



## Frog to Forest Stewardship: Building Climate Resilience into Conservation

This collaborative effort seeks conservation outcomes that address current and future threats to species' persistence in the foothills in and around Yosemite NP. For instance, foothill yellow-legged frog and the western pond turtle have experienced significant population declines across the Southern extent of their respective historic range. Much of the decline is due to threats such as land use changes, changes in hydrology, competition and/or predation from introduced species, and disease [1;2]. While these threats already pose species conservation challenges at present, climate change will exasperate the risk to species' persistence in this geography. To address both the current and future stressors to the foothill yellow-legged frog population, specifically in the Sierra Nevada, this project aims to identify near term conservation strategies in the Southern Sierra Nevada that simultaneously lead to increased adaptive capacity to climate change impacts.

### Ecology and Threats

The decline of amphibian species across North America is an indication of aquatic ecosystems in peril – in the Western US caused in large part by increasing severity of droughts. The foothill yellow-legged frog, *Rana boylei*, occurs historically throughout most of California and western Oregon. As a stream dwelling and obligate stream-breeding species, altered flow regimens from land use changes such as dams and water diversions have been identified as its primary threat [1]. Other threats include competition and predation from invasive species, like the American Bullfrog, Crayfish, and Smallmouth and Largemouth Bass, as well as disease, *Batrachochytrium dendrobatidis* (Bd), which is known to have caused significant declines in the Coastal clade [2]. Climate stressors, such as increased temperatures and decreased snowpack are projected to cause additional stress to the population by further altering flows and water temperatures necessary for breeding.



### Southern Sierra Nevada

Containing iconic peaks, high montane meadows, clear alpine lakes, and rushing rivers, the Sierra Nevada Range is one of California's most prominent geological features. It provides a variety of resources, including habitat for a broad range of wildlife and provides over 50 percent of all of California's water supply, primarily in the form of snow at its alpine environments [3]. Yet, climate change projections show that Sierra Nevada range will experience increased annual temperatures and a decrease in precipitation, with precipitation more likely to come in the form of rain instead of snow, even at higher elevations [4]. These changes will increase Sierra Nevada's vulnerability to increased high intensity fire danger, drought, and decreased snowpack [5], the effects of which will cause further disruption to aquatic species in the area, including the FYLF.

While the FYLF Southern Sierra clade is endangered and faces near extirpation in the area, protecting the region is of high priority as the population maintains high genetic variability, which can be necessary for the species survival against disease and climate change [6]. In addition, the Southern Sierra Nevada offers a unique opportunity for conservation as majority of the target region of the S. Sierra Nevada is publicly owned, lying within the Stanislaus NF, Yosemite NP, and the San Francisco Public Utility District land. This combination of public ownership





offers the opportunity to create a collaborative effort amongst public agencies and utilities for species conservation. Such collaboration can help leverage resources for expertise, funding, and monitoring that will be necessary to understand whether the conservation actions increase the adaptive capacity of these populations.

## Study Goals

While there are a variety of actions known to benefit FYLF persistence, the project aims to use decision sciences and climate refugia modeling to assure the near-term conservation measures are not maladaptive strategies in the long-term given the projected climatic changes. By incorporating near term conservation efforts with the long-term perspective, we hope to overcome the frequently described knowledge-to-action barrier and start implementing climate adaptation actions immediately. Potential actions range from species to landscape scale options including in-situ head-starting, captive rearing, translocation of current populations to climate refugia, and habitat restoration. While many of these conservation actions have been used for other frog populations, they are not always observed and monitored for the long term and their efficacy to increase climate resilience is unknown [7]. Therefore, the project aims to create a comprehensive adaptive management plan with clear definable results that will be monitored and revisited.

Despite the project's currently narrow focus on the conservation and persistence of the FYLF, the project aims to identify opportunities to benefit other aquatic or riparian species. For example, Western Pond Turtles are likely to benefit from invasive species removal and habitat restoration. Other possible actions, like riparian or meadow restoration could also optimize the storage of water and help buffer the effects of decreased snowpack [3;8], which would be beneficial for protecting one of California's most important resources -water. Furthermore, the approach developed for this project to optimize conservation strategies for near-term and long-term climate adaptation will be applied (applicable?) to other natural resources of concern to land-managers.

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