The Future of Island Oaks
Climate change vulnerability assessment of Quercus tomentella

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

Threats & Status
- Degraded populations due to historic ranching on the islands  - Listed endangered by IUCN in 2016
- Restoration and removal of historical threats → initial species recovery
- Climate change → possible further reduction of suitable habitat for QUTO

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

Main Findings

1. Island Oak Climate Preferences
- From the available BCM climate variables, the four that were the most influential for QUTO’s climate preference were: minimum winter temperature, maximum summer temperature, annual precipitation, and climate water deficit. QUTO will be more likely to occur at lower elevations and in areas with higher annual precipitation and lower climate water deficit.

2. Climate Suitability
- Habitats suitable for QUTO are predicted to remain across the most scenarios, followed by Santa Catalina.

3. Integrated Outlook
- The integrated outlook shows the climate suitability summed across all scenario combinations.

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.

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 advisor 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.

More information on our project can be found at: https://oakology19.wixsite.com/oakology or by contacting gg-calcology@bren.ucsb.edu

References

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Figure 1. Future of Island Oaks range
Figure 2. QUTO on Santa Rosa Island. Credit: Denise Knapp
Figure 3. Extent, time period, and scenario options for MaxEnt.
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.
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.
Figure 6. Integrated climate suitability for QUTO on Santa Rosa, Santa Cruz, and Santa Catalina islands across all scenarios.

Main Takeaway:
- QUTO populations are adapted to island-specific climate ranges (local genetic adaptation) or island-wide ranges (physical adaptation to environment) and therefore may be a climate refugium.
- 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.

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

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.

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