



Image Credit: The Nature Conservancy, © Ian Boyle

## Assessing Range Shifts of Coastal Species to Inform Conservation in California's Biogeographic Transition Zones

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### Proposers

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### Client

Erica Nielsen | Anthony W. LaFetra Point Conception Research Fellow | The Nature Conservancy in California | [erica.nielsen@tnc.org](mailto:erica.nielsen@tnc.org)

## **OBJECTIVE**

This project will inform a strategic conservation plan for monitoring and preserving biodiversity under climate change within the Dangermond Preserve. In collaboration with The Nature Conservancy, we will utilize statistical analysis to model current species distribution ranges and predict potential futures to be compiled in a public-facing web dashboard.

## **ENVIRONMENTAL MOTIVATION**

Point Conception is one of California's most prominent marine bio- and phylo-geographic breaks (Dawson, 2001; Doyle, 1985; Miller, 2023). Point Conception may act as a barrier to range expansions, causing a 'pile up' of northward climate-tracking marine species if their larval dispersal cannot cross this topographic barrier (Fredston-Hermann et al., 2018). Yet, range shifts across this break were reported for subtidal and pelagic species marine species in response to recent marine heatwaves (Lonhart et al., 2019)

Predicting species responses to global change is one of the key challenges in contemporary ecology and conservation. Quantifying species range limits and predicting range shifts is particularly difficult within the marine realm as biogeographic barriers are often porous and asymmetrical, and fluctuate with seasons and climate oscillations (Bates et al., 2014). This project aims to fill the knowledge gap of whether rocky intertidal zone species have experienced recent climate-driven species shifts and/or demographic changes across this biogeographic zone.

The rapid pace of climate change places species range shifts as one of the primary impacts on ecosystem function and structure (Dawson et al., 2011). A better understanding of species range limits and expected shifts has wide-ranging conservation implications, from implementing marine protected area networks that act as stepping-stones for range expansions, to assisted migration helping species with limited ability to follow their climatic niches (Wilson et al., 2020). Meta-analyses of documented species movements have shown that shifts are often not in the expected directions of higher latitudes and altitudes, but rather a complex mosaic of responses, often in opposite directions (Burrows et al., 2011; Chen et al., 2011).

This project will serve as a tool for The Nature Conservancy's Dangermond Preserve staff to develop a strategic conservation plan for monitoring and preserving coastal ecological intactness under climate change. The client also envisions some project deliverables will be made public and will provide long-term support for these tools.

While the primary goal of this project does not address specific equity or environmental justice concerns, it is committed to education and accessibility. The web-based interactive map will be designed to engage a broad audience, serving as a valuable educational tool. offering clear, jargon-free information on how climate change affects intertidal species. Features such as alt-text, plain language explanations, and colorblind-safe color schemes will ensure the map is inclusive and accessible to users of varying abilities and backgrounds. Additionally, this project supports the

TNC's efforts to foster deeper partnerships with the Chumash people, aligning with broader goals of collaboration and inclusion.

### **DATA SCIENCE NEED**

This project will use long-term ecological monitoring data from field-based surveys to conduct a vulnerability assessment of the Point Conception region to rocky intertidal species range shifts. Our analyses will offer empirical evidence on whether Point Conception is a barrier to coastal species shifts, and provide novel insights on how climate change is, and will, alter intertidal community dynamics along California's coast. The project will also forecast future coastal species shifts, using species distribution models with climate data pertaining to different emission scenarios.

Through our analysis, we will deliver a product that can be used as an interactive tool by both TNC and the public. TNC will utilize the deliverables to develop a coastal monitoring plan and contribute to the preserve's public access plan. The public will be able to view this data to promote open science and education.

### **PROJECT DELIVERABLES**

We envision the below deliverables to be compiled into a **web-based interactive map** where users can explore the species distribution models, with possible side-panels showing changes in abundance over time, and the report card value per species.

*Objective 1: Identify and map rocky shore species range edges along California's coast.*

**A map** portraying the California coastline broken into equal-size sections (i.e. 0.5-degree latitude or 100 km chunks), indicating the number of rocky intertidal species with northern/southern range edges in each section of the coastline. **A list** of species which have range edges within the coastal section encompassing Point Conception. These products are intended for conservation, grant proposals/donors, and as an educational resource.

*Objective 2: Characterize potential species range shifts occurring within the Point Conception region.*

**A summary table** for each species with range edges near Point Conception from Objective 1 listing any significant changes in abundance over time within the Point Conception region. For those species experiencing a range expansion near Point Conception, an indication of whether the shift is in the arrival, increase, or persistence stage. This will be used by TNC to develop a coastal monitoring plan and a preserve management access plan for the public.

*Objective 3: Predict species range shifts into the future.*

**Habitat suitability maps** from species distribution models of each species with range edges near Point Conception (from Objective 1), projected under future climate scenarios. This product is intended to be used as an interactive tool and contribute to the future of the coastal monitoring plan.

*Objective 4: Create a range shift species list and a ranking system to prioritize monitoring for coastal range extensions/retractions within the Preserve.*

A **'report card'** for each of the species with range edges near Point Conception, representing the degree of change compared to changes in abundance over time for the other sections of the coastline, as well as the likelihood that they will shift past this transition zone from the species distribution models. This product is also intended to be seen in conjunction with the interactive map to explore potential species range extensions/contractions.

## **DATA ACCESS AND AVAILABILITY**

While the data is publicly available, there is no practical API to continually update the project. Rather, the purpose of the analysis is to create client and public-facing products that help those understand the current ranges of rocky intertidal species near Point Conception. This product will be available and maintained by The Nature Conservancy.

The biodiversity/species data will all come from the publicly available long-term ecological monitoring surveys performed by the [MARINe](#) group. We have already gone through the data request process for this data, and have the spreadsheets available for download within [this box folder](#). These data will be used to generate all deliverables. Environmental variables for the species distribution models can be obtained through the [Bio-Oracle dataset](#), and are available to download via the R package *'biooracler'*.

## **PROJECT REQUIREMENTS**

All analyses, data visualization, and species distribution models will be performed in R. Many of the analyses can be conducted with common packages such as raster, terra, dyplr, tmap, biomod2, etc. The web-based interactive map will be developed in RShiny and hosted by The Nature Conservancy on the [Dangermond Preserve Geospatial Hub](#).

Some preliminary work has been conducted on these data in R to identify species range edges, which involved creating a 0.5-degree latitude buffer around Point Conception and filtering to species that are present within that buffer, but absent north (for northern range edge species) or south (for southern range edge species) of the buffer. This approach will be extended to identifying species range edges throughout the California coastline. We anticipate the project following established frameworks (Bates et al., 2014; Lonhart et al., 2019) to classify potential species range shifts around Point Conception and whether the shift is in the arrival, increase, or persistence stage for range extensions. Statistical analyses will be run to assess which species with range edges near Point Conception have significantly increased/decreased in abundance (an indicator of the stage of range shift). The project will also forecast future coastal species shifts, using species distribution models with climate data pertaining to different emission scenarios (2030 to 2050).

## SUPPORTING MATERIALS

### Literature Cited

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### Budget

This project has no additional budget requirements outside of the \$250 allocated for the capstone project by the Bren School of Environmental Science & Management.

### Client Letter of Support

See below



October 4, 2024

To:

Group Project Committee  
Bren School of Environmental Science and Management  
Master of Environmental Data Science  
Bren Hall, 2400 University of California, Santa Barbara, CA 93117

From:

Erica Nielsen, Ph.D.  
Anthony LaFetra Point Conception Institute Research Fellow, Dangermond Preserve  
The Nature Conservancy  
[erica.nielsen@tnc.org](mailto:erica.nielsen@tnc.org)

On behalf of The Nature Conservancy (TNC), I am pleased to endorse the proposed capstone proposal for the Dangermond Preserve. The Conservancy is excited to utilize the interdisciplinary skills of MEDS students and faculty to assess the likelihood coastal species range shifts within the region of Point Conception and Dangermond Preserve. This project will inform climate-smart conservation management actions within this unique biogeographic transition zone. We hope that this proposal allows Bren students to gain necessary skills while exploring long-term ecological datasets and solving environmental issues at this unique place.

This letter serves as confirmation of The Nature Conservancy's support for the Bren MEDS Group Project, providing all data, as well as funding support for data processing or software essential to the project. We also will support the maintenance of deliverables post-project completion.

We look forward to your favorable consideration of our proposal.

Sincerely,

A handwritten signature in black ink, appearing to read "Erica Nielsen".

Erica Nielsen, Ph.D.  
Anthony LaFetra Point Conception Institute Research Fellow, Dangermond Preserve  
The Nature Conservancy