Assessing Climate Refugia from a Terrestrial Vegetation Vulnerability Assessment for 29 Types in California

J.H. Thorne1, J. Bjorkman1, R.M. Boynton1, J. Stewart2, A.J. Holguin1, M.W. Schwartz1, W. Albright3

University of California, Davis1 • University of California, Santa Cruz2 • California Department of Fish and Wildlife3

Abstract

We assessed the climate vulnerability of 29 terrestrial macrogroup vegetation types in the National Vegetation Classification Scheme covering 99% of California's natural vegetation. Using a 2015 landcover map, we defined current and future climate exposure for each type at all known locations. This approach identifies both areas of expected high stress and of climate refugia. Various cutoffs can be selected to describe refugia. Here, we define refugia as locations that retain climate conditions found 80% of the time where current vegetation exists and climate change for areas in these refugia is found in the top 5% of climate conditions or non-analog conditions. Under a warm and wet future (CNRM CSM 8.5: 26-45°C, 155-254 km^2) of current vegetation is in refugia, while 52.1% is in climatically stressed locations (182,888 km^2). Under a hot and dry future (MIROC-ESM 8.5: 35°C, 122,644 km^2) most vegetation is in refugia, while 45.4% is in climatically stressed locations (198,271 km^2). Areas classified as refugia under both conditions cover 78,972 km^2. Climate velocity within refugia indicates that 80,493 km^2 have the least climate change for CNRM and 74,934 km^2 have the least-under MIROC.

Methodology

Flowchart

Analysis for a single type

Current (1981-2010) Climate Exposure of Vegetation

Future (2100) Climate Exposure of Vegetation

Climate Refugia and High Exposure Zones

Climate Model Agreement

Less than 90%

Greater than 90%

Non Analogue

Climate Velocity in Refugia

Climate Velocity in High Exposure Zones

MG009: Macrogroup California Forest and Woodland - Common Name: California Foothill and Valley Forests and Woodlands

Includes all Mediterranean climate woodlands and forests in California from sea level to the point where snow and frost in combination with high winter precipitation enable cool temperate species of trees to dominate the overstory. These forests and woodlands are composed of tree species largely adapted and endemic to the warm, dry summers, and cool rainy winters of California's Mediterranean climate. They may be open woodlands to dense forests, and may be dominated by broadleaf evergreen or deciduous hardwoods, co-dominated by hardwoods and conifers, or dominated entirely by conifers. This macrogroup contains two groups, one dominated by broadleaf trees and the other dominated by conifers. The fire ecology is varied depending on the spacing of trees and the buttress or woody understorey characteristics.

Discussion

The use of the vegetation community map permits examination of the rates of transition from climatically suitable to climatically stressed extents for each vegetation type. Of particular importance to resource managers, the predictions in this report can be used to establish monitoring protocols to track the trajectory and rates of change for important biotic resources of the state. As further information becomes available, these species-specific scores can be adjusted, which may adjust the overall ranking of the vegetation communities they occupy. And, more detailed climate vulnerability work on an individual dominant plant species can be developed, to better predict how the species will respond, and to seek adaptation strategies that California's natural resource managers could potentially employ to lower the predicted impacts.

These simple methods are particularly useful for resource regulators, who are constrained to work in specified areas with limited budgets, and who need estimates of what areas within their jurisdictions are likely to be highly stressed, and what are areas likely to be less-stressed, in effect the climate refugia areas.

Acknowledgements

This work was funded by the California Department of Fish and Wildlife in association with the State Wildlife Action Plan 2015 update, under agreement number 15-21016. We thank the following individuals and agencies: Professor Mark Schwartz, UC Davis, Alan and Lorrie Hirt, UC Davis, John Hoshi, California Department of Fish and Wildlife.