

# The Future of Island Oaks

## Climate change vulnerability assessment of *Quercus tomentella*



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### Background

#### Island oak

*Quercus tomentella* (QUTO)

- ☞ Rare endemic: 6 islands in the California Island Archipelago (CAIA)
- ☞ Benefits: habitat, forest litter, and soil moisture collection through fog drip<sup>1</sup>

#### Threats & Status

- ☞ Degraded populations due to historic ranching on the islands → listed endangered by IUCN in 2016<sup>2</sup>
- ☞ Restoration and removal of historical threats → initial species recovery
- ☞ Climate change → possible further reduction of suitable habitat for QUTO



Figure 1. Extent of QUTO range.



Figure 2. QUTO on Santa Rosa Island. Credit: Denise Knapp.

#### Study Motivation

In collaboration with The Nature Conservancy and the Santa Barbara Botanic Garden, our study investigates how climate change may affect the future distribution of suitable habitat for QUTO and aims to inform adaptive management for climate change to increase the likelihood of species persistence.

### Objectives

- 1 **Determine** current climate preferences of QUTO across islands
- 2 **Analyze** where current suitable habitat is located and how climate change might impact habitat suitability in the future
- 3 **Evaluate** the outlook of species persistence on each island, given uncertainty in future climate scenarios

### Approach

- ☞ Used MaxEnt, a presence-only species distribution model, to identify QUTO's current climate preferences and to predict areas of habitat occurrence through the end of the century

Island Extent	Time Period	Fog Scenario	Climate Scenario
Santa Cruz	1981 - 2010	No Fog	MPI 4.5 Warm Wet
Santa Catalina	2010 - 2039	Fog Constant	MIROC 4.5 Warm Dry
Santa Rosa	2040 - 2069	Fog Increase	CCSM 8.5 Hot Wet
All Islands	2070 - 2099	Fog Decrease	MIROC 8.5 Hot Dry
		Fog Elevation	

Figure 3. Extent, time period, and scenario options for MaxEnt.

- ☞ Performed analysis for Santa Cruz, Santa Rosa, and Santa Catalina using QUTO presence points and climate variables from the Basin Characterization Model (BCM)<sup>3</sup>
- ☞ For Santa Cruz and Santa Rosa, developed future fog scenarios to explore uncertainty in fog trends<sup>4</sup>

### Main Findings

#### 1 Island Oak Climate Preferences

From the available BCM climate variables, we chose the 4 that were the most influential for QUTO probability of presence. QUTO's climate range is unique on each island (Figure 4).

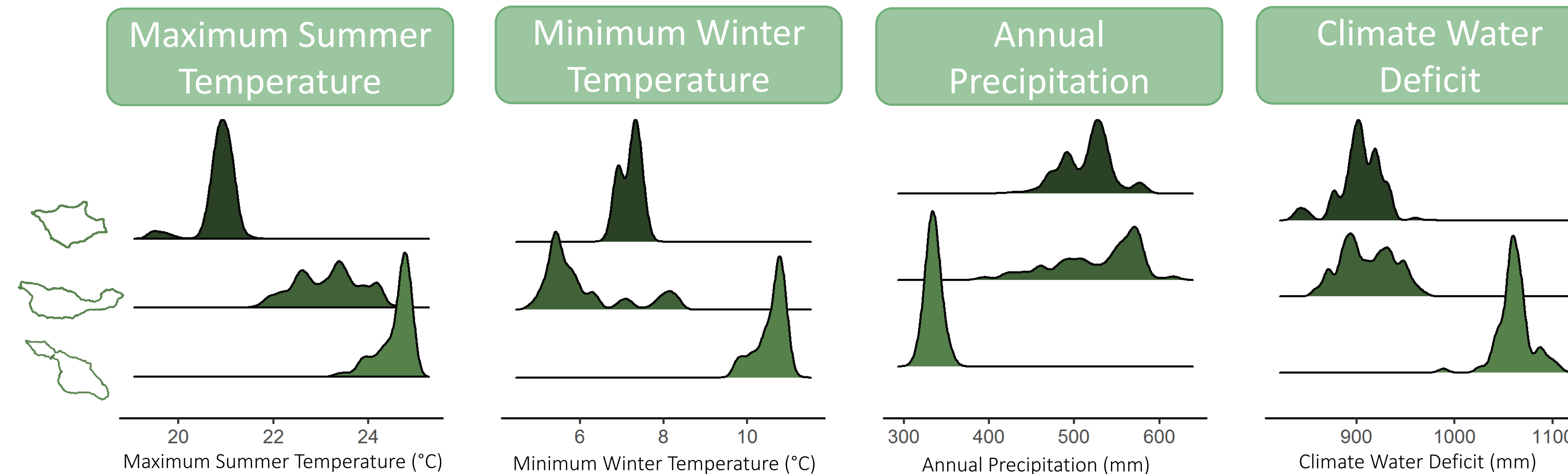


Figure 4. QUTO presence counts across climate conditions on each island, with x-axis as range of climate conditions and y-axis as presence density.

#### Main Takeaway:

- ☞ QUTO occupies wide range of climate conditions across islands
- ☞ Climate preferences differs substantially by island

Are QUTO populations adapted to island-specific climate ranges (local genetic adaptation) or island-wide ranges (physical adaptation to environment)?

#### 2 Climate Suitability

Habitat distribution differs when all islands are run individually (Figure 5A) compared to when all islands are run together (Figure 5B).

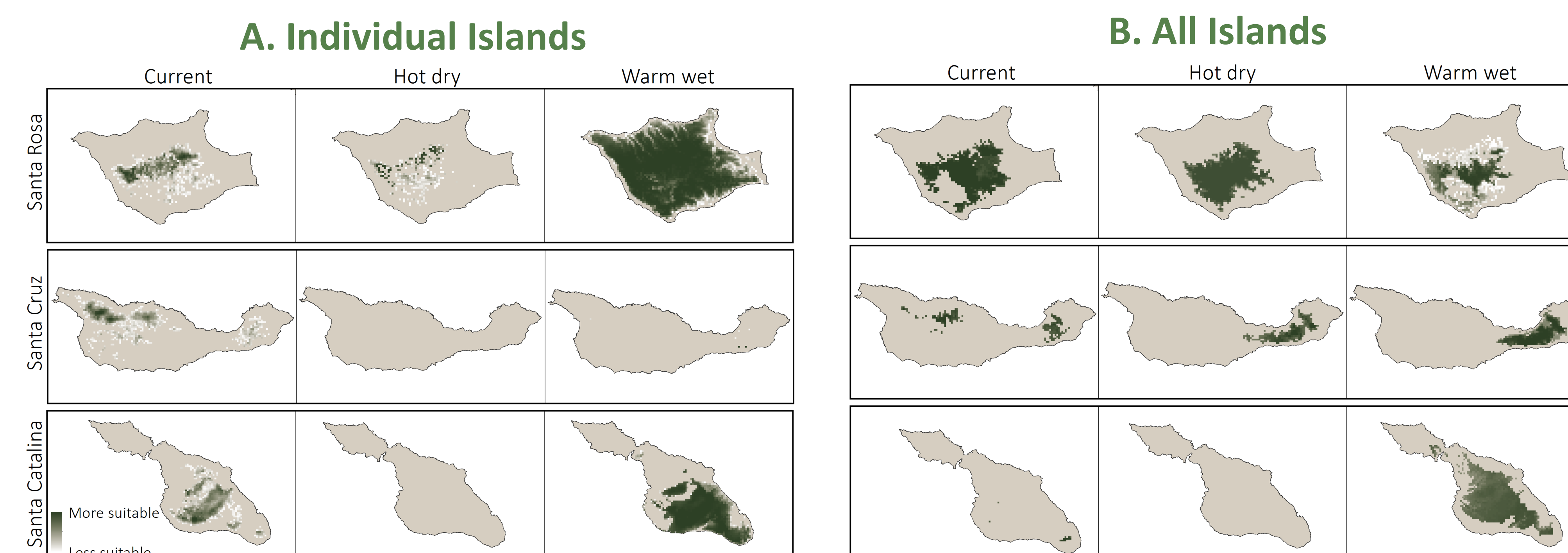


Figure 5. Probability of QUTO presence on Santa Rosa, Santa Cruz, and Santa Catalina Islands, with each island run individually (A) and all islands run together (B). Current climate conditions represent 1981 – 2010, and the two climate scenarios (hot dry, warm wet) represent 2070 – 2099.

#### Main Takeaway:

- ☞ Future suitability is largely dependent on whether the species' climate preferences are island-specific or island-wide
- ☞ Suitable habitat is predicted to expand or contract around areas of current suitability, rather than shift in elevation or latitude

#### 3 Integrated Outlook

The integrated outlook shows the climate suitability summed across all scenario combinations (Figure 6).

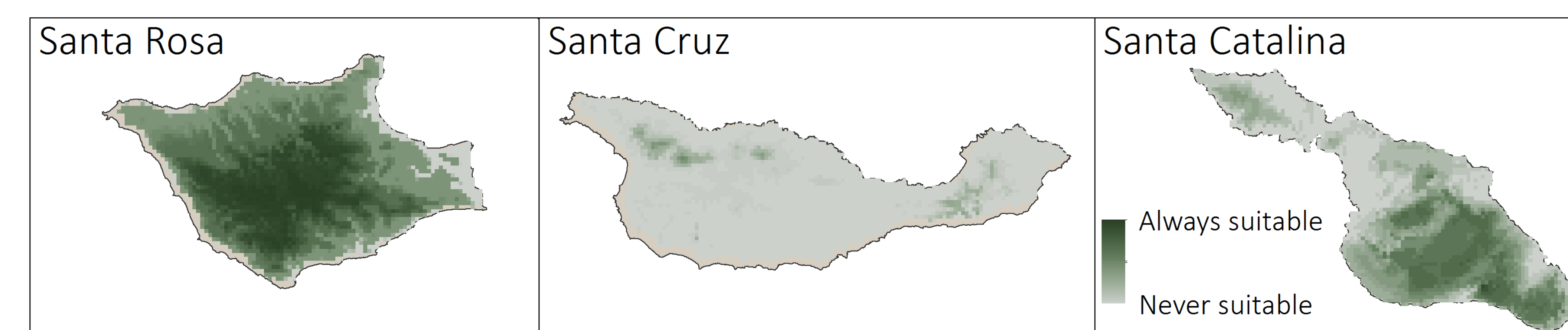


Figure 6. Integrated climate suitability for QUTO on Santa Rosa, Santa Cruz, and Santa Catalina Islands across all scenarios.

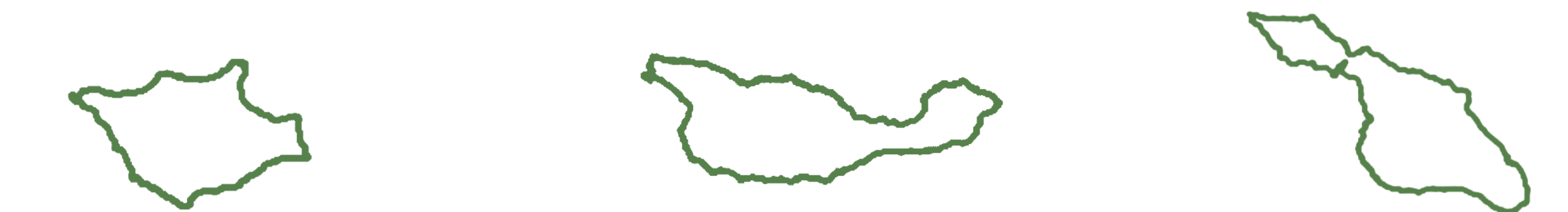
#### Main Takeaway:

- ☞ Distribution of predicted future suitable habitat varies by island and climate change scenario
- ☞ Habitat on Santa Rosa is predicted to remain across the most scenarios, followed by Santa Catalina
- ☞ QUTO populations on Santa Cruz appear to face highest risk from climate change due to low suitability across scenarios

### Recommendations

#### Management

- ☞ **Augment current island oak groves** since suitable habitat is expected to contract rather than shift as climate change progresses
- ☞ **Restore habitat quality to mitigate water stress** through fog nets, native species planting, erosion control, and soil restoration, especially for seedling establishment
- ☞ **Develop assisted-migration procedures** with an initial focus on intra-island translocation, further establishing procedures between islands if necessary



#### Santa Rosa

Focus efforts on southern Santa Rosa near Soledad Peak, which remained suitable through all scenarios and therefore may be a climate refuge

#### Santa Cruz

Complete more comprehensive survey of QUTO on southern Santa Cruz to account for potential sampling bias towards oak points on the northern side

#### Santa Catalina

Prioritize habitat restoration of current groves and protect seedlings from Santa Catalina's remaining non-native grazers

#### Future Research

- ☞ **Establish experimental plantings** at a range of sites to explore QUTO's climate preferences and identify the degree of local adaptation
- ☞ **Expand fog and climate monitoring** to develop higher resolution climate models and more complete climate data coverage across the CAIA
- ☞ **Explore historic human impacts** to define their influence on current spatial distribution of QUTO populations

### Acknowledgements

Thank you to our faculty advisors Bruce Kendall and John Melack; clients John Knapp at The Nature Conservancy and Denise Knapp at the Santa Barbara Botanic Garden; external advisors Frank Davis, Kathryn McEachern, Ben Best, and Charles Jones; collaborators Laura Kindsvater, The National Park Service, Catalina Island Conservancy, El Grupo de Ecología y Conservación de Islas, the Islands of the Californias: Botanical Collaborative, and Island Conservation. This research is funded [in part] by the James S. Bower Foundation.

More information on our project can be found at <https://oakology19.wixsite.com/oakology> or by contacting [gp-oakology@bren.ucsb.edu](mailto:gp-oakology@bren.ucsb.edu).



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