Conserving Climate Change Refugia for Climate Adaptation in the Sierra Nevada

WORKSHOP REPORT

> *Climate Change Refugia: Areas that remain relatively buffered from contemporary climate change over time and enable persistence of valued physical, ecological, and socio-cultural resources.*
>
> *(Morelli et al. 2016, PLOS ONE)*

On November 8, 2019, the first meeting of the Southwest Climate Change Refugia Research Coalition was held in Yosemite Valley, Yosemite National Park, under funding from the Southwest and Northeast Climate Adaptation Science Center (CASCs).

The objective of this workshop was to bring together natural resource managers and researchers to move forward on climate change adaptation and begin to build a climate change refugia conservation strategy for the Sierra Nevada. Goals were to identify opportunities to apply existing data and modeling results to ongoing local conservation efforts in order to optimize limited resources.

The meeting started with presentations by experienced researchers and resource managers that have been working on climate change refugia in the Sierra Nevada.

1. Carlos Carroll, Klamath Center for Conservation Research: Translating climate adaptation science into effective conservation outcomes
2. Lorrie Flint, U.S. Geological Survey-California Water Science Center: Water Balance Modeling to Characterize Refugia: The Basin Characterization Model
3. Toni Lyn Morelli: Mapping Refugial Meadows in the Sierra Nevada
4. Shana Gross, US Forest Service: Prioritizing and monitoring meadow conservation and restoration actions based on climate vulnerability
5. Sarah Sawyer, U.S. Forest Service-Pacific Southwest Regional Office: USFS Refugia Information Needs for the Southern Sierra
6. Deana Dulen, National Park Service-Devils Postpile National Monument: Managing Soda Springs Meadow as a Climate Change Refugium
7. Jim Thorne & Ryan Boynton, UC Davis: Using Maps for Vegetation Refugia Planning & Management
8. Jody Tucker, U.S. Forest Service-Pacific Southwest Region: Assessing the potential impacts of climate change on fisher and marten in the southern Sierra Nevada
9. Andrea Adams, National Park Service: Threatened Amphibians of Yosemite

Next, we broke into groups to Answer the question *What should we map refugia for?* The 6-7 focal resources that received the highest votes are listed below, summarized notes can be found at the end of the report.

1. High Elevation/Alpine
2. Meadow
3. Hydrology
4. Old Growth Forest/Fisher
5. Giant Sequoia
6. Fire
7. Migration Corridors/Connectivity

After lunch, we broke into groups focused on each of these topics to answer the questions *How to apply climate change refugia results to ongoing or future management actions?* and *What data and partnerships are available?* To wrap up the day, we discussed the needs and next steps for climate change refugia conservation.

Summary and Next Steps

The workshop participants identified some priority focal resources to identify climate change refugia for, and then described data and potential management actions to take to conserve them. The next steps for these topics are: in the short-term, to convene videoconference meetings to discuss what data are available for mapping refugia and what actions should be prioritized once refugia are mapped; in the medium term, develop these ideas into federal and state grant proposals; in the long term, carry out an adaptive management project, e.g., focused on a particular geography, to map climate change refugia, monitoring responses to climate change and tracking impacts of management actions.

1. High Elevation/Alpine Group
    a. *Research Focus:* pika, rosy-finches, bighorn sheep, whitebark pine, sky pilot?
        i. These refugia can texture the idea that alpine species don't have anywhere to go in important ways - are there slopes, aspects, microclimates that at least short term can contribute to persistence?
        ii. High Sierra Sky Islands
            1. Because they were unglaciated, they have deeper soil, higher plant diversity, important for endemics
            2. Could be refugia because they're adapted to climate variability (or not – testable)
    b. *Potential Management Actions*
        i. Consider impact by climbers/hikers
        ii. Monitor to learn about shifts in phenology and composition
        iii. Translocation/assisted migration
    c. *Data and Partnerships*
        i. Data: Resurvey of plant communities (Dena Grossenbacher); snow surveys (to better model future persistence); Hetch Hetchy water and power 2-week LiDAR data to find snowpack data for sky islands (5-7 year LiDAR record); Bighorn sheep occupancy/habitat use
        ii. People: Southern Sierra Leadership Forum: landscape-scale Sierra conservation, Bighorn Sheep biologists (NPS, CDFW)

2. Meadow Group
    a. *Research Focus*:
        i. Sierra meadows (montane, sub-alpine, and alpine as well as different hydrogeomorphic types, such as dry meadows, riparian, discharge slope, lacustrine, etc)
        ii. Focal species: Yosemite toad, Belding ground squirrels, meadow voles, Great gray owl, Willow flycatcher, Raptors, Bats, Wetland obligate plants
    b. *Potential Management Actions*:
        i. Rerouting trails, removing packstock, and also direct funding towards existing identified projects in those areas
        ii. Restoration targeted at refugial meadows (and their hydrology)
        iii. Facilitate connectivity or even assisted migration of species to refugial meadows
        iv. Monitoring
        v. Adaptive Management
        vi. Protect from extreme events - slow down the water/dissipate the energy through actions
        vii. Beaver reintroduction and beaver dam analogs
    c. *Data and* Partnerships: UC Davis (Meadows Clearinghouse), Sierra Meadows Partnership, Sierra Meadow Prioritization Tool, American Rivers' watershed-wide assessment data, Maher and Morelli Sierra refugial meadow map, Inventory and Monitoring Data (e.g., YOSE)

Still need to know: occupancy data, life history data, species distribution models, thresholds, groundwater and subsurface flows, which meadows are degraded

3. Hydrology Group
    a. *Research Focus*: Identify watershed ranking system by looking at annual mass balance of water including input, output and storage.
    b. *Potential Management Actions*: introduce beavers, manage: timber, canopy cover, stream bank, water table
    c. *Data and Partnerships*: DWR, NPS, SNC, NASA and ASO, Downstream water users (cities, counties, agriculture). Need smaller scale data for each watershed.

4. Old Growth Forest Group
    a. *Research Focus*: Pacific fisher, Giant sequoia, Sugar pine, Whitebark pine, Red fir, Black oak, big trees, hardwood, mixed conifer, Mountain yellow-legged frog, Yosemite toad. Denning habitat, topographic features, and connectivity. Sites resilient to drought, fire, w/available water
    b. *Potential Management Actions*:
        i. Targeted thinnings, prescribed fire, fuels reduction
        ii. Maintain connectivity
        iii. Extra marijuana site enforcement and remediation
        iv. Fisher reintroductions to sites within and near refugia
        v. Restoration (e.g., oak)
        vi. Promote hardwood component
        vii. Incentives on private land within refugia to retain oaks; revise CA Forestry Practice rules to require oak retention in identified refugia
        viii. Promote high canopy cover (and multi-story canopy) in refugia, and more heterogeneity (and lower canopy cover) outside of refugia
        ix. Limit infrastructure/road development that would sever areas identified as key for connectivity between identified refugia
    c. *Data and Partnerships*: Have good fisher habitat models and monitoring data from USFS (including Jody Tucker) and Yosemite scat data; Have FRID, all the fire data; climate water deficit data; historic veg maps; vegetation projections; topographic maps; Have fire/fuels MOU between USFS, CalFIRE, and many private (timber) landowners (spotted owl focus), Southern Sierra Nevada Fisher Working Group, Conservation Biology Institute S. Sierra Nevada Fisher Conservation Strategy, Dinkey Collaborative Group, Southern Sierra Prescribed Fire Council, Governor's Forest Management Task Force – Sierra geographic group, tree-mortality working group
    Needed: Data on private land, beyond timber landowners (e.g., S. CA Edison); data on topographic features selection for fisher; future connectivity and habitat modeling.

5. Giant Sequoia Group
    a. *Research Focus*: Where are sequoia groves more/less sensitive to future hot droughts (potentially due to hydrologic refugial characteristics?) and/or fire?

i. Are current sequoia (hydrologic refugia?) areas actually NOT future sequoia refugia under more hot/long droughts?

b. *Potential Management Actions*:
   i. In the 'less-refugial' areas, do even more extensive fuels reduction, and during/before fire do actions to minimize fire residence time
   ii. Do prescribed fires more or less often in refugial vs. non-refugial areas?
   iii. Experimental planting in areas identified as potential refugia
   iv. Facilitate natural regeneration in areas identified as refugia (i.e. through fire to get down to bare mineral soil)
   v. Increase tree species diversity in sites more vulnerable to drought/beetles (to confuse beetles)

c. *Data and Partnerships*: SEKI, YOSE partnerships, Nate Stephenson data. Need: Learn from sequoias that have been planted outside of their range over the last 100 years – what are their climate characteristics?

6. <u>Fire Refugia Group</u>
   a. *Research Focus*: areas likely to burn at lower severities, natural 'barriers' to fire - Where can we support old forest (multi-layer canopy) under future fire regime? Ie where are areas that are most likely to burn at lower severities rather than high severity under severe fire weather? Where are natural 'barriers' to severe fire that might naturally stop the spread of severe fire?
   b. *Potential Management Actions*:
      i. Can potentially re-introduce fire without having to do mechanical pre-treatment in areas unlikely to burn at high severity
      ii. Limit human development in areas non-refugial to high severity fire
      iii. Manage fire refugia as corridors for forest or cover-dependent species
      iv. allow type conversion in areas that are likely to continuously re-burn at high severity, rather than continuing to waste resources re-planting areas that will be lost
   c. *Data and Partnerships*: FRID, Westerling climate fire projections for future; CWD. Missing: fire weather information? Extreme events prediction?

Appendix 1: List of Participants

Name	Organization
Toni Lyn Morelli	USGS
Deanna Dulen	NPS - Devils Postpile National Monument
Nicole Athearn	NPS - Yosemite National Park
Rachel Mazur	NPS - Yosemite National Park
Andrea Adams	NPS - Yosemite National Park
David Campbell	NPS - Yosemite National Park
Athena Demetry	NPS - Yosemite National Park
Rachel Friesen	NPS - Yosemite National Park
Victoria Hartman	NPS - Yosemite National Park
Breezy Jackson	NPS - Yosemite National Park
Tim Kuhn	NPS - Yosemite National Park
Sarah Stock	NPS - Yosemite National Park
Irene Vasquez	NPS - Yosemite National Park
Abby Childs	NPS
Melissa Booher	NPS
Kimi Nichter	NPS
Matt Warbritton	NPS
Sarah Sawyer	US Forest Service Regional Office
Claudia Mengelt	US Fish and Wildlife Service
Margarita Gordus	California Department of Fish and Wildlife
Jennifer Morales	CA DWR- Climate Change Program
Carlos Carroll	Klamath Center for Conservation Research
Marian Vernon	Point Blue Conservation Science
Jim Thorne	UC Davis
Mary Clapp	UC Davis
Tim Brown	UC Santa Cruz
Laura Van Vranken	University of California, Merced
Rose Nelson	Mono Lake Committee
Christina Kastely	Natural History Museum of Los Angeles County