



IMPACT OF SEA LEVEL RISE ON PLANT SPECIES: A THREAT ASSESSMENT FOR THE CENTRAL CALIFORNIA COAST

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OVERVIEW

- The State of California projects that by the end of the 21st century, the Pacific Ocean will rise by 1.4 meters. Although rare coastal plant species will be increasingly exposed to sea level rise, they have received relatively little attention.
- Our findings show that plant species at low elevations are most at risk to be affected by SLR. Habitat loss from climate change may exacerbate the situation, although projections show conflicting results. In general, the future is uncertain!

INTRODUCTION

Sea level rise poses a threat to the survival of rare plant species along the central California coast. While global sea level has been steadily increasing for at least 20,000 years, this trend has accelerated in the last 15 to 20 years in response to climate change.

The U.S. Fish and Wildlife Service (USFWS) is interested in how SLR will affect plant species as part of its Strategic Plan for Responding to Accelerating Climate Change. In particular, USFWS would like to evaluate the impact of SLR in listing decisions and recovery plans for threatened and endangered species. By assessing the impact of SLR, the agency can better comply with its mission under the Endangered Species Act of 1973 to protect vulnerable species from extinction.

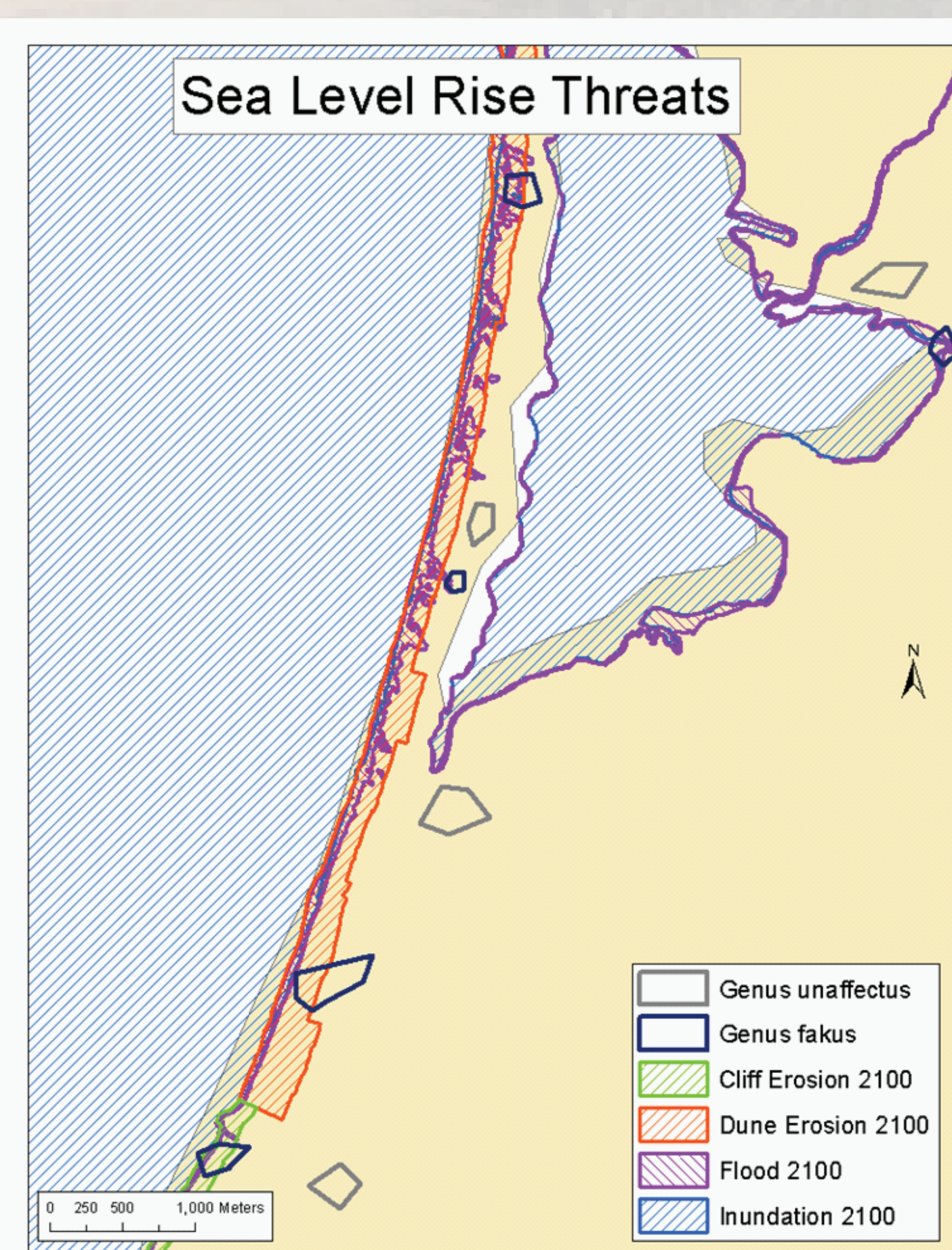
To address this information gap, we developed for the U.S. Fish and Wildlife Service a method of quantifying the exposure of coastal plant species to sea level rise.

METHODS

SLR Threats Analysis

We quantified the exposure of coastal plant species to SLR by modeling:

- Inundation
- Cliff erosion
- Flooding
- Dune erosion



We measured how each of these threats would affect individual species occurrences for 9 species:

- Percent of area affected
- Number of occurrences affected

We also analyzed the statistical relationship between elevation and impact from SLR for 88 species.

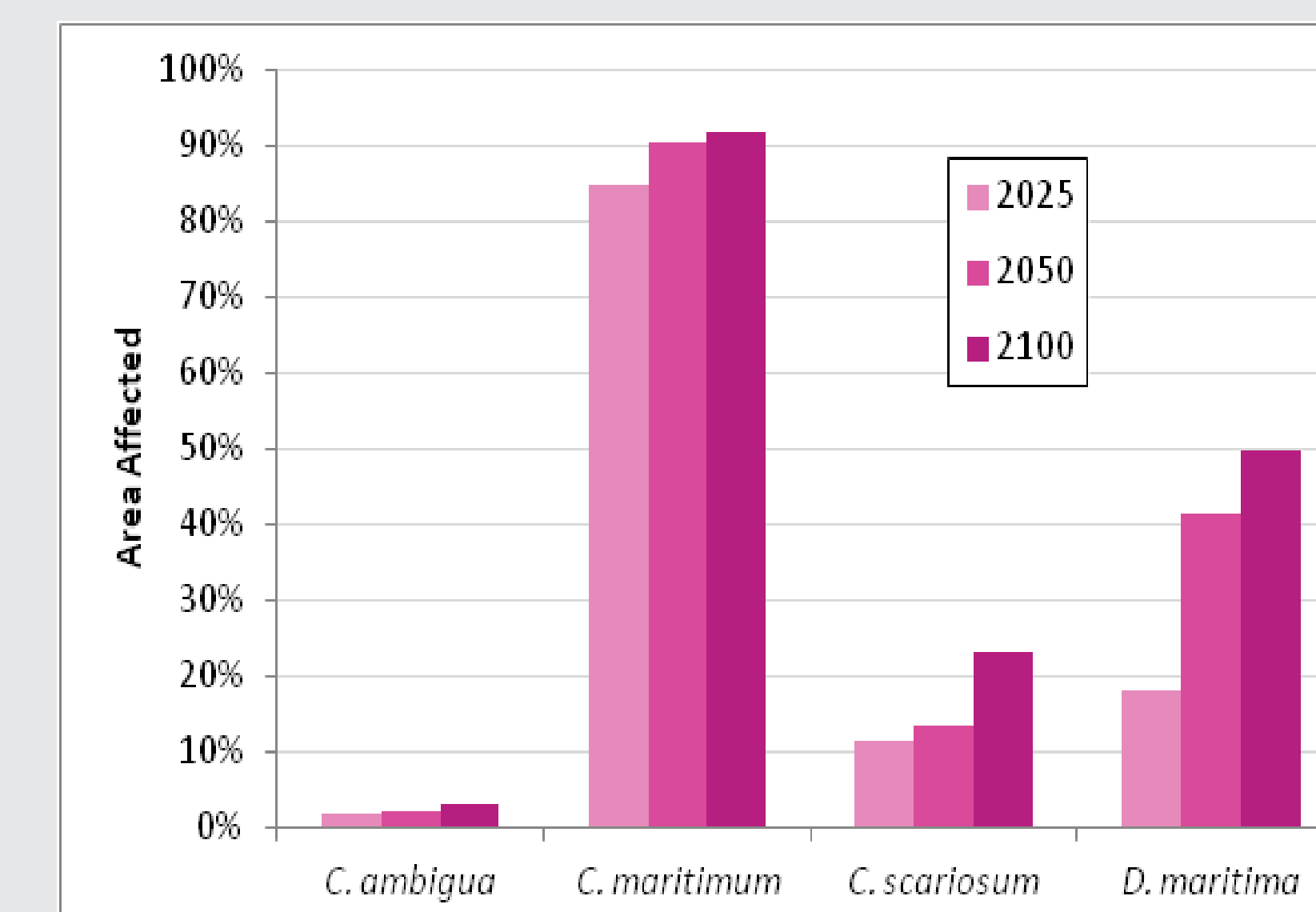
Suitable Habitat Analysis

For the most affected species in the SLR Threats Analysis, *C. maritimum*, we then modeled future suitable habitat in 2100 using MaxEnt, based upon 6 environmental variables and 2 general circulation models based upon the IPCC A2 emissions scenario.

RESULTS

SLR Threats Results

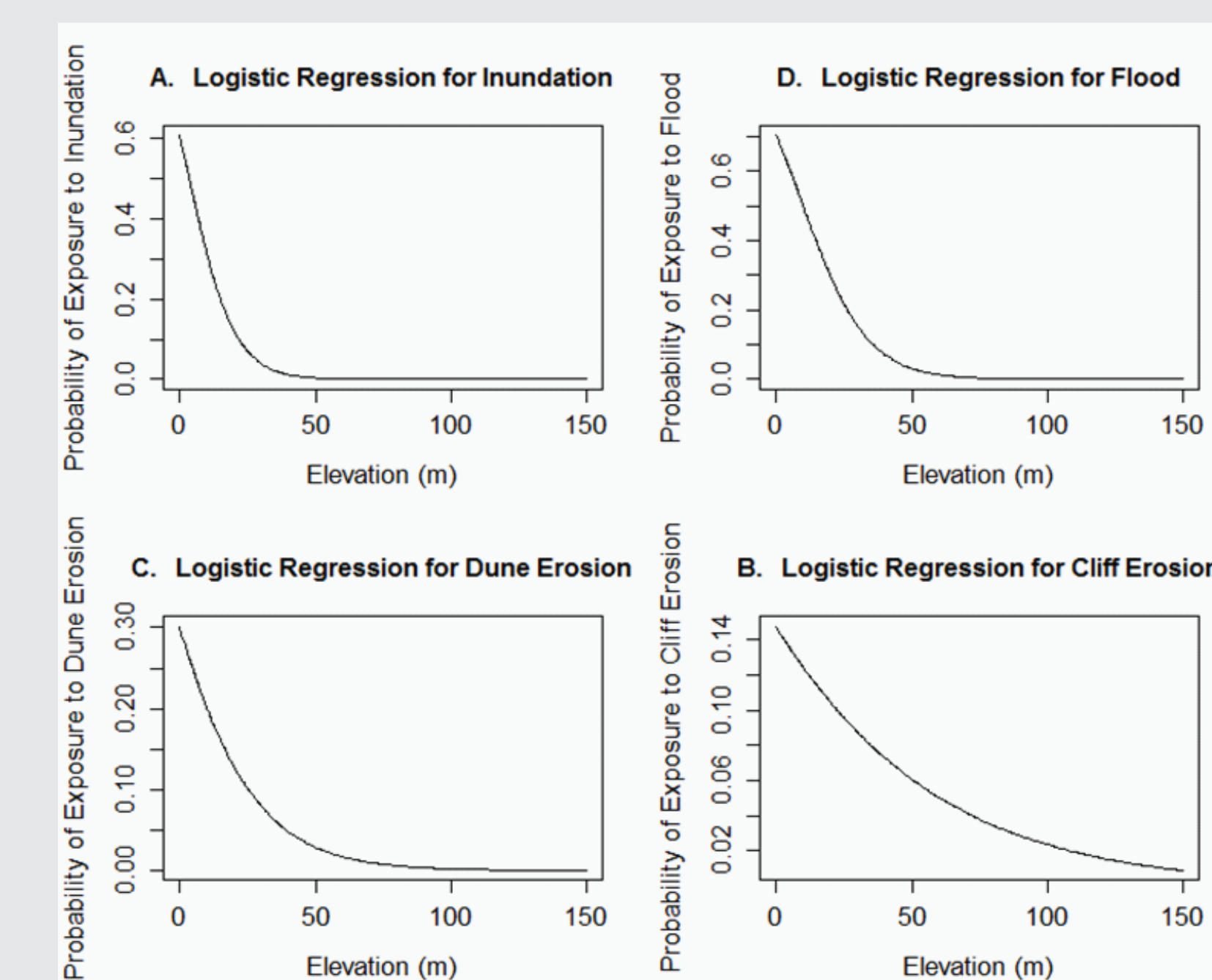
- The species most significantly threatened by sea level rise is projected to be *C. maritimum* as 85% of its total area is threatened by SLR as soon as 2025.
- Impact of SLR on *D. maritima* also increased dramatically between 2025 and 2100, to nearly 50% of its total area.
- *C. scariosum*, is projected to have less than 25% of its area affected by SLR by 2100.
- *C. ambigua* is the least concerning because less than 5% of its total area is threatened by 2100.



The output of the logistic regression on all 88 species indicates that probability of threat significantly correlates with the average elevation for each species. All threats showed a negative trend where the odds ratio decreases with increasing elevation. The slope of the logistic regression varied for each threat.

Beyond a certain elevation we found no threat of exposure to:

- inundation at 30 m
- flooding at 50m
- dune erosion at 55m
- cliff erosion at 150m



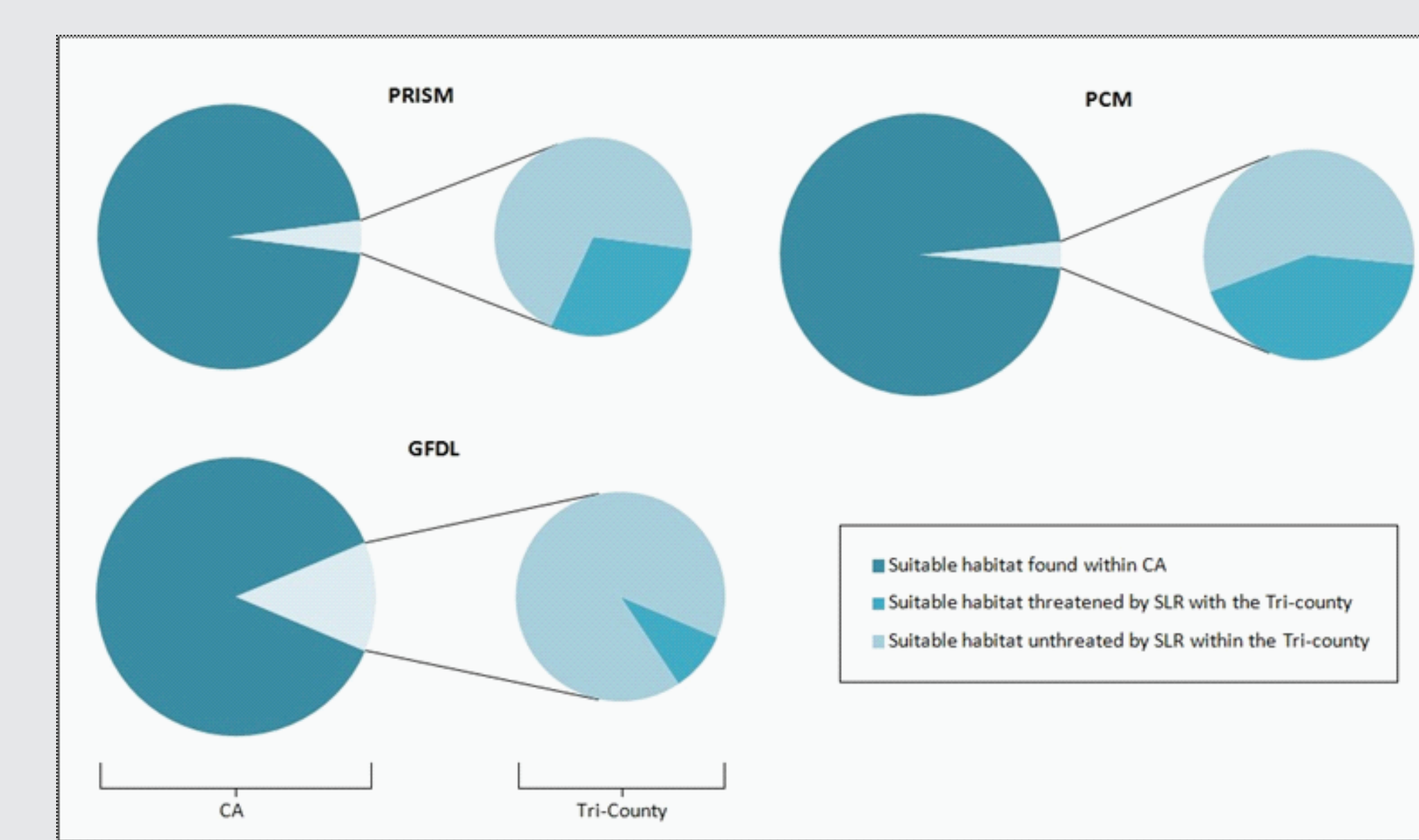
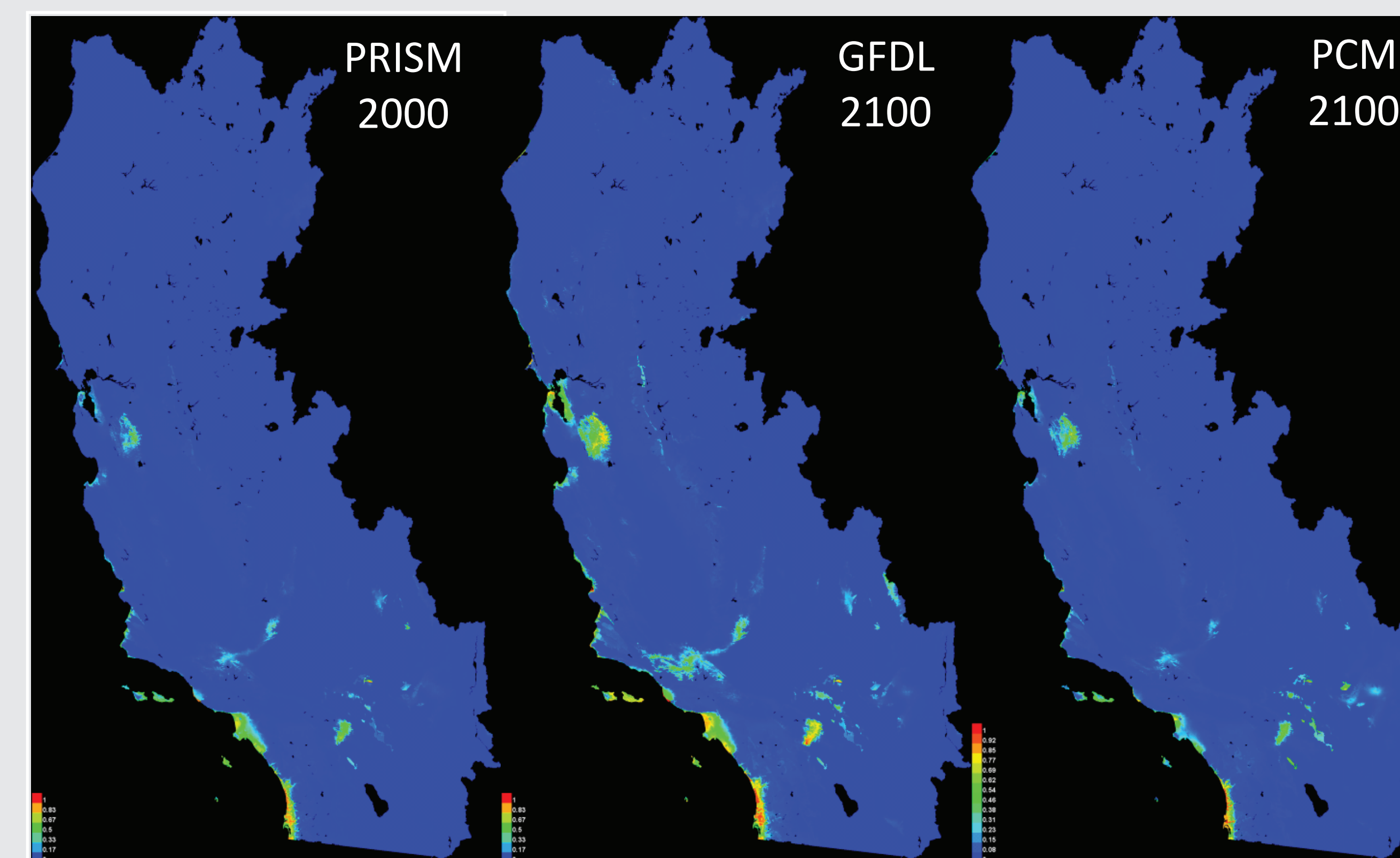
Suitable Habitat Results

Most suitable habitat for *C. maritimum* was found in Southern California and located close to the shoreline.

The total amount of suitable habitat was:

- PRISM (2000): 2,842km²
- GFDL (2100): 7,170km²
- PCM (2100): 2,630km²

Comparing the PRISM model to the two future scenarios, the GFDL predicted an expansion in habitat; the PCM predicted a contraction in habitat.



Of the suitable habitat predicted in CA, only 4%, 13%, and 3% were located within the Tri-County area for the PRISM, GFDL, and PCM models, respectively.

Of the suitable habitat located within the Tri-County Area, SLR threats affected 30%, 9%, and 43% of this area in the PRISM, GFDL, and PCM model predictions, respectively.

SPECIES CASE STUDIES



Michael L. Charters



Bob Huettmann 2005



Chris Winchell 2011



California Native Plant Society 1984

CONCLUSIONS

Our research was a first attempt at modeling SLR and climate change and its potential affect on coastal plant species.

- Species found at very low elevations are extremely likely to be exposed to SLR.
- As SLR impacts coastal plant species, climate change may also substantially shift the location of species' suitable habitat.
- These results may help the USFWS argue for their listing, ensuring more protection for at-risk species.
- USFWS may use the threats analysis output from our model to avoid resource-intensive management efforts in the areas identified as sea level rise threat zones.

REFERENCES

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- IPCC, Climate change impacts, adaptation, and vulnerability. 2007, Cambridge University Press: Cambridge.
- Phillips, S., R. Anderson, and R. Schapire, Maximum entropy modeling of species geographic distributions. Ecological Modelling, 2006. 190(3-4): p. 231-259.
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