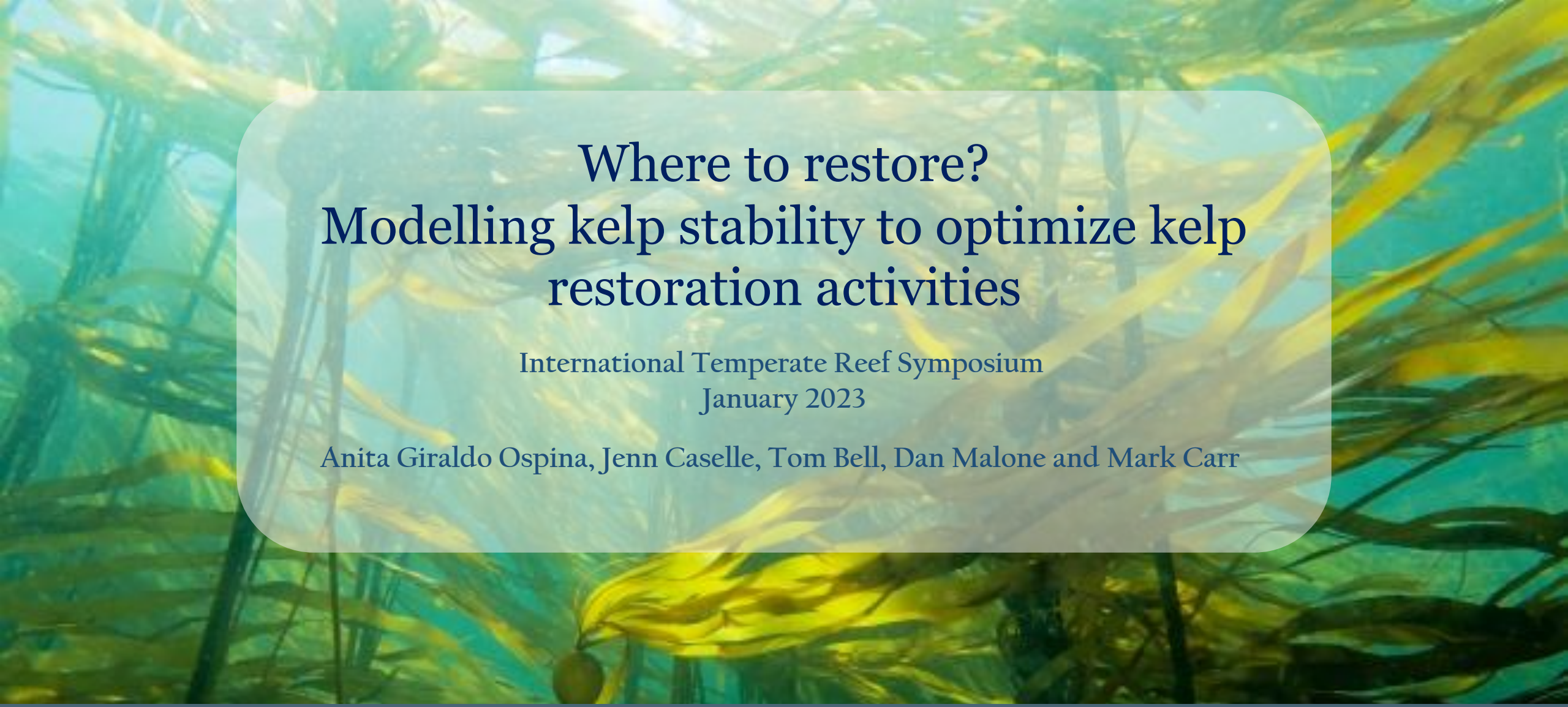


Where to restore? Modelling kelp stability to optimize kelp restoration activities

International Temperate Reef Symposium
January 2023

Anita Giraldo Ospina, Jenn Caselle, Tom Bell, Dan Malone and Mark Carr

Sea Grant California

OCEAN PROTECTION COUNCIL

UC SANTA BARBARA

UC SANTA CRUZ

WOODS HOLE OCEANOGRAPHIC INSTITUTION®

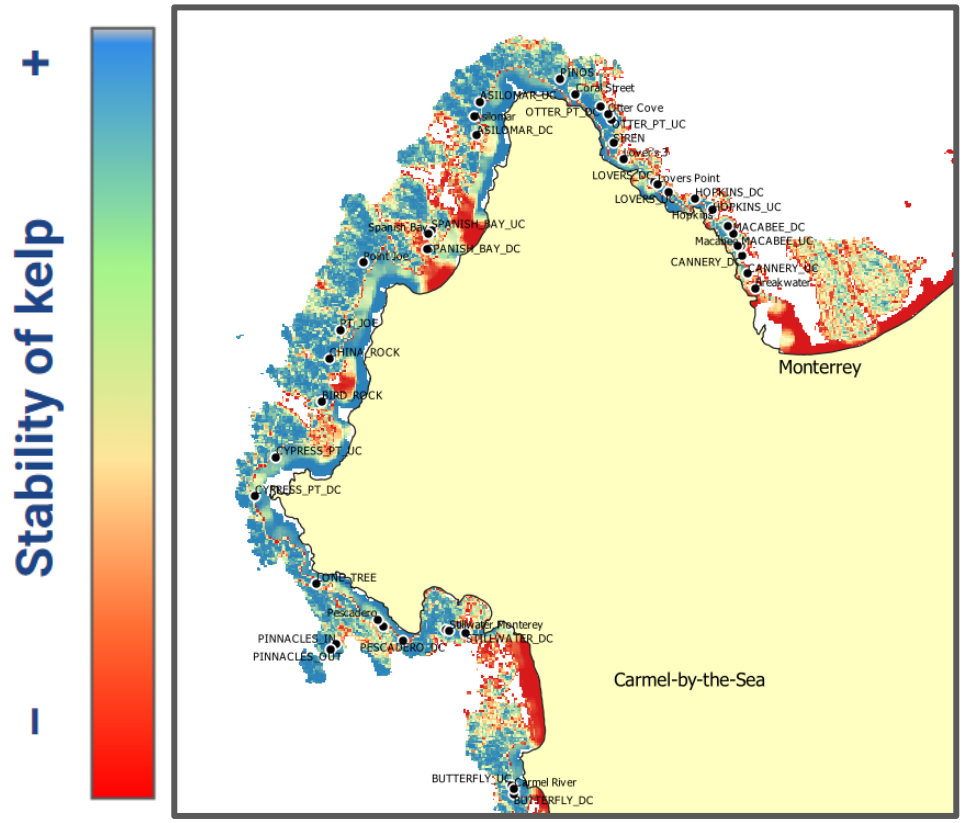
Overarching goal

Produce a tool that helps resource managers to choose **optimal locations** to conduct kelp restoration activities statewide.

Use modeling techniques to **identify key** ecological, oceanographic, environmental **drivers of kelp density dynamics** to estimate kelp stability.

Satellite images show the dramatic reduction from 2008 to 2019 in the area covered by kelp forests (gold) off the coast of Mendocino and Sonoma Counties in Northern California. (Images by Meredith McPherson)

Kelp stability to inform restoration



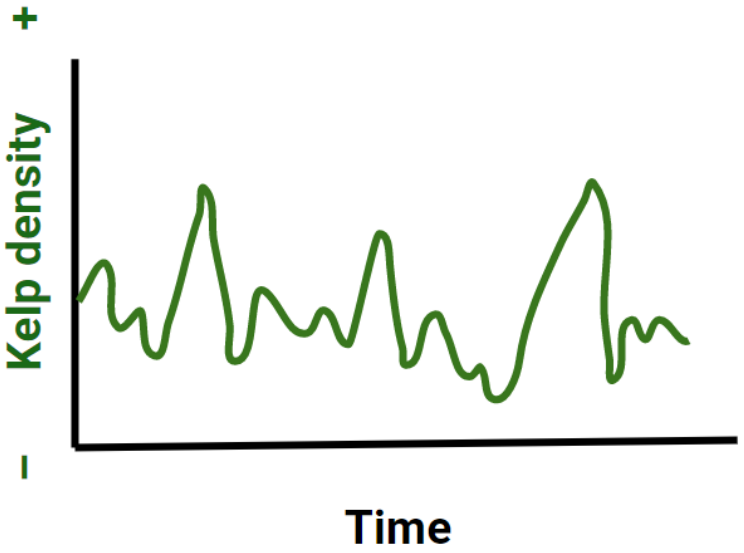
Stability as a key element of restoration success

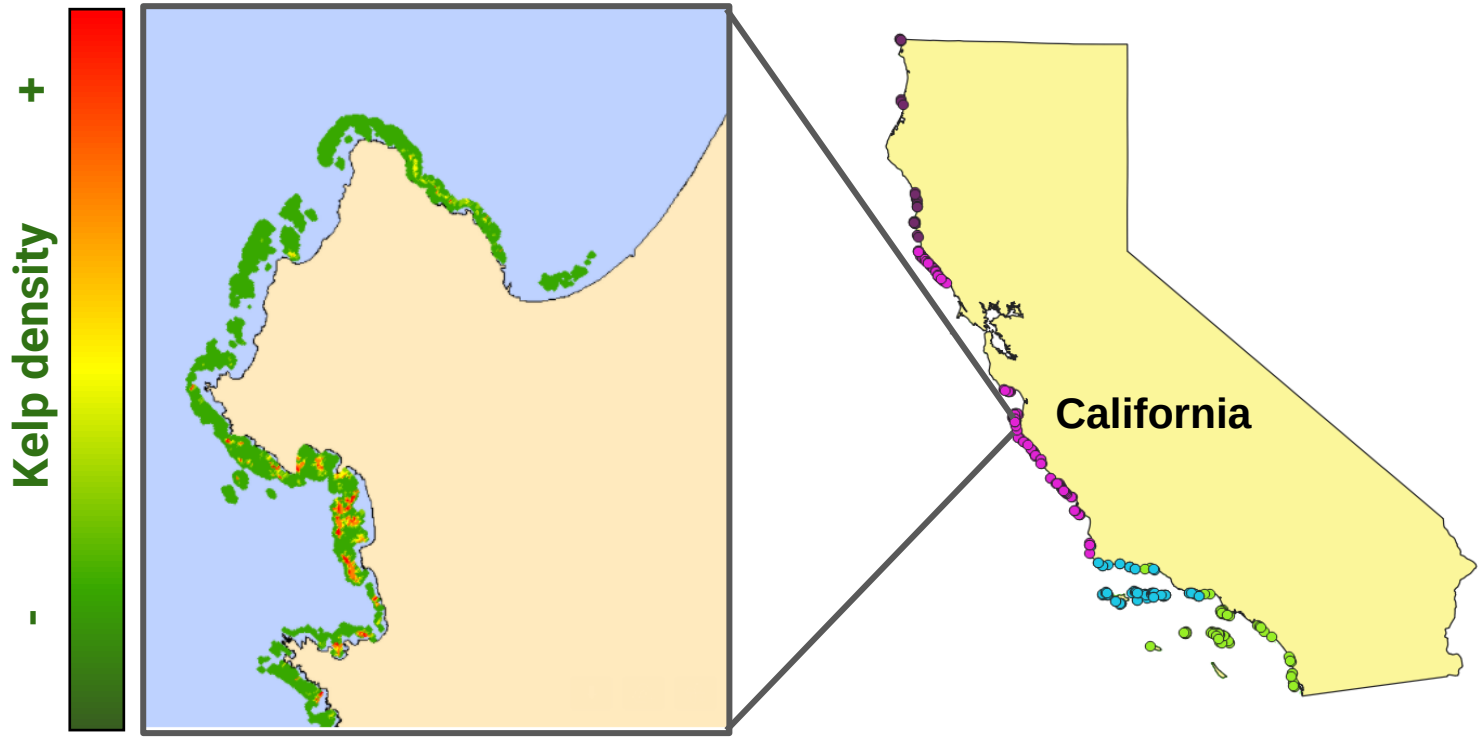
Stability incorporates metrics of kelp abundance and how it varies through time for each site

Stability = mean of density^2/standard deviation of density

Why kelp dynamics?

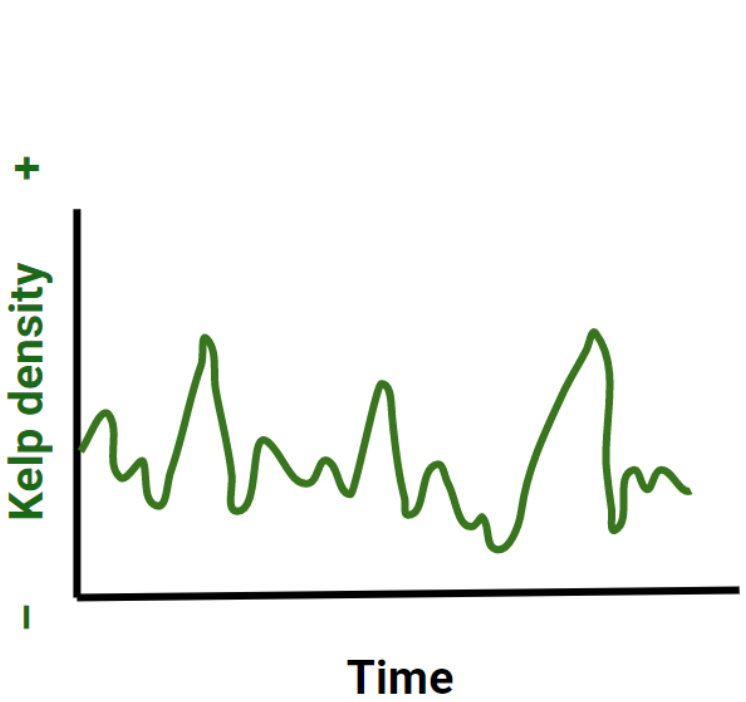
Kelp is very variable

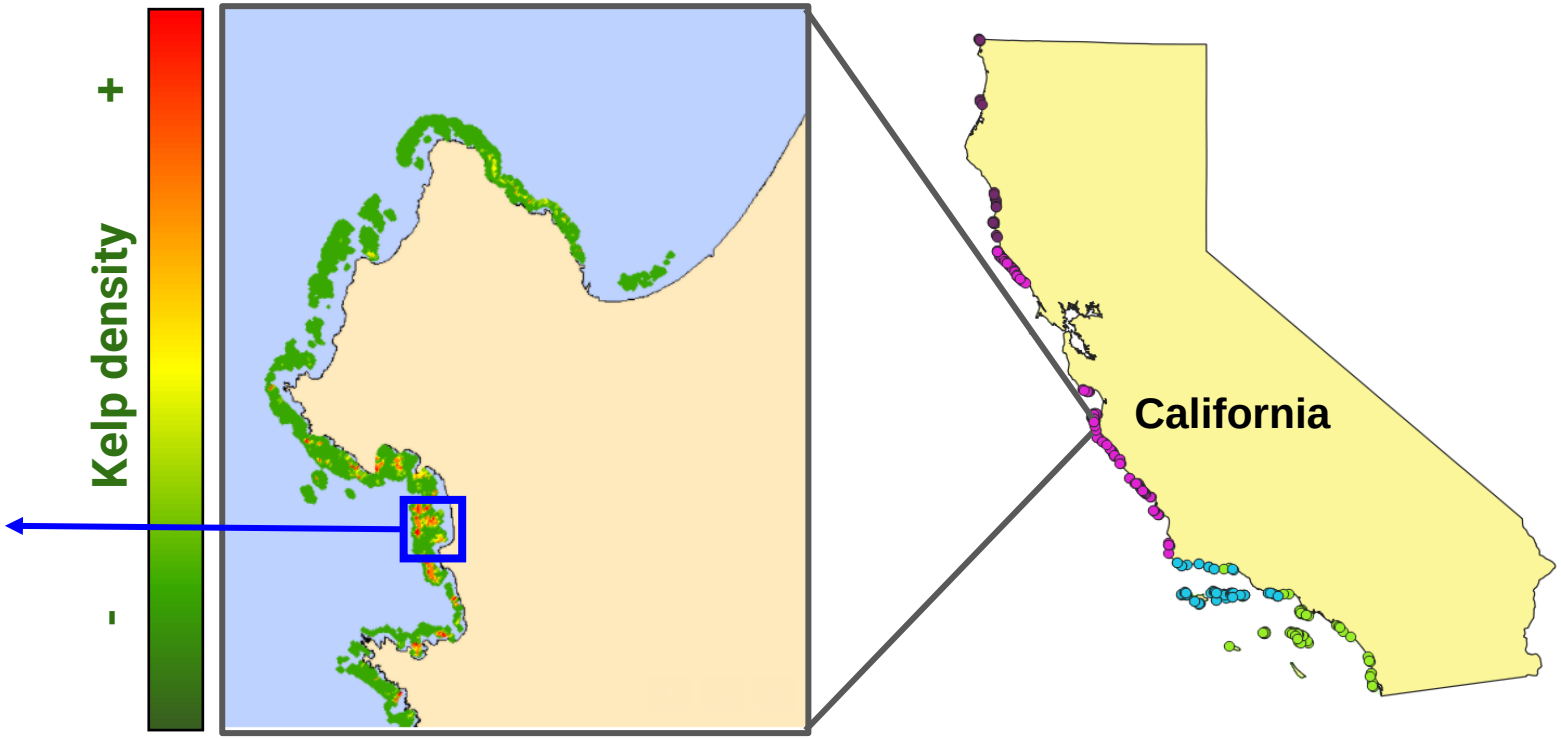




Why kelp dynamics?

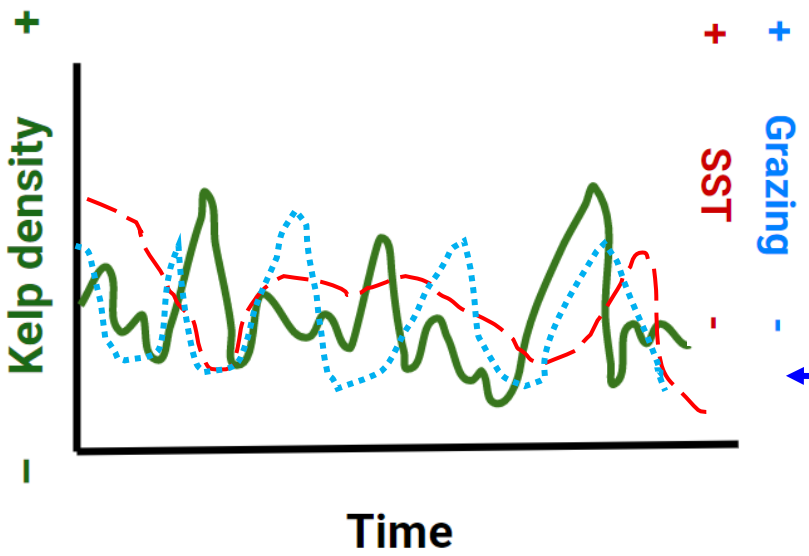
Kelp is very variable

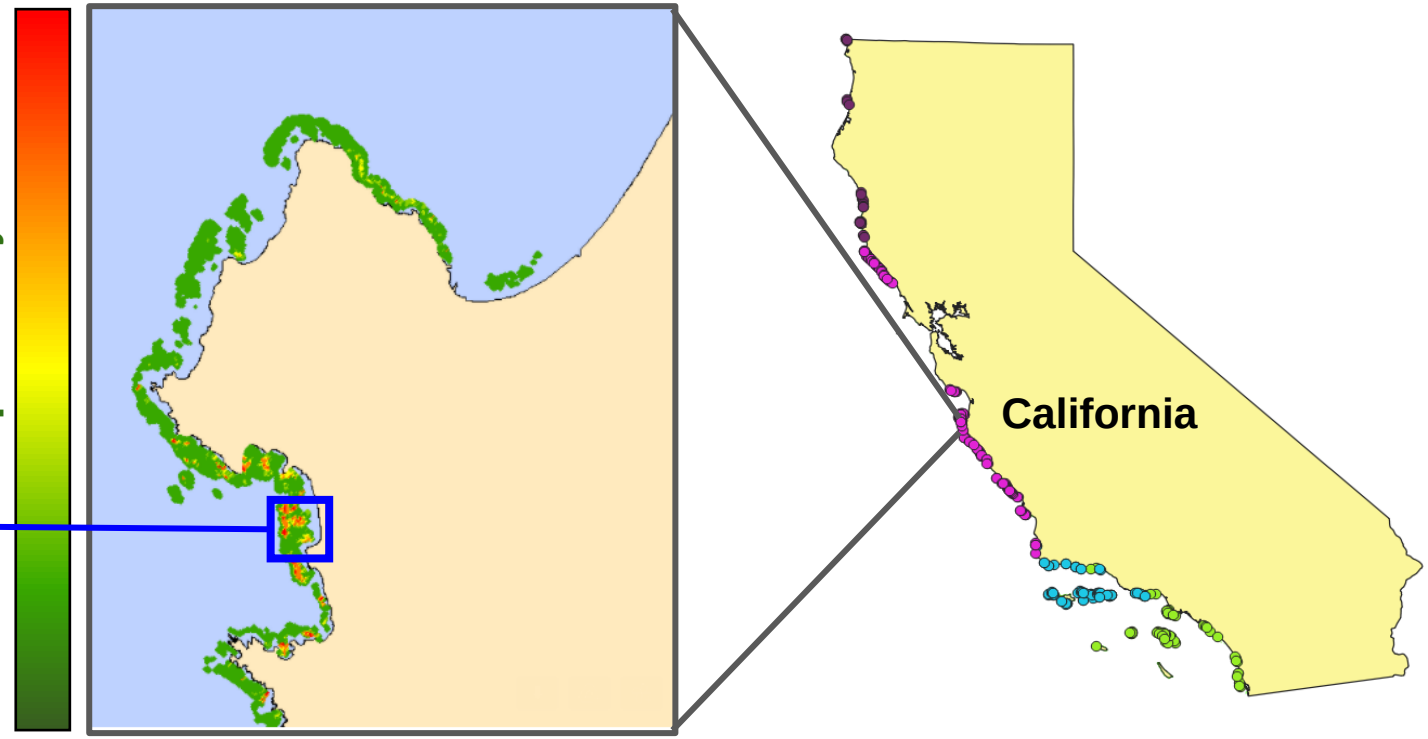




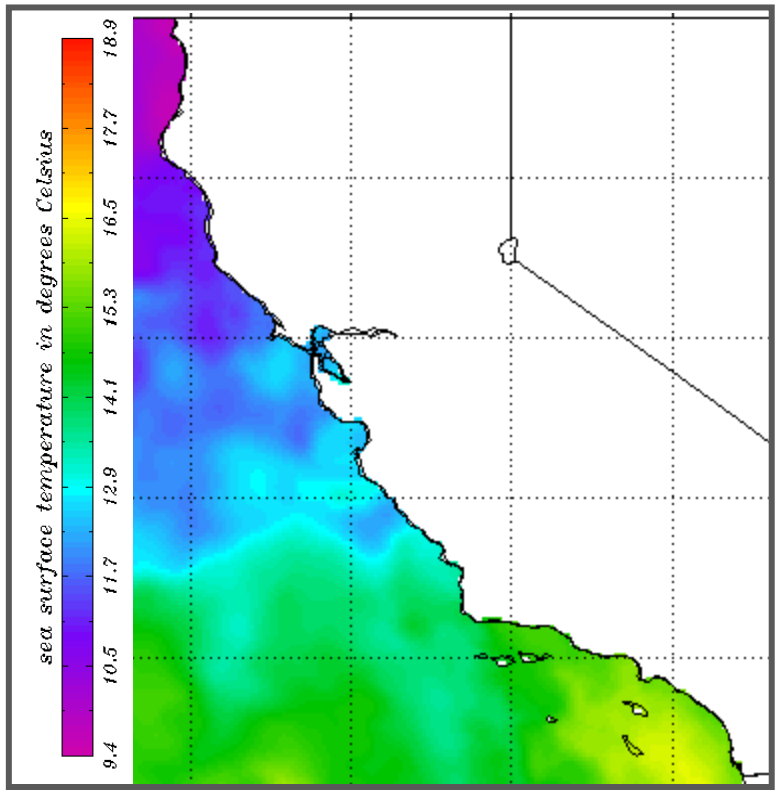
Why kelp dynamics?

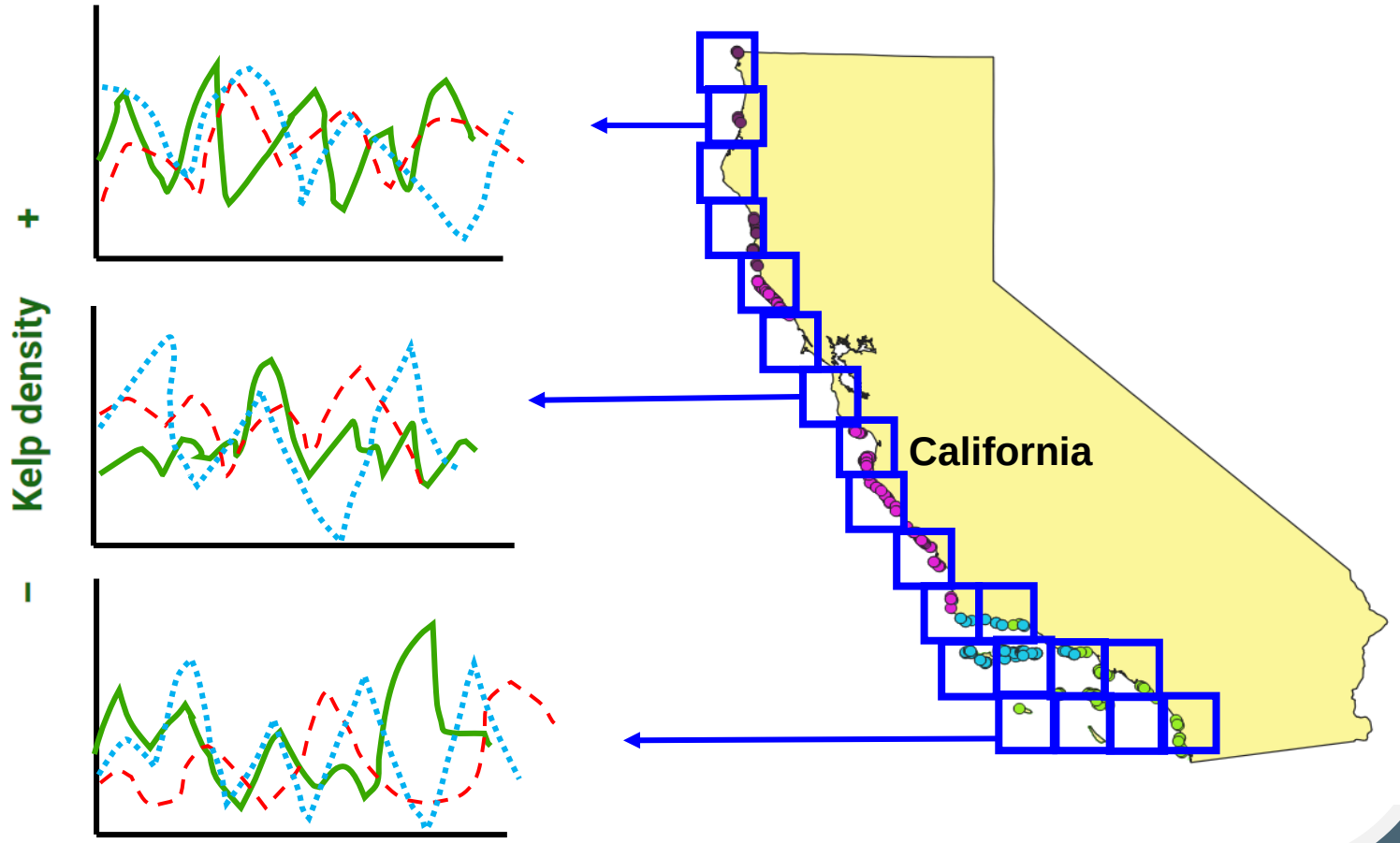
Environmental factors
Ecological processes





The drivers of kelps also vary in space and time



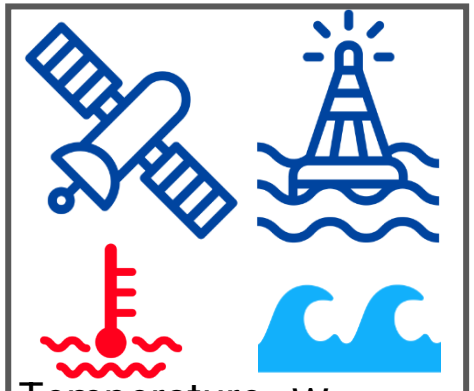


Identifying the key drivers of kelp dynamics

Bathymetry

Depth
Slope
Rugosity
Rock

Environmental

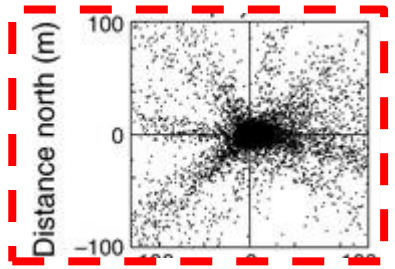


Temperature
Waves
Nutrients

In situ ecological

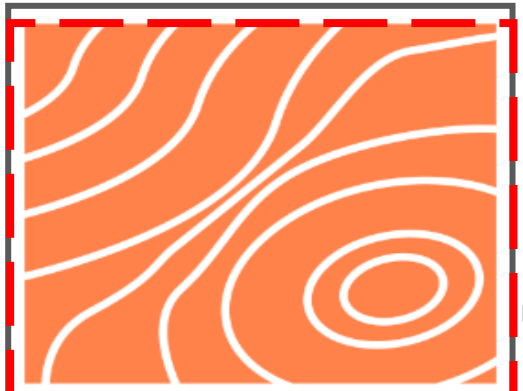
2004-2021

M. pyrifera



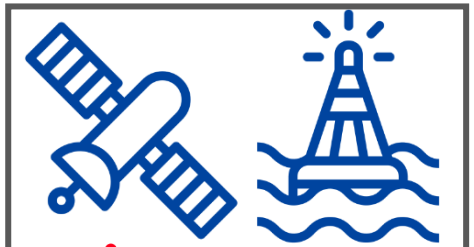
Identifying the key drivers of kelp dynamics

Bathymetry



Depth
Slope
Rugosity
Rock

Environmental

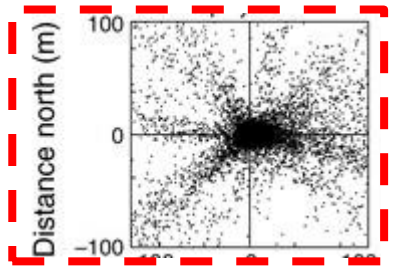


Temperature
Waves
Nutrients

In situ ecological

2004-2021

M. pyrifera



The drivers of kelps also vary in space and time

Bathymetry

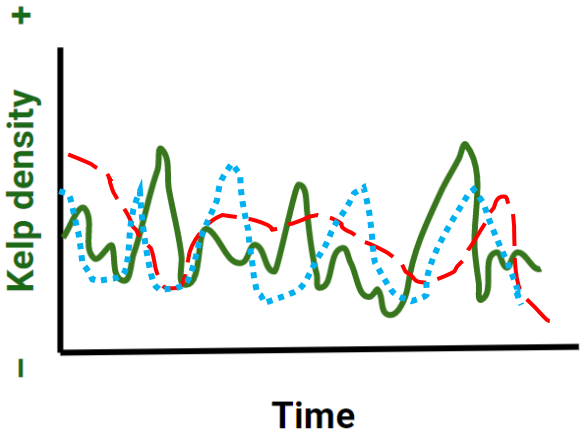
Environmental

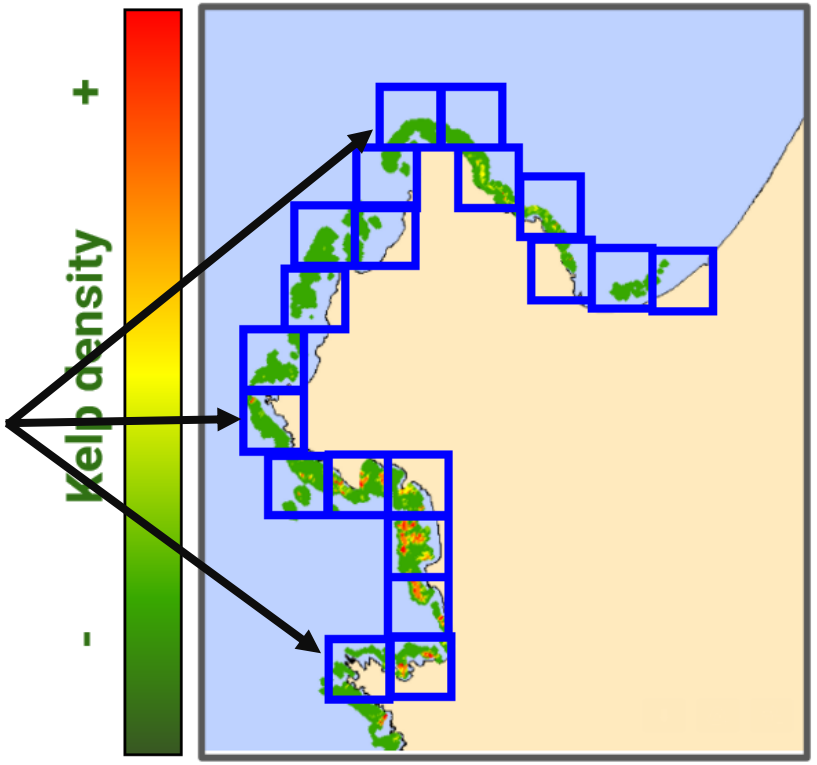
Depth

In situ ecological

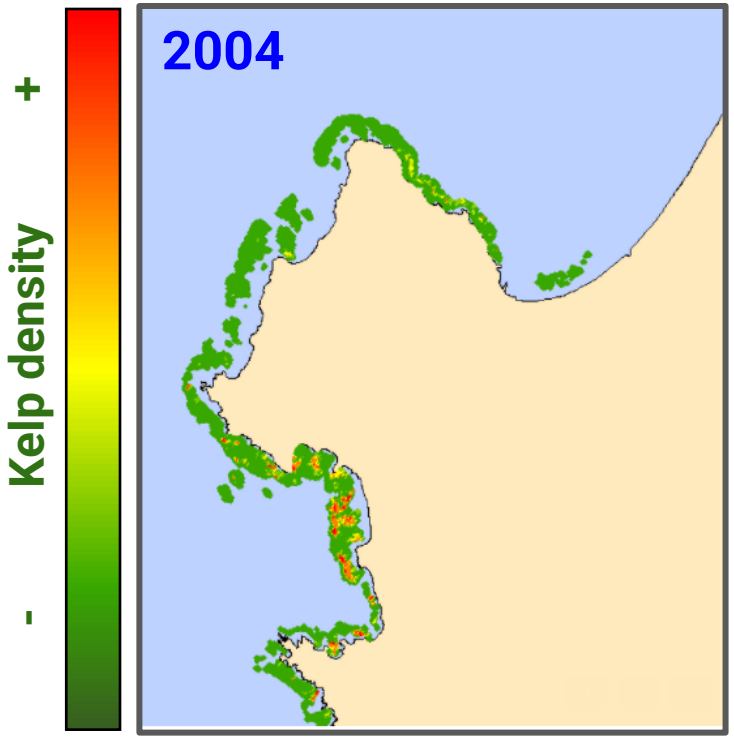
PISCO

REEF CHECK
CALIFORNIA

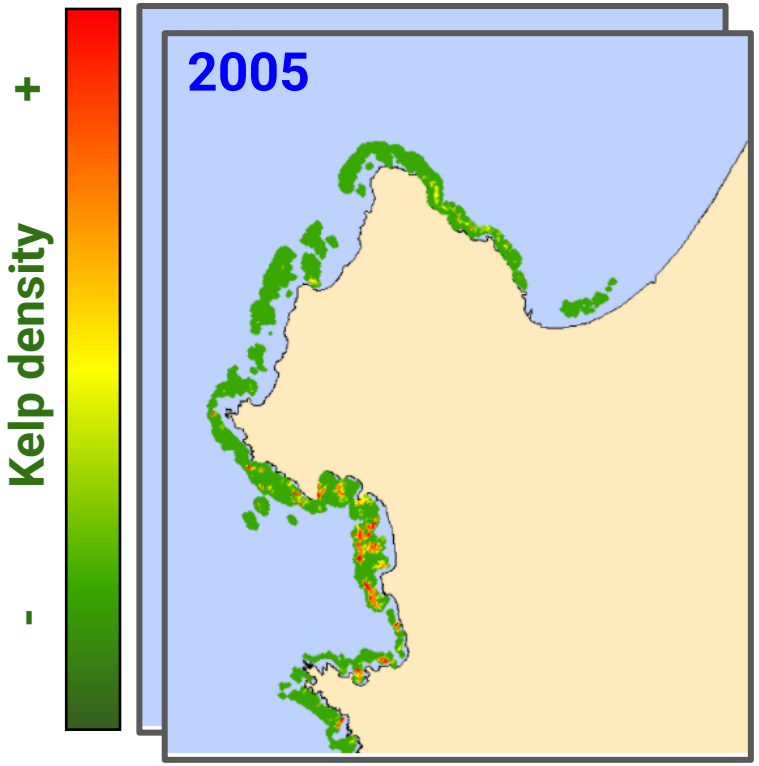




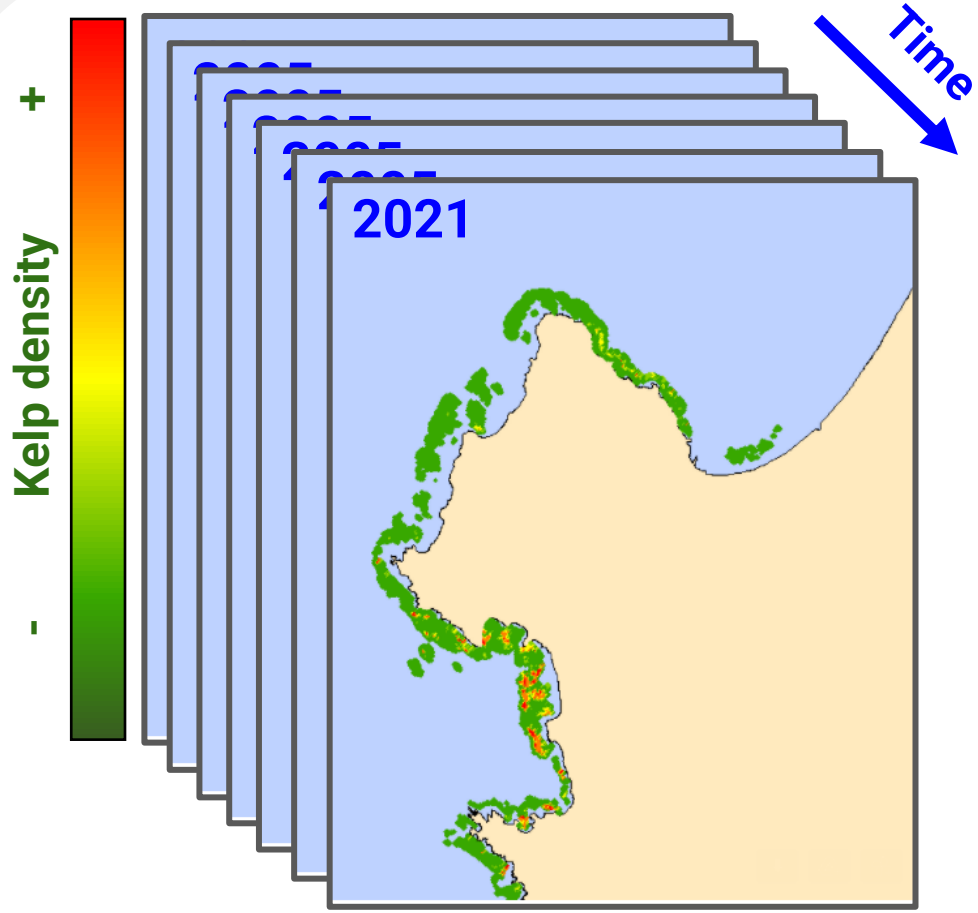
With key drivers we can project continuous maps



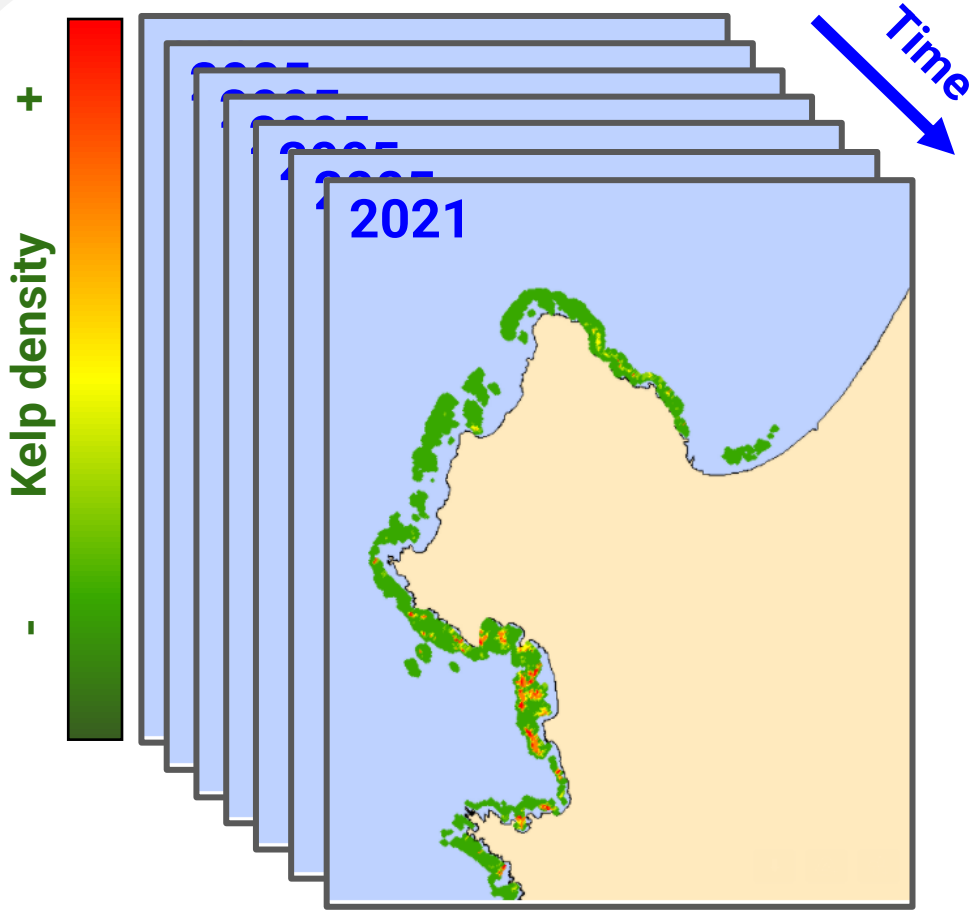
With key drivers we can project continuous maps



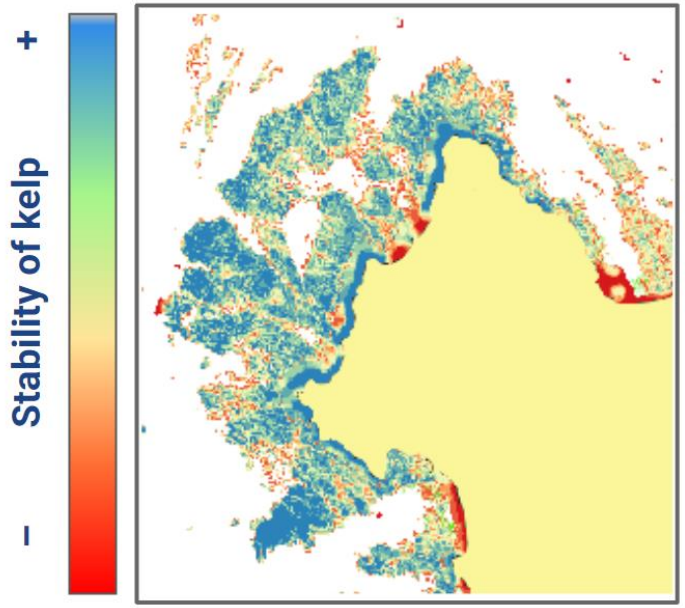
With key drivers we can project continuous maps



With key drivers we can project continuous maps



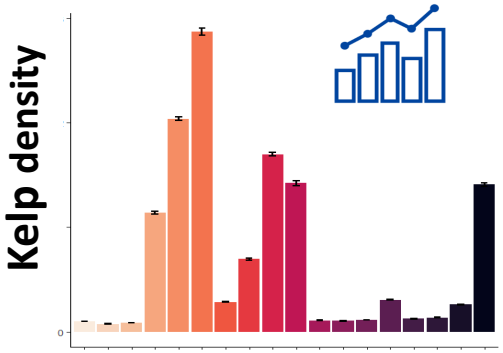
Estimate kelp stability as proxy for kelp restoration success

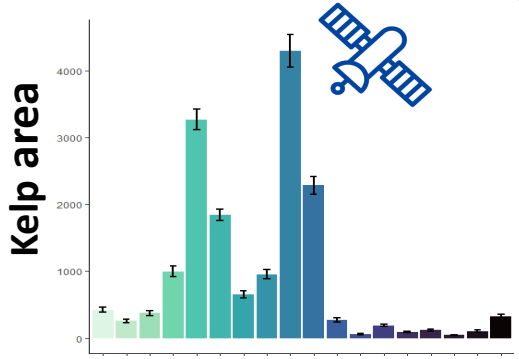


Stability = mean^2/standard deviation

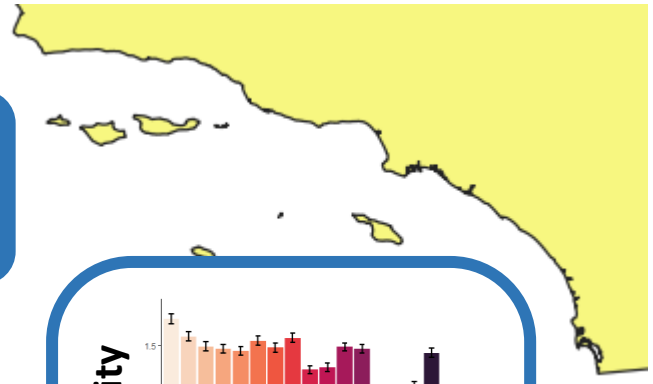
Kelp dynamics from key environmental drivers

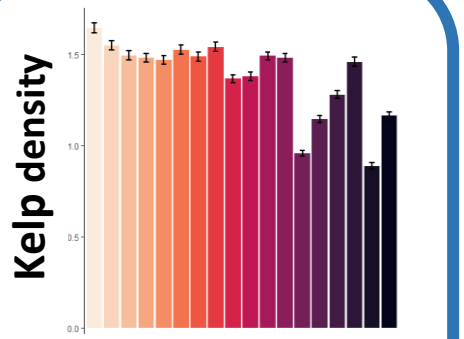
North Coast

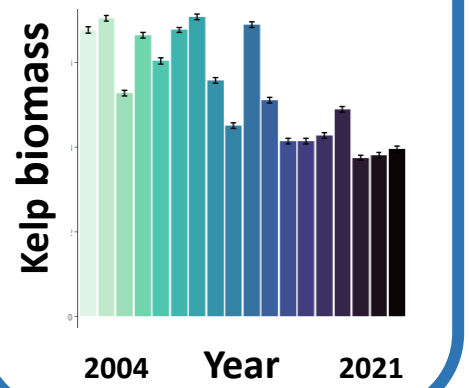




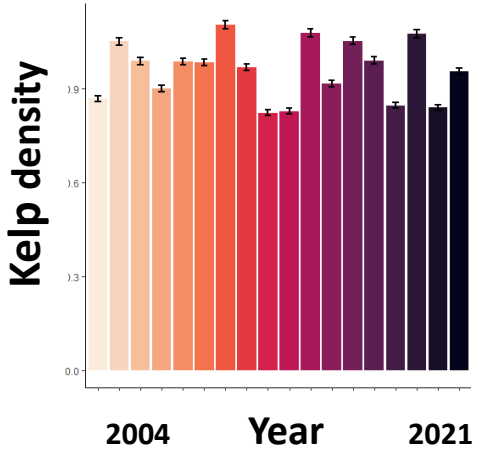
South Coast

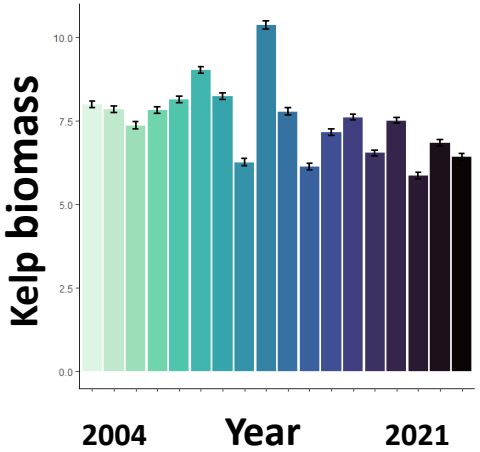


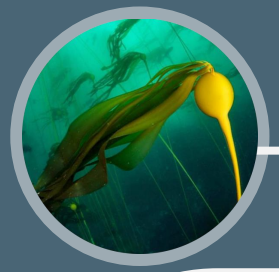




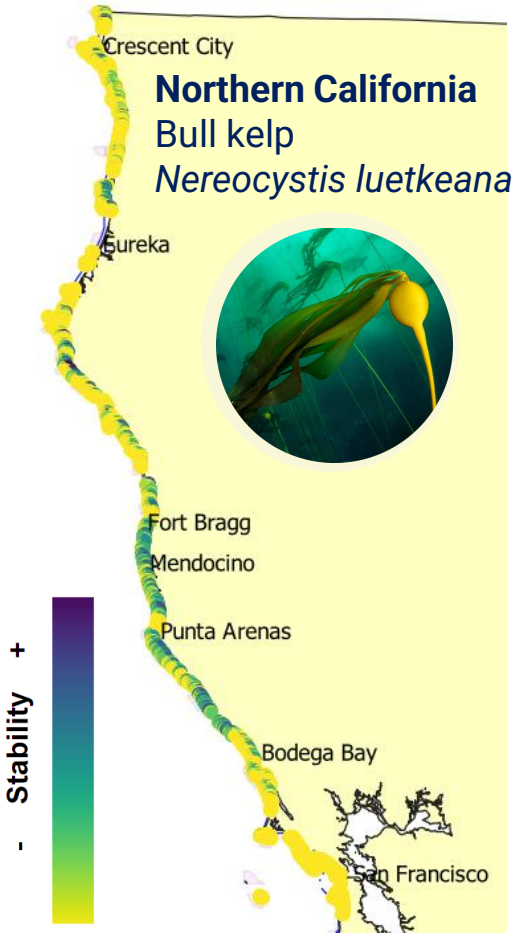
Central Coast

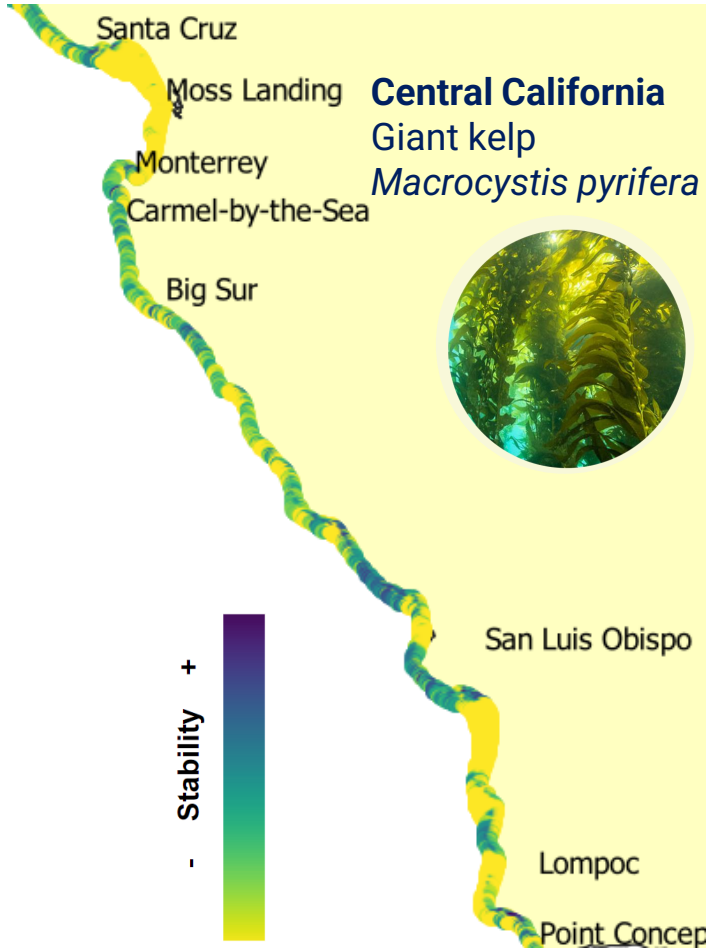


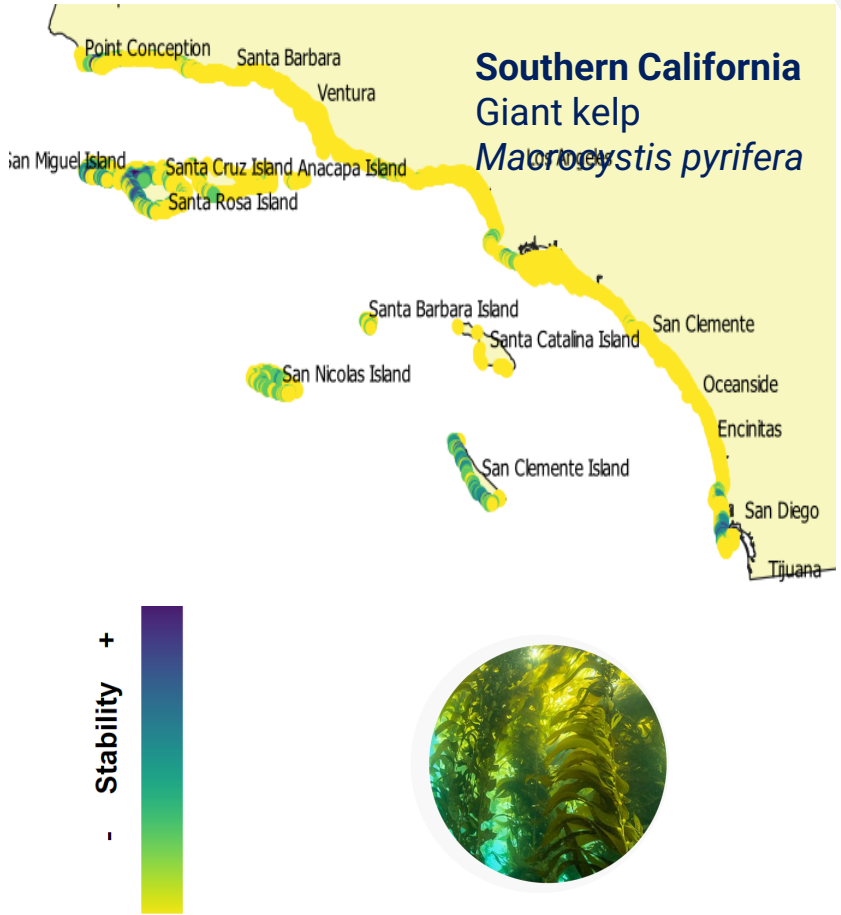




Estimated kelp stability

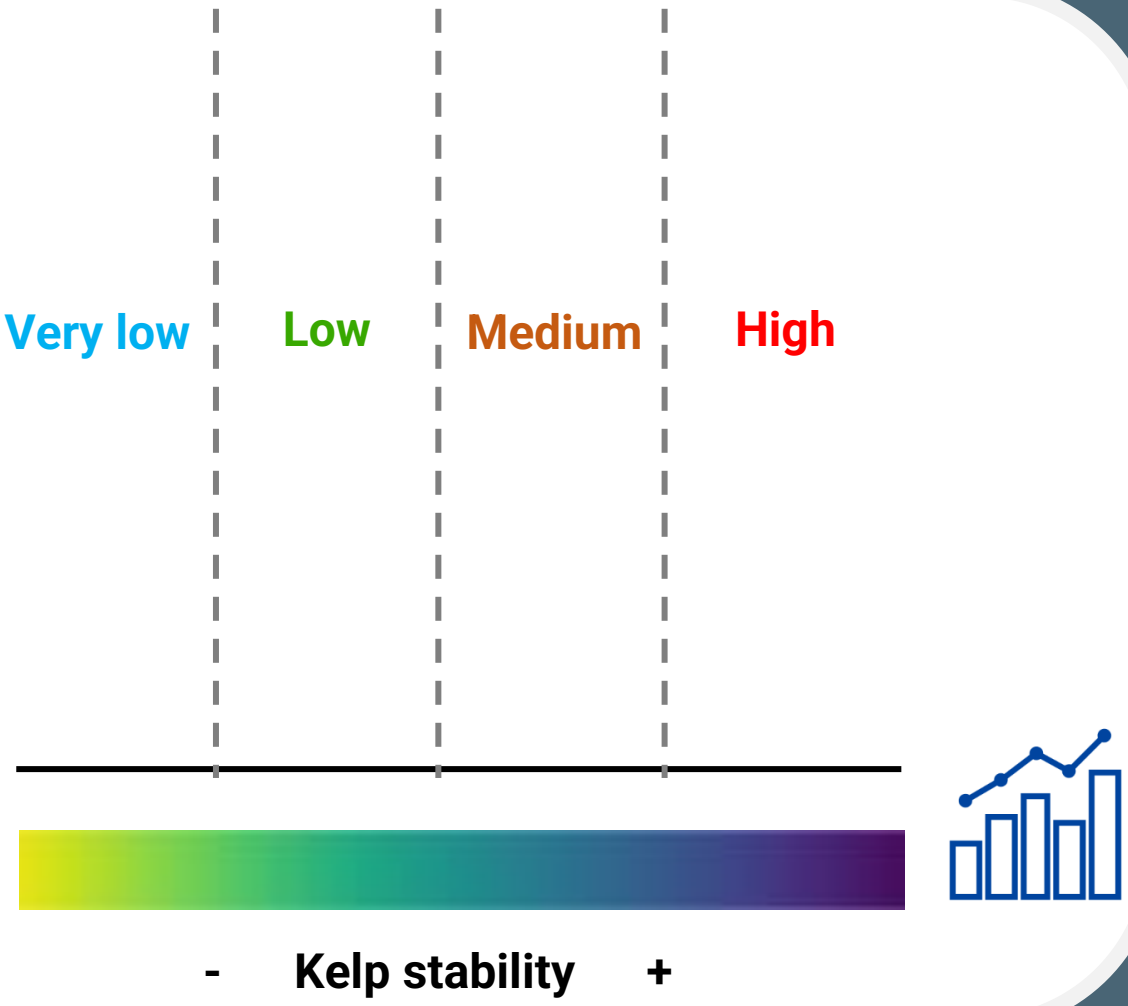






Defining priority sites for kelp restoration

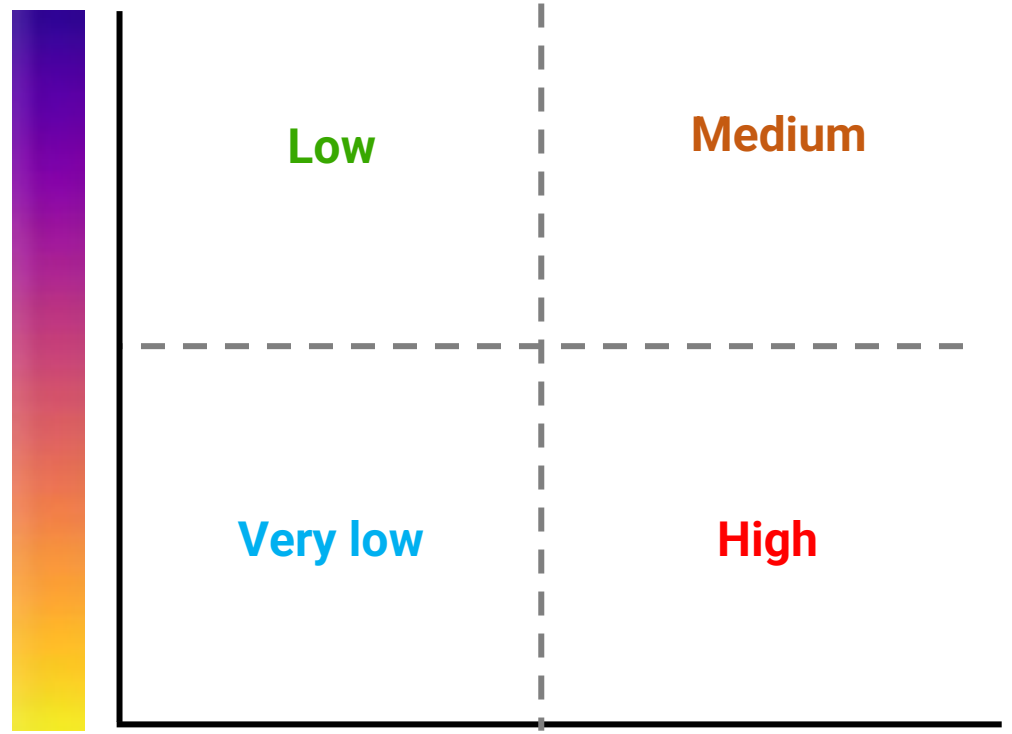
Where to restore kelp?



Defining priority sites for kelp restoration

Kelp recovery

Kelp abundance 2021 - Lowest kelp abundance 2014-2019



Defining priority sites for kelp restoration

Kelp recovery

Kelp abundance 2021 - Lowest kelp abundance 2014-2019

Kelp recovery (Post MHW)

\+

-

Low

High risk investment due to natural variability

Medium

Prioritize monitoring, protection, facilitation

Very low

Restoration very unlikely to succeed

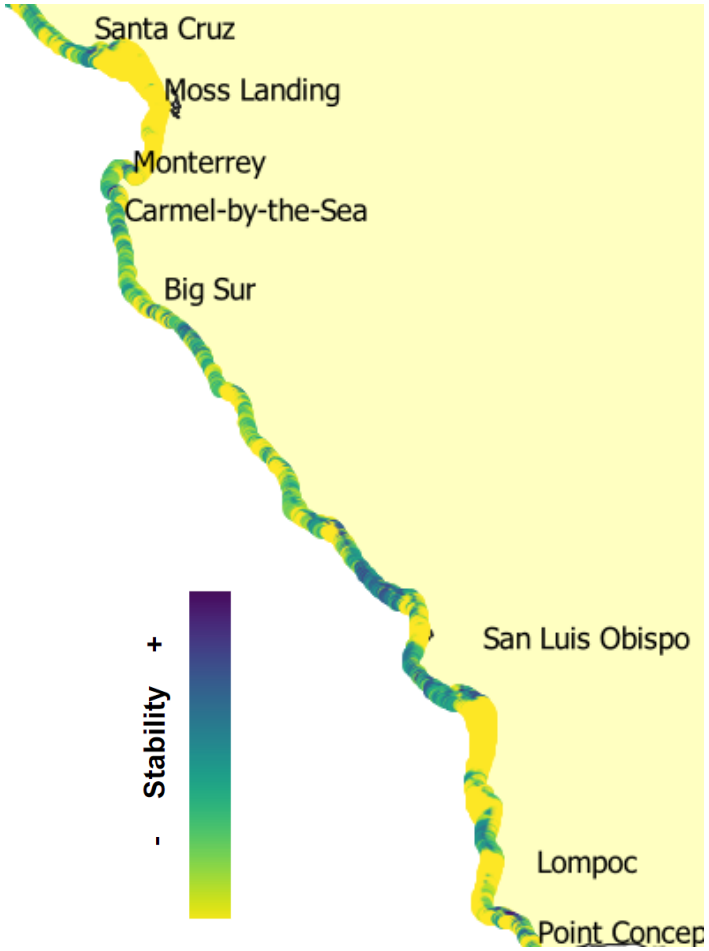
High

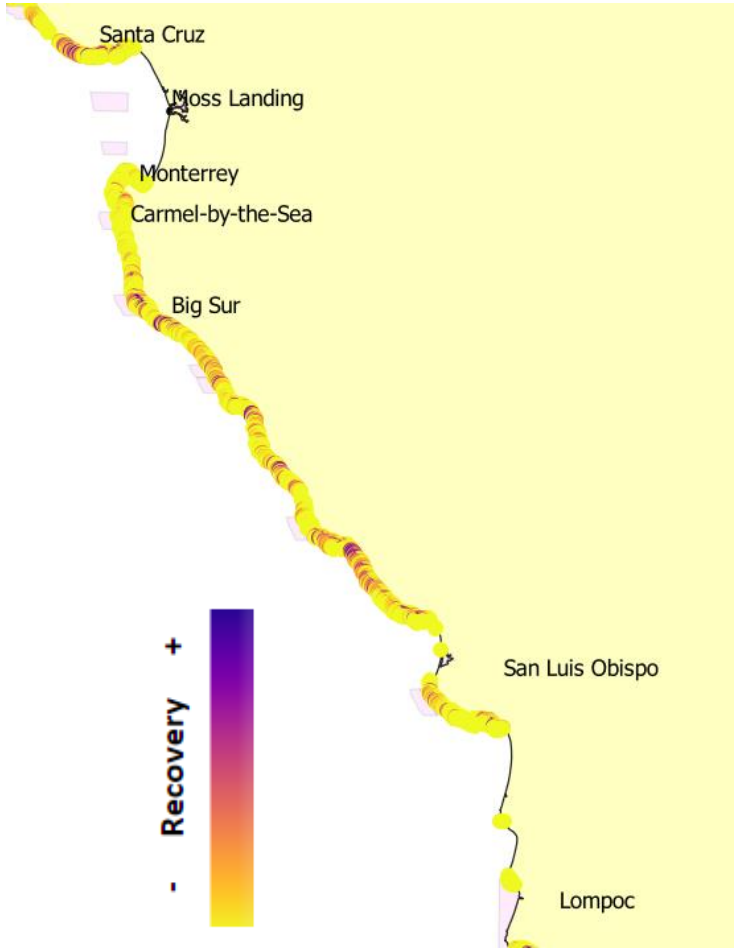
Restore, rehabilitate, adaptation

\- **Kelp stability (Pre MHW)** \+

Recovery and stability of giant kelp in central California

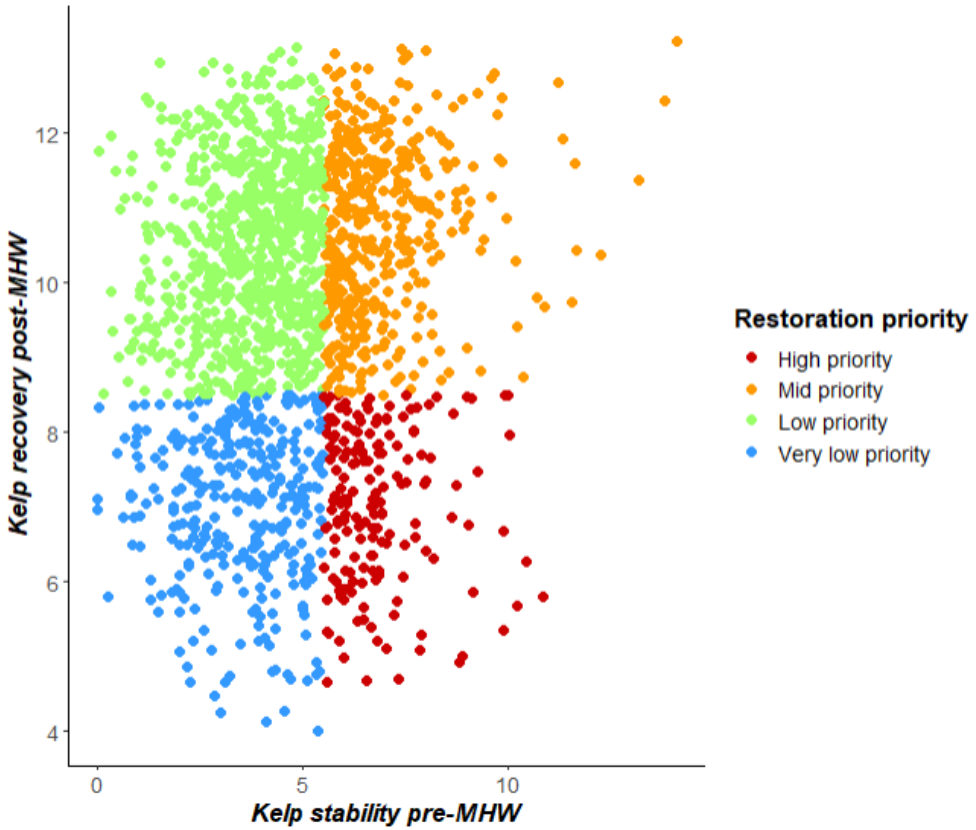
Central California
Giant kelp
Macrocystis pyrifera





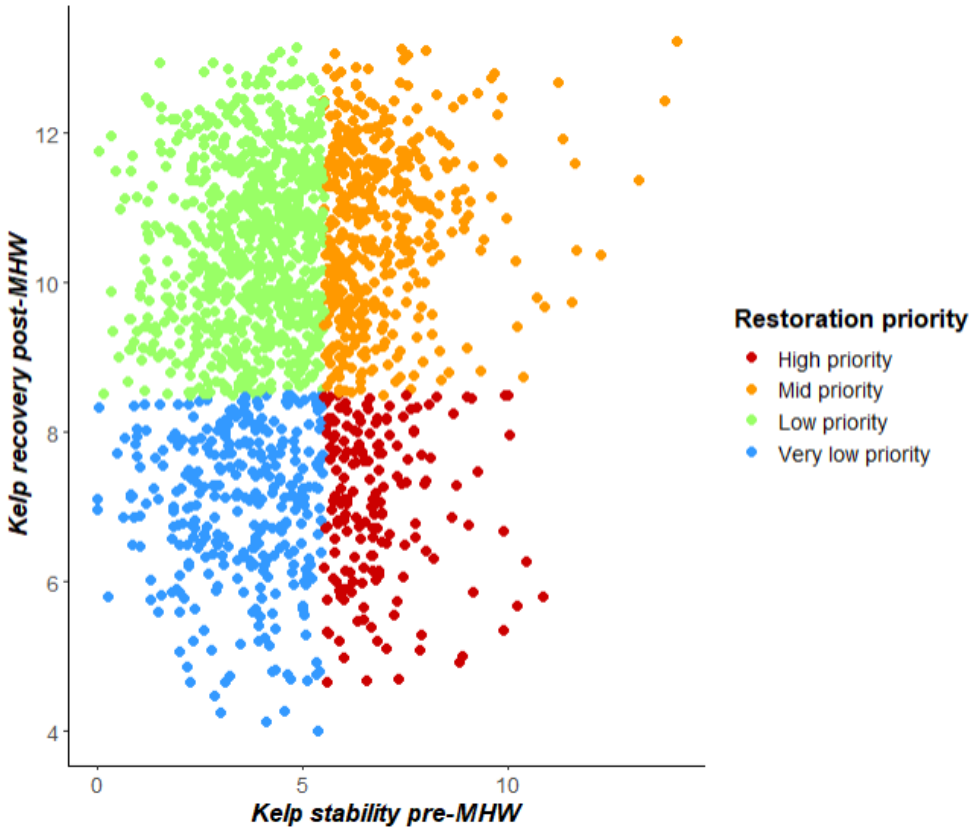
Recovery and stability of giant kelp in central California

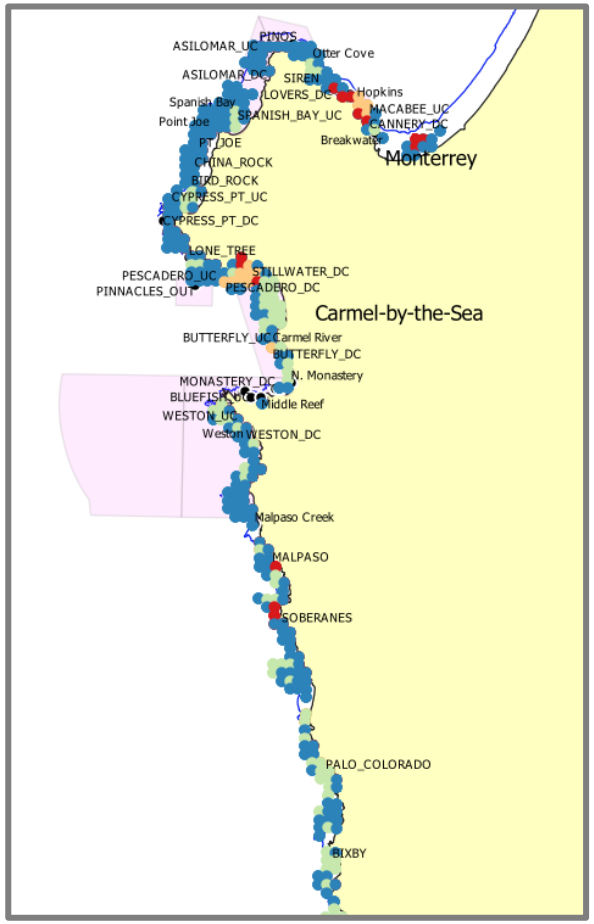
Central California
Giant kelp
Macrocystis pyrifera



Recovery and stability of giant kelp in central California

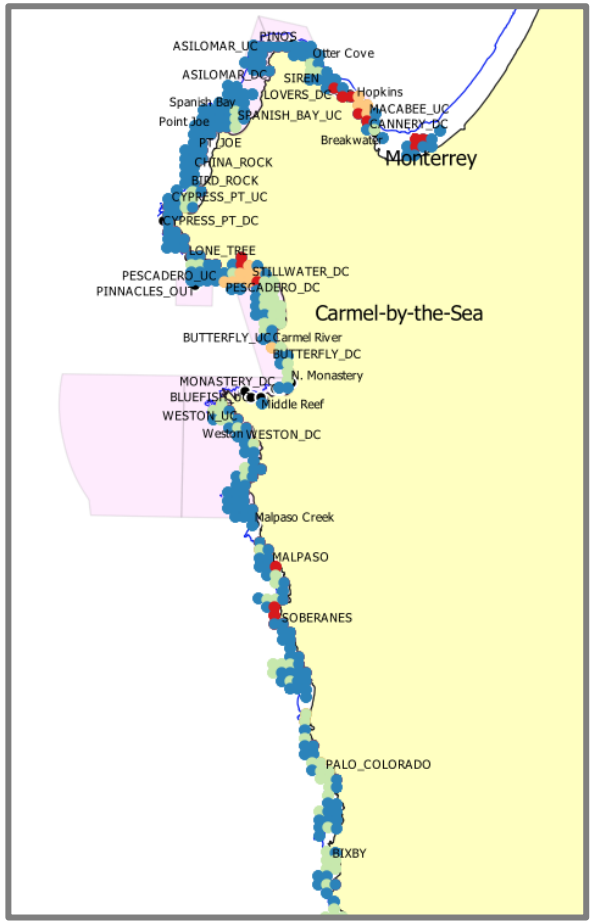
Central California
Giant kelp
Macrocystis pyrifera

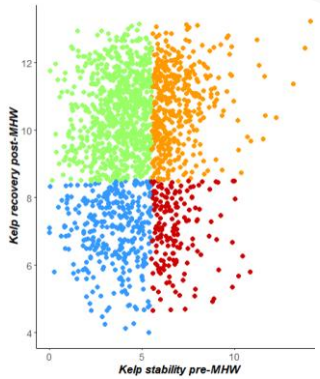




A tool to identify where to restore

- Effectively predict kelp dynamics
- Identifies key regional drivers of kelp stability
- Combined with other considerations:
  - Logistics
  - Socio-ecological priorities
  - Administrative factors





Restoration priority

- High priority
- Mid priority
- Low priority
- Very low priority

Thanks to:
Mallarie Yeager, Dan Malone, The Caselle Lab,
Chunting Zheng, Emily Saarman, PWIS Group

Sea Grant California

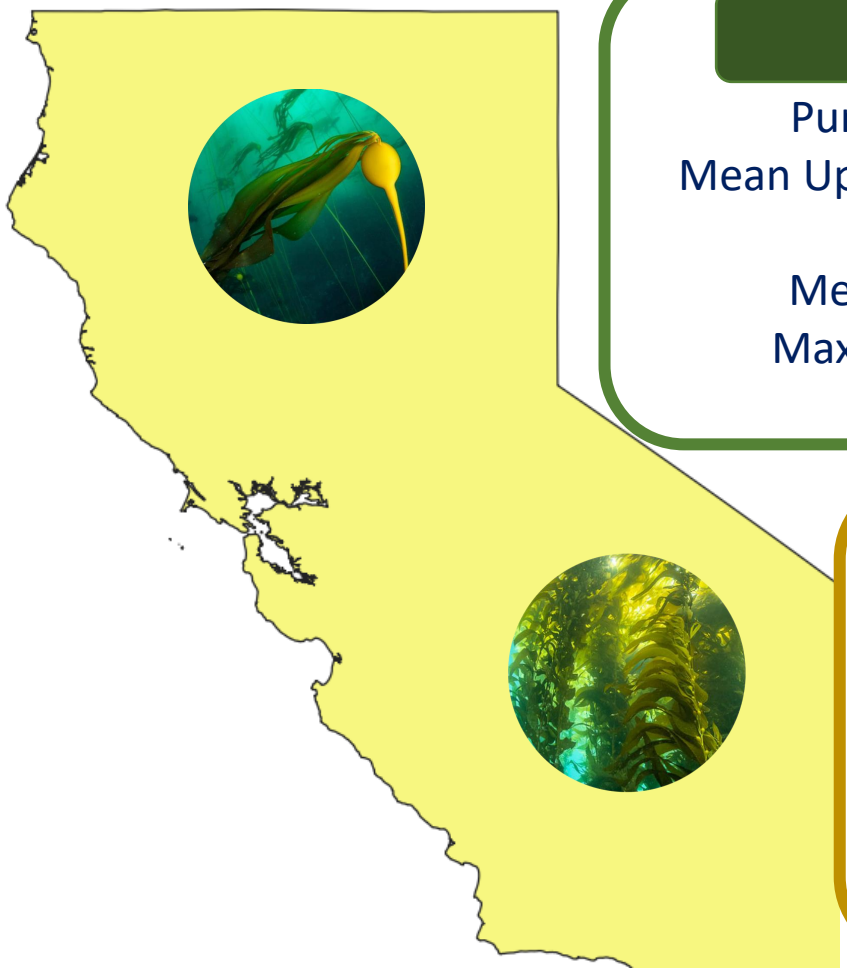
OCEAN PROTECTION COUNCIL

UC SANTA BARBARA

UC SANTA CRUZ

WOODS HOLE OCEANOGRAPHIC INSTITUTION®

Kelp dynamics from key environmental drivers



North Coast

Purple sea urchins
Mean Upwelling Temperature
Max Nitrate
Mean wave height
Max Orbital Velocity
Depth

Central Coast

Purple sea urchins
Days 4N
Mean wave height
Depth
Previous year spore density

South Coast

Purple sea urchins
Days 21C
Days 4N
Mean wave height
Max Orbital Velocity
Depth
Previous year spore density