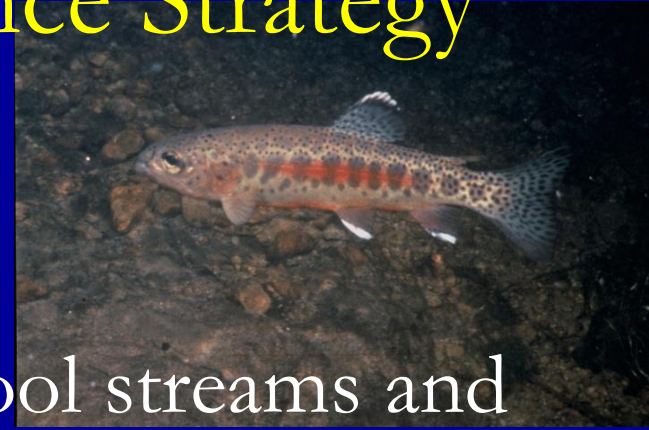
The American Legacy of Wilderness
Honoring 50 Years of Preservation, Use, and Enjoyment

Beschta et al. 2013 Environmental Management article on Grazing and Climate Change

“Removing or reducing livestock across large areas of public land would alleviate a widely recognized and long-term stressor and make these lands less susceptible to the effects of climate change.”

“we recommend removing livestock ...from national parks, monuments, **wilderness areas**, and wildlife refuges wherever possible...”

California Golden Trout Resilience Strategy



- Focus on management actions that cool streams and increase resiliency—restoration
- Set aside refuges or reference sites in Wilderness— areas that minimize or eliminate activities such as grazing that render stream habitats less resilient to increased warming
- Open question—Can we have resilient salmonid streams and cattle grazing??

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