

California Golden Trout: Is their habitat vulnerable to climate warming?

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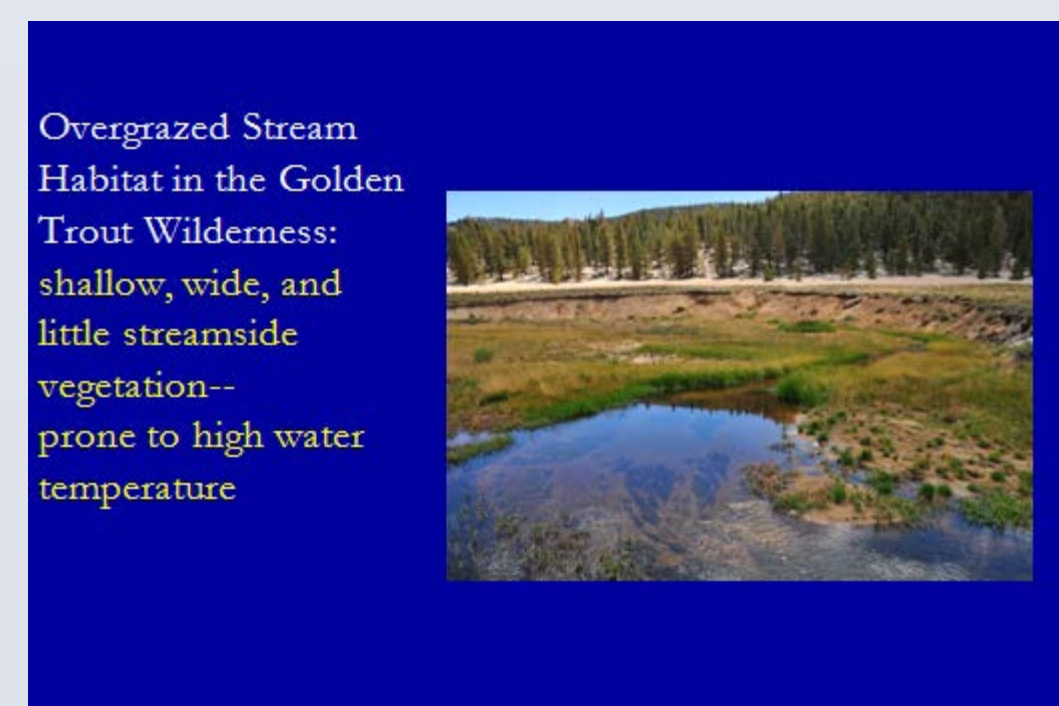
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California golden trout (CGT), *Oncorhynchus mykiss aguabonita*, the state fish of California



Abstract

The California golden trout (CGT), *Oncorhynchus mykiss aguabonita*, is one of the few native high-elevation fishes in the Sierra Nevada. They are imperiled because of exotic trout, genetic introgression, and degraded habitat, and now face further stress from climate warming. Their native habitat on the Kern Plateau meadows mostly in the Golden Trout Wilderness (GTW) currently includes stream areas impacted by cattle grazing. As a result, some areas have reduced streamside vegetation (willows or sedge) and widened channels with shallow stream depths that often lead to warmer water temperatures. Climate change may further compromise CGT and their habitat in stream areas still being grazed, because the warmer water temperatures predicted under most warming scenarios could increase to lethal levels. One important management response to climate warming will be to ensure that habitats are more resilient to predicted changes in water temperature. My CGT study is determining the climate change resiliency of golden trout habitat by conducting a spatially explicit analysis of stream temperatures in GTW meadows.

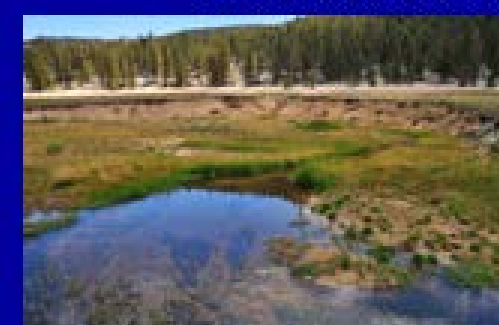


What is the problem?

- Vulnerable stream section degraded from overgrazing already experience warm stream temperatures
- Climate warming will exacerbate the problem
- Temperatures above 21°C are considered stressful for salmonids
- Streams may not have the resiliency to withstand further warming

What happens to trout with warmer (>21°C) water temperature?

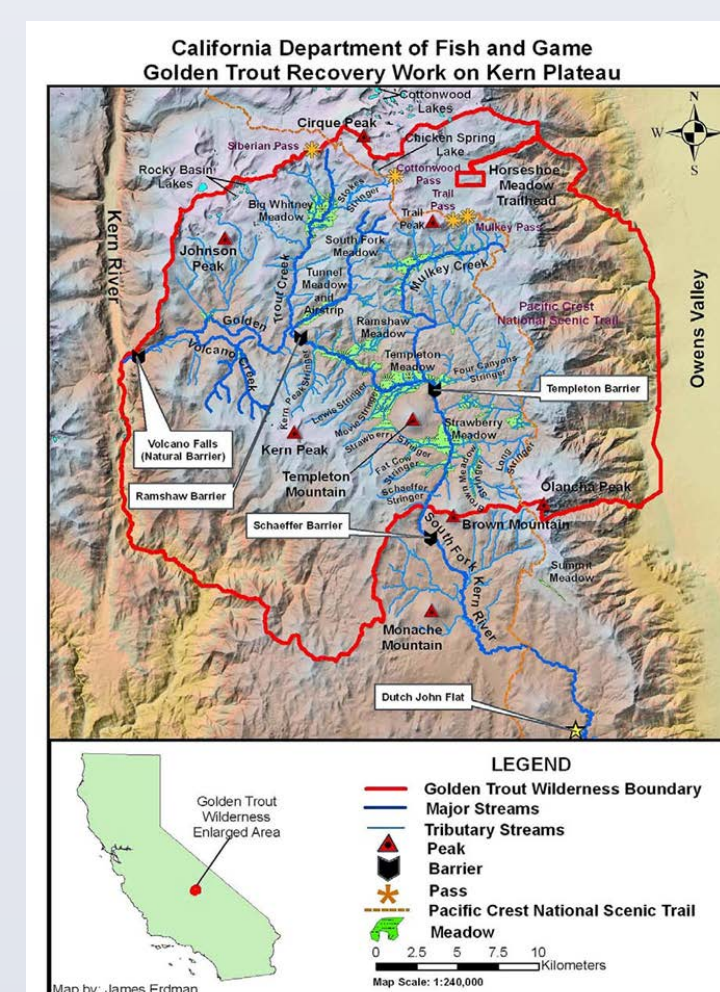
- Increased metabolism/decreased growth
- Increased susceptibility to disease/fungal infections
- Decreased survival/low condition
- Dissolved oxygen becomes lower



Trout stress > 21°C

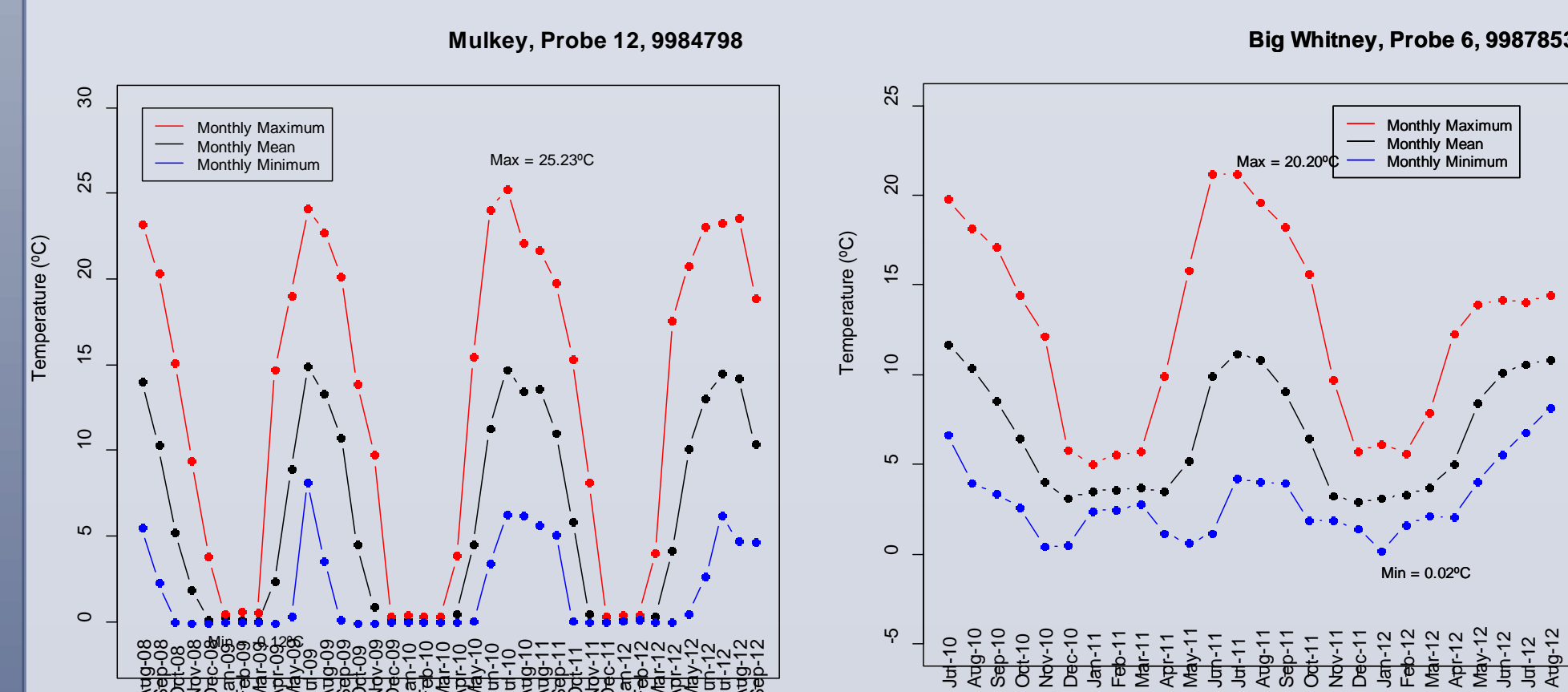
Study Description & Results

To determine the water temperature vulnerability of the CGT within its stream habitat in the GTW, I deployed temperature probes (Onset HOBO Water Temp Pro v2 and tidbits) throughout the stream to include a typical range of stream areas: areas degraded by cattle grazing (collapsed banks, little vegetation, shallow depth) and those in recovering areas with more vegetation and greater depth. The analysis is being conducted in Mulkey, Ramshaw, and Big Whitney meadows in the GTW. Temperature probes were downloaded in 2010-2012: 32 probes in Mulkey meadow, 23 in Big Whitney, and 31 in Ramshaw meadow. This study was conducted in three large (5–7 km long) montane meadows of the Golden Trout Wilderness in the Inyo National Forest of the southern Sierra Nevada.



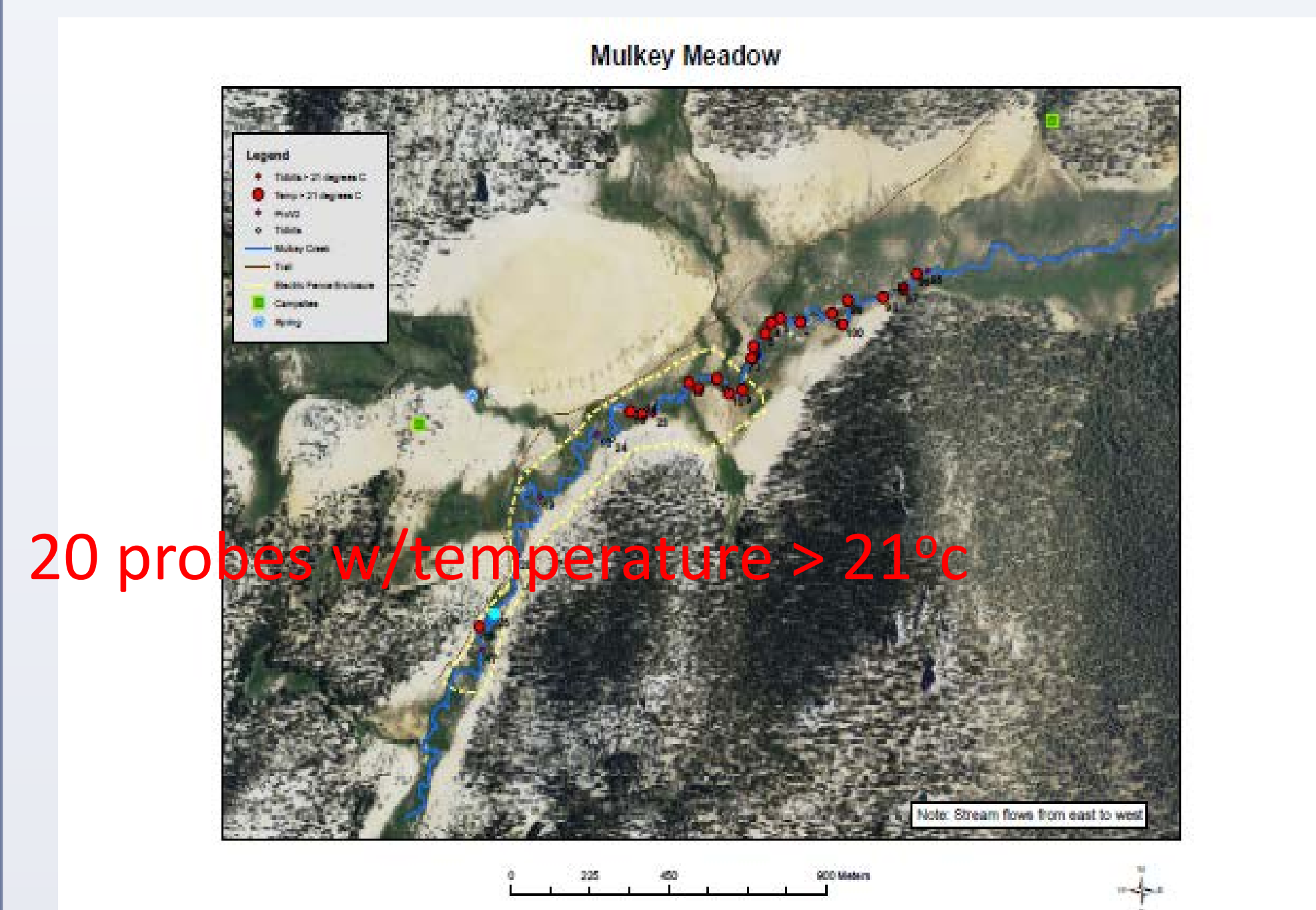
CGT habitat—meadow streams on the Kern Plateau

Preliminary data indicate that stream temperatures often reached 25°C during the summer. These high temperatures are reportedly lethal for salmonids, but may affect CGT in more subtle ways such as growth, condition, or long-term survival. Moreover, CGT experienced an extremely high diel range of temperatures ($\pm 15^\circ\text{C}$) which will further stress the CGT.

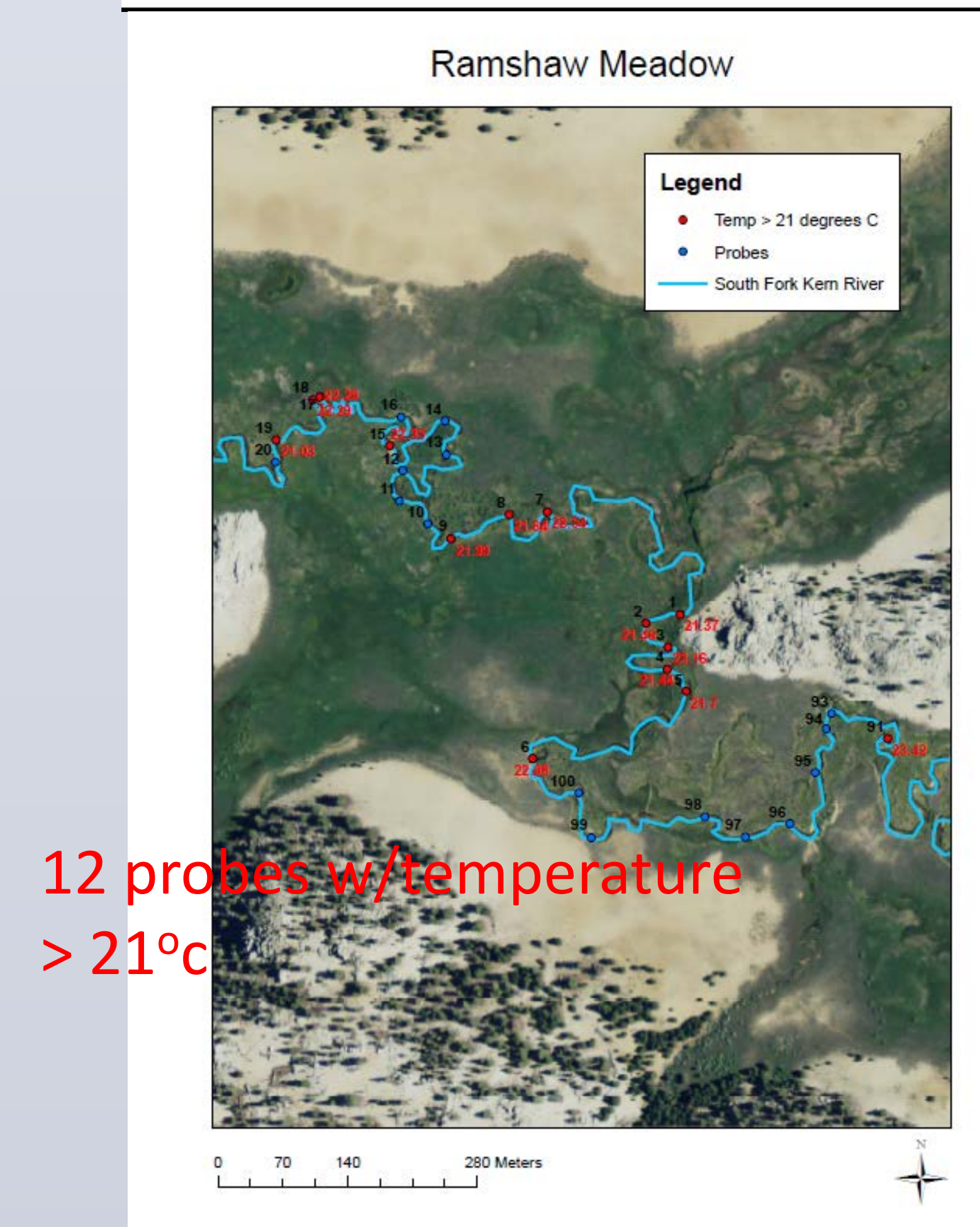
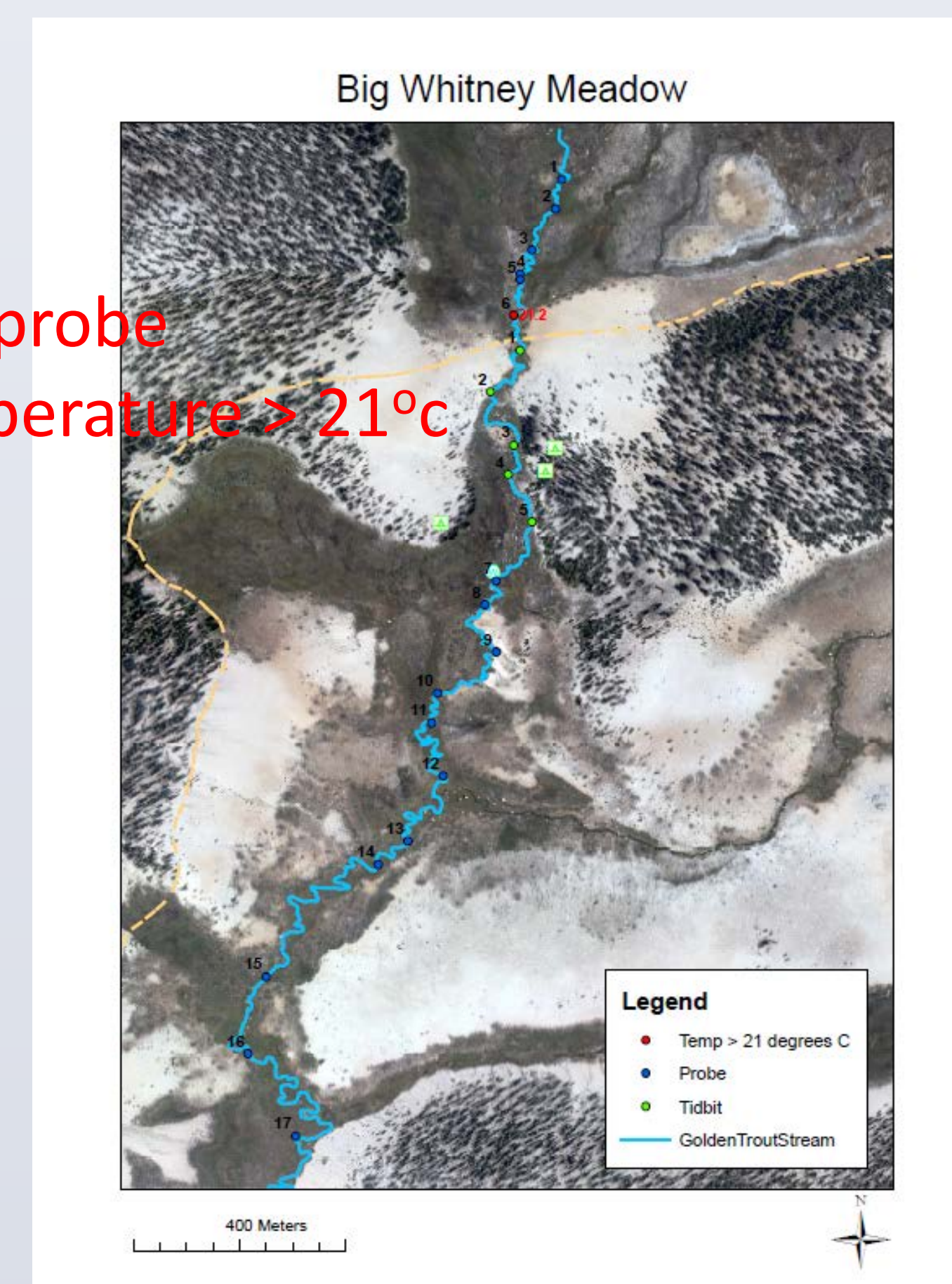


Water temperature often exceeds 25°C in the summer in Mulkey Meadow while temperature did not exceed 22°C in Big Whitney Meadow

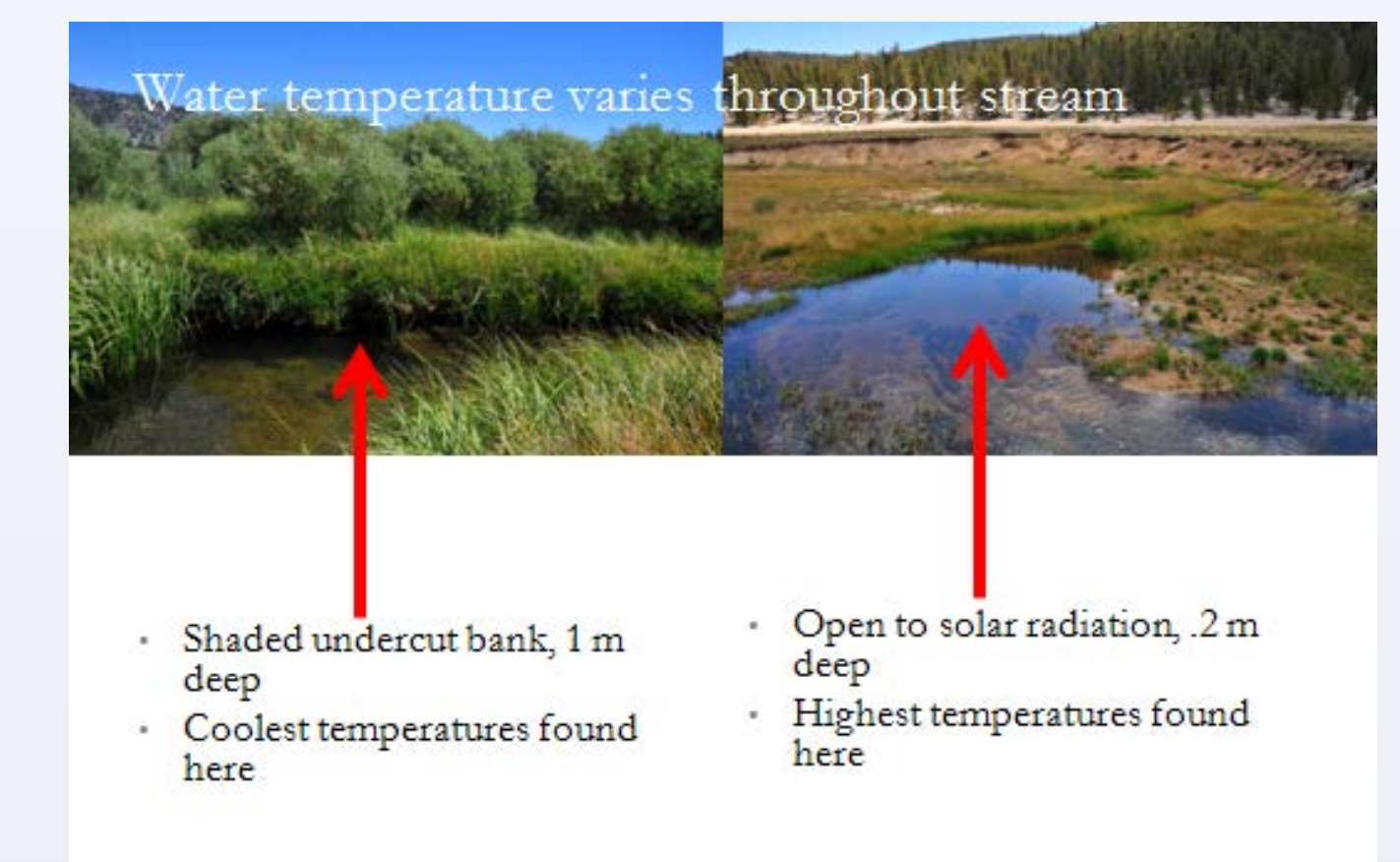
Meadow Maps-Probe placement in Mulkey, Ramshaw, and Big Whitney meadows Highest summer temperatures in Mulkey Meadow



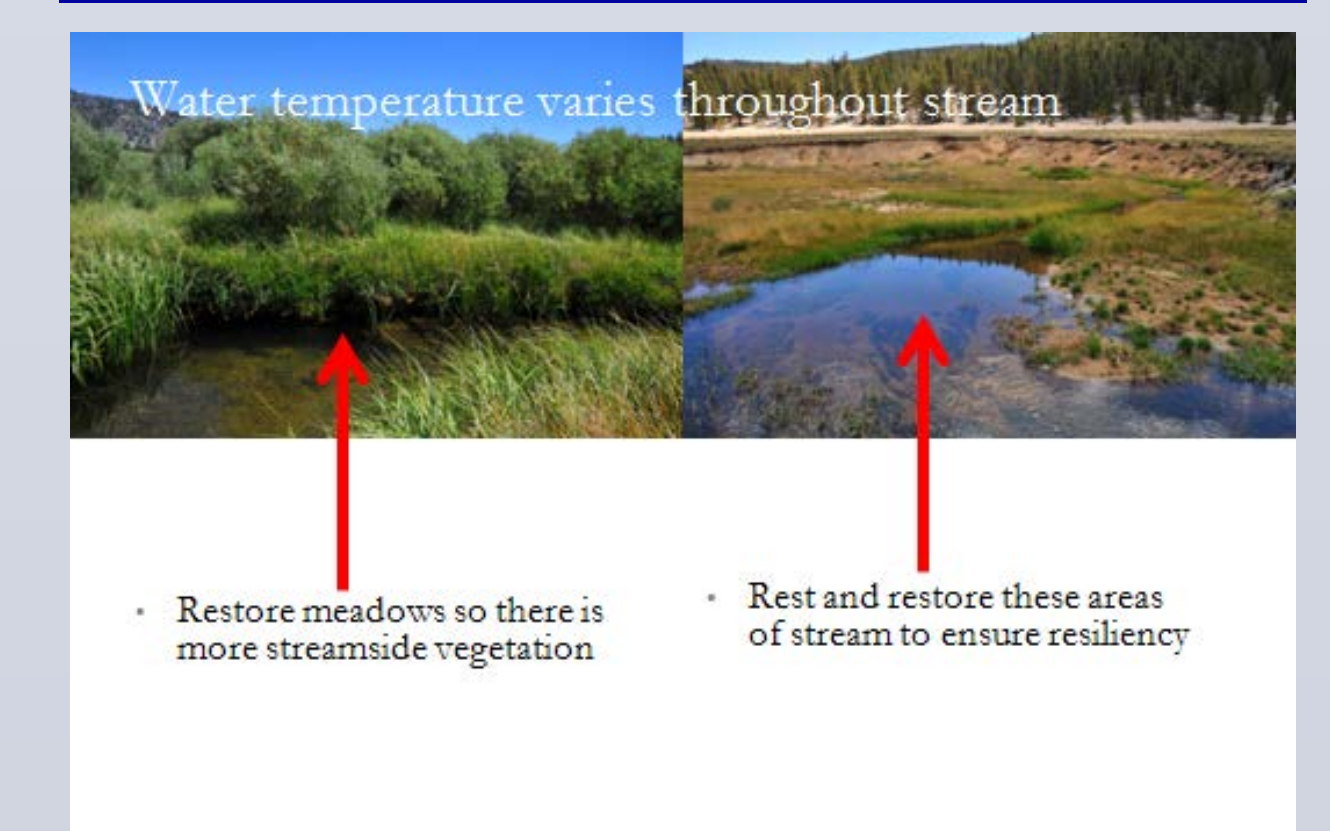
Only 1 probe w/temperature > 21°C



Conclusions



Mulkey and Ramshaw meadow stream do not have the resiliency to withstand further warming and temperatures are at critical levels. Restoring streams from shallow and wide to narrower and deeper, and increasing streamside vegetation and shade will make streams more resilient to climate warming. As temperatures warm in native trout habitat, research is necessary to determine how fish respond and whether CGT long-term survival will be impacted. In the Sierra Nevada, there is great opportunity to increase resiliency of high elevation aquatic habitats because most of it is within federally designated Wilderness set aside by U.S. Congress to “to preserve its natural conditions and which generally appears to have been affected primarily by forces of nature” (Kloepfer et al. 1994). Wilderness areas could be used as refuges, i.e., the freshwater version of marine preserves. In these preserves, managers could eliminate or minimize activities that are currently allowed, such as cattle grazing, but are lowering the resiliency of freshwater habitats to increased warming. Understanding vulnerability of meadow stream ecosystems to increased warming is crucial so that restorative management can improve their long-term resiliency.



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