Welcome!

OAH and West Coast Shellfish Aquaculture: Adaptation in a Changing Climate

WORKSHOP
October 24, 2024

Support from: NOAA Ocean Acidification Program

Project Team

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Oregon Ocean Science Trust

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Additional contributors: Dr. Kristy Kroeker & team, ecological thresholds work (+ many more!)

Funding: NOAA OAP

NOAA Ocean Acidification Program

Objectives

NOAA Ocean Acidification Program, Regional Vulnerability Assessment

Objective 1: Assess the vulnerability of resource-dependent communities to OA (shellfish aquaculture), drawing on ecological/oceanographic data sources; and collect data to assess community sensitivity and adaptive capacity.

Objective 2: Review factors driving coastal stakeholders' ability to adapt to OA, paired with an analysis of existing policy instruments which may support present or future adaptive capacity

Objective 3: Develop novel research project governance with continuous communication with policy-makers, end users, and stakeholders throughout. Translate findings into policy briefs for governing entities in California and Oregon.

Introductions

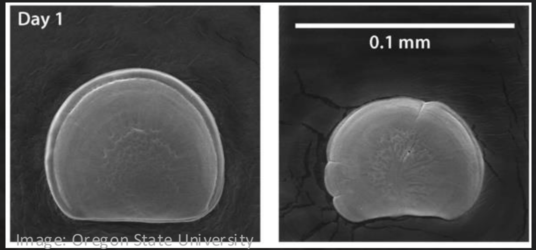
Looking Back: Ocean Acidification & Aquaculture

Ocean Acidification

1990's – 2000's: OA highlighted as a key issue, growing concern and science on impacts to marine organisms (in particular, early stages of marine calcifiers)

- Complexities in the nearshore, exacerbated by upwelling-induced pH stress
- Lack of evidence of human community impact

Ocean acidity has increased by 26%, with increases in >100% by 2100 (UN SDG Report, 2019)



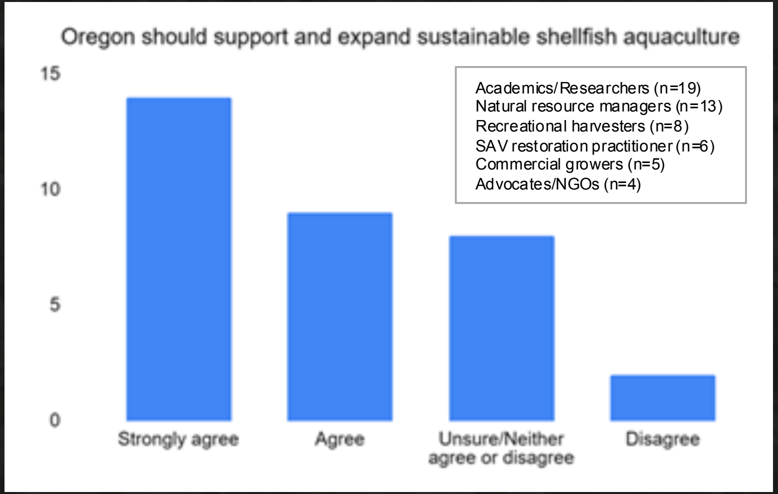
Aquaculture

Ebbs & flows in public perception of aquaculture

60-85% of seafood is imported from outside the U.S. (Gephart et al. 2019; NOAA)

~20% of the US seafood consumption comes from aquaculture (NOAA, 2013). National seafood trade deficit ~$17 billion (NOAA, 2020).

Many support expansion of sustainable aquaculture (Ward, Katz et al. In Prep).



Merging Narratives: OA and Shellfish Aquaculture

2007 - 2008: Large-scale hatchery die off of oyster larvae in PNW, ultimately attributed to carbonate chemistry stress – what has happened since?

- Provided and example of a linkage between OA, marine organisms, and human communities.

2008-present: Ongoing support for OA research, legislation, and funding, including human coastal communities potentially affected by OA.

- Movement towards solutions-oriented work (e.g., Turner et al. 2021; Wolters et al. *In Review*).

OA does not occur in a vacuum: other environmental and non-environmental stressors contribute to oceanographic, ecological, and social vulnerability.

Resilience and Adaptation

How can we make coastal communities and industries resilient to OA, and support strategies for adaption?

- What are key/prevalent stressors?
- When/where will tipping points be reached?
- Will OA be the first tipping point? How can we best detect this?
- How do we weigh other stressors against OA?
- What strategies are growers using, or would growers like to use?
- Can these strategies be implemented now? Why or why not?
- How can we be nimble and responsive to environmental change – aiming to be proactive rather than reactive?

Addressing these questions requires good science, policies, dialogue, and cooperation across stakeholder and rightsholder groups.

Workshop Goals:
Consensus, recommendations, and defining goals

1) Assess recent research within California. Where to next?
    a) Knowledge exchange across attendees, consensus building
    b) Discuss future research priorities

2) Inform guidance and recommendations for research and policy development around shellfish aquaculture resilience to OAH and other stressors
    a) Policy opportunities? Communication needs?

3) Consider how we can advance progress within our agencies/organizations/roles towards common goals

Agenda

9:55 - 11:00 am, Part 1, Coastal Vulnerability to OAH stress

11:00-11:15 BREAK

11:15 - 12:30 pm, Part 2, Social Vulnerability & Industry Perspectives

12:30 - 1:30 pm LUNCH

1:30 - 2:30 Part 3, Policy & Management

2:30 - 4:15 Part 4, Discission: Opportunities and Recommendations

4:00 - 4:30: Outcomes, products, closing remarks

Speakers

Alex Puritz, NOAA OAP Human Dimensions Research Manager
Building industry resilience & adapting to OA: Examples from OAP-funded projects

PART ONE

Existing Knowledge on Coastal Vulnerability to OAH and Environmental Stress

1) **Meghan Zulian,** UC Davis
   Using Observational Data to Map Oceanographic Conditions in the California Current System

2) **Dr. Rachel Carlson**, UC Berkeley
   Impacts of freshwater on ocean acidification in coastal ecosystems

3) **Dr. Kristy Kroeker,** UC Santa Cruz
   Ecological thresholds and species vulnerability

PC: Athena Maguire

Using Observational Data to Map Oceanographic Conditions in the California Current System

Meghan Zulian, PhD. Candidate at UC Davis, on behalf of broader research team

Mapping conditions in the CCS is difficult

- Complex oceanography
- Prior maps based on models or ind. cruises
- Fragmented observational network.
  - Data split between many projects/owners
  - Lots of variation in instruments used, parameters measured, and quality

Motivation: Make stressful regions easy to identify for management and scientific inquiry

CA Ocean Protection Council

Collaborators


Professor Tessa Hill, UC Davis


Dr. Sara Hamilton Postdoctoral Scholar, ORKA


Dr. Esther Kennedy, Postdoc. Scholar, U. of Alaska Fairbanks


Professor Kristy Kroeker, UCSC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Genece Grisby, UC Davis


Maddie Wilmot, UC Davis


Dr. Hannah Palmer, UC Davis


Lupe Carrasco, BML & SRJC

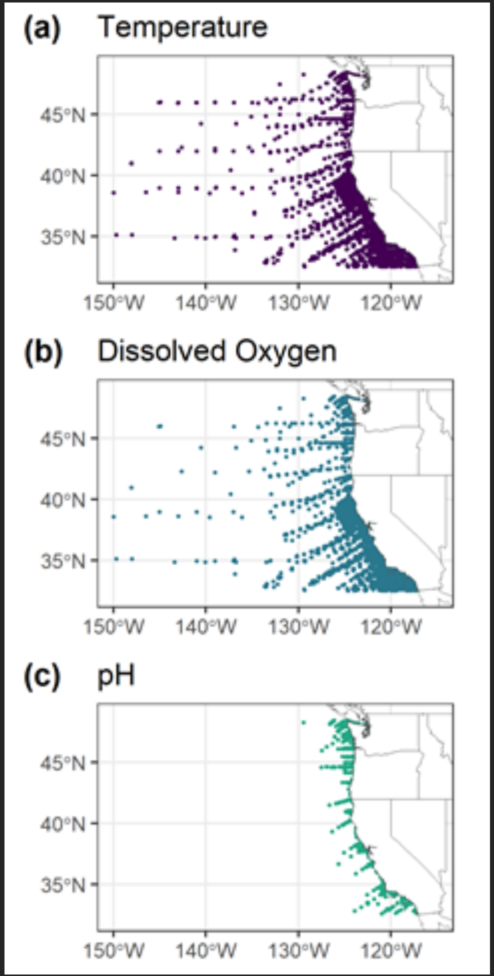
Synthesis results: the MOCHA dataset

- Multistressor Observations of Coastal Hypoxia and Acidification (MOCHA)

- Moorings, research cruises, and shore based field sampling

- 17 million observations from >65 sources, spans 1949 - 2020
    - Newly published observations from Hill & Kroeker labs

- Optimized for investigations of temperature, oxygen, and acidification stress



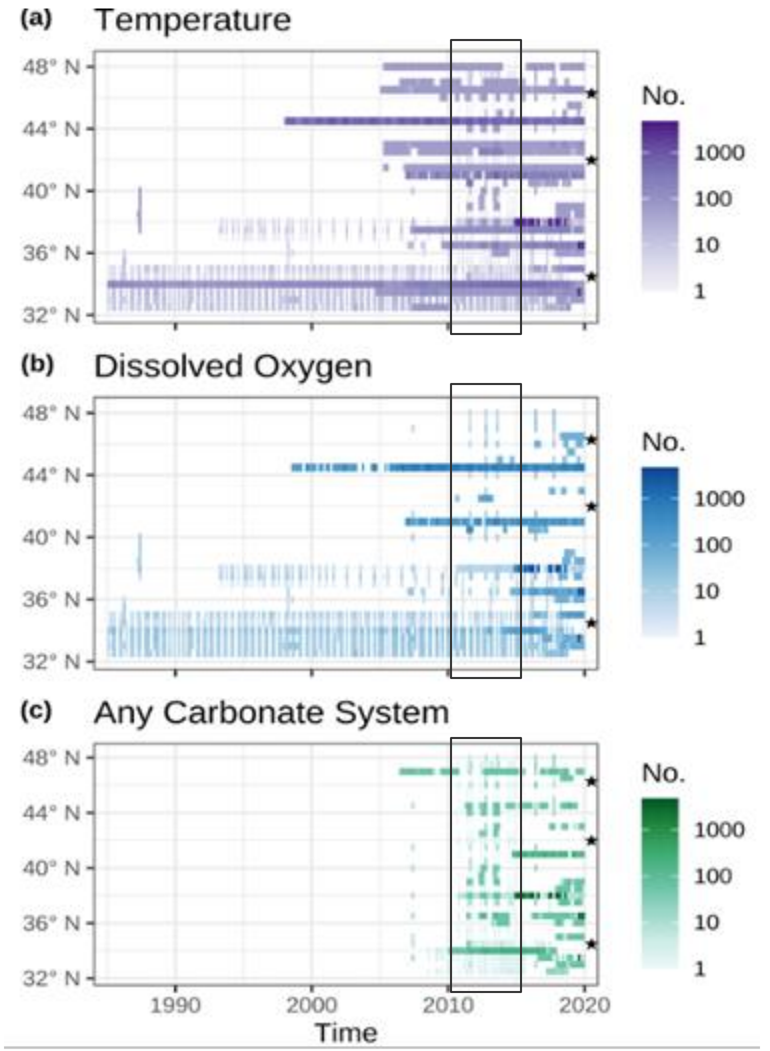
Kennedy et al., 2024

What did we learn?

Significant spatial and temporal gaps

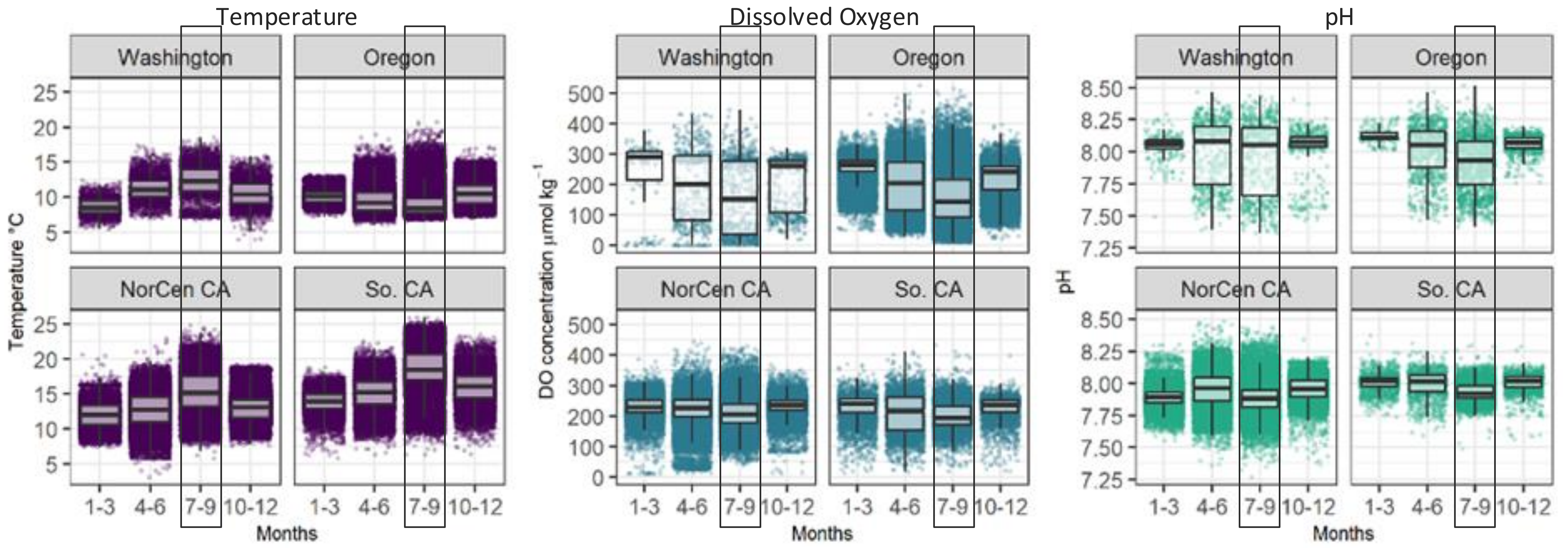
- Data is clustered adj. to population centers (stars)
- Spatial coverage was most complete from 2010-2015 (box)
- Carbonate system monitoring lags far behind temperature and dissolved oxygen

Kennedy et al., 2024



What did we learn?

- The highest variability and most extreme conditions are found in mid-late summer, rather than in spring upwelling season



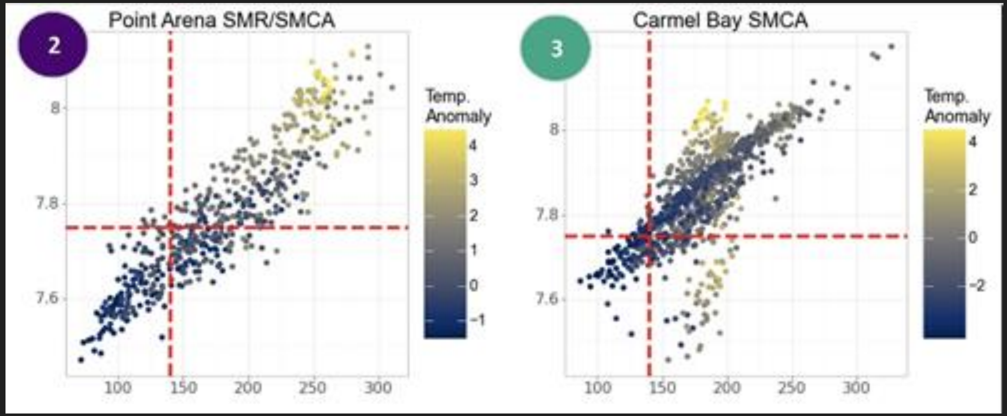
Multiple stressors in California MPAs

- Data from within 10km of a MPA
- Time periods of single and multi stressor

Found that

- Upwelling influence varies
- Most MPAs cross have pH and oxygen conditions that could be stressful to organisms (bottom left quadrant)

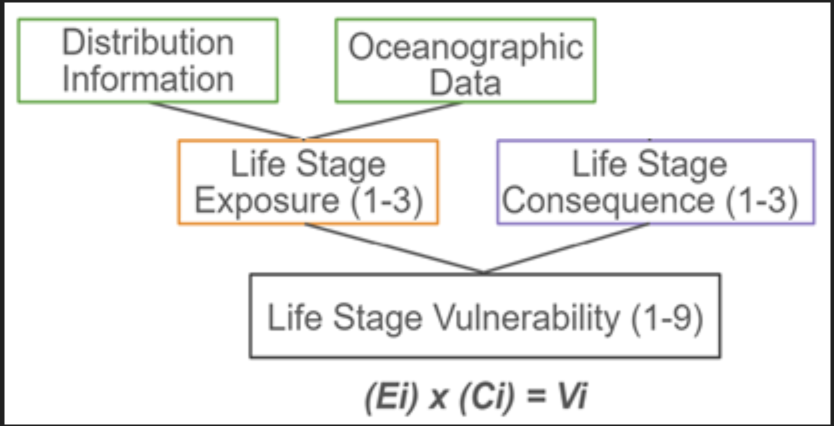
Hamilton et al., 2023



Invertebrate Vulnerability & Efficacy of Monitoring Networks

Meghan Zulian, Ph.D. Candidate, UC Davis

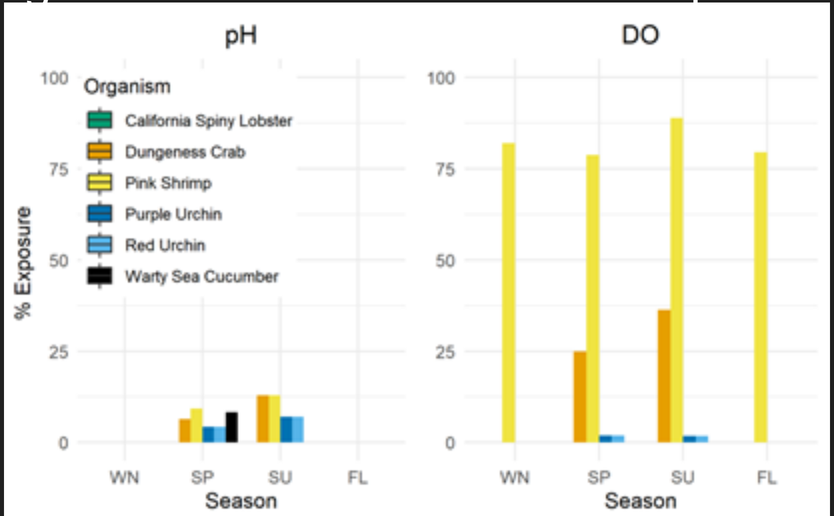
- Use oceanographic data to calculate **how frequently** key benthic invertebrates experience acidic, hypoxic conditions that could evoke negative effects



- Assess where data gaps hinder our uncertainty in vulnerability calculations → Monitoring recommendations

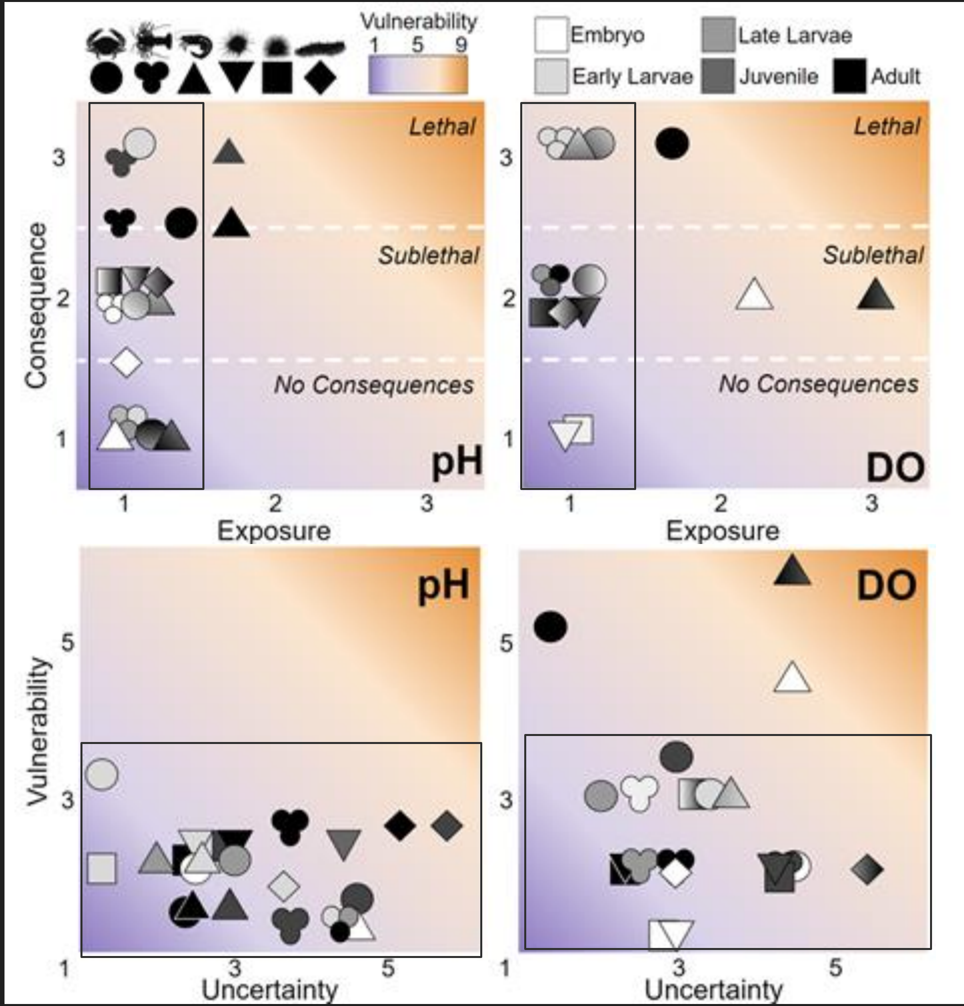
What have I found?

- Most organisms experience low pH (<7.6) more frequently than low oxygen (<35.5%)
- Deeper dwelling life stages (>75m) experience low oxygen more frequently
  - 25% for Dungeness crab (30-90m)
  - 82% for Pink Shrimp (80-230m)
- These life stages also experience the strongest seasonal fluctuations in exposure
  - Highest for DO: Dungeness crab
  - Highest for pH: Pink shrimp



What have I found?

- Exposure and vulnerability remain low for most species & life stages
- Oceanographic data gaps hinder vulnerability estimates
  - Seasonal biases
  - Sparse near bottom data collection at critical depths



Limitations, Ongoing Work, & Feedback

What we did not do

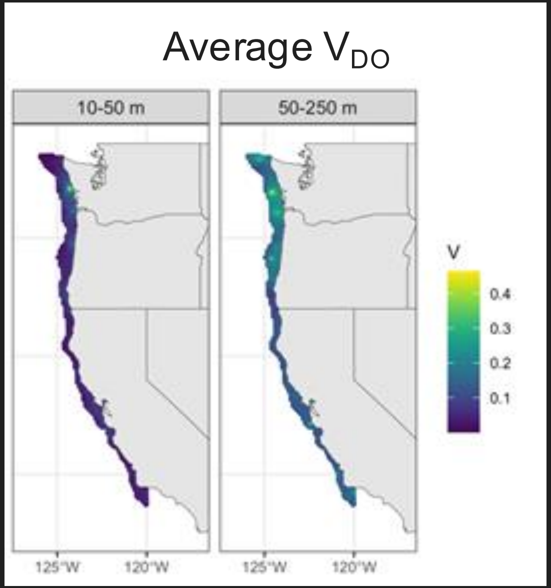
- Incorporate estuary data or private datasets
- Predictive modeling

We are still working on:

- Merging oceanographic data w results from Kristy & Ben's sensitivity
    - Identify locations with highest and lowest vulnerability for species of interest

Input / Questions

Dungeness crab

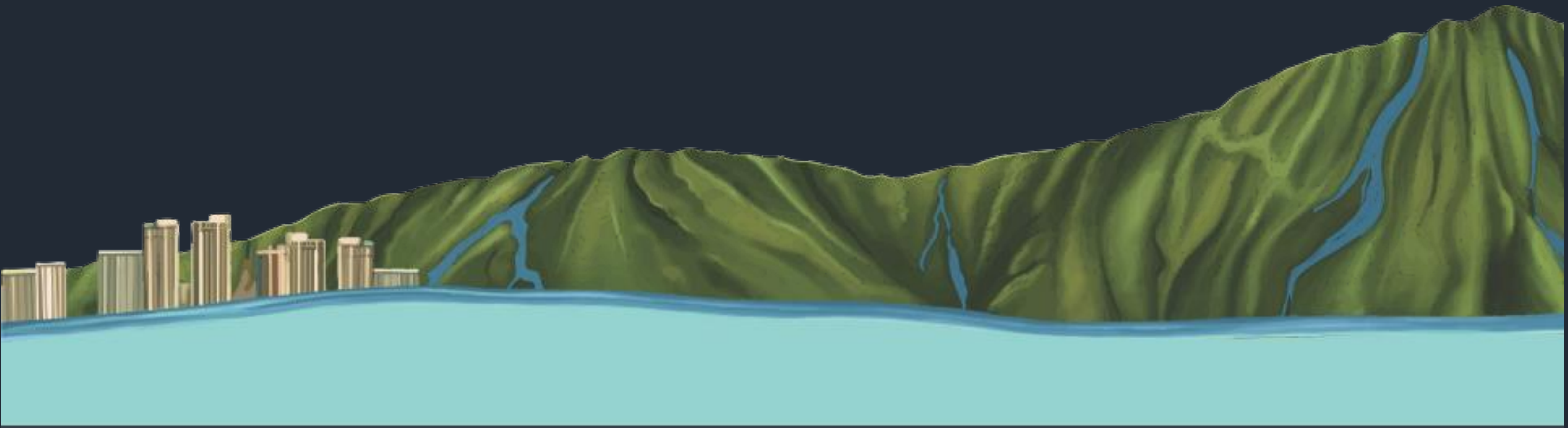


Kennedy, Hamilton et al., *in Prep*

Impacts of freshwater on ocean acidification in coastal ecosystems

Rachel Ragnhild Carlson (she/her)

Assistant Professor, UC Berkeley/Postdoc at Bodega Marine Lab



ENVIRONMENT

The world's oceans are acidifying — but it's happening twice as fast off California

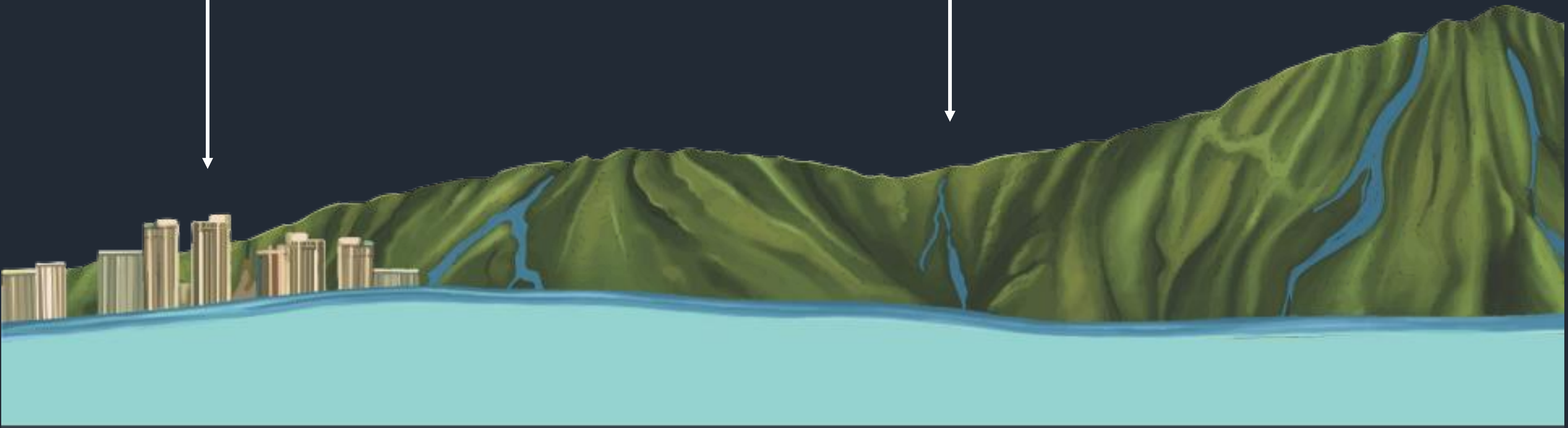
Ocean acidification takes a toll on California's tide pools at nighttime

JANUARY 11, 2021

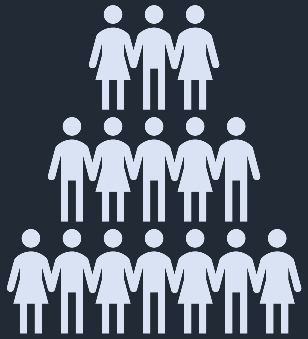
Ocean acidification is transforming California mussel shells

by University of California - San Diego

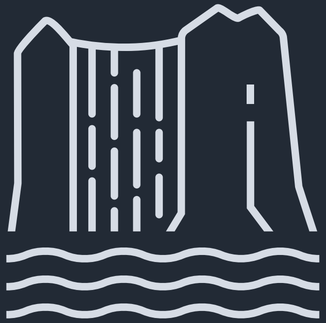
Coastal processes affect OA at small (km) scales



Coastal habitats are extremely heterogeneous and effects of climate change vary locally



PEOPLE



SURFACE WATER

GROUND WATER

WAVE ACTION AND UPWELLING

Carlson et al., 2021. Synergistic benefits of conserving land-sea ecosystems.

Coastal habitats are extremely heterogeneous and effects of climate change vary locally

PEOPLE

SURFACE WATER

GROUND WATER

WAVE ACTION AND UPWELLING

Carlson et al., 2021. Synergistic benefits of conserving land-sea ecosystems.

How do local-scale coastal interactions affect organism susceptibility to OA?

How do coastal processes affect…

Ocean carbonate chemistry? (exposure)

Organism vulnerability to OA stress?

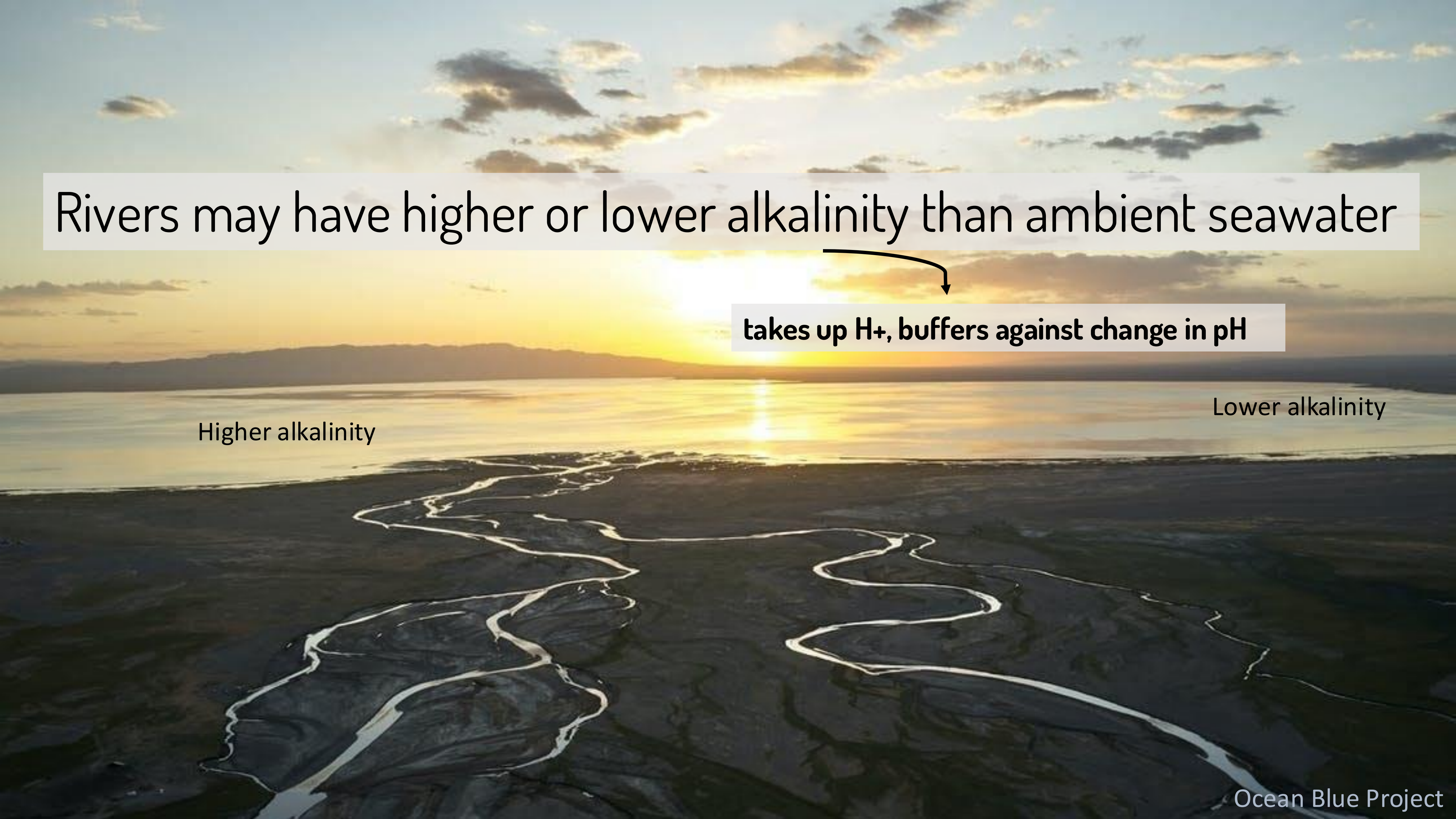
Question 1:

How do coastal interactions affect **ocean carbonate chemistry?**

Rivers may have higher or lower alkalinity than ambient seawater

Ocean Blue Project

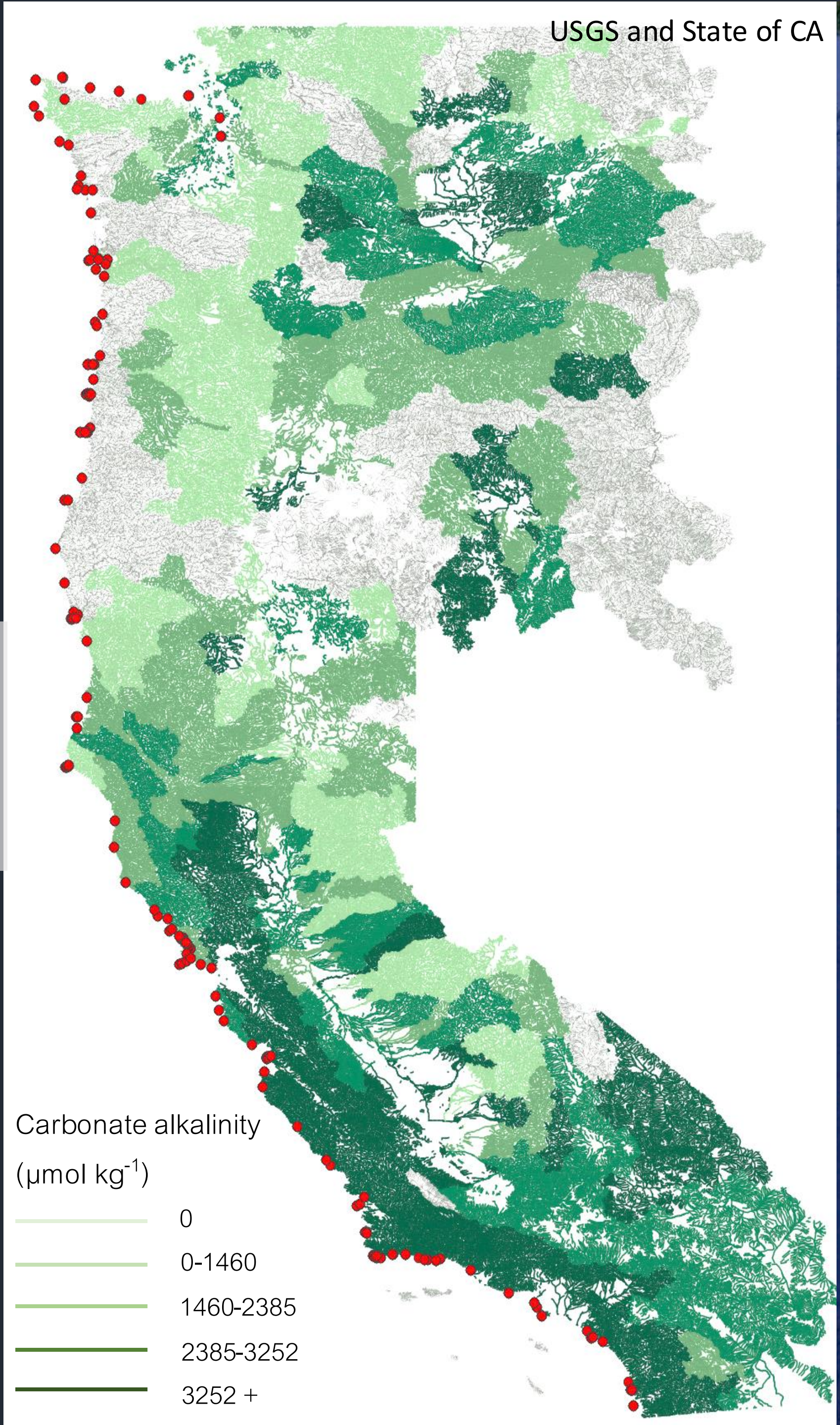
Rivers may have higher or lower alkalinity than ambient seawater

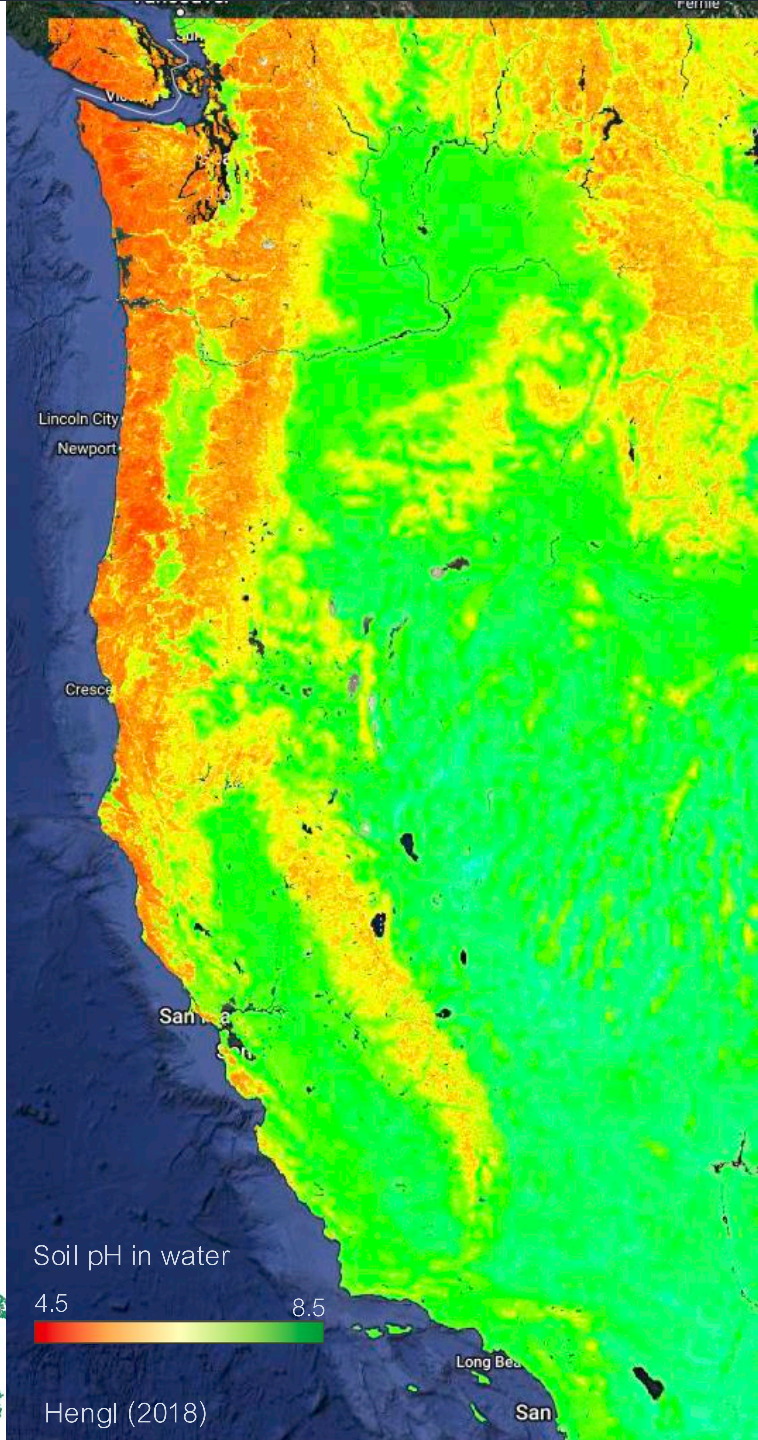


Freshwater influence on OA in the California Current may be important and is generally overlooked.

NASA

Freshwater alkalinity and pH vary with lithology





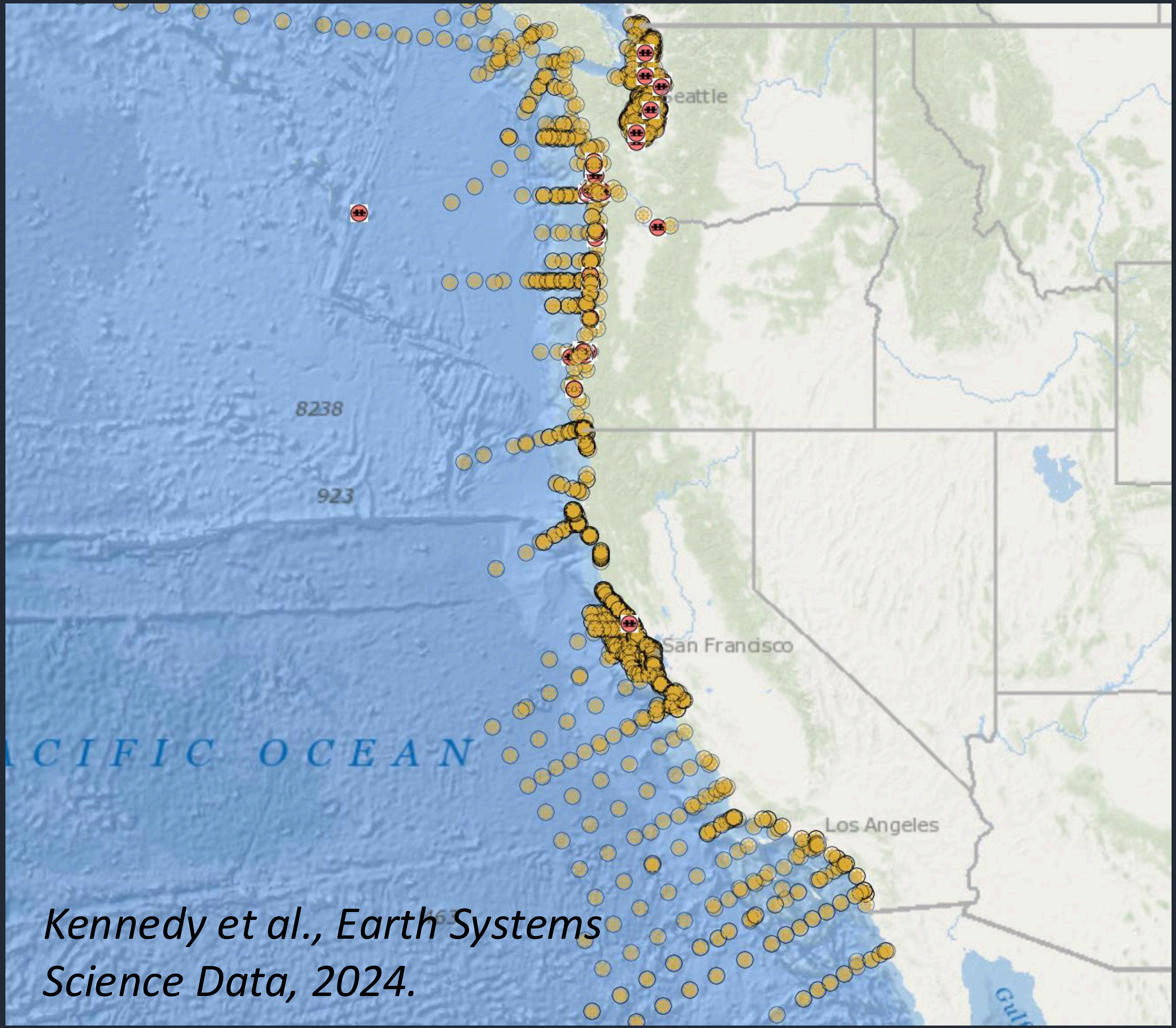
How/where does freshwater chemistry alter OA?

Esther Kennedy, PhD Candidate, UC Davis

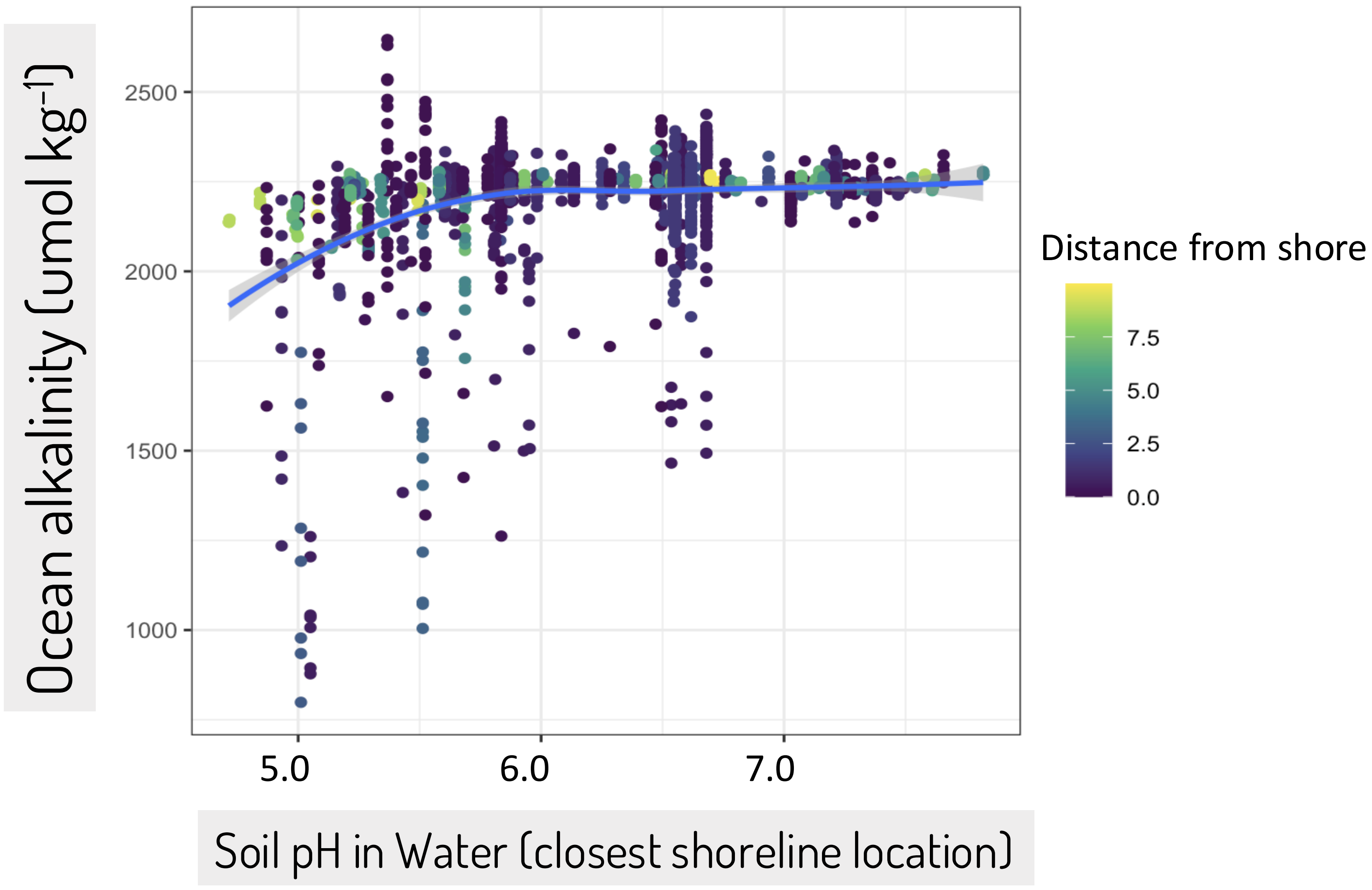
Meghan Zulian, PhD Candidate, UC Davis

Dr. Sara Hamilton, former Postdoctoral Scholar, now Oregon Kelp Alliance

Dr. Tessa Hill, Professor, UC Davis

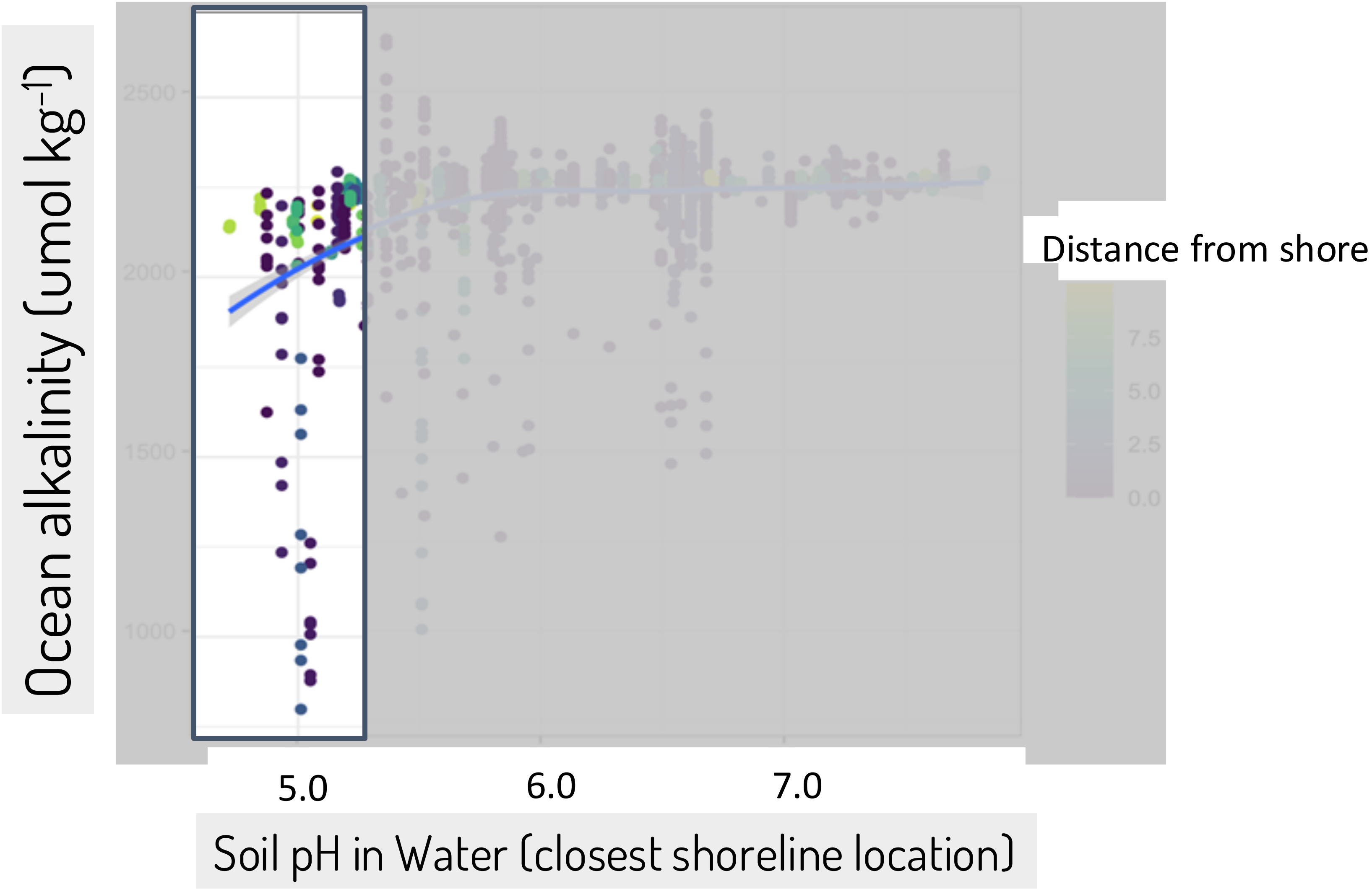


Kennedy et al., Earth Systems Science Data, 2024.



Ocean alkalinity (umol kg-1)
2500
2000
1500
1000
5.0
6.0
7.0
Soil pH in Water (closest shoreline location)
Distance from shore
7.5
5.0
2.5
0.0

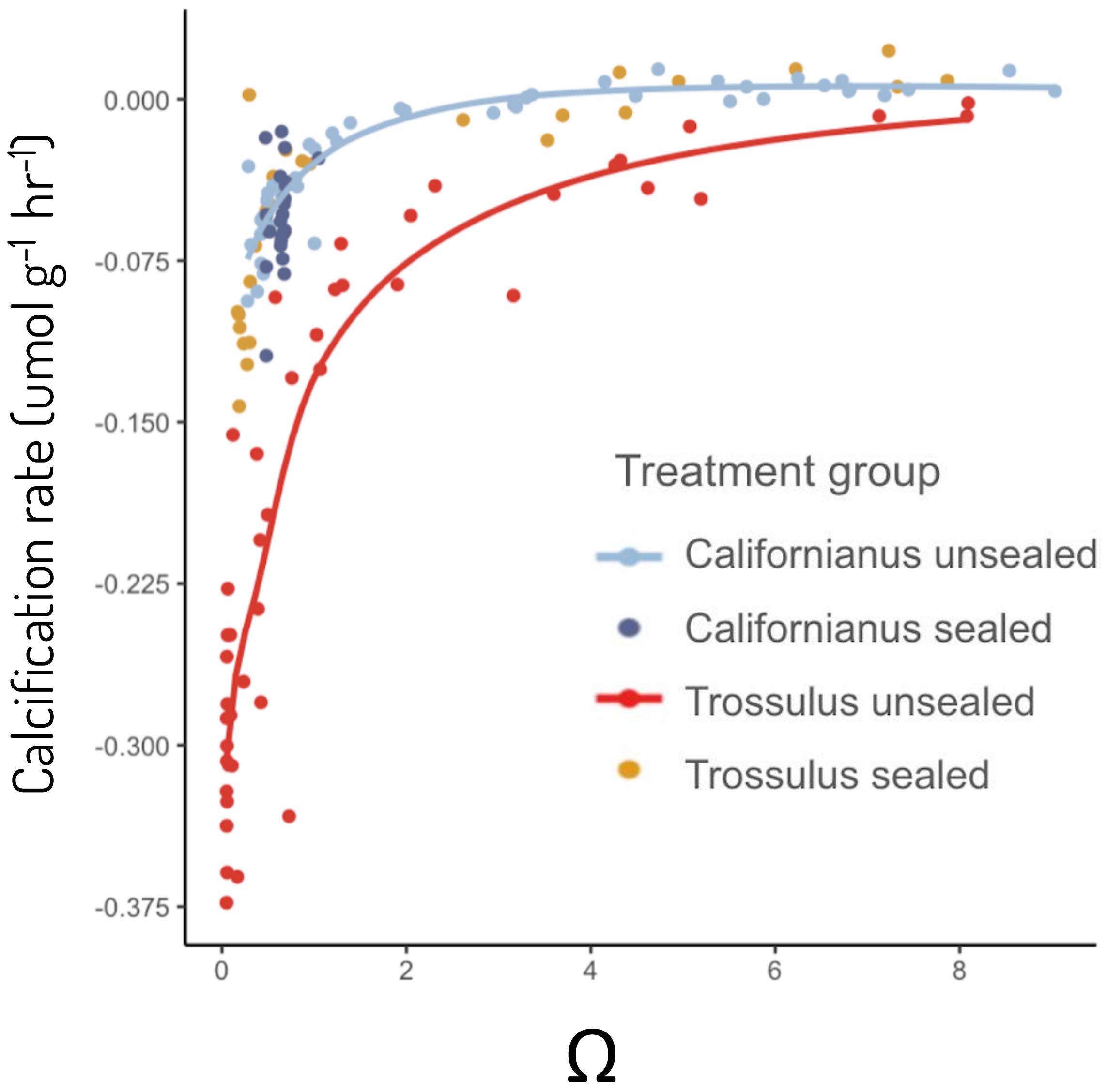
Nearshore (dark) points show very low ocean alkalinity where terrestrial pH is low (Pacific NW).



Mytilus trossulus

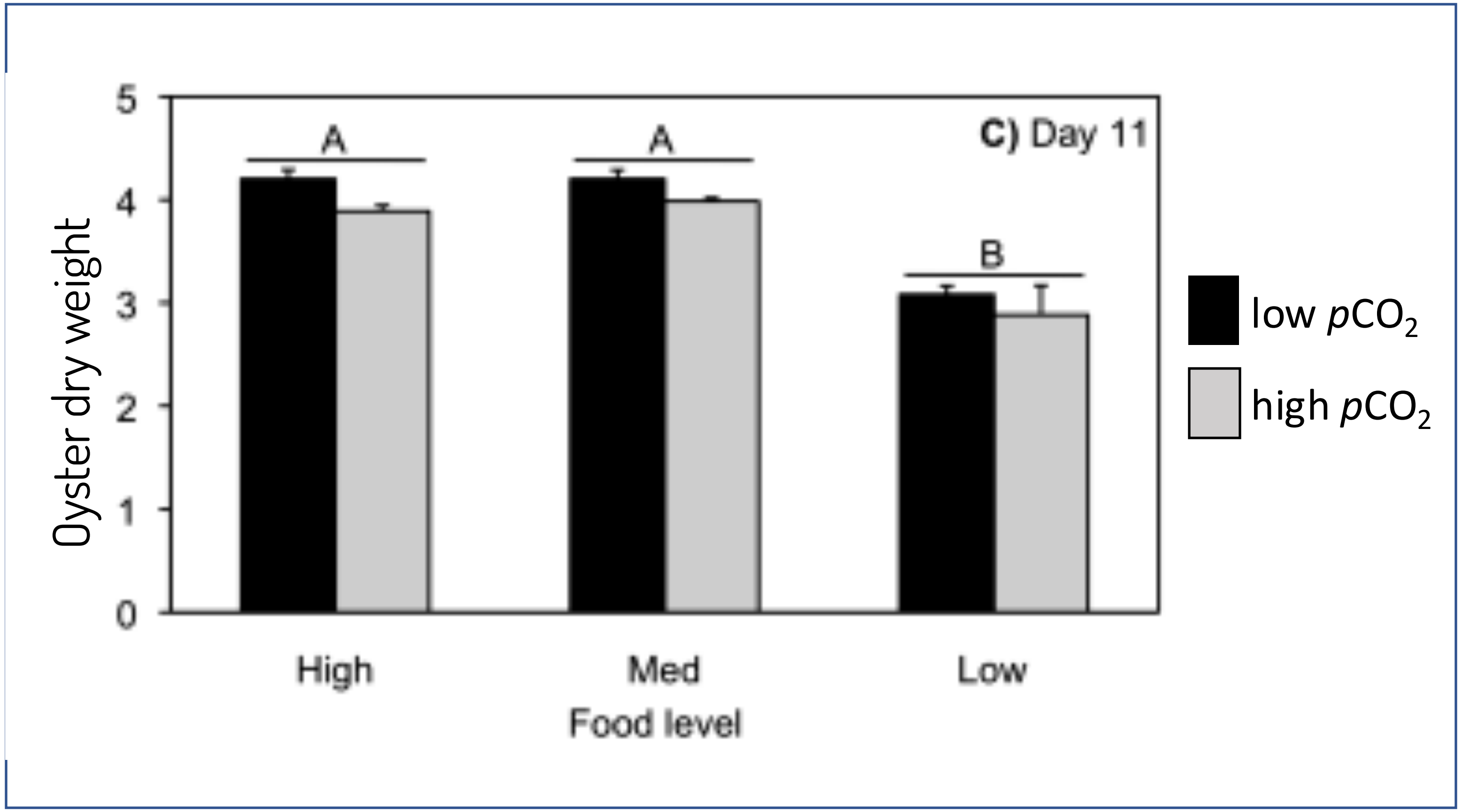
MUSSELS, CLAMS & OYSTERS
Penn Cove Shellfish, LLC
COUPEVILLE, WASHINGTON

Higher dissolution rate in M. trossulus (freshwater tolerant), likely due to lack of inner calcite layer.



Question 2:

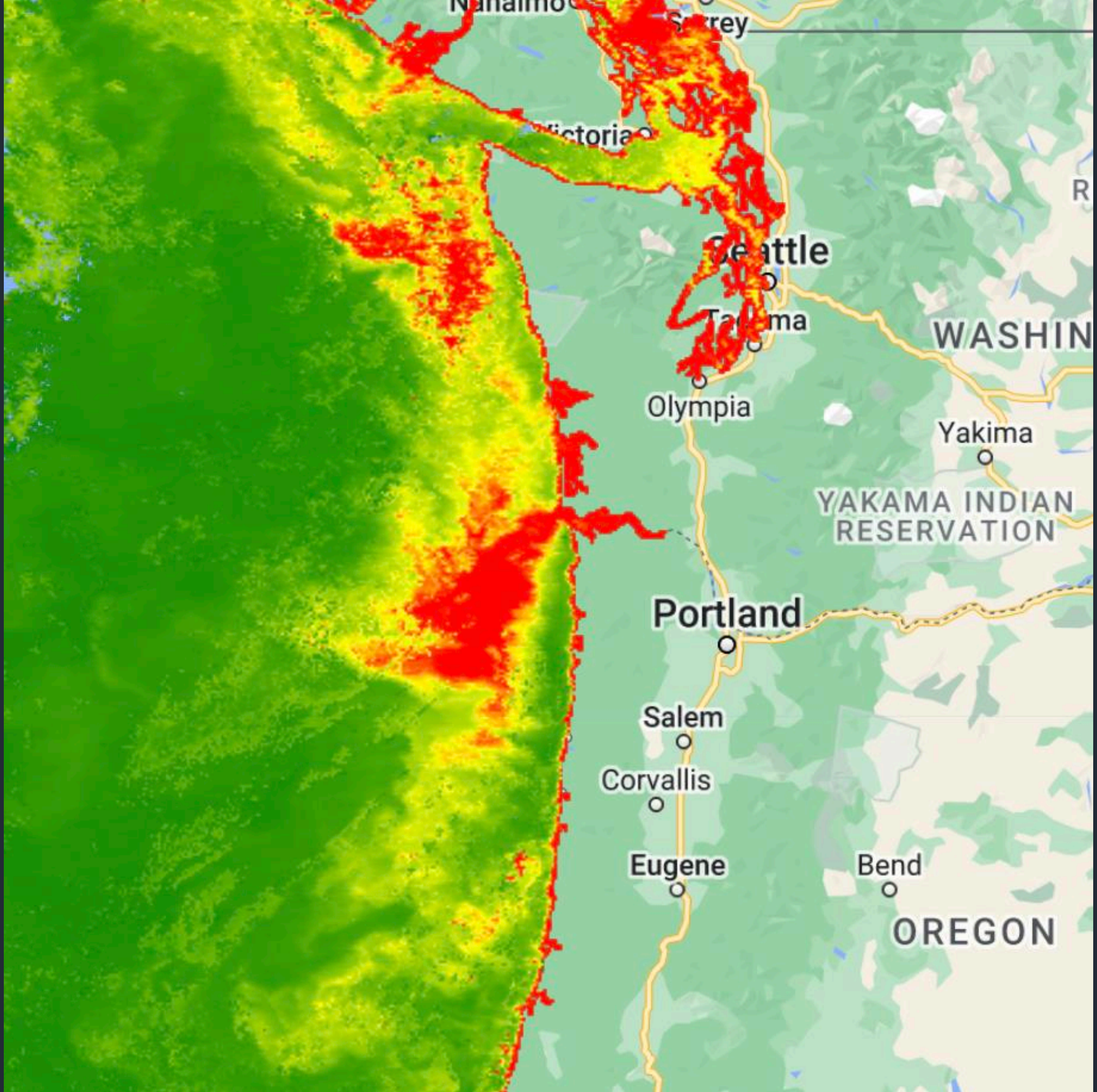
How do coastal processes affect **organism ability to survive OA stress?**



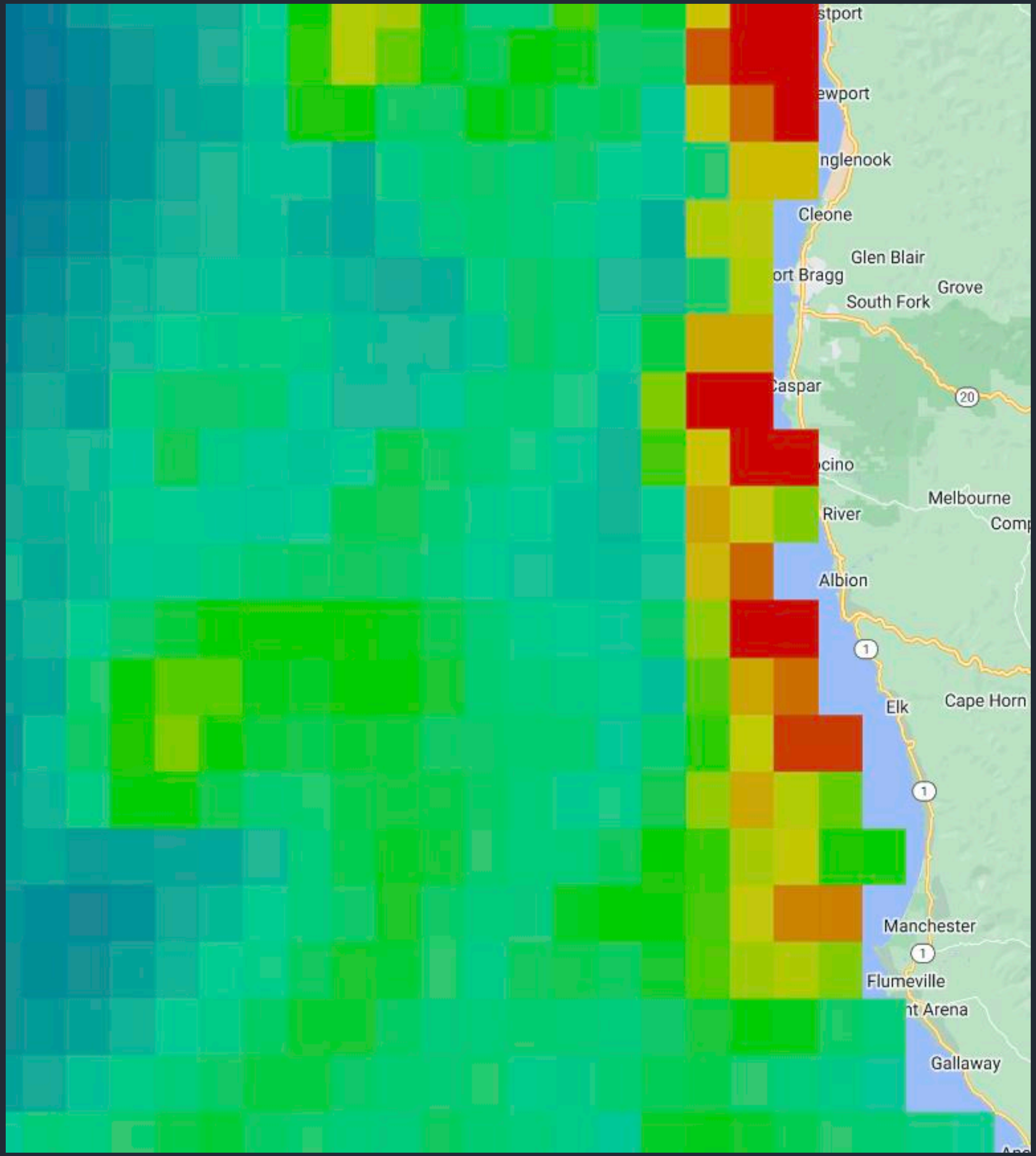
Hettinger et al., 2013

Food may offset ocean acidification effects

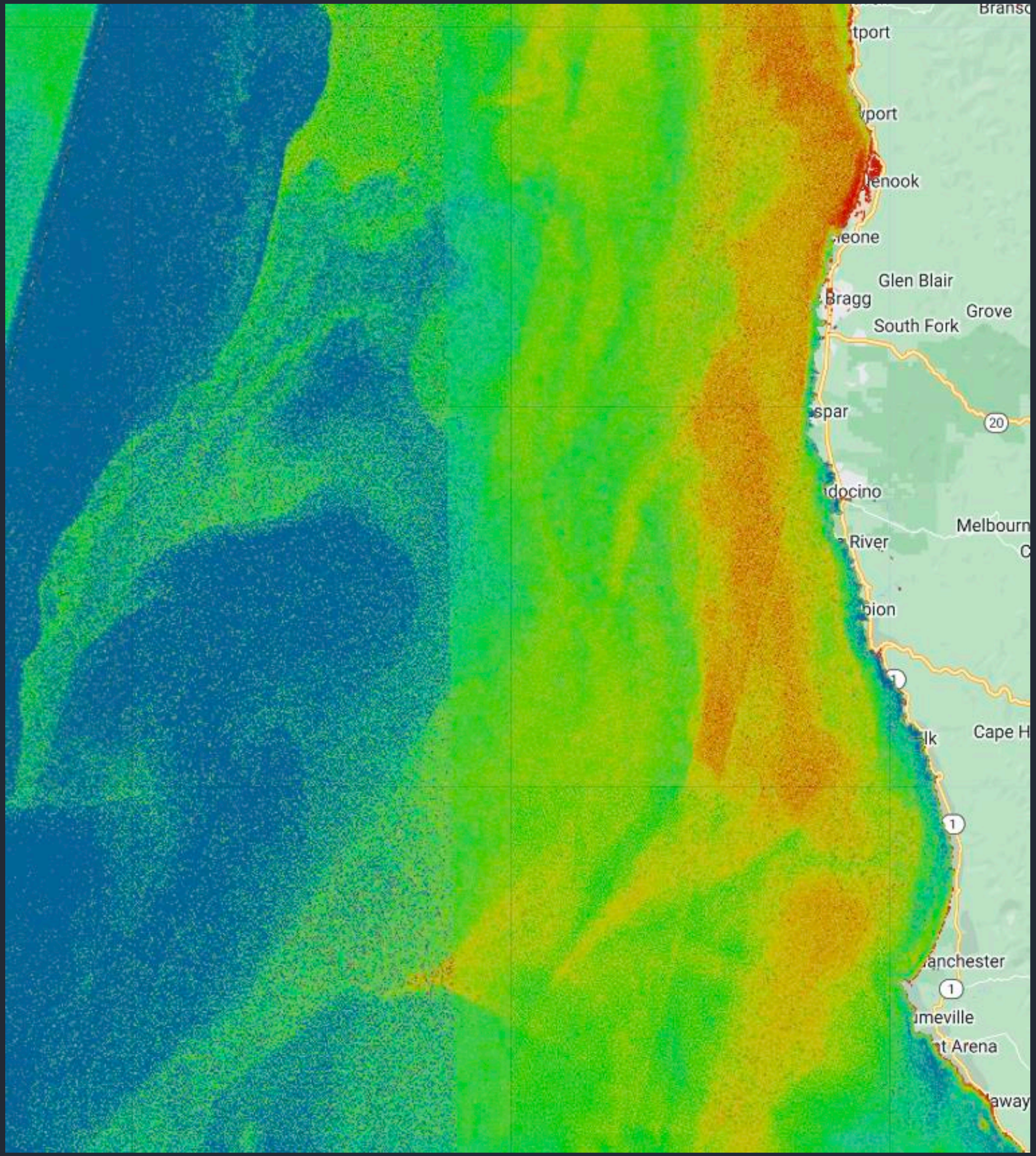
Map OA stress against food availability



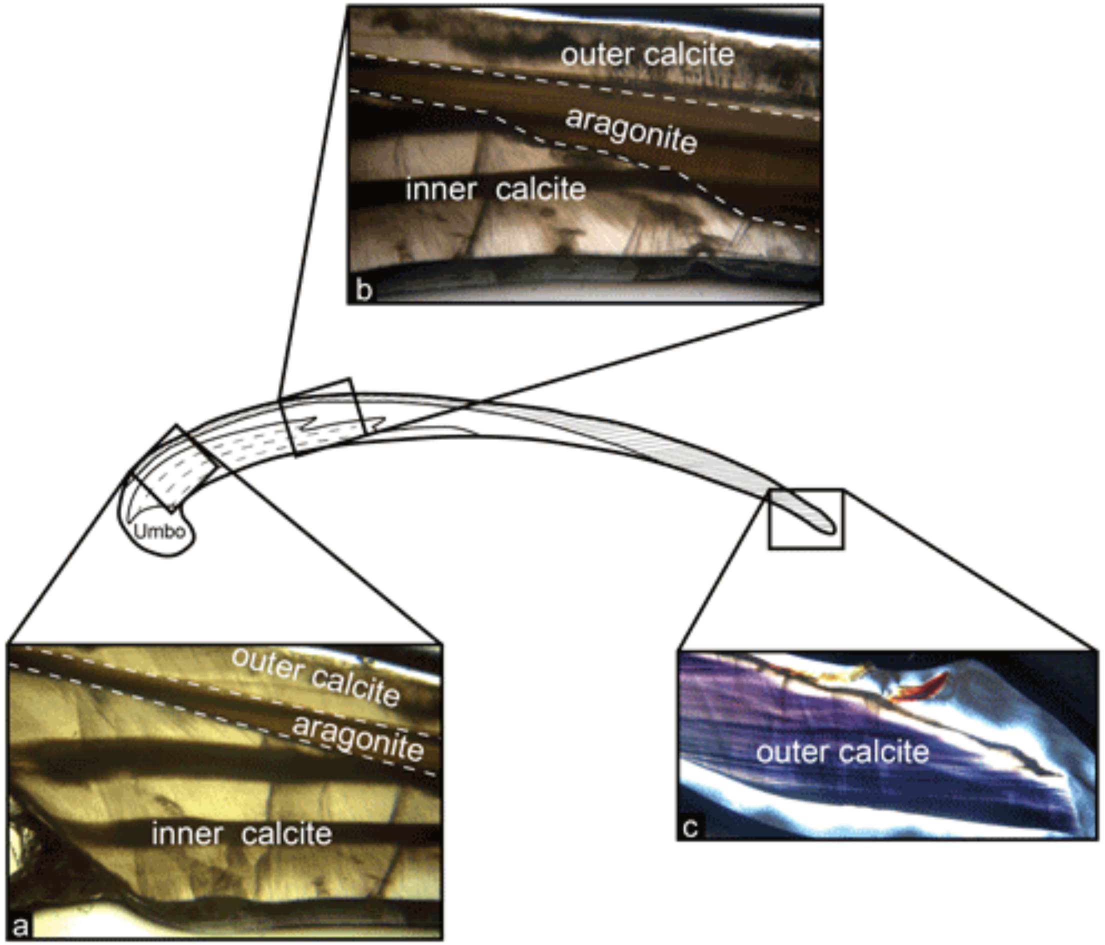
MODIS-Aqua, 2020 June 1-8



SENTINEL-2/OLCI, 2020 June 1-8



Future work



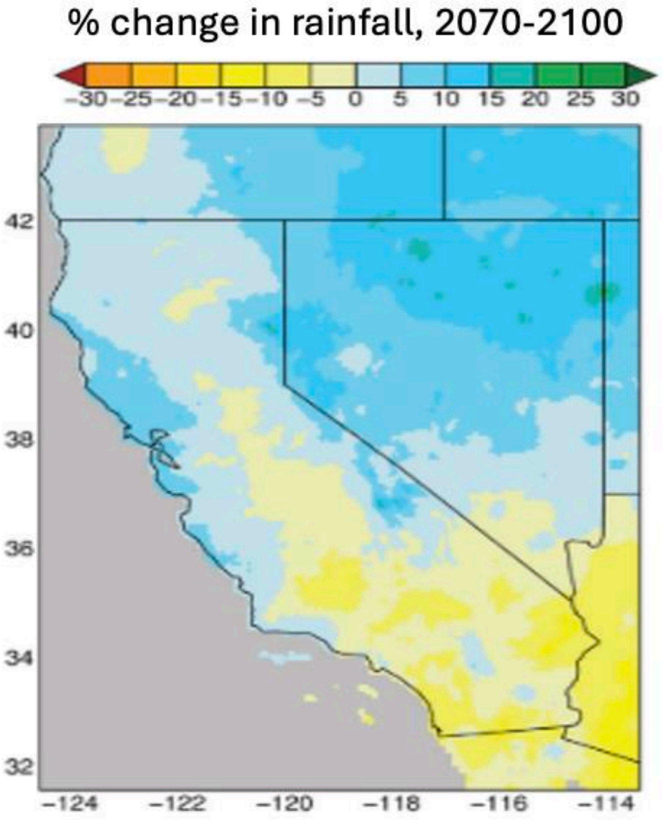
Characterizing M. trossulus and M. edulis shell mineralogy to understand OA effects on shell structure.

Veronica Vriesman

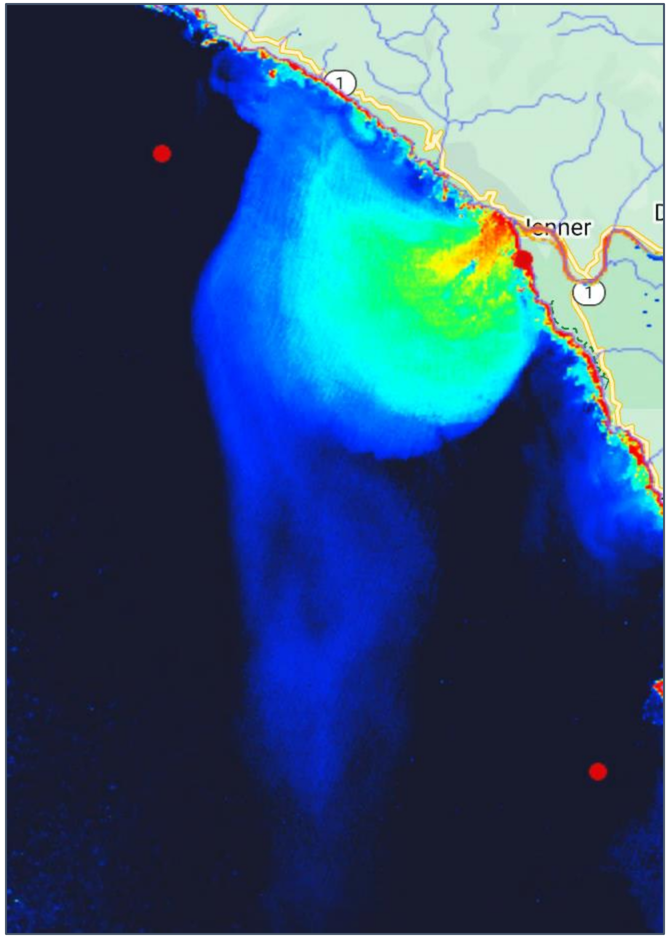
Mazie Lewis

Where will freshwater runoff change, and by how much?

Use rainfall predictions → to forecast runoff



Pierce et al., 2018



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Manny Delgado
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Alisha Saley

Partners
Penn Cove Aquaculture

Funders
UC Chancellor’s Postdoc Program

Species vulnerability and ecological thresholds

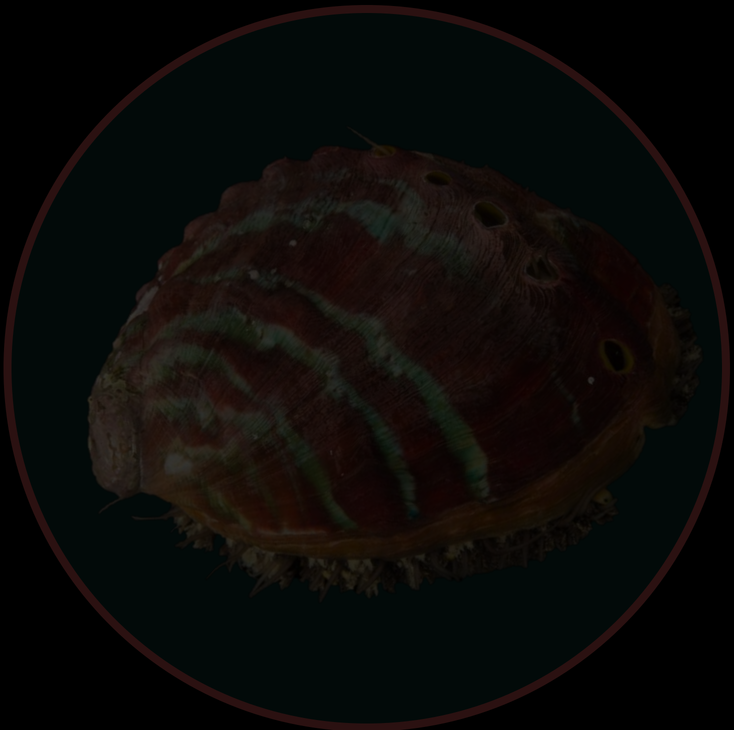
Kristy J. Kroeker
University of California, Santa Cruz


Community ecology
Environmental change
Sustainability
Policy and Management

New insights

Mediating factors

New insights



Mediating factors

High vulnerability of shellfish to OA

The Seattle Times
Winner of Nine Pulitzer Prizes

Local News

Oysters in deep trouble: Is Pacific Ocean's chemistry killing sea life?

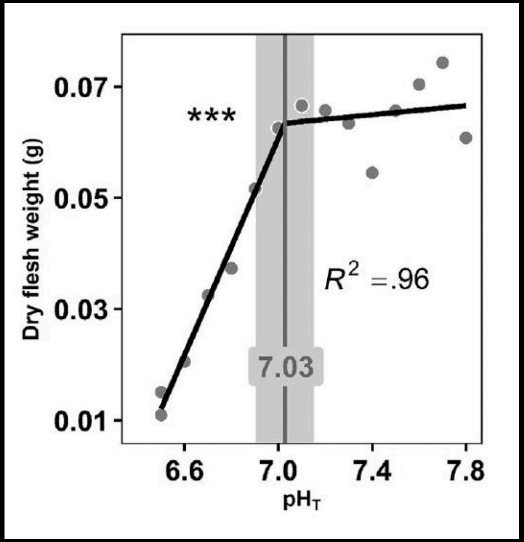
Oysters: new insights

Some evidence for transgenerational effects

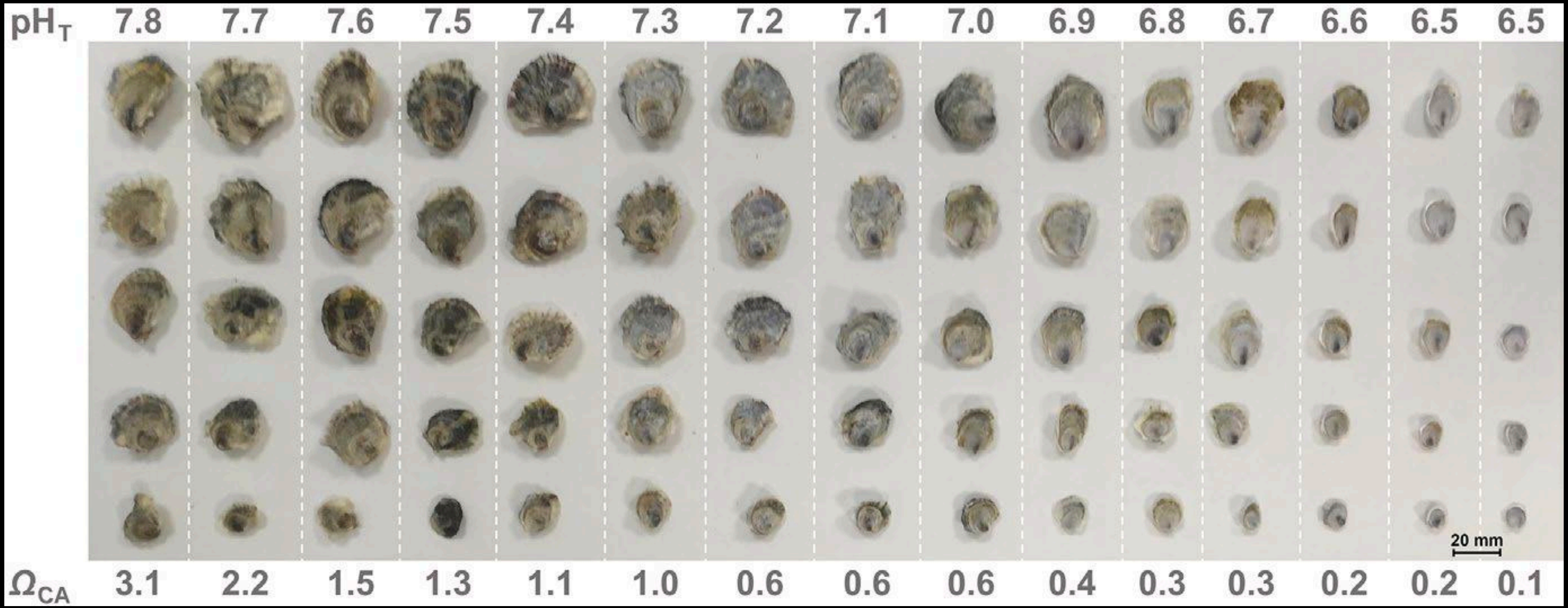
Potential for adaptive capacity: Selected>wild

Durland et al. 2019; Gibbs et al. 2021

Oysters: new insights

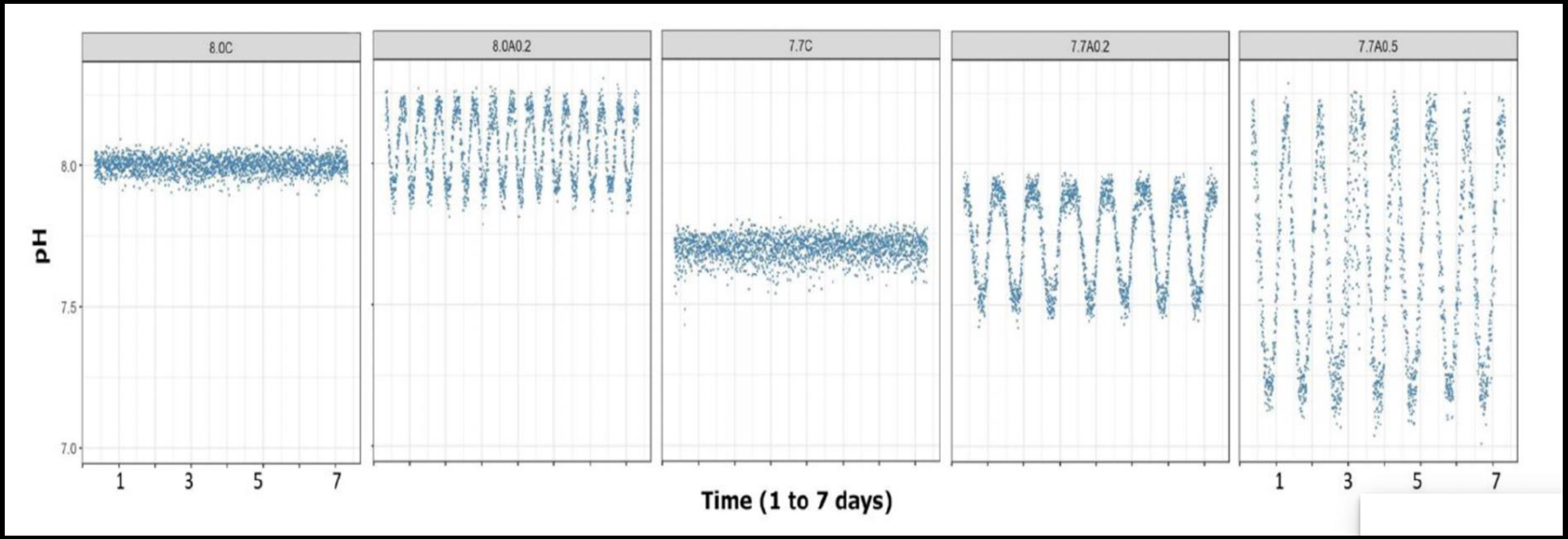


Tipping points - juveniles
C. gigas physiology = 7.3-6.9 pH



Lutier et al. 2022

Oysters: new insights

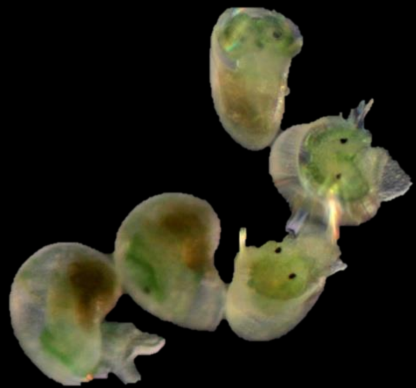


Juveniles more vulnerable to
Variable conditions

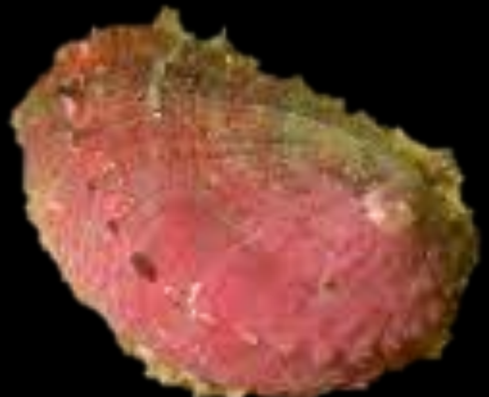
Greatest dissolution

Bednarsek et al. 2022

Abalone



<u>Near-future scenarios</u>
Reduced fertilization
Slower development
Decreased survival

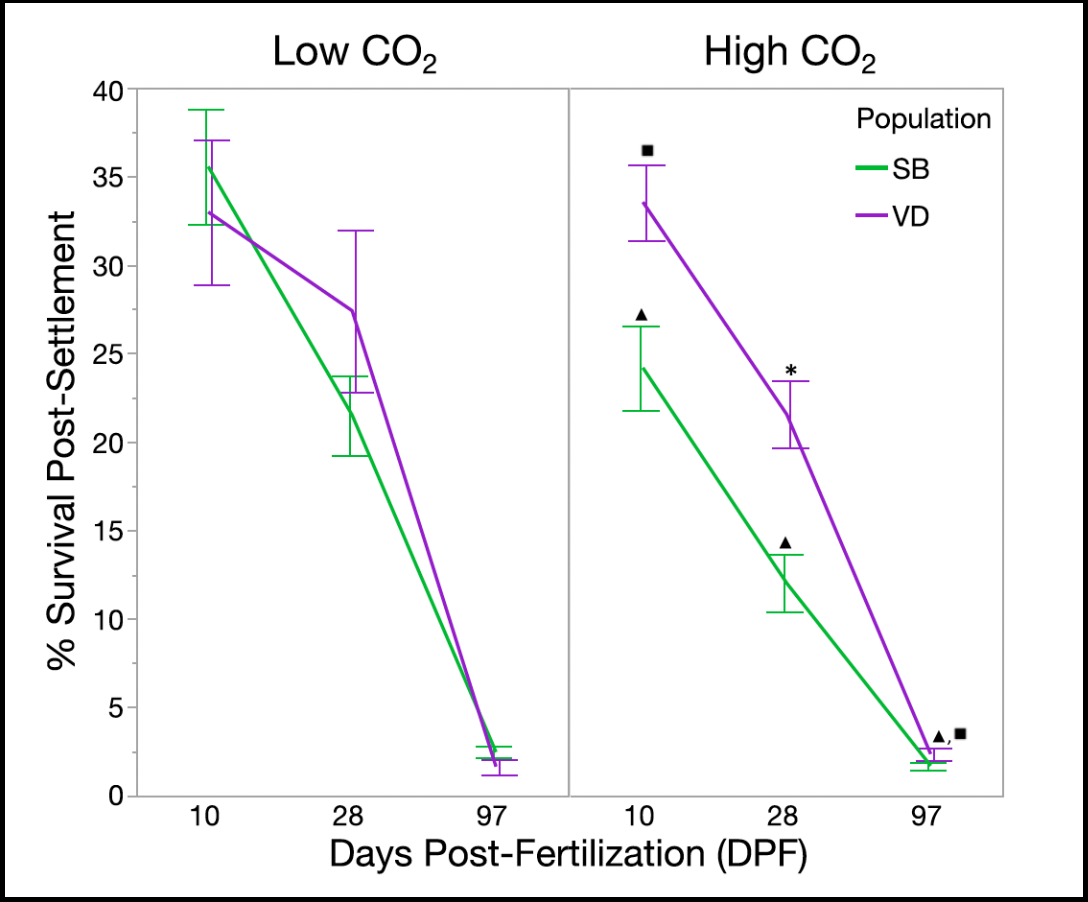


Crim et al. 2011; Boch et al. 2017; Swezey et al. 2020

Abalone: new insights

Evidence for adaptation

Suggestions of trade-offs between growth and survival



Swezey et al. 2020

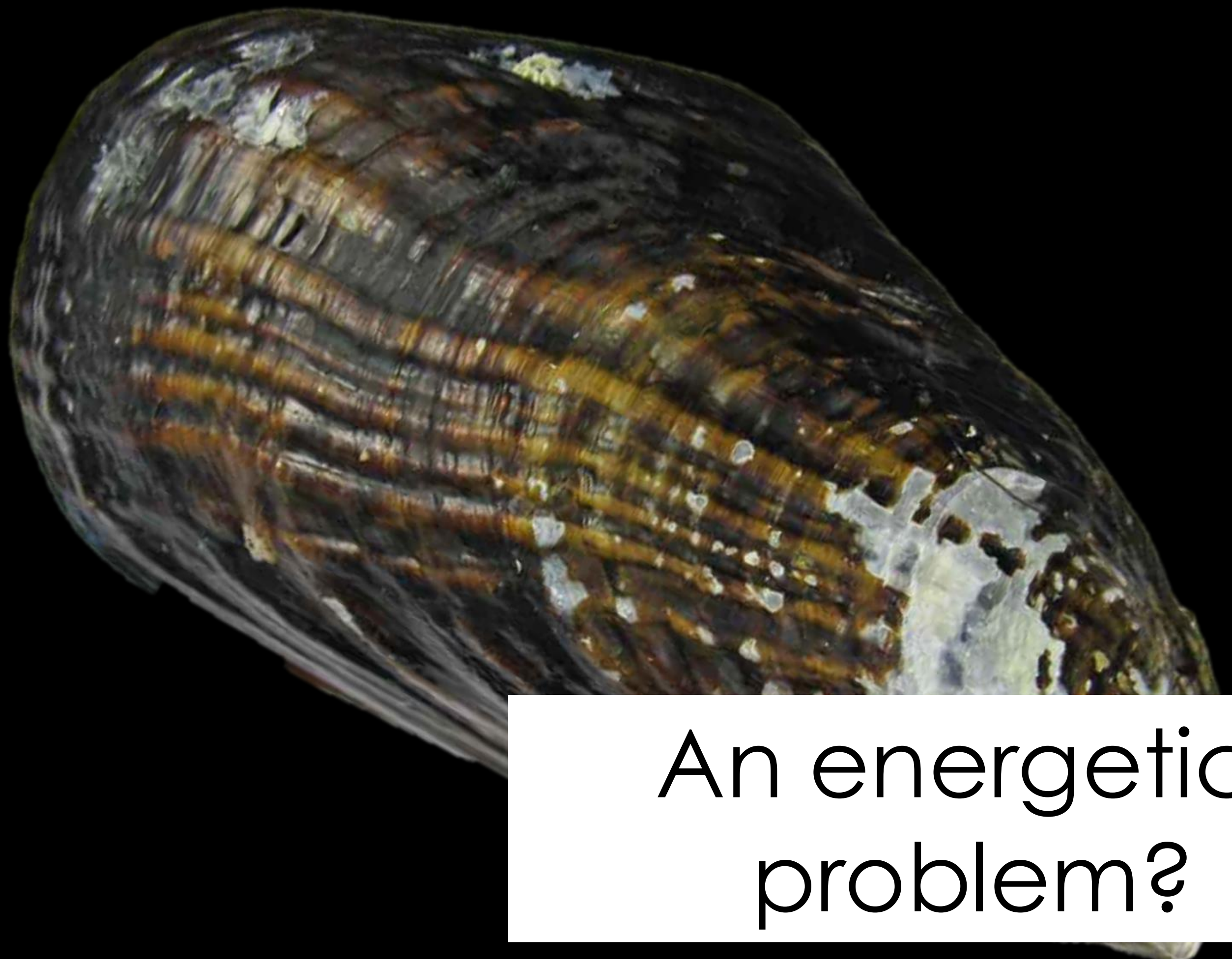
New insights

Mediating factors

New insights

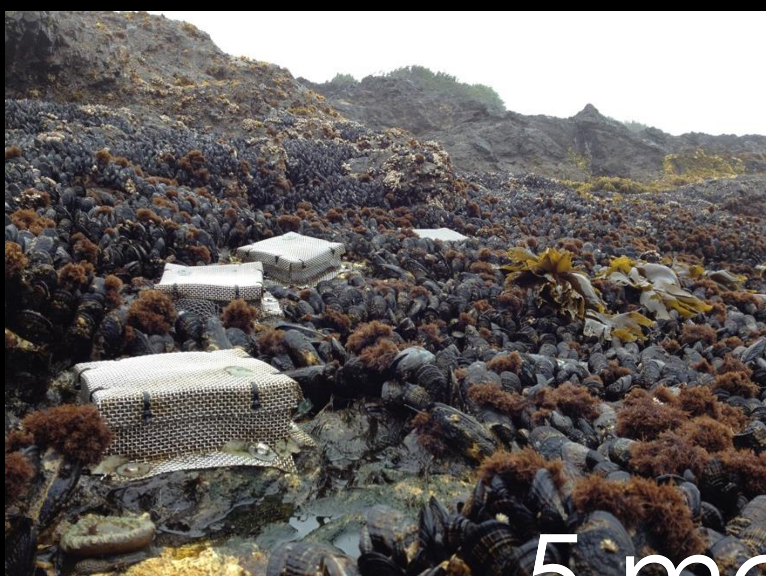
Mediating factors

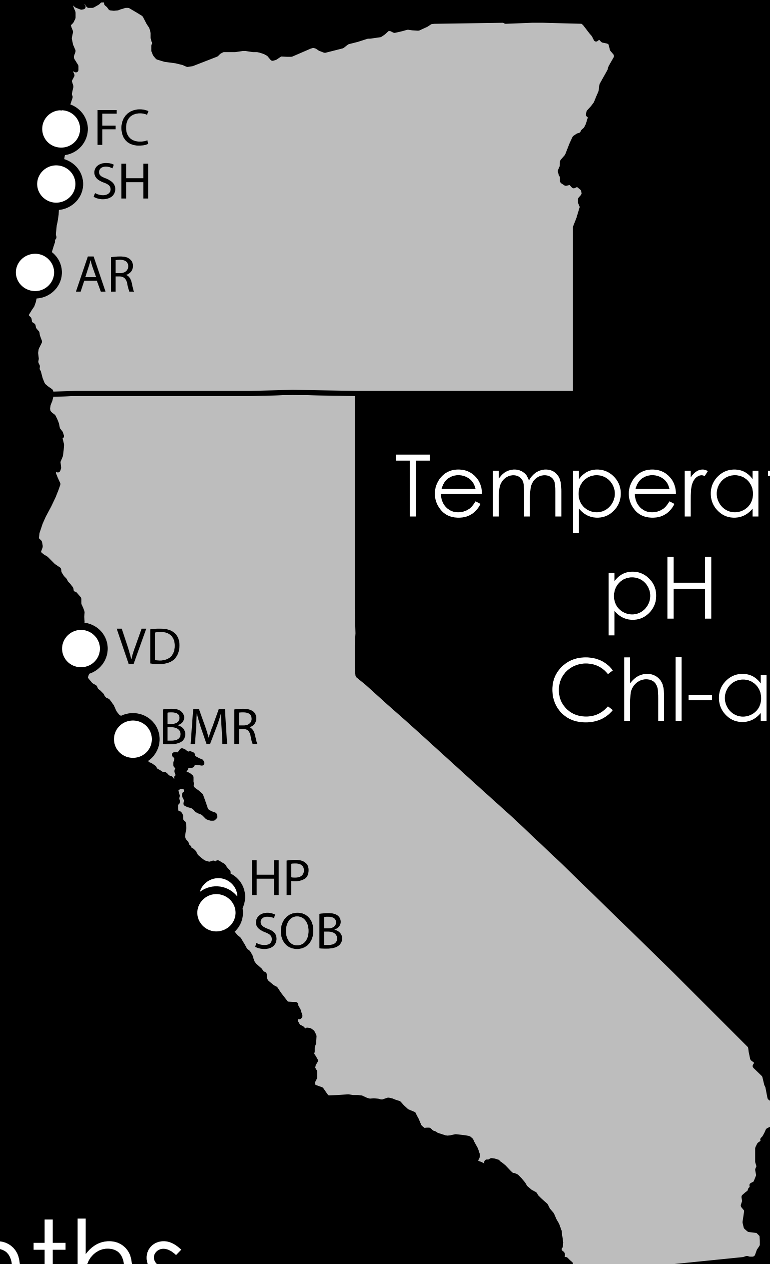
California mussel
Mytilus californianus



An energetics problem?

Methods

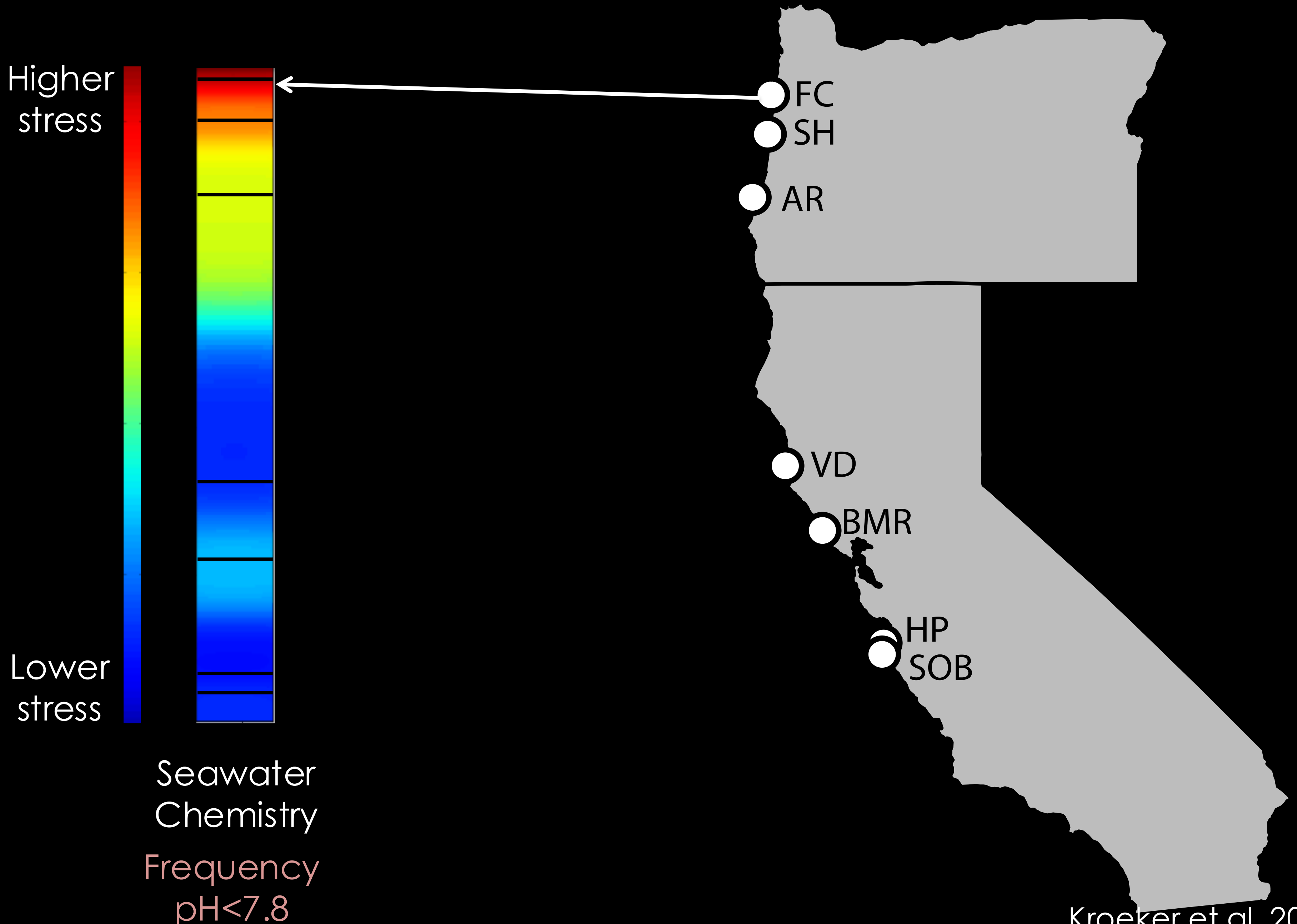




Temperature
pH
Chl-a

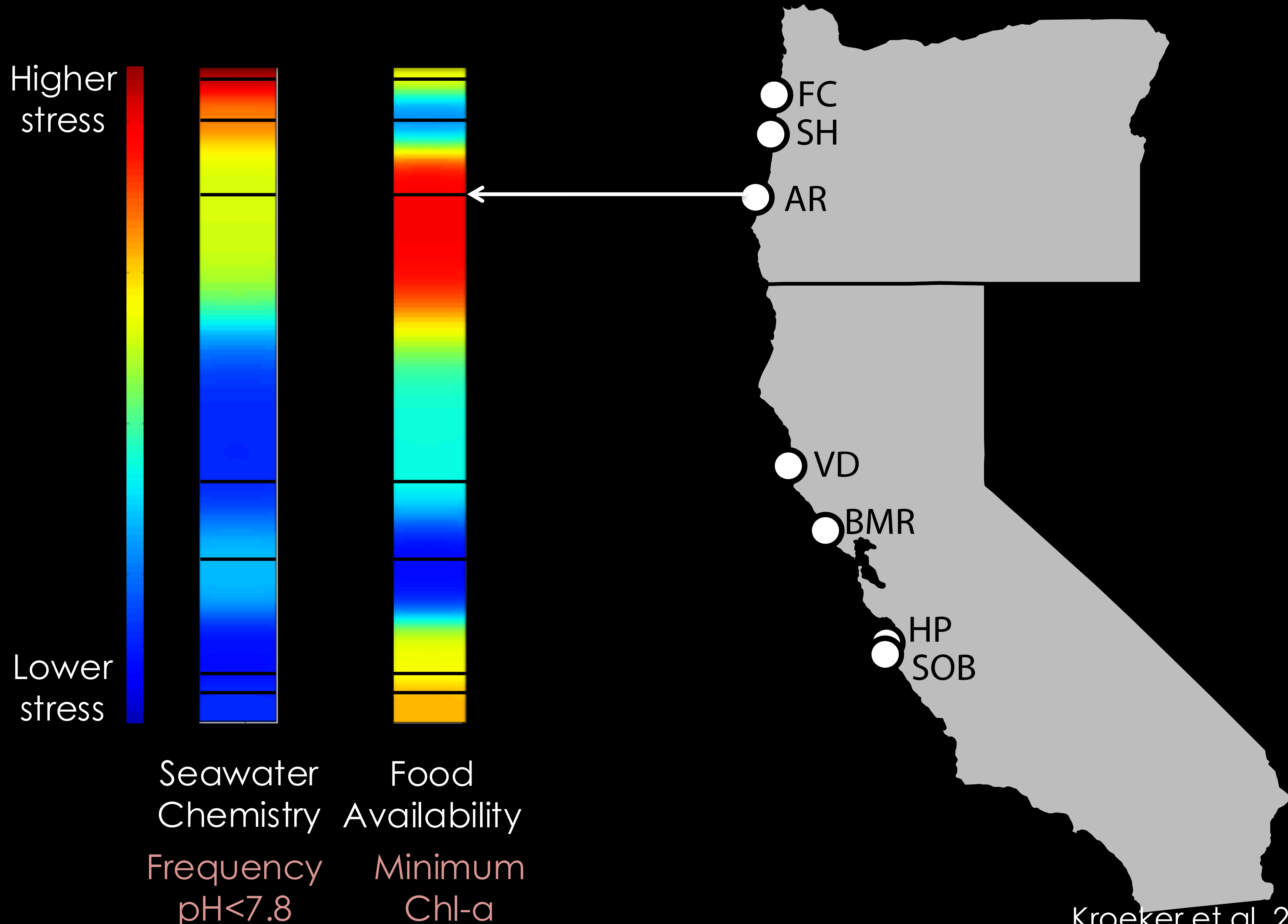
5 months

Mosaic of exposure to OAH



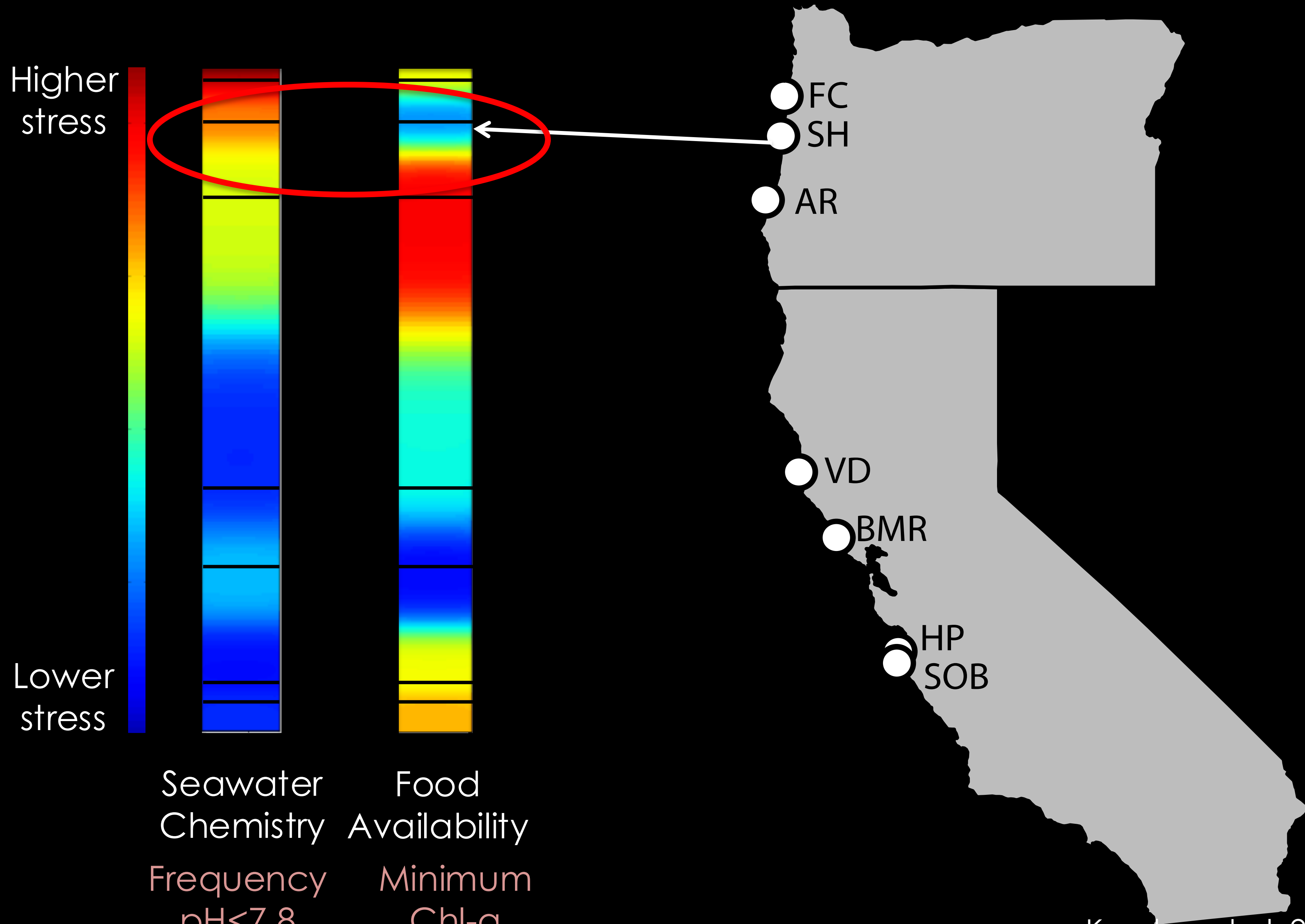
Kroeker et al. 2016

Mosaic in food availability



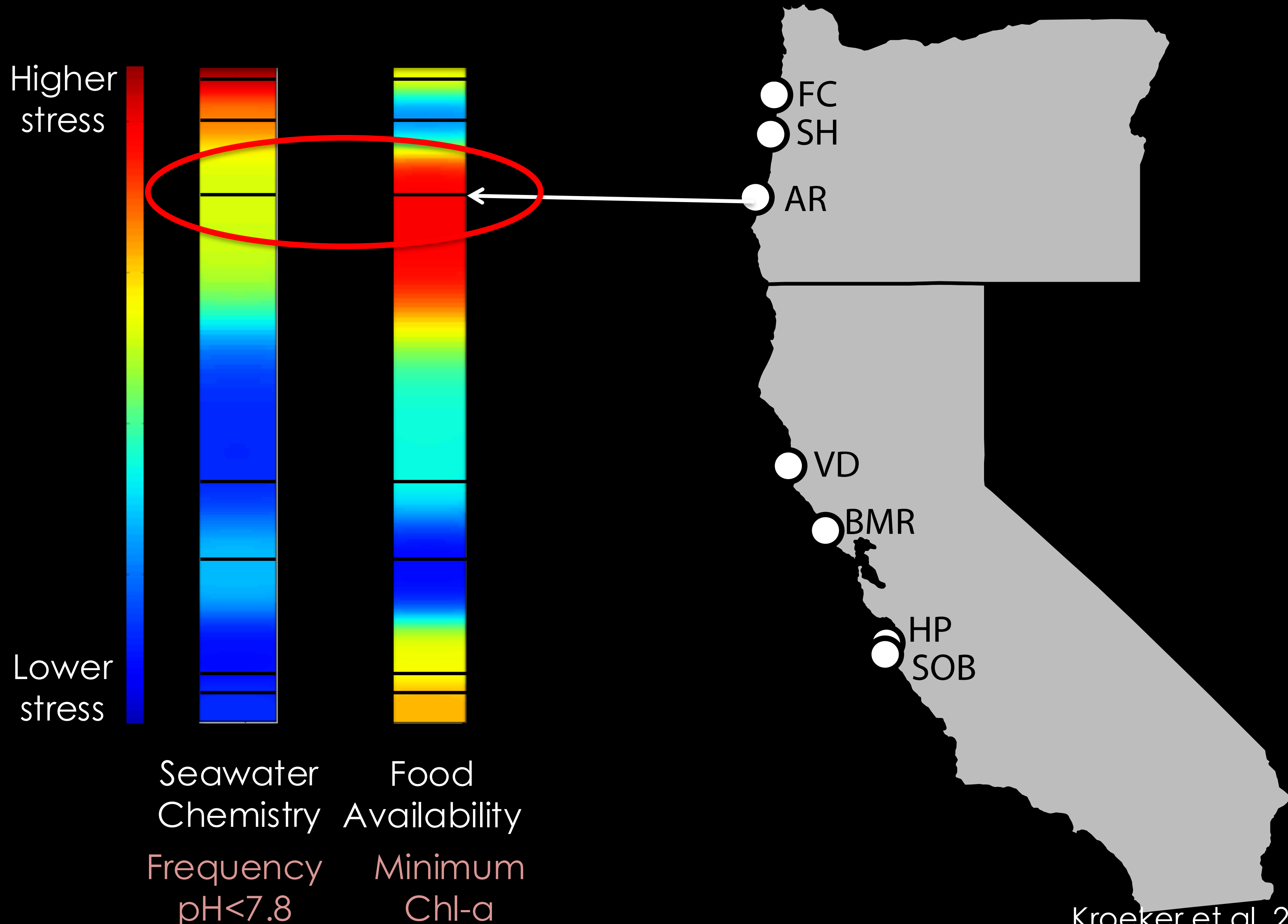
Kroeker et al. 2016

Shellfish resilient to low pH with high food



Kroeker et al. 2016

But moderate pH is trouble with limited food!



Kroeker et al. 2016

Food can buffer effects of OA on vulnerable species

Kroeker et al. 2016

Pinto abalone
Haliotis kamtschatkana

Kroeker et al. 2021

Current summer
pH 8.1

Current winter
pH 7.9

Future winter
pH 7.5

Kroeker et al. 2021

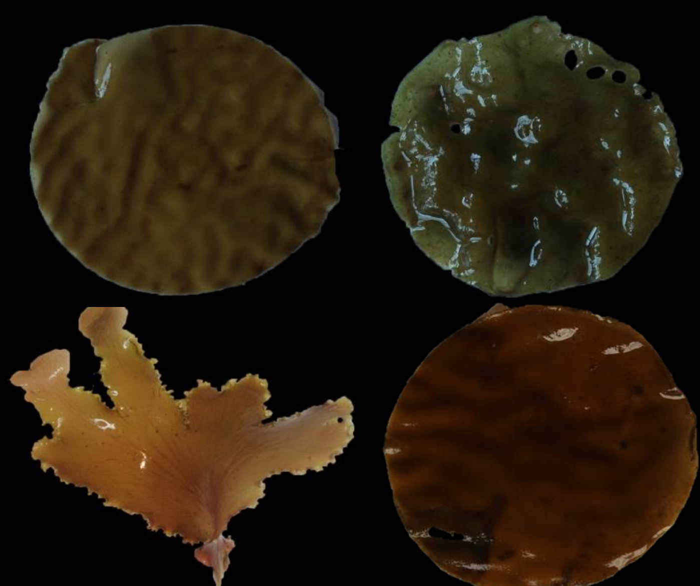
Current summer
pH 8.1

Current winter
pH 7.9

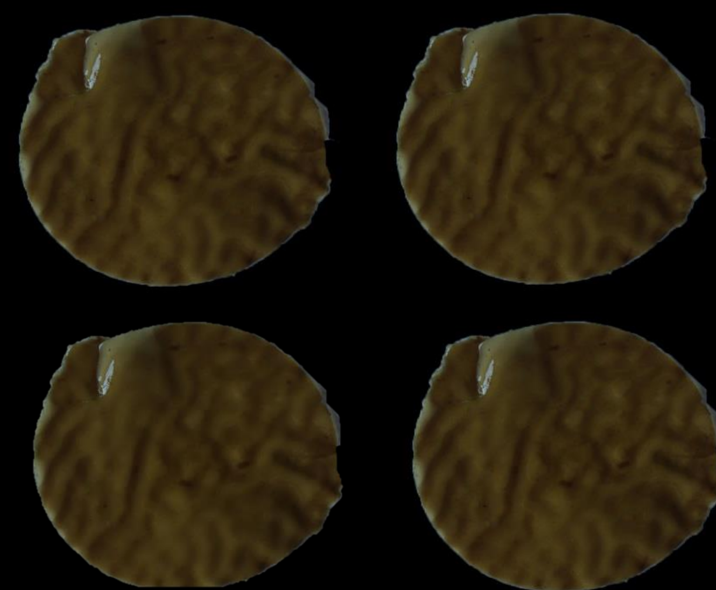
Future winter
pH 7.5

X

Mixed algal diet



Macrocystis pyrifera

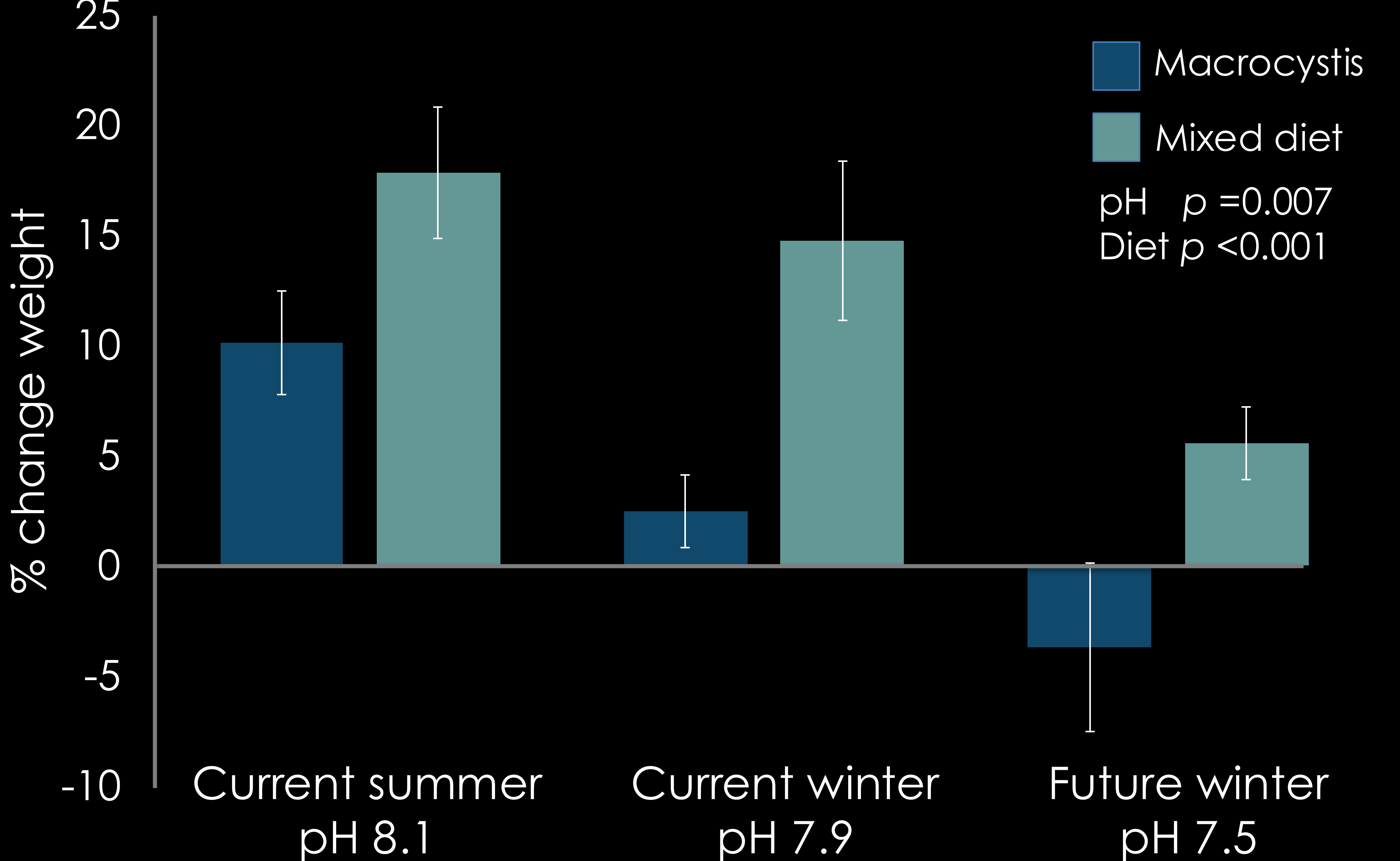


Kroeker et al. 2021

OA reduces growth

Kroeker et al. 2021

Diet mediates effects of OA on growth



Kroeker et al. 2021

Quality of food can buffer effects on vulnerable species

Kroeker et al. 2021

Red Abalone
Haliotis rufescens

Dr. Racine Rangel

Can diet influence red abalone response to high CO_2 conditions?

UNIVERSITY OF CALIFORNIA SANTA CRUZ

THE CULTURED ABALONE FARM
Santa Barbara, California

UCDAVIS BODEGA MARINE LABORATORY

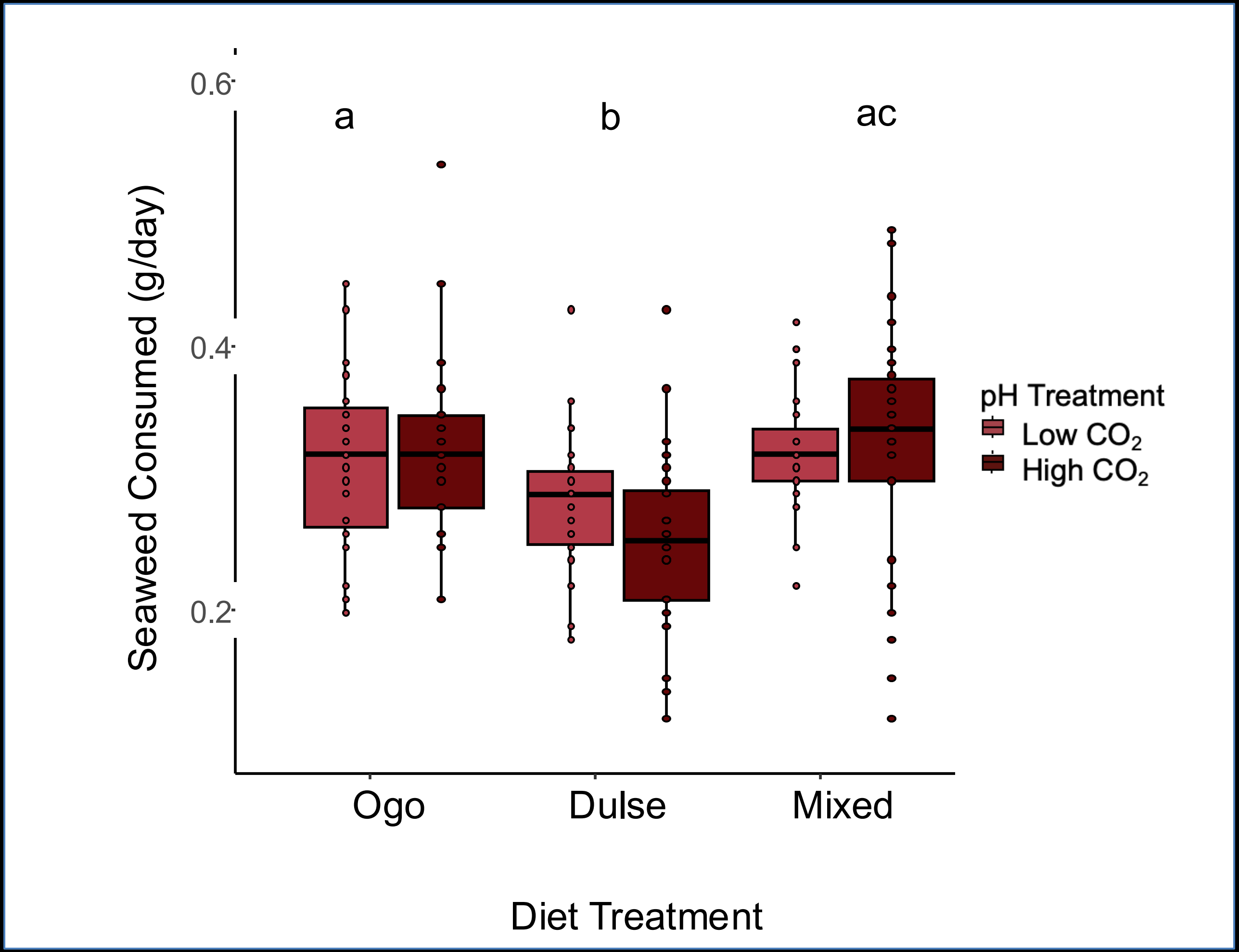
Kelp was hard to find during heatwave!

Red Ogo Se

Dulse Seaweed

Growth, grazing, digestion, respiration, and survival

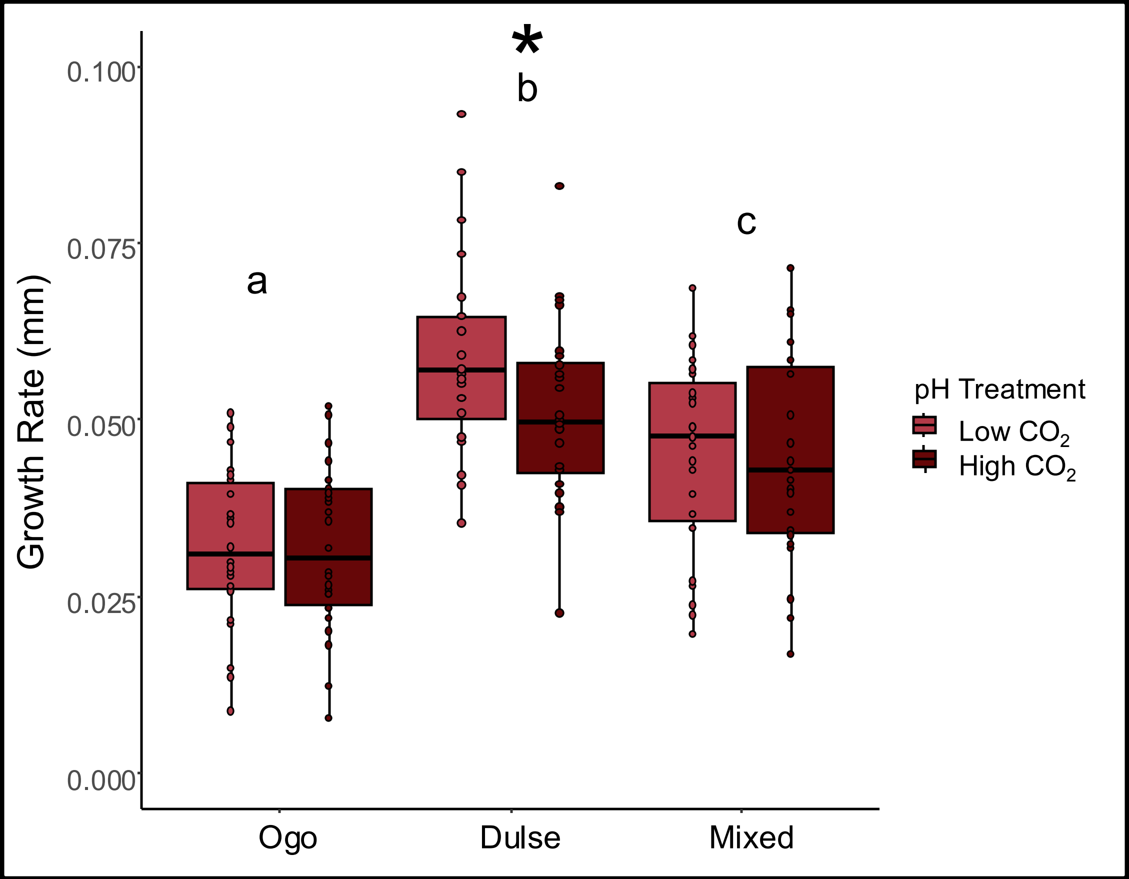
Grazing rates were higher for mixed and ogo diets



ANOVA + Post Hoc Results
Diet = **P < 0.001**
a,b,c = **P < 0.001**

Rangel et al. *in prep*

Increased growth rates on dulse and mixed diet



<u>*ANOVA + Post Hoc Results*</u>
Diet = **P < 0.001**
a,b,c = **P < 0.001**
Dulse: * Low CO2 vs High CO2 **P = 0.042**

Rangel et al. *in prep*

Developing new diets may be critical for climate-resilience

New insights

Mediating factors

Thank you!

NSF
the David & Lucile Packard Foundation
The Nature Conservancy
Alfred P. Sloan Foundation
Sea Grant California
Ocean Protection Council
The University of California 1868
UCSC

Review of taxa

Vulnerability
Current trends
Areas of resilience/insight

Urchins

<u>Near-future scenarios</u>
Smaller sized larvae
Local adaptation to pCO_2
Experimental evolution!

Kelly et al. 2013; Pespeni et al. 2013

Dungeness crab: new insights

Near-future scenarios
Reduced survival of zoeae
Smaller sized megalopae

Current conditions
Dissolution of exoskeleton of larvae

Miller et al. 2016; McElhany et al. 2022;
Bednarsek et al. 2020

Dungeness crab: new insights

Multiple stressor models

Highest vulnerability is exposure of adults to hypoxia in summer

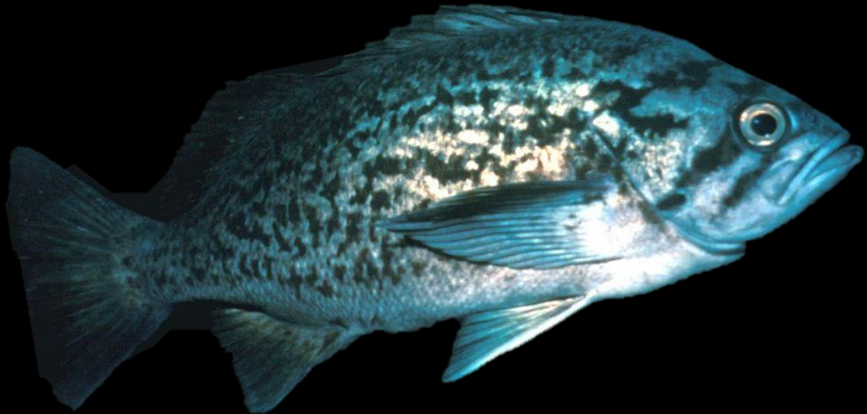
Ecosystem models

Indirect effects of OA on food availability = biggest threat

Marshall et al. 2017; Berger et al,. 2021

Fishes: new insights

Rockfishes
Some effects on behavior
Some species resilient



Effects on hearing?
Low pH – larger otoliths
Low DO – smaller otoliths

Hamilton et al. 2017; 2019

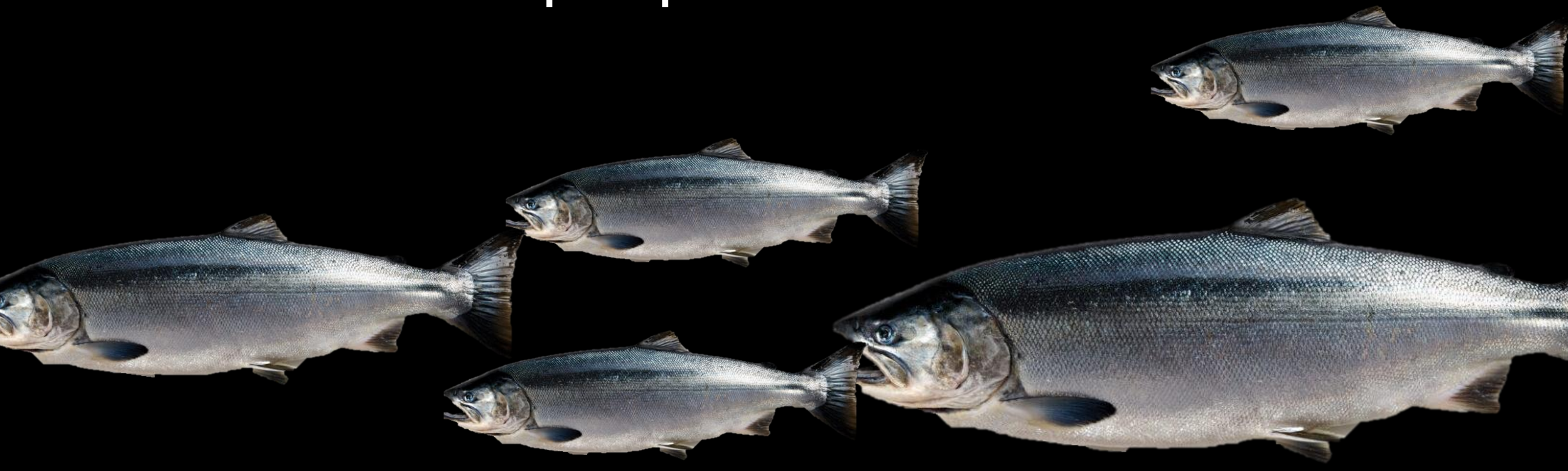
Fishes: new insights

Coho Salmon
Olfaction impaired
Juvenile Pink Salmon
Physiologically resilient?

Lingcod
Egg hatch declines
with upwelling intensity

Williams et al. 2018; Frommel et al. 2020;
Willis-Norton et al. in review

Most research doesn’t predict effects on population…



PC: Athena Maguire

PART TWO

Social Vulnerability and Industry/Community Perspectives

1) **Terry Sawyer,** Hog Island Oyster Company
   Industry Perspectives

2) **Brian Wall,** Kashia Band of Pomo Indians of Stewarts Point Rancheria, Aquaculture Technician
   Restoration and Aquaculture on the Kashia Coastline

3) **Dr. Arielle Levine**, San Diego State University
   Adaptive capacity of California shellfish growers in multi-stressor landscape

4) **Dr. Luke Gardner,** Moss Landing Marine Labs
   Climate resilience for shellfish aquaculture - challenges and opportunities

Down on the Farm: Adapting to changing ocean conditions at Hog Island Oyster Co.

Terry Sawyer, Co-founder


HOG ISLAND OYSTER CO.


SUNSHINE
BICYCLE
FAIRFAX CA


Hog Island Oyster Co.
Point Reyes National Seashore
Tomales Bay, CA

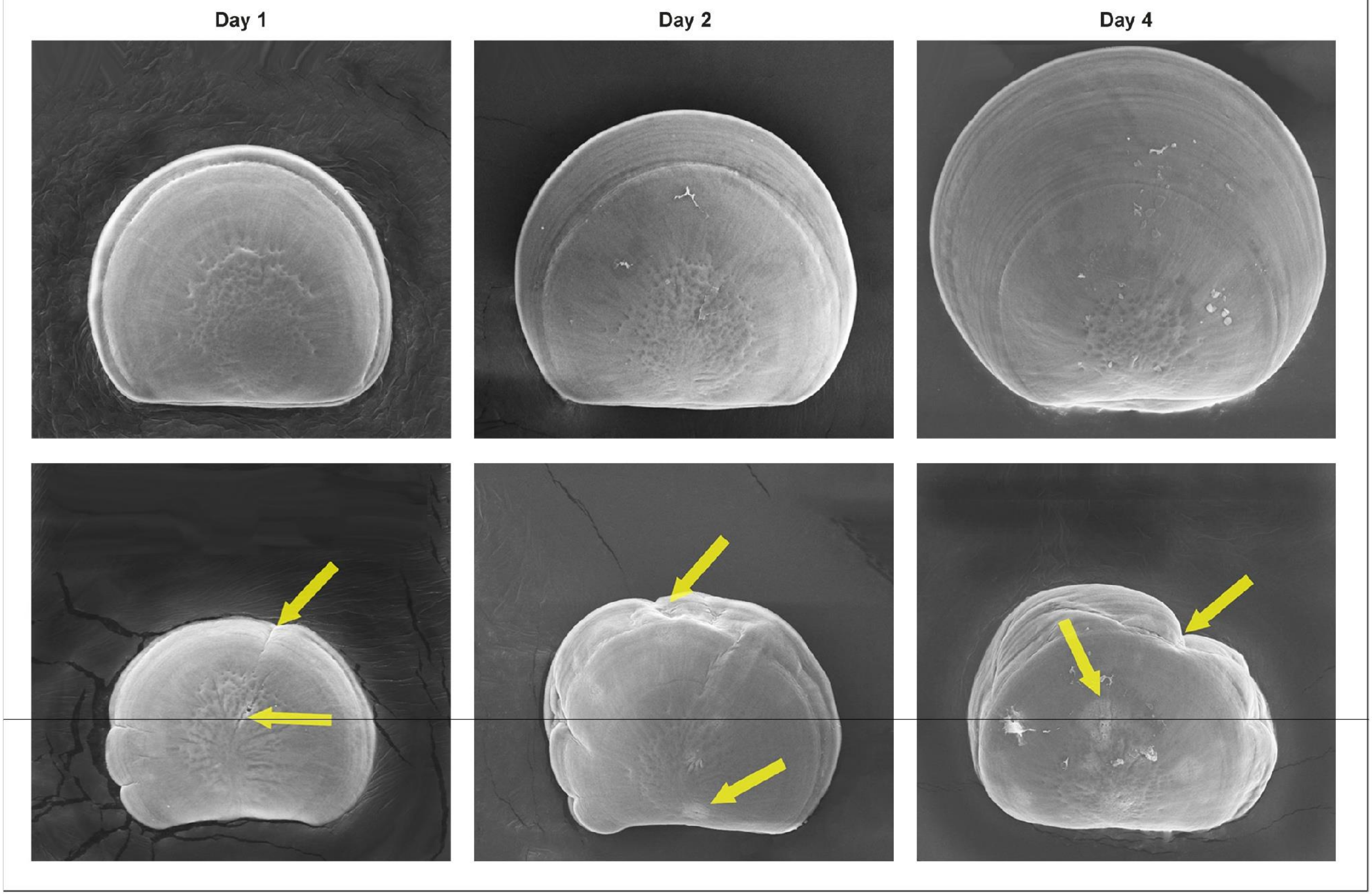

HOG
ISLAND
OYSTER
CO.


HOG
ISLAND
OYSTER
CO.
Certified
B
Corporation
MARSHALL
SAN FRANCISCO
NAPA
HUMBOLDT


HOG ISLAND OYSTER CO.
11


HOG
ISLAND

Farm Science



Source: Elizabeth L. Brunner and George G. Waldbusser. | GAO-14-736


CAL POLY
HUMBOLDT


Better Data
Better Science
Better Decisions

Restoration on the Kashia Coastline

Dan Swezey
Nina Hapner
Brian Wall
Kashia Band of Pomo Indians

10/24/24

Brian Wall

Aquaculture Technician

Kashia Band of Pomo Indians

Stewarts Point Rancheria Kashia Department of Environmental Planning - Kashia Band of Pomo Indians -

Dan Swezey Phd

Director for Oceans and Aquaculture

Kashia Band of Pomo Indians

Stewarts Point Rancheria Kashia Department of Environmental Planning - Kashia Band of Pomo Indians -

Nina Hapner

Managing Director for Natural Resources + KDEP Staff

Kashia Band of Pomo Indians

Stewarts Point Rancheria Kashia Department of Environmental Planning - Kashia Band of Pomo Indians -

Kashia

KASHIA POMO TRIBAL GOVERNMENT

Original inhabitants and stewards of the Sonoma Coast, having lived here for 12,000+ years.

1850: California becomes the 31st state

1857: State government legalizes violence against California's indigenous peoples. Thousands of Pomo people were forced from their traditional lands.

Facing incredible adversity, Kashia peoples survive in hiding, maintaining their history and culture in Sonoma County.

In 1916, the federal government formally recognizes the Tribe establishing the Stewarts Point Rancheria.

For well over 150 years, Kashia has had little say over the the management of marine resources that had sustained the Tribe and its identity.

Kashia

700 ACRES RETURNED TO THE KASHIA

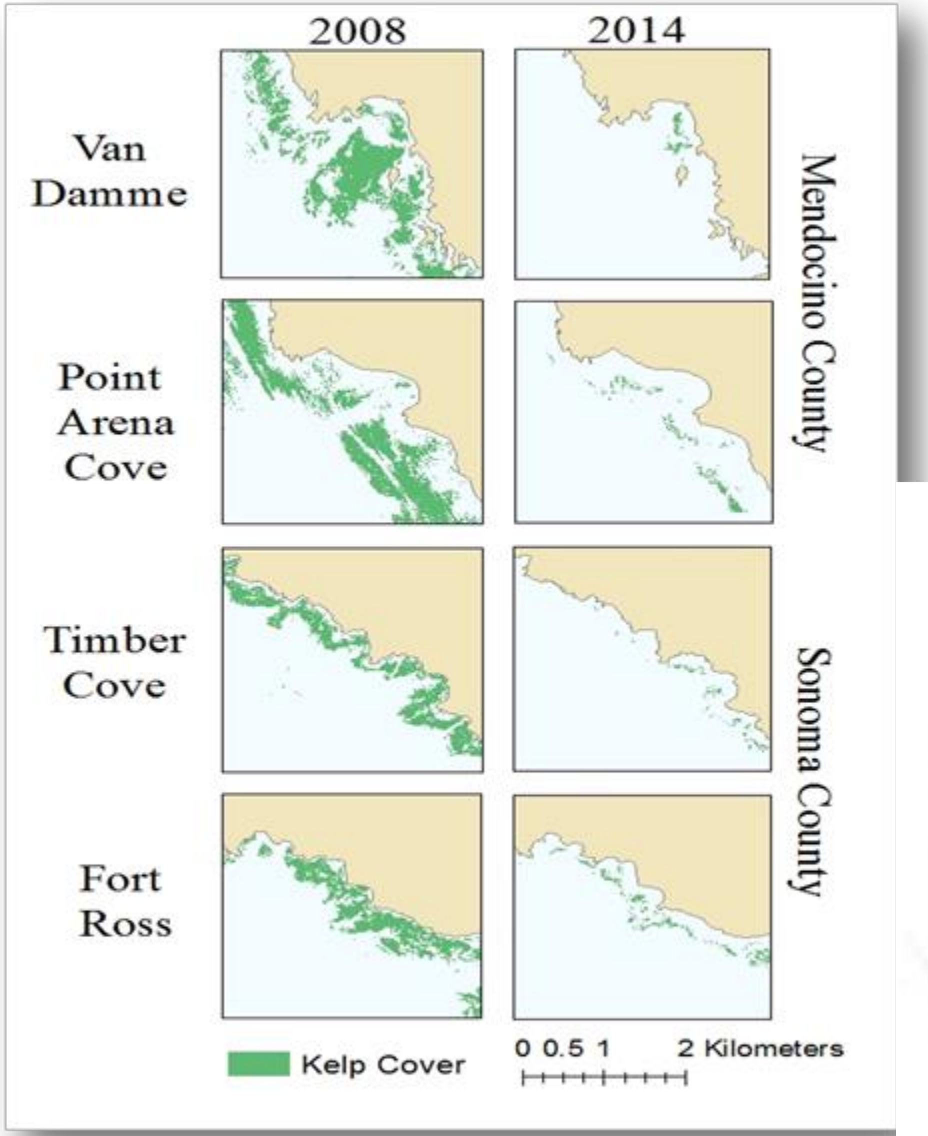
12,500 YEARS OF KASHIA HISTORY ON THIS LAND

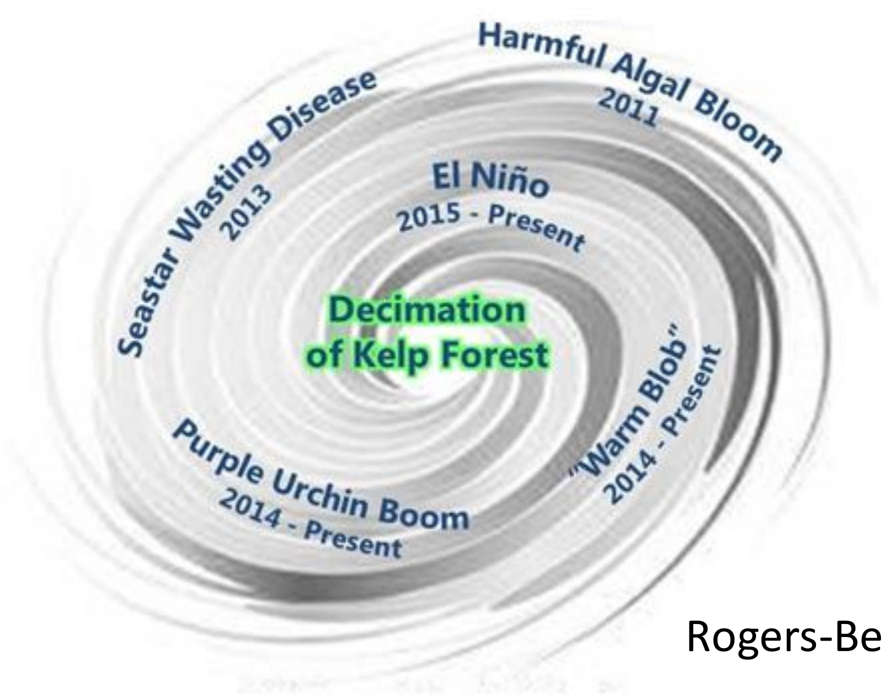
2016: First land ever returned to the Tribe, a 1-mile stretch of coastline establishing the Kashia Coastal Reserve

Kashia Band of Pomo Indians Aboriginal Territory
Stewarts Point
Rancheria
Cloverdale
Annapolis
The Sea Ranch
Stewarts Point
Plantation
Walsh Landing
Cazadero
Fort Ross
Guerneville
Duncans Mills
Jenner
Occidental
Carmet
Salmon Creek
Bodega Bay
Dillon Beach
N
Chico
Sacramento
Coastal Range
Fairfield
Antioch
Stockton
Livermore
Fremont
San Jose
0 15 30 60 90 120
Miles
0 1 2 4 6 8
Miles

NORTH FACE
NATIVE

Kelp Loss in California



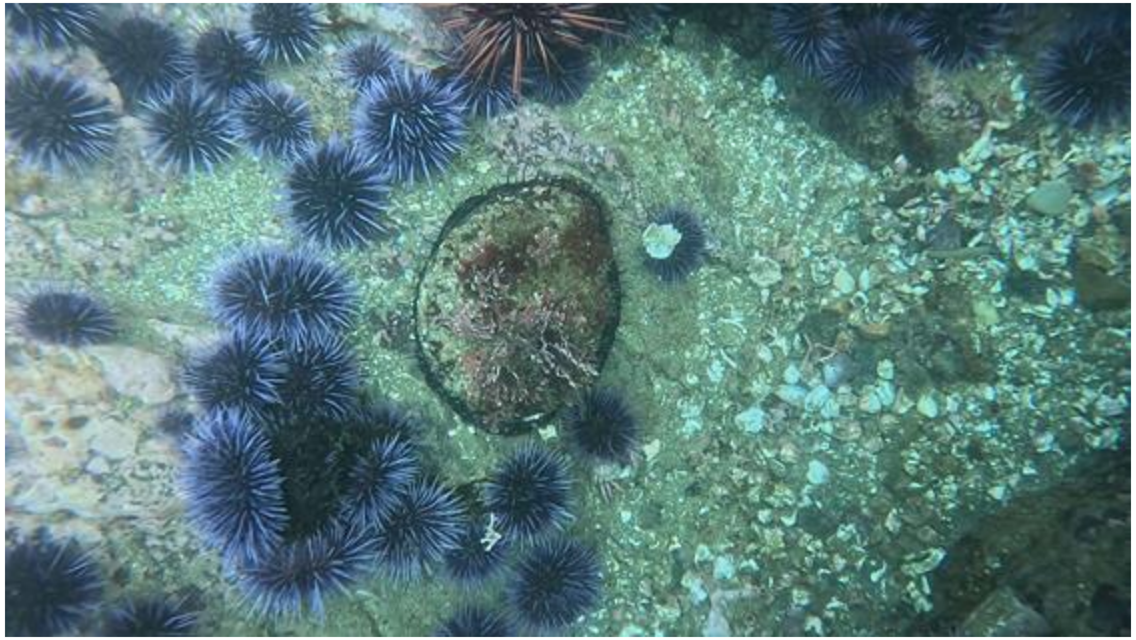


Rogers-Bennett and Catton (2019)

Abalone Fishery Decline

- 6000% increase in purple sea urchins
- 90%+ loss of kelp biomass
- 80% Decline in abalone stocks in Northern California since 2014

- Previously largest recreational abalone fishery in the world
- Starving with no reproduction since 2015
- Fishery Closed in 2018

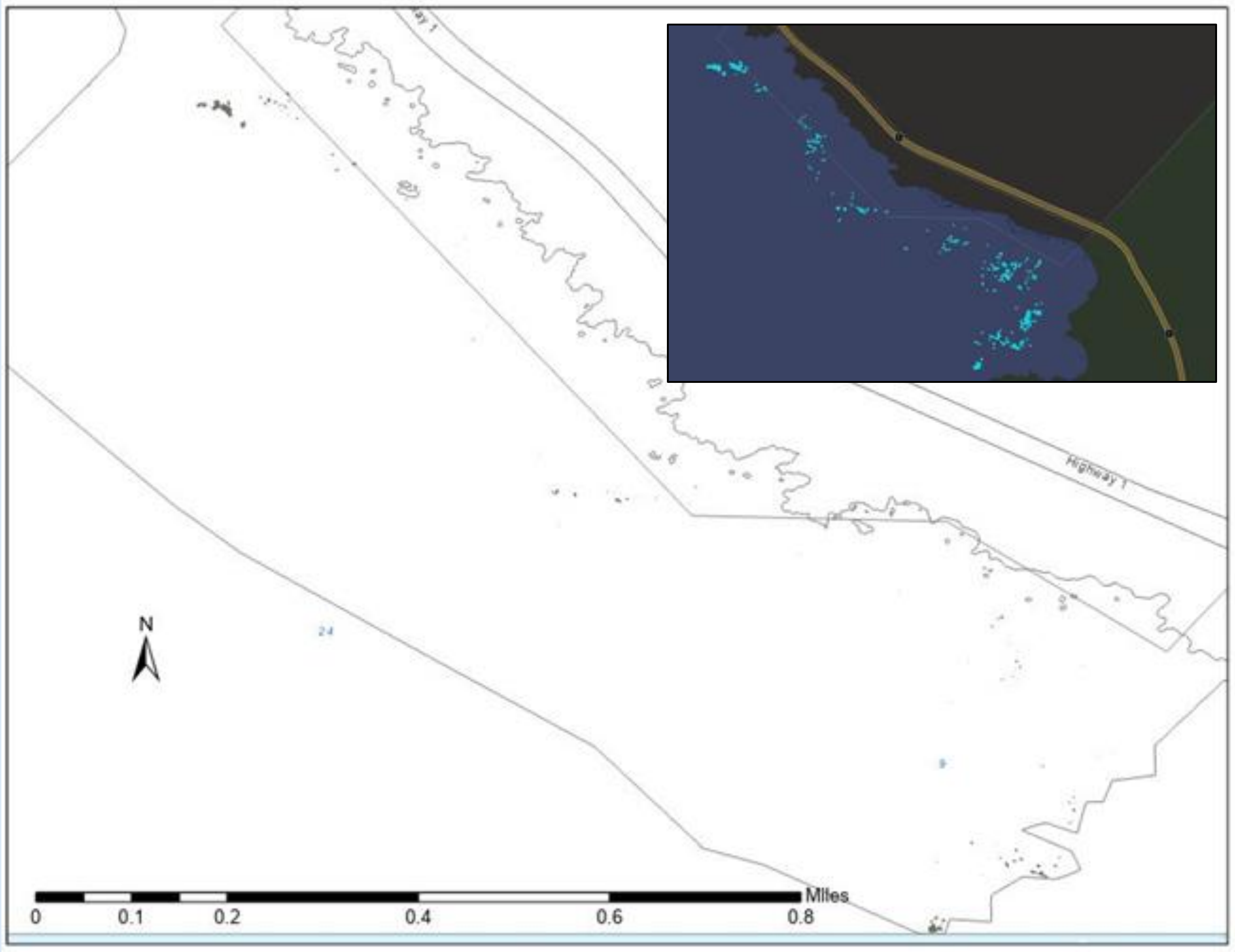



Monitoring

Monitoring

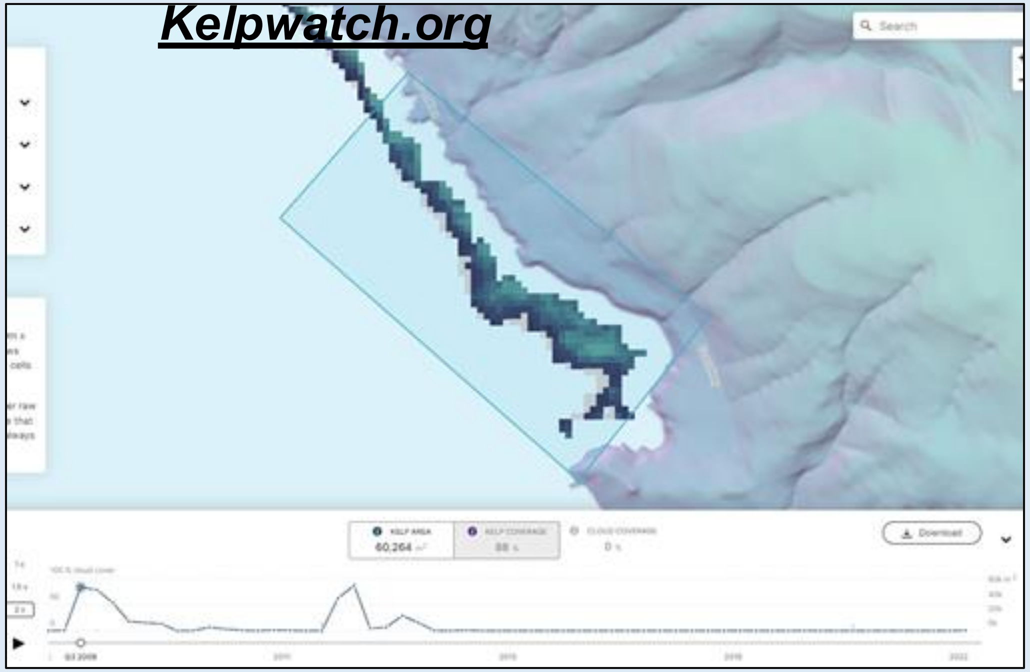
Kelp Surveys

Surveys conducted in collaboration with Greater Farallones Association 2021 & 2022.



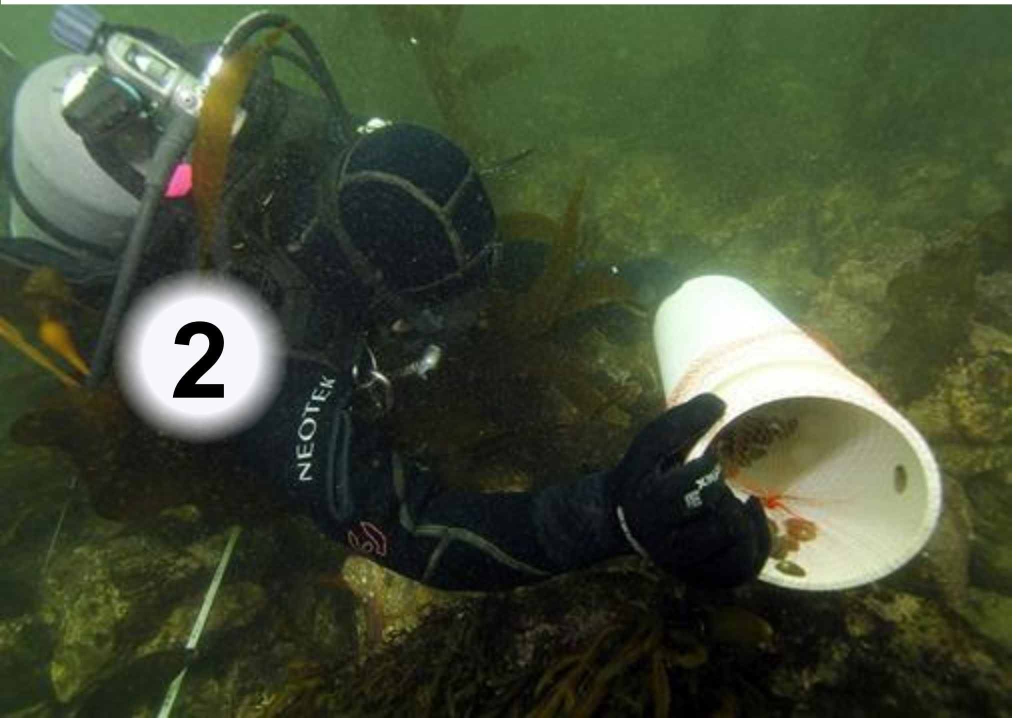
2021 Survey Results
Area = 494 m2

Satellite Imagery from Kelpwatch.org



Restoration

A Tribal-Scientific Alliance to Restore Red Abalone in California's Kelp Forest Ecosystem



Tribal Aquaculture Development

THE CULTURED ABALONE FARM

LACO

KASHIA POMO TRIBAL GOVERNMENT

OCEANS DESIGN

Tribal Aquaculture Development

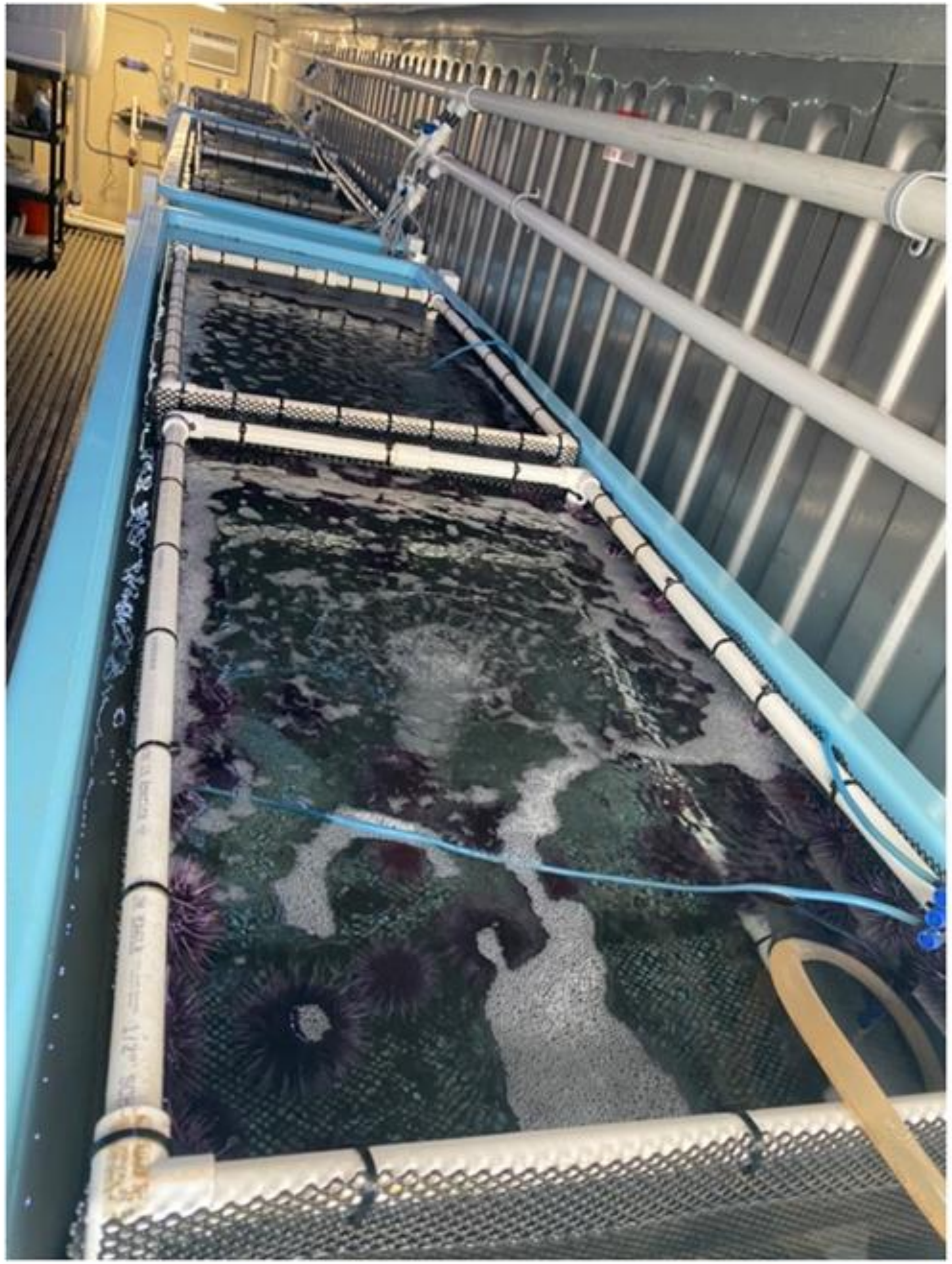
- Genetics
- Disease Concerns
- Culturing Needs
- Coordination

Funding:

NFWF

NOAA FISHERIES

Tribal Aquaculture Development



Funding:

U.S. DEPARTMENT OF THE INTERIOR
1824
BUREAU OF INDIAN AFFAIRS

Thank you!

Yahwee

!

Oregon State University

SAN DIEGO STATE UNIVERSITY

Adaptive capacity of California shellfish growers in multi-stressor landscapes

Results from interviews with growers in California and Oregon

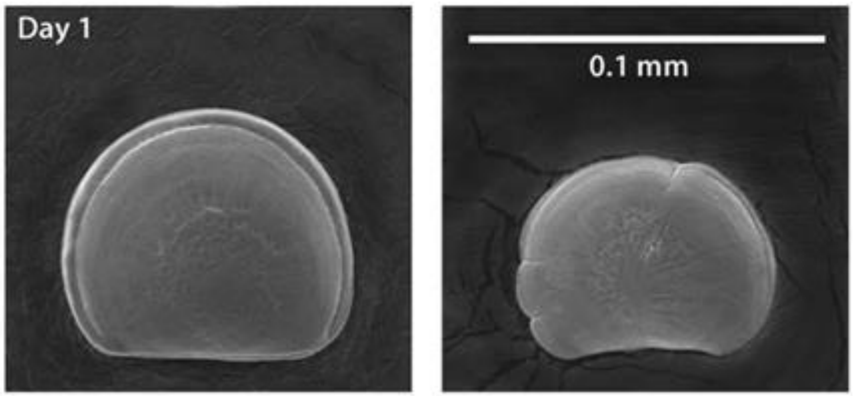
Dr. Arielle Levine
San Diego State University

Co-authors: Melissa Ward, Kristen Green, Ana Spalding, Erika Wolters, Sara Hamilton & Lauren Rice

Ocean Acidification (OA) Consequences

Favorable Conditions

Unfavorable Conditions



OSU, 2013

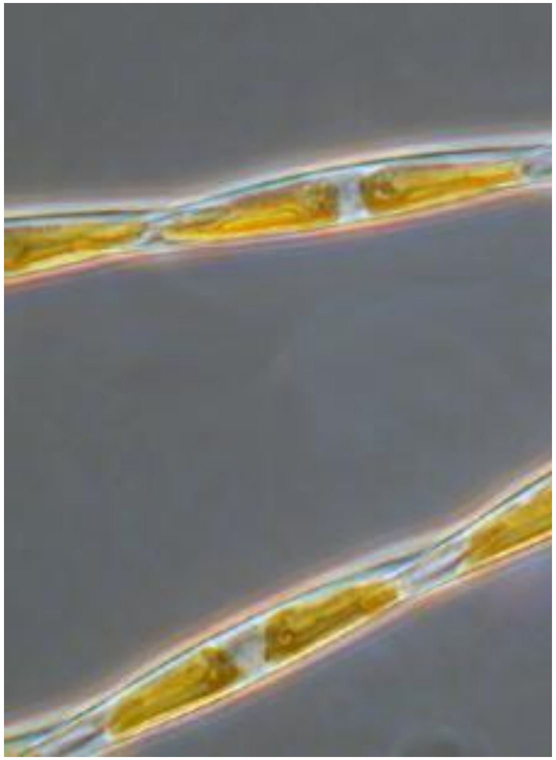
Ecological consequences

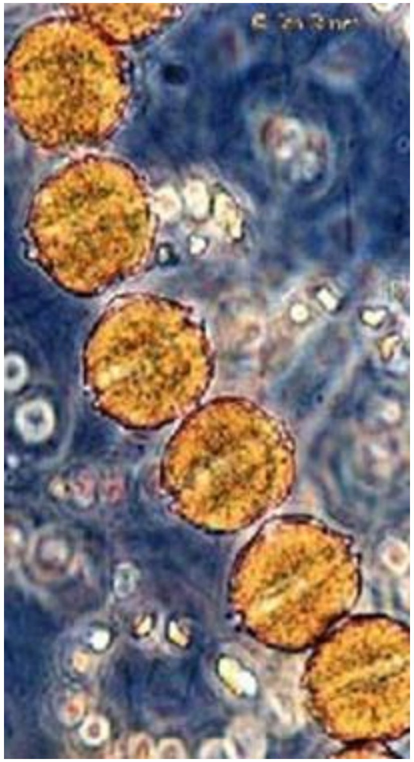
- Calcification
  - Decreased growth and survival
- Behavioral changes
- Physiological changes

Socioeconomic consequences

- Whiskey Creek Oyster Hatchery - supports a $270 million dollar industry
- Crashed during 2008 upwelling events

Rising sea surface temperatures,
air temperatures and marine disease also stress shellfish and shellfish-harvesting communities



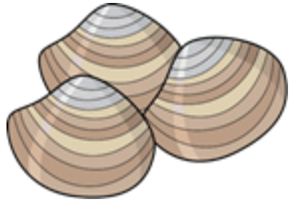


How do shellfish growers perceive and respond to OA and environmental change?

- What environmental stressors are growers experiencing?
- What strategies do growers employ (or would like to employ) in order to adapt to OA and environmental change?
- What factors facilitate or inhibit growers' ability to respond to such stressors

Connecting with Shellfish Growers

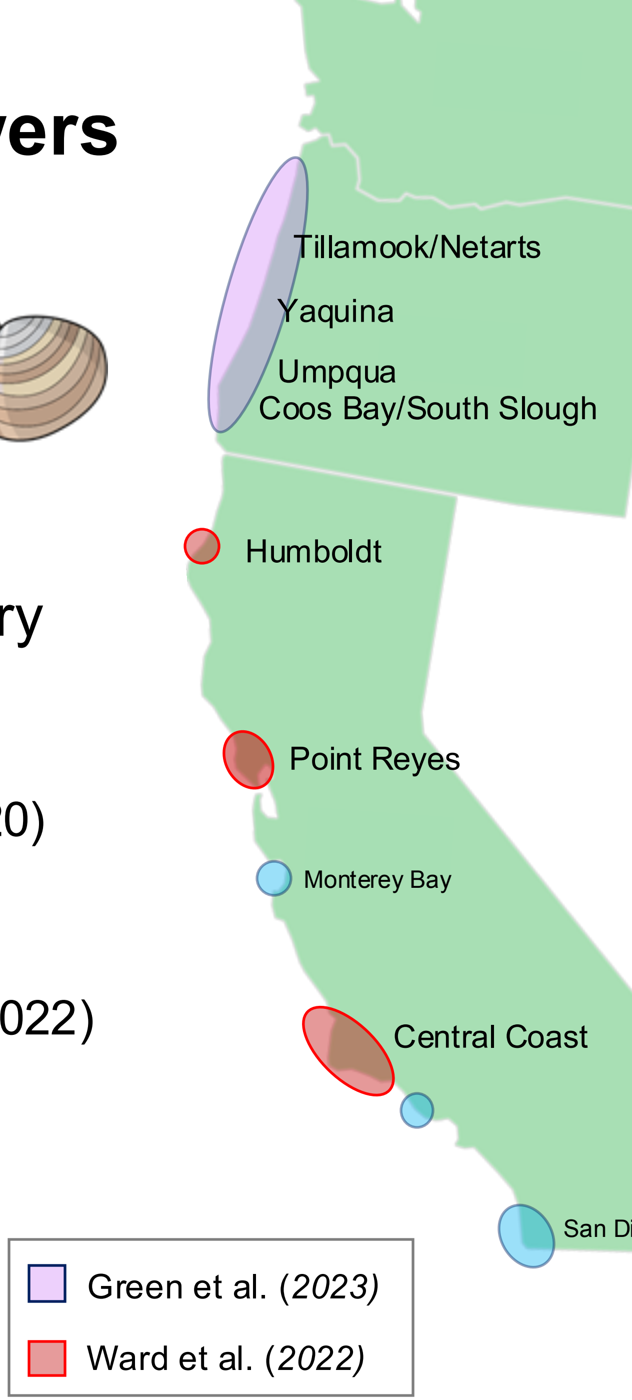


- Interviews conducted with the owners/primary managers of:
    - 11 (out of 19) total operations in California (2020)

      (Ward et al. 2022; Ocean & Coastal Management)
    - 15 (out of 19) Oregon operations interviewed (2022)

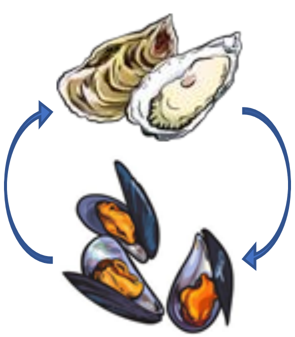
      (Green et al. *2023*; Ocean & Coastal Management)



Interviews: Thematic Coding

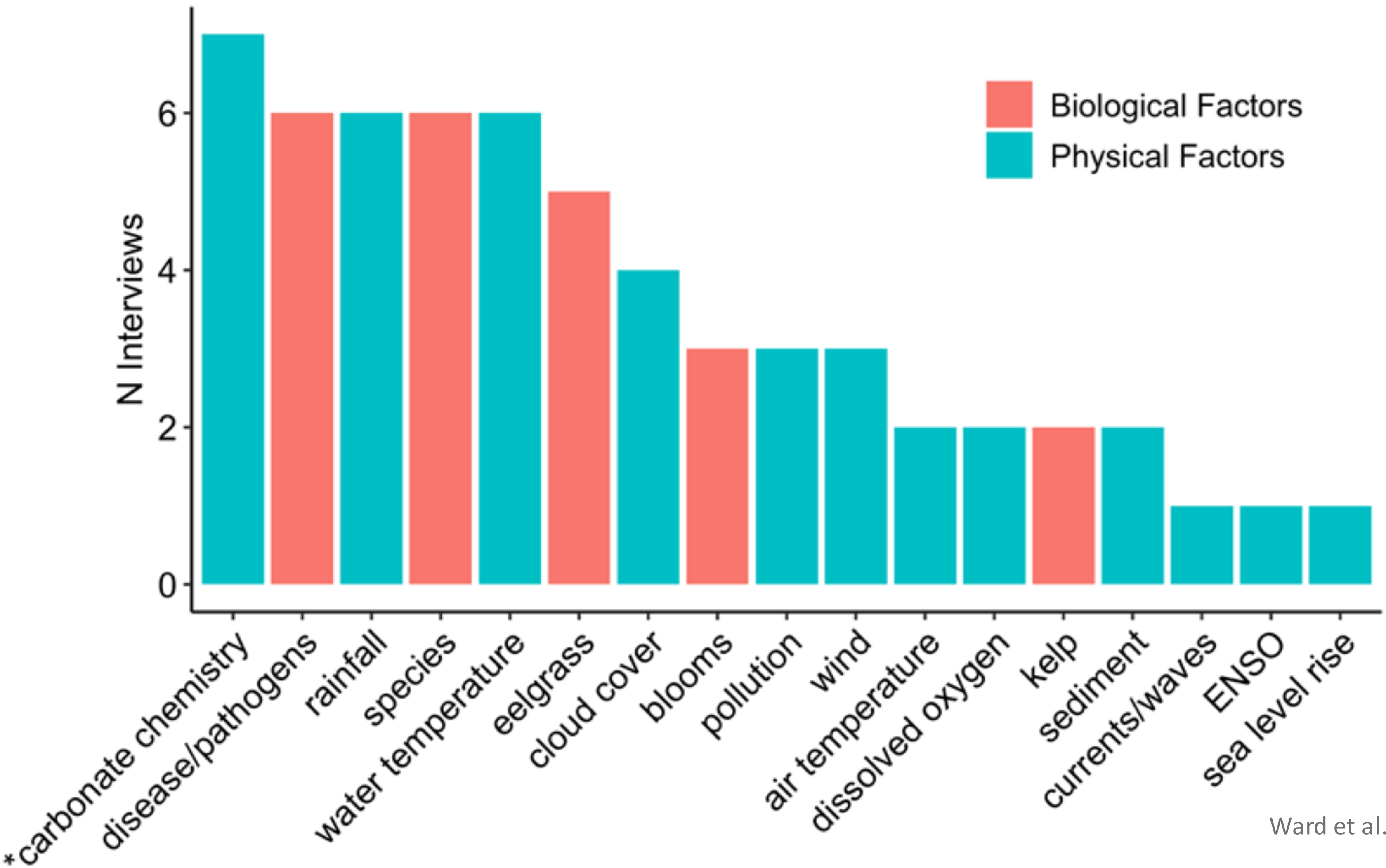
Interviews were transcribed and tagged using two sets of codes:

1) Stressors impacting shellfish growers
    - Environmental (e.g., ghost shrimp, kelp cover, pathogens)
    - Economic (e.g., labor, supplies)
    - Social (e.g., pandemic)
    - Regulatory(e.g., regulations that affect permitting)

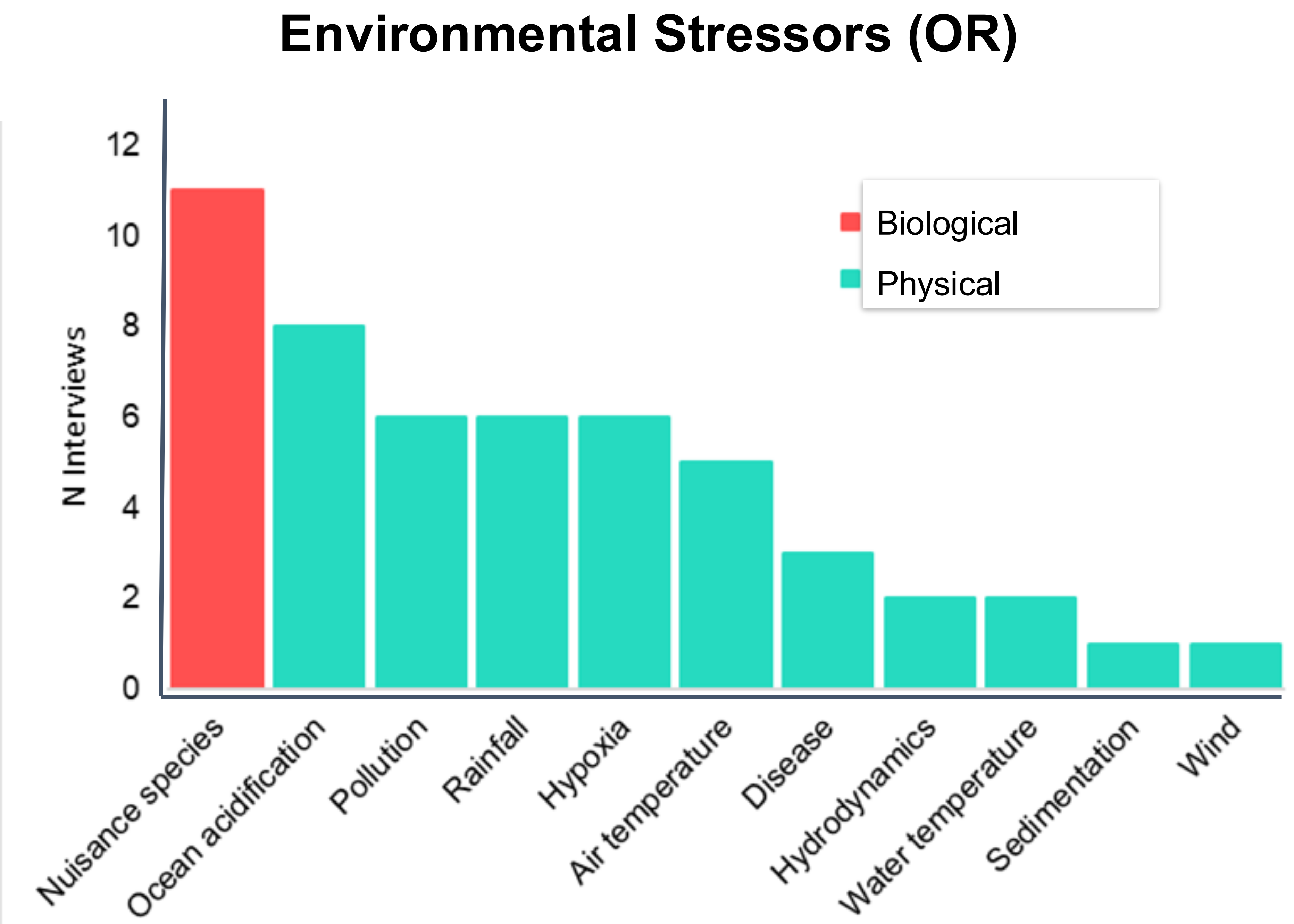


2) Strategies for adaptation (e.g., improve monitoring, culturing multiple species)

Environmental Stressors (CA)



Ward et al. (*2022)*



Environmental Stressors (OR)
N Interviews
12
10
8
6
4
2
0
Biological
Physical
Nuisance species
Ocean acidification
Pollution
Rainfall
Hypoxia
Air temperature
Disease
Hydrodynamics
Water temperature
Sedimentation
Wind

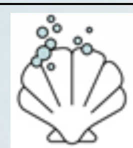
Examples of Environmental Change

Marine pathogens

"There was a huge virus or something all up and down the West Coast. It took out so many oysters, some farms lost 90 percent of their oyster crop, and when you're waiting a year for something to be able to harvest it, that's a huge loss."

Nuisance species

"[Ghost shrimp] build burrows . . . When they do that, that ground turns into a soft and soupy mess. The oysters will sink and suffocate in that mud . . . . We've lost hundreds and hundreds of farmable ground to ghost shrimp. . . in the last four years."



Ocean Acidification

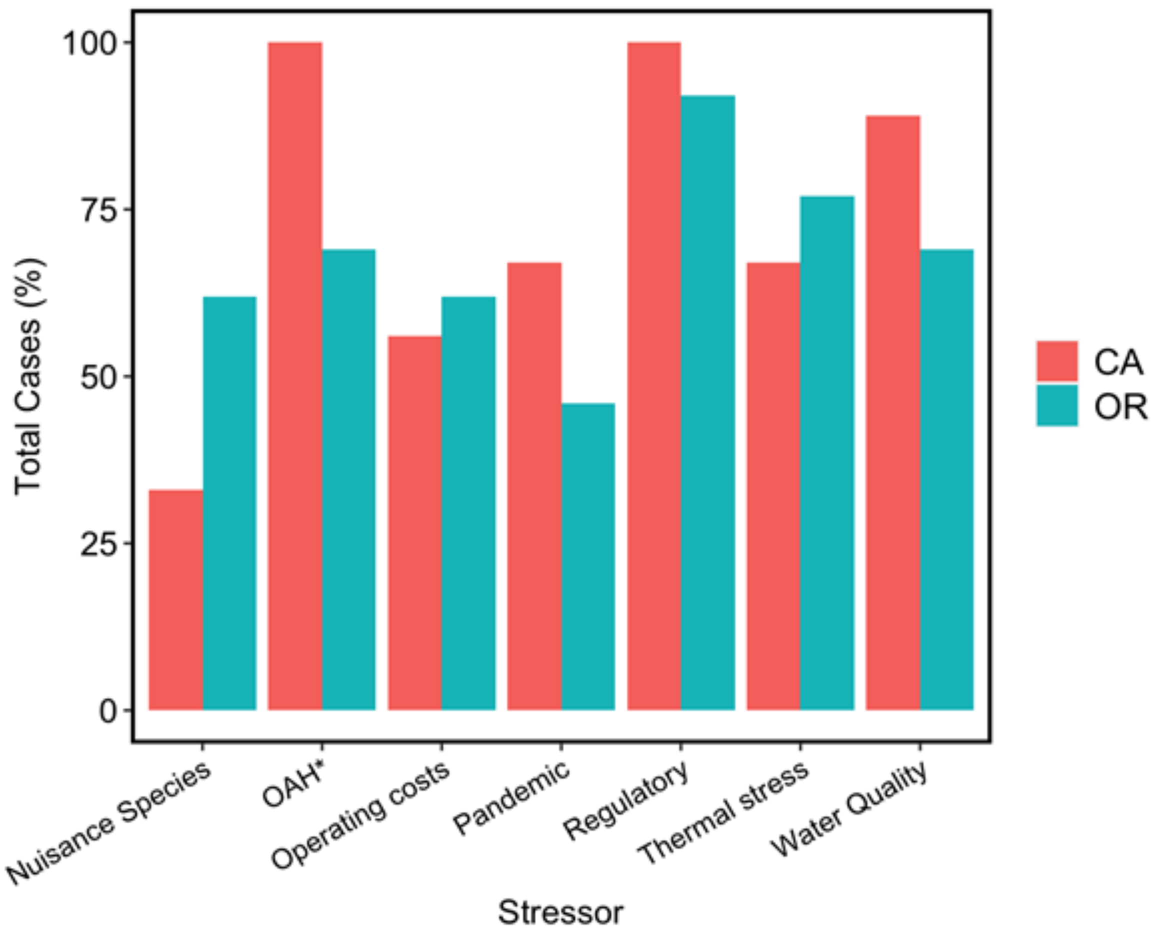
"We haven't seen much with the bigger-sized oysters. I'm thinking in the hatchery… they have a harder time to form this shell. The older oysters that the growers are involved with are hardier and less susceptible to change or to the product."

"We are not currently using any kind of instrument or observation to look for acidification because, number one, we don't know how to do that."

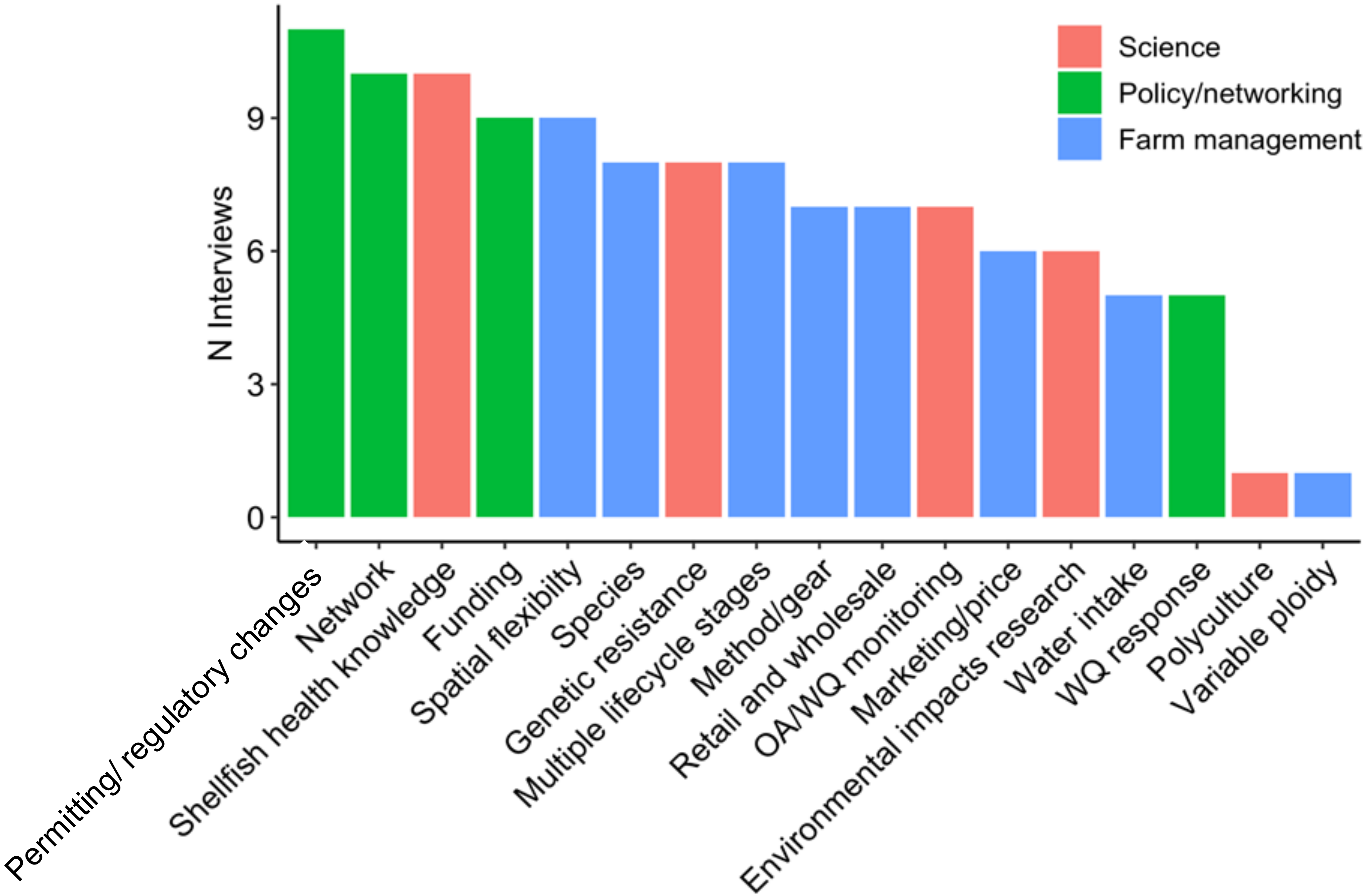
Most cited operational stressors

- Regulatory stressors most frequent for both states, followed by OAH, water quality, and thermal stress

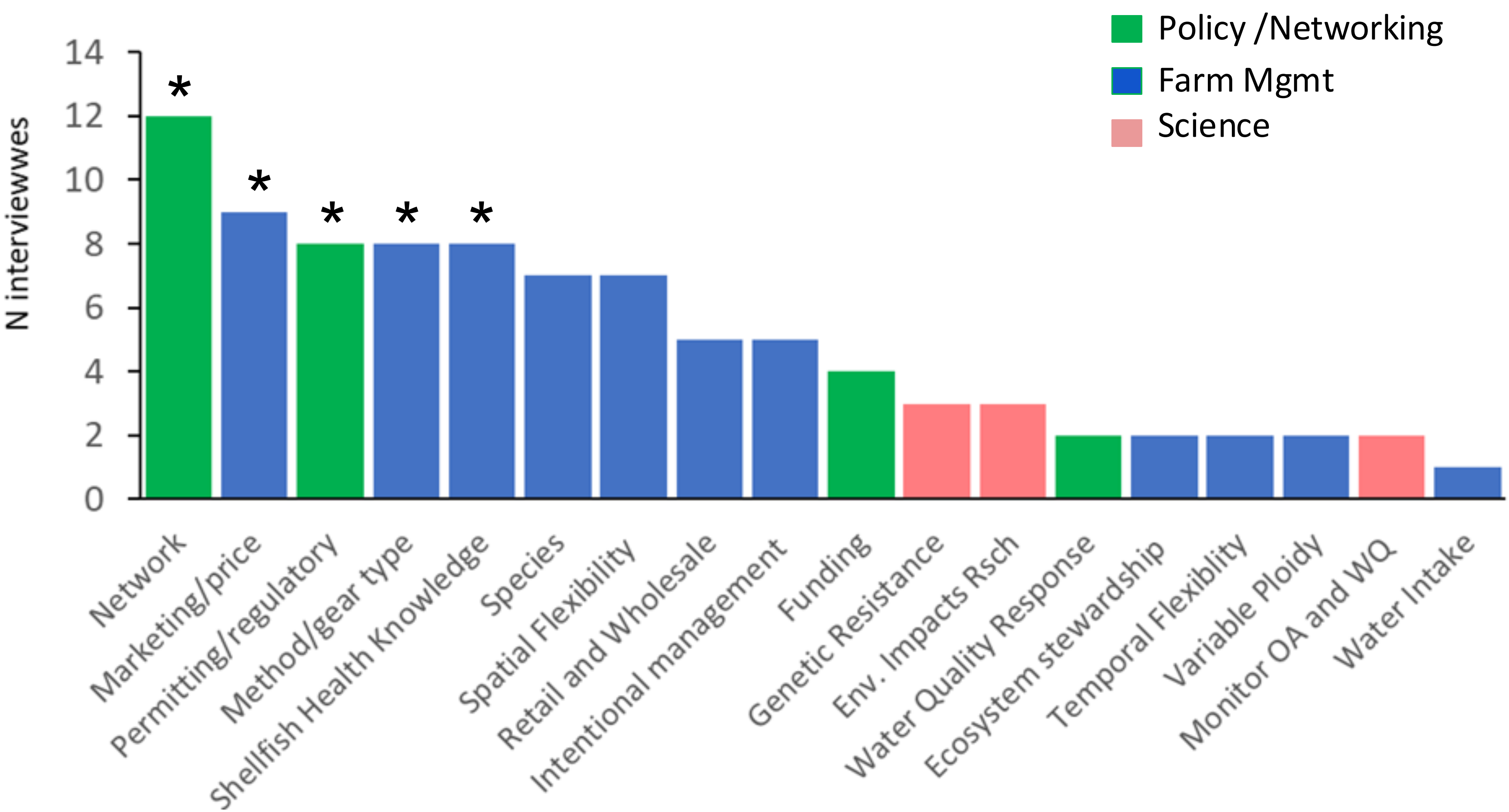
- Nuisance species reported more frequently for Oregon growers



Results: Adaptive Strategies (CA)

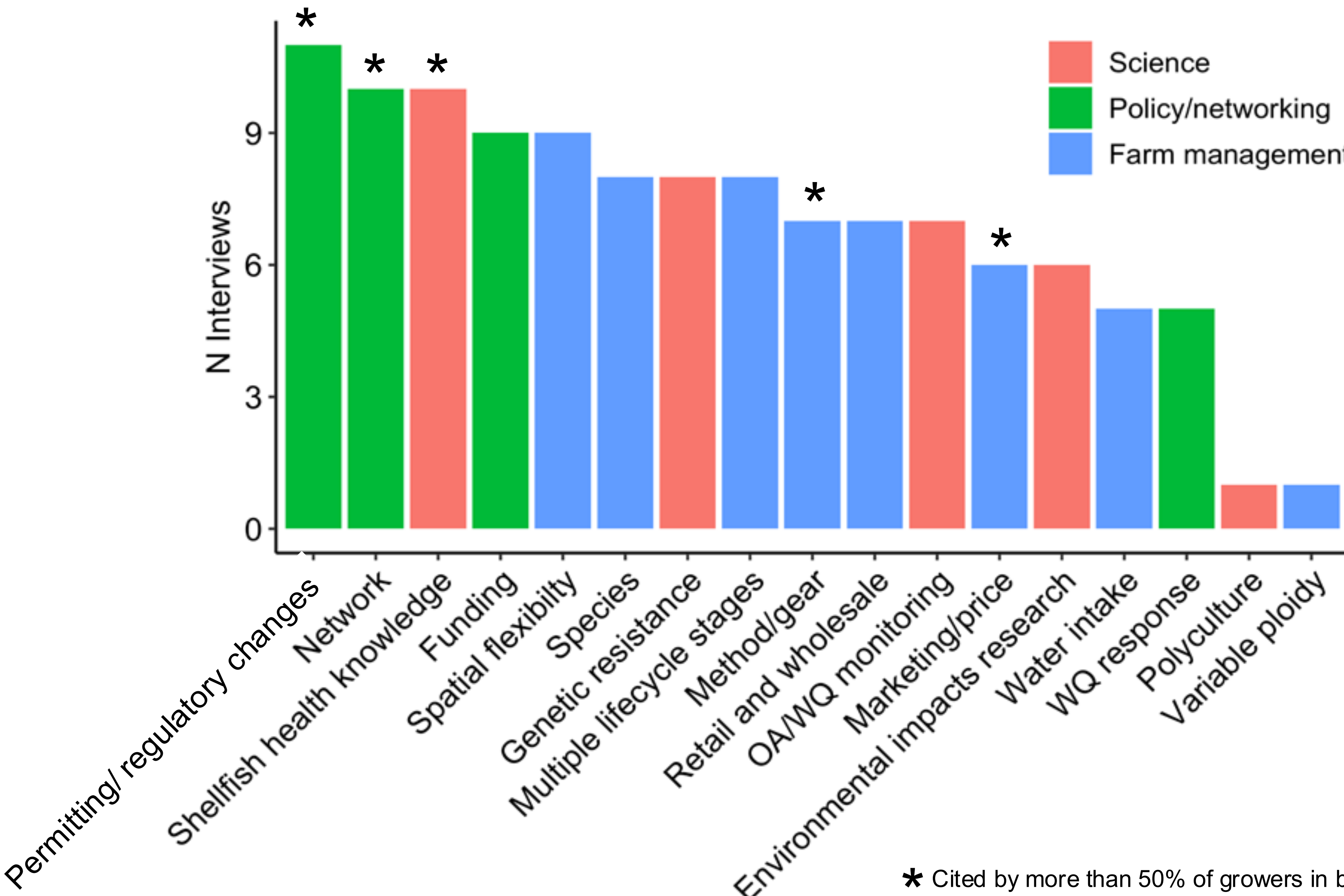


Results: Adaptive Strategies (OR)



* Cited by more than 50% of growers in both CA and OR

Results: Adaptive Strategies (CA)



* Cited by more than 50% of growers in both CA and OR

Farm Management Strategies: CA and OR

- Spatial & temporal flexibility
- Species
- Ecosystem stewardship
- Intentional mgmt.
- Method/gear type
- Retail and wholesale
- Marketing/price
- Water intake
- Variable ploidy

"*I'm very interested in growing different varieties of Pacific oyster such as Kumamoto or maybe a hybrid or ones that are more adapted to warmer water.*" - CA grower

"*You could potentially move [oysters] around the bay, and we've done that a little bit in relation to summer mortality.*" – CA grower

Farm Management Strategies: CA and OR

- Spatial & temporal flexibility
- Species
- Ecosystem stewardship
- Intentional mgmt.
- Method/gear type
- Retail and wholesale
- Marketing/price
- Water intake
- Variable ploidy

"*You can't just say, oh, this is the best place to grow and I'm going to start growing them here. You have to get permits obviously, and so it's very restrictive.*" - CA grower

Policy and Networking: CA and OR

- Permitting/regulatory changes
- Network
- Funding
- Water quality (WQ) response

"All the coordination amongst the different agencies, it's been consuming a considerable amount of time… It's just been increasing in cost and increasing in time and increasing in complexity over the years… What it means is that for people at an entry level, the bar is very, very high." - CA grower

"We work really closely with some of these agencies that are giving us the green light or red light… and they are really key. Having people that are knowledgeable…" – CA grower

Science and Monitoring: CA and OR

- Shellfish health knowledge
- Genetic resistance
- Monitor OA and water quality (WQ)
- Environmental impacts research

“There are these mortality events that happen in oyster culture that are usually not clear why they happen but they often happen in the summertime and they might be related to warm water or spawning events… we just had a big die off in June of this year where we lost about half of our year-old oysters, and I have no idea what caused it or why.” - CA grower

Science and Monitoring: CA and OR

- Shellfish health knowledge
- Genetic resistance
- Monitor OA and water quality (WQ)
- Environmental impacts research

"Our crew can log in on their phone when they've harvested, we can add everything from water temperature to when it goes into wet storage, out of wet storage, and all that.. . . The oyster tracker gives us better control of our inventory, will give us better control of mortality, . . our true larvae to product count"– OR grower

Key similarities and differences between CA and OR

- More variety in CA shellfish growing operations (cultured more species) than OR (predominantly oysters)
- Disease was the most frequently mentioned environmental stressor in CA, predators/nuisance species in OR
- Permits and licensing burdensome in both locations
- Permitting changes and networking important strategies in both locations; shellfish health knowledge & funding described more consistently by CA growers, marketing & method/gear type by OR growers


TNC, 2019

Persistence of ecosystems, communities, and industries will require nimble and flexible adaptive responses that keep pace with multiple stressors


Brian Feulner, SF Chronicle

Questions??

For more information:

Ward, M., Spalding, A., Levine, A. and Wolters, E., 2022. California shellfish farmers: Perceptions of changing ocean conditions and strategies for adaptive capacity. *Ocean & Coastal Management*, *225*, p.106155.

Green, K., Spalding, A., Ward, M., Levine, A., Wolters, E., Hamilton, S.L. and Rice, L., 2023. Oregon shellfish farmers: Perceptions of stressors, adaptive strategies, and policy linkages. *Ocean & Coastal Management*, *234*, p.106475.

Funding:

Climate resilience for shellfish aquaculture - challenges and opportunities

Luke Gardner

OAH and West Coast Shellfish Aquaculture:

Adaptation in a Changing Climate

October 24th

Existential Crisis

- OA can effect shellfish aquaculture
- Farmers recognize it as a threat but don't act
- Too big of a problem or not pressing enough
- Acceptance

Challenges

- Knowing what the issue is
- Hatchery OA effects well documented and mitigated with controlled conditions and buffering


HATCHERY INTERNATIONAL

MENU NEWS FEATURES GENETICS EVENTS WEBINARS TOP 10 UNDER 40 VIDEOS MA

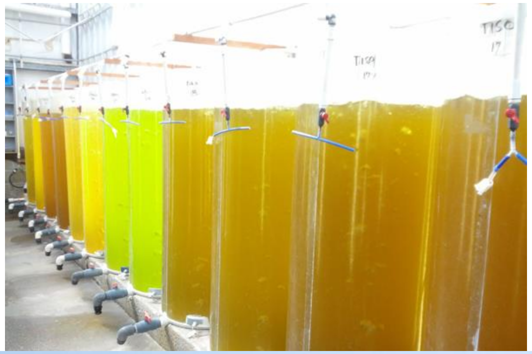
Features > Restocking

Shellfish hatchery recovers lost ground with careful OA monitoring

The Whiskey Creek Shellfish Hatchery at Netarts Bay in Tillamook Oregon

Challenges

- What about juveniles and adults?
- Hatcheries are controllable but expensive
- Raising juveniles in controlled settings is unlikely profitable
- Raising adults in controlled settings is prohibitively expensive



Challenges

- What about juveniles and adults?
  - Less is known but…
  - OA shown to effect a number of aspects but more subtly
    - Increased energy metabolism
    - Decreased growth
    - Decreased immune functions
    - Impaired reproduction
    - Weakened shells

marine drugs MDPI

Mar Drugs. 2010 Aug 11;8(8):2318–2339. doi: 10.3390/md8082318

Impact of Ocean Acidification on Energy Metabolism of Oyster, *Crassostrea gigas*—Changes in Metabolic Pathways and Thermal Response

Gisela Lannig[1,*], Silke Eilers[1], Hans O Pörtner[1], Inna M Sokolova[2], Christian Bock[1]

SCIENTIFIC REPORTS natureresearch

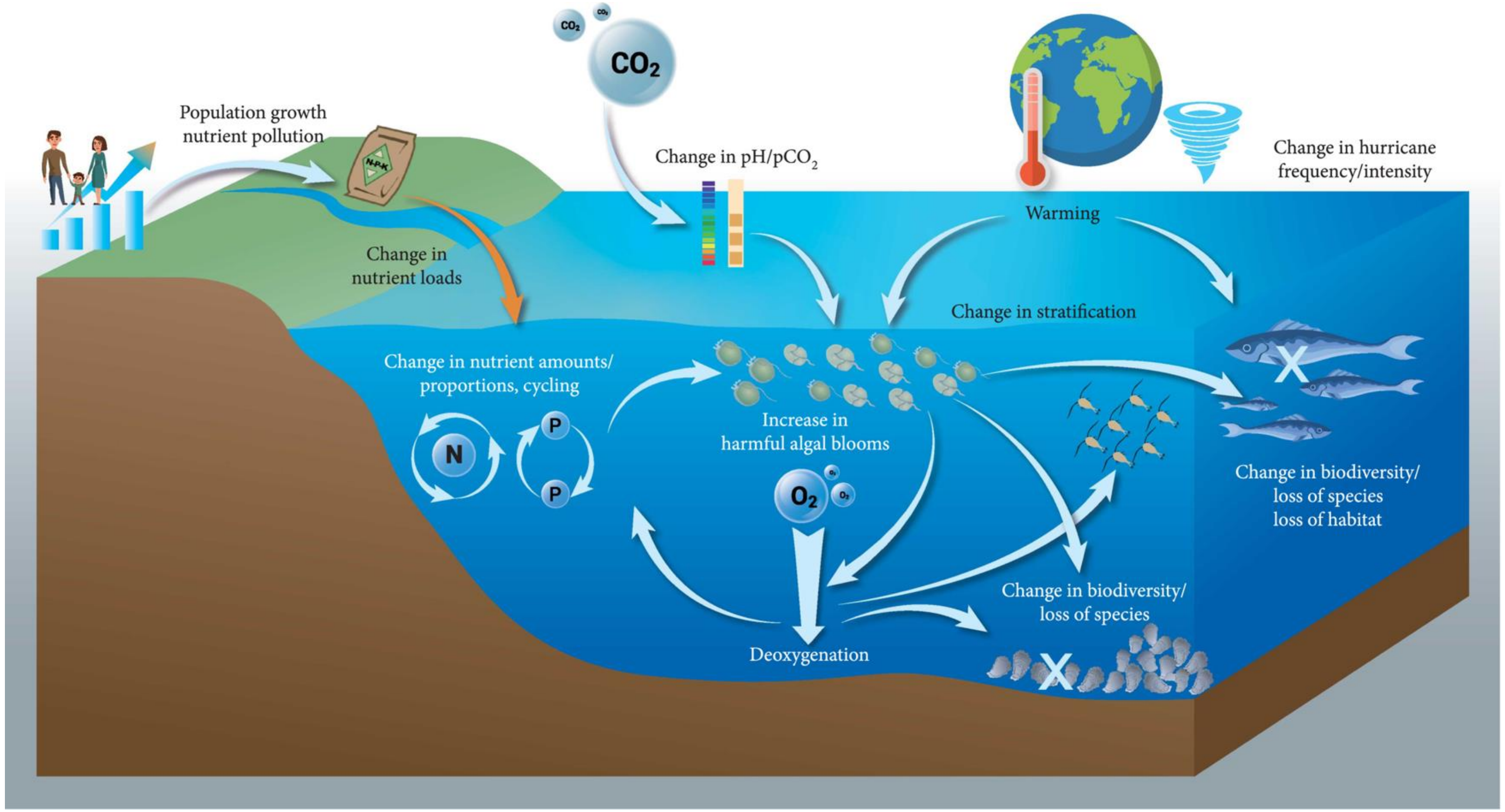
Sci Rep. 2017 Oct 16;7:13276. doi: 10.1038/s41598-017-13480-3

Oyster reproduction is compromised by acidification experienced seasonally in coastal regions

Myrina Boulais[1,✉], Kyle John Chenevert[1], Ashley Taylor Demey[1], Elizabeth S Darrow[1], Madison Raine Robison[1], John Park Roberts[1], Aswani Volety[1]

Challenges

- Multi-stressors
  - Climate change brings lots of changes beyond OA
  - Estuaries are highly variable environments
  - Increasingly observed that stressors have additive effects on shellfish performance
  - Very complex to understand



Challenges

- Summer Oyster Mortality Syndrome / Sudden Usual Mortality Syndrome
  - Very difficult to identify risk factors
  - Getting worse – up to 90% of adult oysters on farms dying
  - Some indications that it is associated with triploid oysters
  - Regulators are requiring the exclusive use of triploid oysters

Brutal season for farmed oyster mortality along NC coast

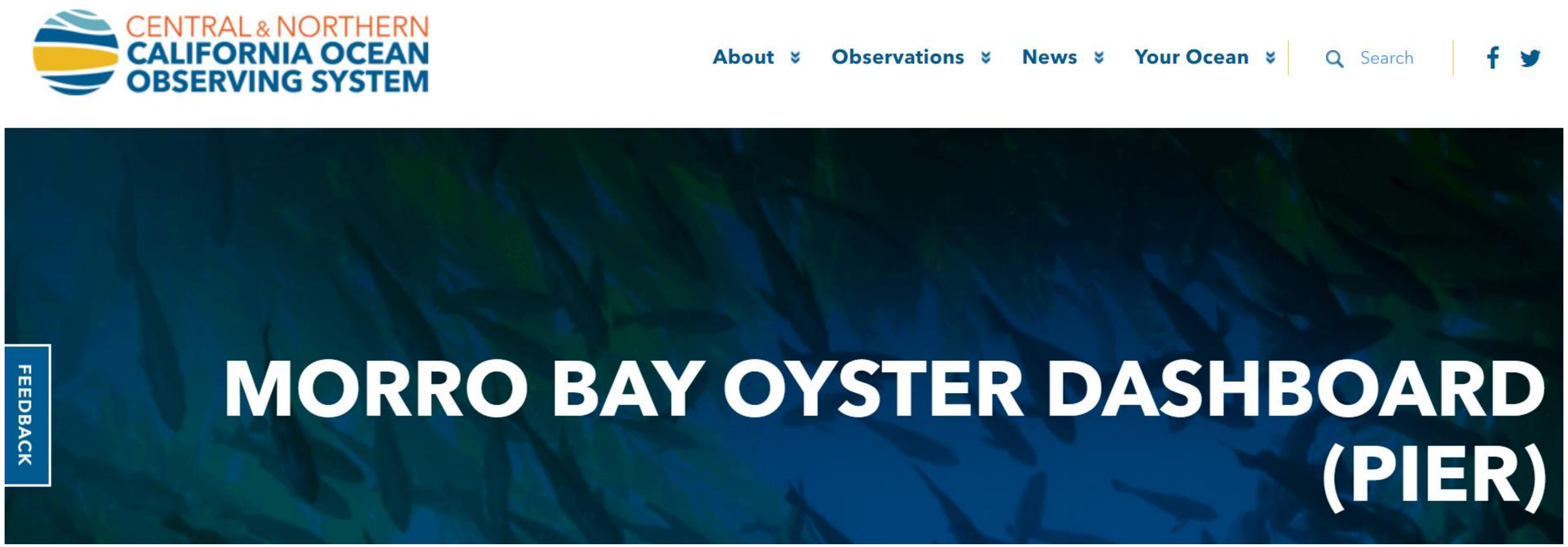
June 27, 2022 | CMAST | 3-min. read

Challenges

- Solutions have been slow to come
  - While studying the issue is important so is testing potential solutions
  - Shellfish aquaculture is usually done extensively as opposed to intensively making intervention difficult
  - Regulations limit research, adaptability, and innovation

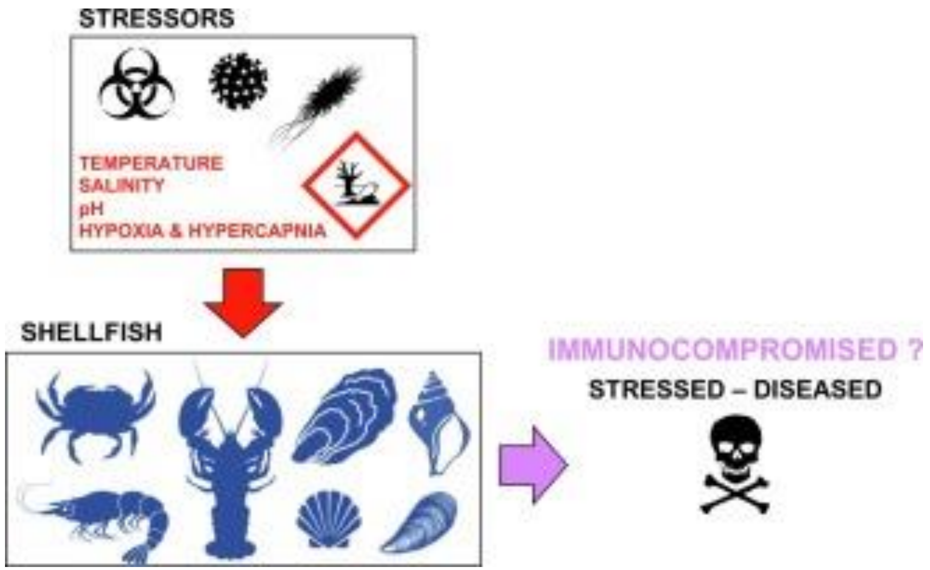
Opportunities

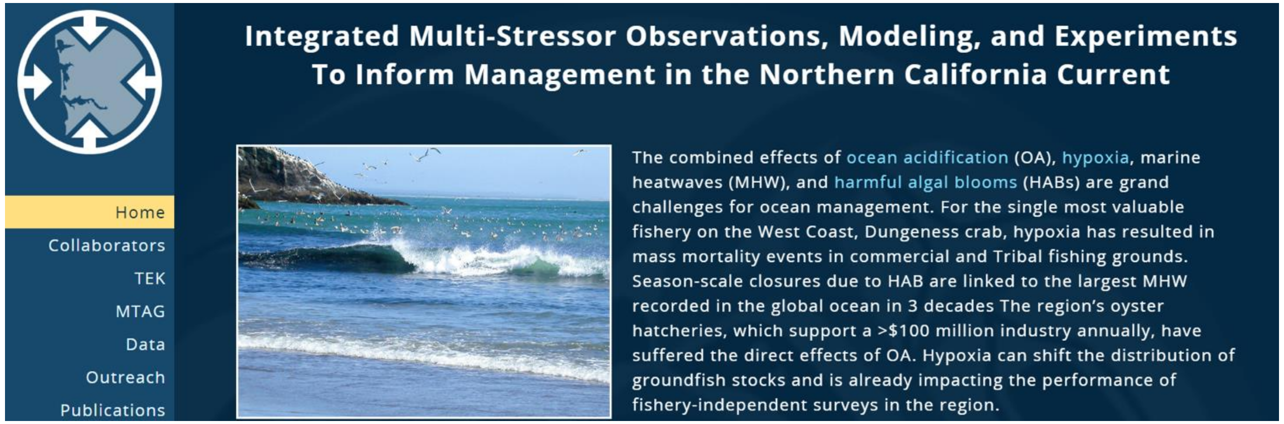
- Monitoring
  - Co-location of sensors with farms
  - more extension of information



Opportunities

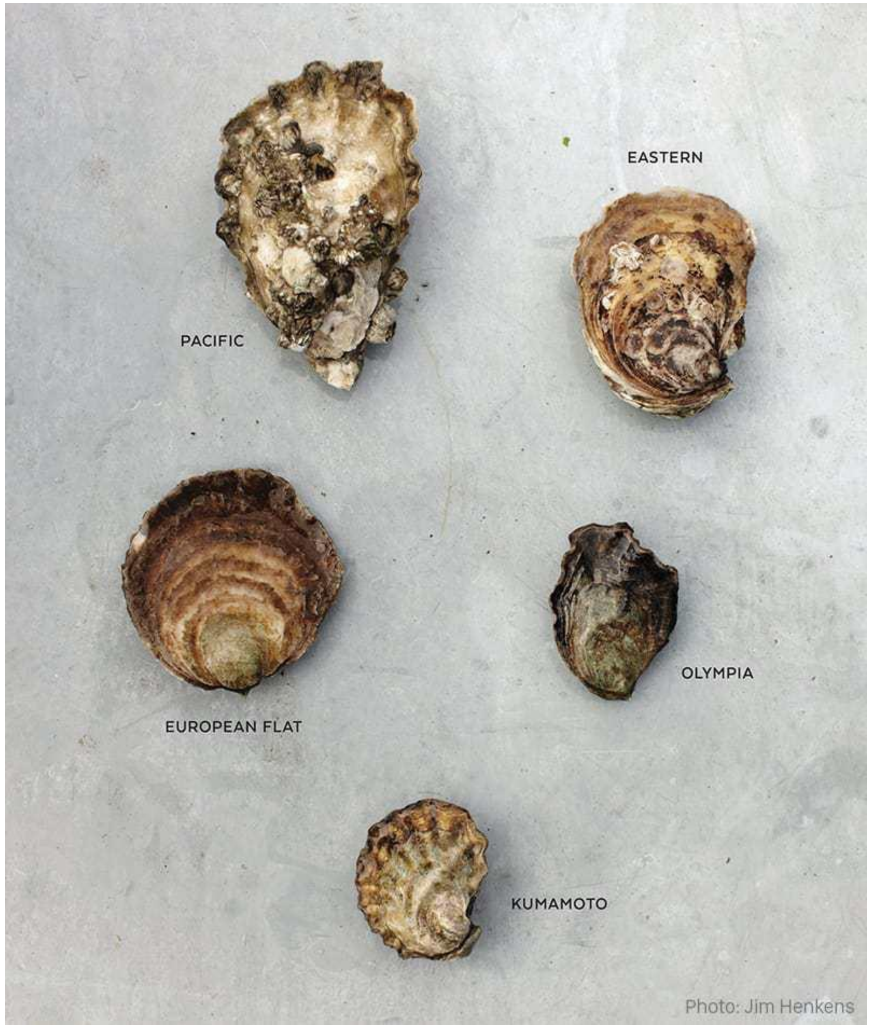
- Multi-stressor research
  - Combination of stressors are having effects
  - Highly dynamic environments - need better understanding of risk factors and impacts to farms
  - Will help with forecasting and mitigation measures
  - Sentinel farming research sites to understand farm level impacts, requires same farming methods





Opportunities

- Species Diversification
  - Different species of shellfish have different resilience to OA and other co-factors
  - Integrated Multitrophic Aquaculture, potential for seaweed to have buffering halo effect on shellfish farms



Sea Grant California

Opportunities

- Hardening shellfish
  - Studies have shown a propensity to prime shellfish during early life stages to perform better as adults and confer transgenerational resistance
  - Genetic selection has shown promise again OA and other stressors in shellfish

RESEARCH ARTICLE

Persistence of Positive Carryover Effects in the Oyster, *Saccostrea glomerata*, following Transgenerational Exposure to Ocean Acidification

Laura M. Parker, Wayne A. O'Connor, David A. Raftos, Hans-Otto Pörtner, Pauline M. Ross

Published: July 6, 2015 • https://doi.org/10.1371/journal.pone.0132276

Ocean acidification

Adult exposure to ocean acidification is maladaptive for larvae of the Sydney rock oyster *Saccostrea glomerata* in the presence of multiple stressors

Laura M. Parker, Wayne A. O'Connor, Maria Byrne, Ross A. Coleman, Patti Virtue, Michael Dove, Mitchell Gibbs, Lorraine Spohr, Elliot Scanes and Pauline M. Ross

Published: 01 February 2017 | https://doi.org/10.1098/rsbl.2016.0798

Scared strong: Enhancing oyster resilience for aquaculture and restoration by inducing oysters to grow stronger shells

Dataset extent

Opportunities

- Hardening shellfish
  - Studies have shown a propensity to prime shellfish during early life stages to perform better as adults and confer transgenerational resistance
  - Genetic selection has shown promise again OA and other stressors in shellfish

BREEDING OA-RESISTANT OYSTERS

Crossbreeding and Selection for Resistance to Ocean Acidification in Pacific Oysters

Researchers used genetic approaches to develop broodstocks for the shellfish industry that are better adapted to increasingly corrosive seawater impacting our coasts and estuaries.

Opportunities

- Regulatory and farming flexibility
  - Ability to do field research and pilots in a timely manner
  - Being able to move stocks seasonally and quickly
  - Ability to change farming gear and techniques
  - Species diversity available to farm
  - Diploid vs triploid use of oyster species
  - Adaptative response to real-time data
  - Affordable crop insurance

LUNCH BREAK

Reconvene at 1:30 (if we are on time at this point…)

PC: Athena Maguire

PC: Athena Maguire

PART THREE

Policy and Management: Shellfish Aquaculture and Adaptive Capacity

1) **Randy Lovell,** California Department of Fish and Wildlife
   Realistically improving adaptive management within California’s aquaculture regulatory framework

2) **Katie Cieri**, California Ocean Protection Council
   OPC Aquaculture, Ocean Acidification, and Hypoxia Priorities

3) **Anthony Rogers**, *Ocean Science Trust*
   Ocean Science Trust: Navigating science-policy linkages to support California on OAH and aquaculture

Realistically improving adaptive management within California's aquaculture regulatory framework

OAH and West Coast Shellfish Aquaculture: Adaptation in a Changing Climate

24 Oct 2024

Randy Lovell
State Aquaculture Coordinator
CA Dept Fish and Wildlife

“Regulatory Framework”

= STATUTES, REGULATIONS, AND ENFORCEMENT ACTIONS GOVERNING AN ACTIVITY;

GOVERNANCE – REGULATORY FRAMEWORK – CONCEPT OF COMPLIANCE

vs “Management Framework”

SET OF TOOLS AND APPROACHES – REFLECT SOCIETAL PRIORITIES

[*IDEALLY*] OBJECTIVELY INFORMED BY SCIENCE AND TRANSPARENT PUBLIC DISCOURSE/DECISION-MAKING,

TOWARD BROAD DESIRED OUTCOMES

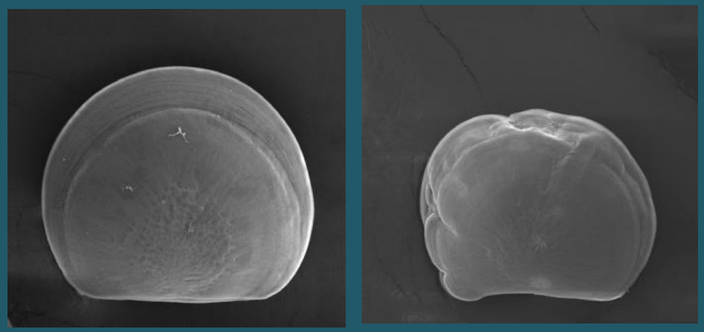
EMPLOYING ADAPTIVE MANAGEMENT

"Adaptive Management"

as defined in CA Fish & Game Code §13.5

... improves the management of biological resources over time by using new information gathered through monitoring, evaluation, and other credible sources as they become available, and adjusts management strategies and practices to assist in meeting conservation and management goals.

Under adaptive management, program actions are viewed as tools for learning to inform future actions.



= Expect Change

“Adaptive Management”

as mandated throughout CA Fish & Game Code, and CA Water Code,

exemplified in FGC §703.3:

… Resource management decisions of the Department (CDFW) and Commission (CFGC)

should also incorporate adaptive management to the extent possible.

= Respond to Change

HOW WELL ARE WE RESPONDING TO CHANGE?

AQUACULTURE PERMITTING – WHO'S INVOLVED ?

+ THE PUBLIC

EXISTING REGULATORY FRAMEWORK

CONSISTS OF MANY STATUTORY ACTS, CODES, AND REGULATIONS

FISH & GAME CODE

TITLE 14 REGULATIONS (NATURAL RESOURCES)

CEQA (CA ENVIRONMENTAL QUALITY ACT)

CA COASTAL ACT / CZMA (COASTAL ZONE MGT ACT)

RIVERS & HARBORS ACT - US ARMY CORPS OF ENGINEERS

CLEAN WATER ACT & PORTER-COLOGNE - WATER BOARDS, USACE

ESA, MMPA, M-S ACT - NOAA (PROTECTED RESOURCES DIV)

PRIVATE AIDS TO NAVIGATION – US COAST GUARD

PUBLIC HEALTH CODE & NATIONAL SHELLFISH SANITATION PROGRAM

Is Our Aquaculture Management Framework Adaptive ?

MANAGEMENT FRAMEWORK BUILT UPON REGULATORY FRAMEWORK

SITING - LEASE APPLICATION PROCESS (CEQA + F&G COMMISSION HEARINGS) F&G COMMISSION

SENSITIVE HABITAT PROTECTIONS – CEQA + NEPA PROCESSES, USACE CONSULTATION W/ NOAA

STRUCTURAL CONSIDERATIONS – MATERIALS & DESIGNS – COASTAL ACT (CCC)

MIN. NAVIGATIONAL CONFLICTS - US COAST GUARD + USACE (SEC 10: R&H ACT) + F&G CODE

REASONABLE PUBLIC ACCESS - F&G CODE SEC. 15411 + 15413; COASTAL ACT (CCC)

PROTECT WATER QUALITY - CLEAN WATER ACT (USACE + WATER BOARDS)

SUBSTRATE QUALITY & BENTHIC IMPACTS - CLEAN WATER ACT (USACE + WATER BOARDS)

PREVENT DISEASE AND SPREAD OF INVASIVE SPECIES - *TITLE 14 REGULATIONS (DFW)*

FOOD SAFETY & PUBLIC HEALTH – NSSP & PUBLIC HEALTH CODE (CDPH + EPA)

SPILL PREVENTION AND RESPONSE - LEASE TERMS & CEQA (FGC)

MANAGEMENT CONCERNS ADDRESSED BY EXISTING CODE & REGULATIONS

CEQA

THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (1970)

REQUIRES PUBLIC AGENCIES TO:

- CONSIDER AND DISCLOSE TO THE PUBLIC THE ENVIRONMENTAL IMPLICATIONS OF THEIR ACTIONS, AND

- AVOID OR REDUCE SIGNIFICANT ENVIRONMENTAL IMPACTS OF THESE ACTIONS WHEN FEASIBLE TO DO SO.

PUBLIC RESOURCES CODE § 21000 ET SEQ.

CEQA

THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (1970)

THE PRIMARY PURPOSES OF CEQA ARE TO:

- REDUCE OR PREVENT ENVIRONMENTAL DAMAGE, AND

FOSTER AN INFORMED AND TRANSPARENT PUBLIC DECISION-MAKING PROCESS

BY PROVIDING INFORMATION TO DECISION-MAKERS AND THE PUBLIC

CONCERNING THE ENVIRONMENTAL EFFECTS OF PROJECTS

EITHER UNDERTAKEN **OR APPROVED** BY LEAD AGENCIES.

PUBLIC RESOURCES CODE § 21000 ET SEQ.

CEQA

THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (1970)

Regulations

Title 14 CCR

§ 237. Leasing of State Water Bottoms for Aquaculture.

(b) Applications.

(7) The change of any authorized cultural practices as specified in the aquaculture lease or agreement must have approval of the commission before the change is put into effect.

36. SPECIAL CONDITIONS. This lease is for the sole purpose of cultivating Pacific oysters (*Crassostrea gigas*), Quahog clams (*Mercenaria mercenaria*), Manila clams (*Venerupis philippinarum*), Mussels (*Mytilus* spp.), Ghost shrimp (*Neotrypaea* spp.), and Innkeeper worms (*Urechis* spp.). Shellfish cultivation methods for this lease shall be confined to longlines, bags, stakes, barge, and on-bottom culture methods. No other mode of operation or culture method is authorized.

A CHANGE TO THE APPROVED SPECIES OR CULTURE METHODS TRIGGERS CEQA

CEQA

THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (1970)

CEQA IS "A SELF-EXECUTING STATUTE" - NO SINGLE AGENCY ENFORCES.

PUBLIC AGENCIES ENTRUSTED TO COMPLY WITH CEQA, AND
ITS PROVISIONS ARE ENFORCED, AS NECESSARY, BY THE PUBLIC THROUGH LITIGATION AND THE THREAT THEREOF.

IN ADDITION TO THE ENVIRONMENTAL IMPACTS OF A PROJECT,
LEAD AGENCIES DRIVEN BY CONSIDERATION OF LEGAL RISK IN THEIR ADMINISTRATIVE AND DECISION-MAKING PROCESSES.

NAVIGATING CEQA OFTEN RELIES ON LEGAL COUNSEL WITH KNOWLEDGE OF SURROUNDING CASE LAW,
WITH SUBJECT MATTER EXPERTISE OFTEN PROVIDED BY PROFESSIONAL CONSULTANTS.

= $$$$

= $$$$

Selecting for what suite of management options?

What implications for Access to Opportunity?

for Diversity, Equity, Inclusion?

What implications for nimble, adaptive management?

Possible solutions:

Programmatic CEQA

consolidate similar projects and
analyze environmental impacts together in one CEQA process

Programmatic or General Permitting

utilize programmatic CEQA to permit similar projects;

Organize proponents & pool high costs

amortize cost of programmatic CEQA across many projects;
consider revolving fund model;
pool financial surety deposits for cleanup funds;

(**business parks, ports, associations, joint power authorities, RCD's ?**)

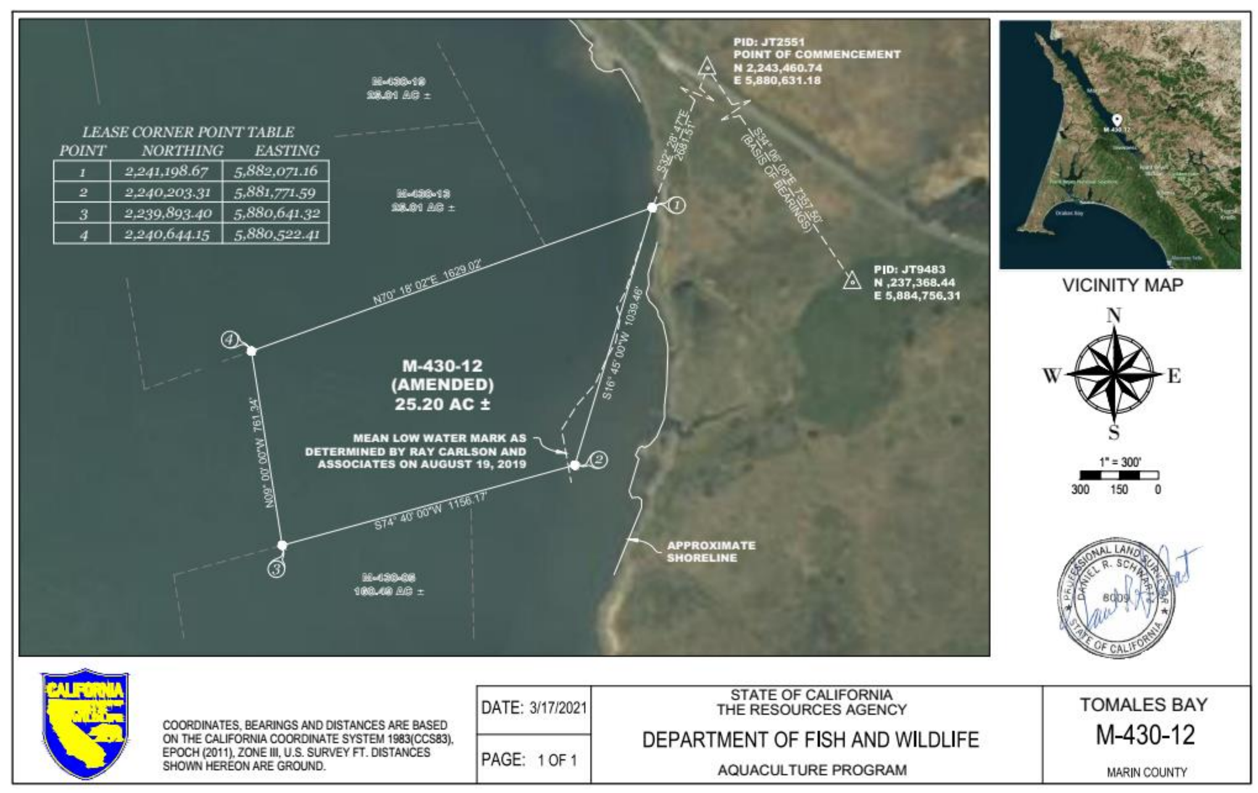
LOCATION – LOCATION - LOCATION

ADAPTING TO CHANGING OCEAN CONDITIONS

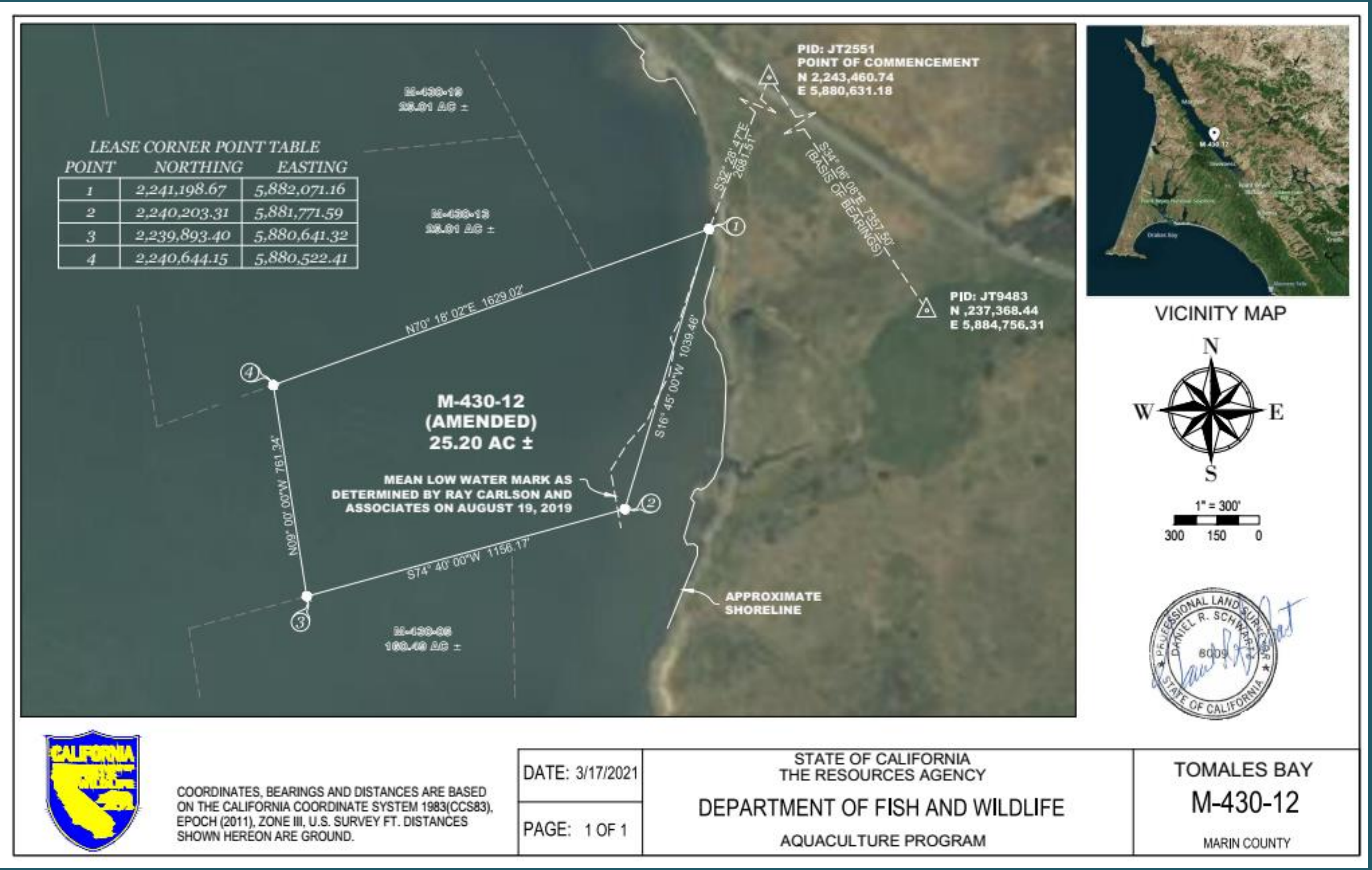
WATER LEVELS (DEPTHS / ELEVATIONS)

IDEAL CULTURE SETTING

LEASE BOUNDARIES AND DESCRIPTIONS



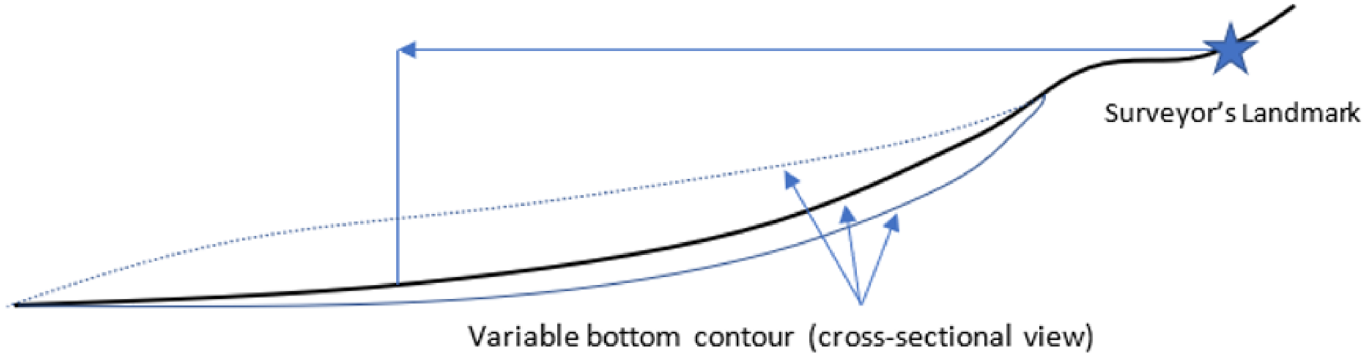
ADMINISTRATIVELY, HOW DO WE ADAPT ?



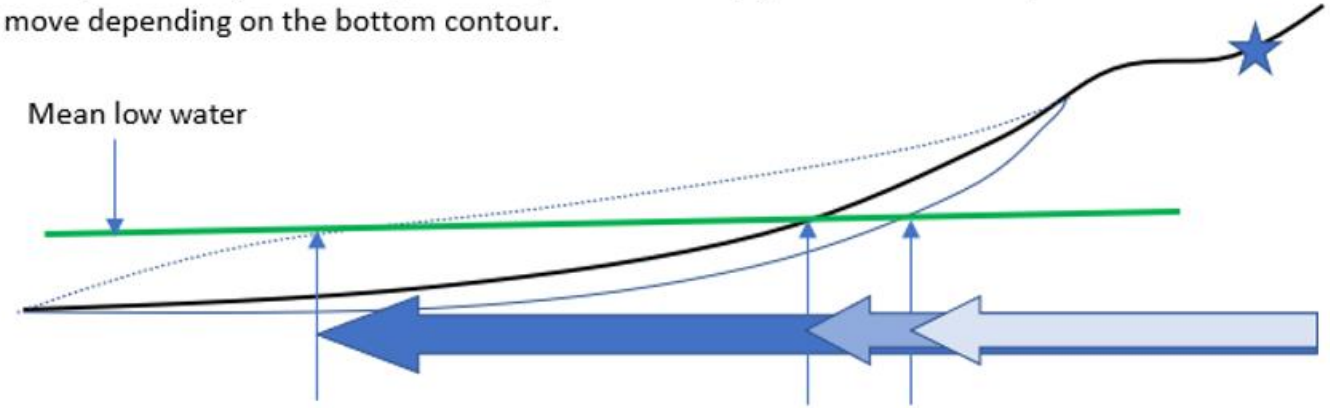
LEASE CORNER POINT TABLE

POINT	NORTHING	EASTING
1	2,241,198.67	5,882,071.16
2	2,240,203.31	5,881,771.59
3	2,239,893.40	5,880,641.32
4	2,240,644.15	5,880,522.41

Metes & bounds lease description (as used in state water bottom leases by FGC):
regardless of bottom contour changes, horizontal distance from landmark remains constant.



Ambulatory boundary description:
reference (in this case) is vertically defined by tidal datum (eg: Mean Low Water), and
may move depending on the bottom contour.



(horizontal) boundary may change as bottom contour changes

INFORMATION / FORMS: **WILDLIFE.CA.GOV / AQUACULTURE**

OUTREACH: **AQUACULTUREMATTERS.CA.GOV**

RANDY LOVELL
STATE AQUACULTURE COORDINATOR
AQUACULTURECOORD@WILDLIFE.CA.GOV

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

OPC Aquaculture, OAH Priorities

Katie Cieri, Sustainable Fisheries and Aquaculture Program Manager

OAH and West Coast Shellfish Aquaculture Workshop

October 24, 2024

OPC Mission & Priorities

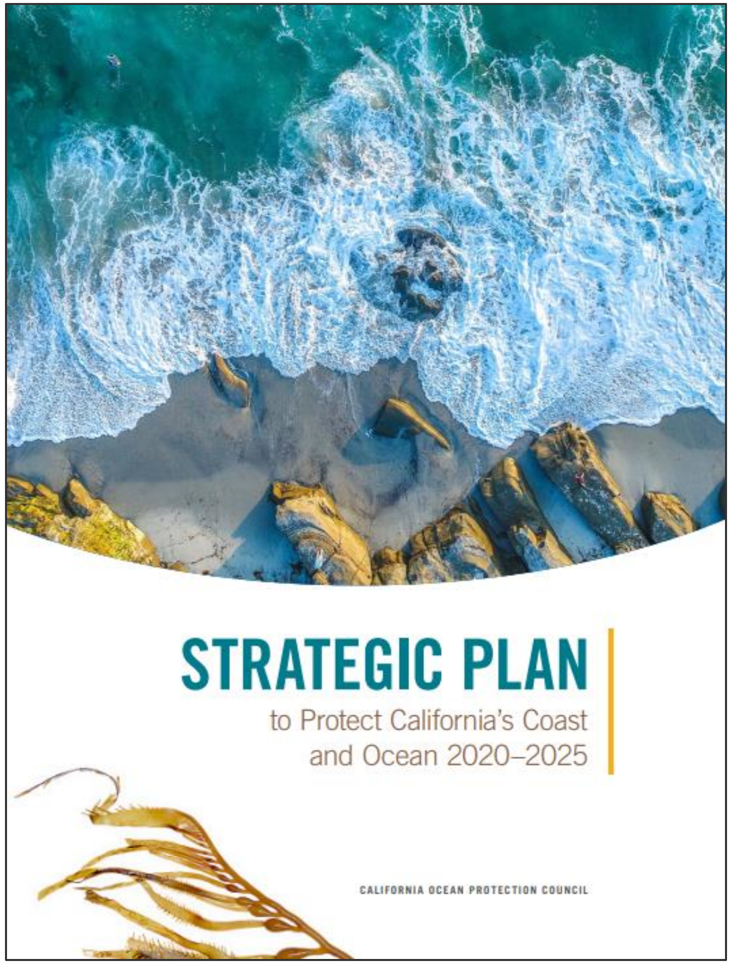
Protect California's coast and ocean by advancing innovative, science-based policy and management, making strategic investments, and catalyzing action through partnerships and collaboration.

Climate Change

Equity

Biodiversity

Sustainable Blue Economy



CALIFORNIA OCEAN PROTECTION COUNCIL

2026-2030 Strategic Plan

Fall-Winter 2025
Public listening sessions and tribal roundtables

Late Spring-Summer 2024
Draft release and public comment

June 2025
Present draft at OPC meeting

November 2025
Release Final Strategic Plan

December 2025
Approval at OPC Meeting

First Public Listening Session

Wednesday, November 20, 2024
3-4pm
opc.ca.gov/2026-2030-strategic-plan/

CALIFORNIA OCEAN PROTECTION COUNCIL

Talk Outline

Climate Change

- Ocean Acidification and Hypoxia
    - Nutrients and OAH
        - Modelling Efforts
    - Ocean Acidification Action Plan
        - Monitoring Recommendations
            - Coordination and standardization
            - Research, monitoring, and synthesis

Coast and Ocean Report Card

Sustainable Blue Economy

- Aquaculture
    - Aquaculture Action Plan

Safeguard Coastal and Marine Ecosystems and Communities in the Face of Climate Change

Objective: Minimize Causes and Impacts of Ocean Acidification and Hypoxia

CALIFORNIA OCEAN PROTECTION COUNCIL

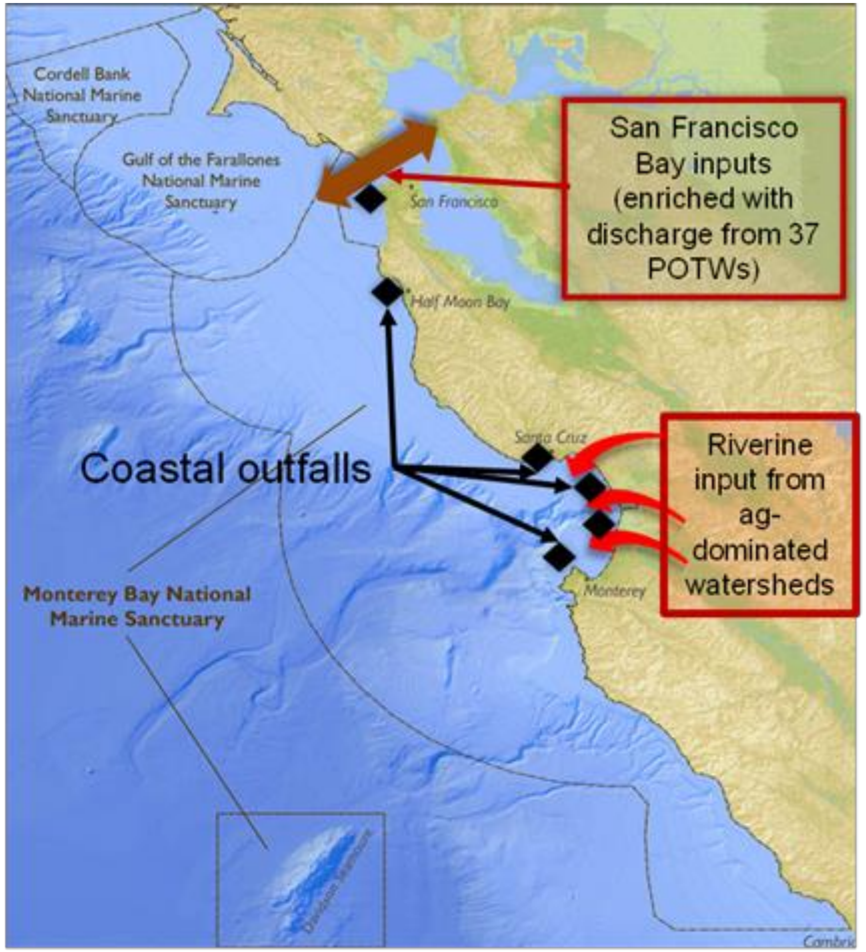
Water Quality and OAH

Targets:

- Conduct scientific analysis on nutrients and OAH impacts

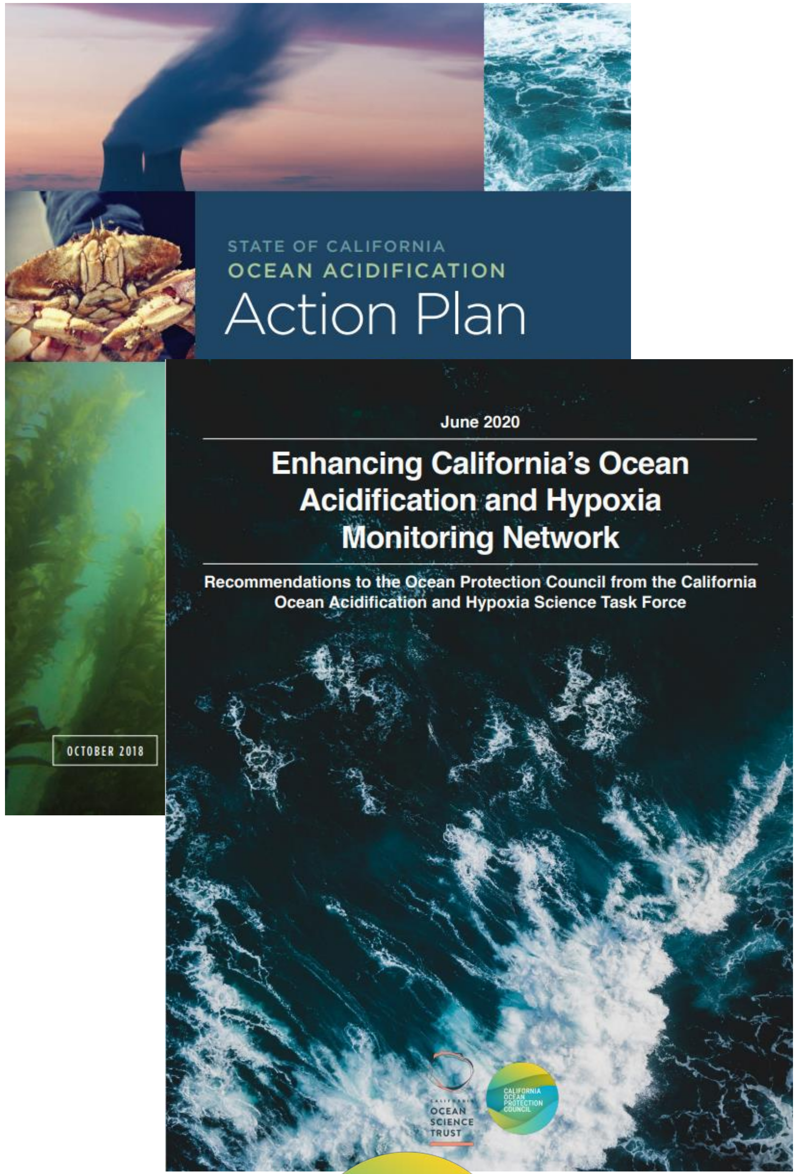
Ongoing funding:

- Research and modeling on the impacts of nutrients from coastal pollution sources on OAH
    - Southern California Bight
    - Central Coast



CALIFORNIA OCEAN PROTECTION COUNCIL

Implementation of California's Ocean Acidification Action Plan



Target: Support the development of an OAH monitoring and observation system

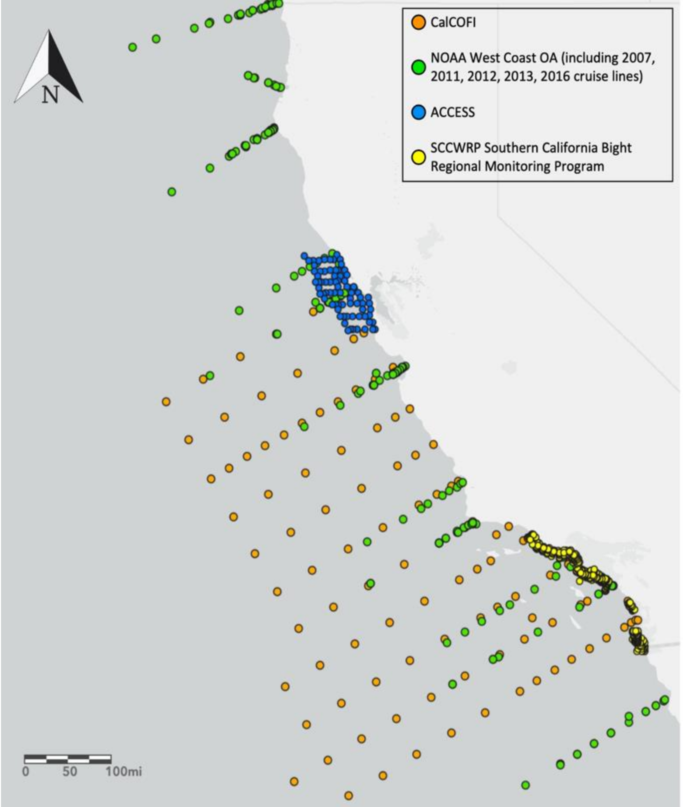
Actions:

- OAH Science Task Force - Monitoring gap analysis
    - Coordination and standardization of biological and chemical monitoring
    - Projects to address research, monitoring, and synthesis priorities

CALIFORNIA OCEAN PROTECTION COUNCIL

Enhancing California's OAH Monitoring Network

Coordinated set of projects to better connect chemical and biological monitoring



Tasks:

- Develop protocols and best practices
- Adopt standardized sampling and analysis
- Enhance coordination and protocols for HABs and eDNA
- Conduct data management, aggregation, and curation
- Synthesize and interpret across programs to support management

Outcomes:

- Paired biological and chemical monitoring
- Enhance coordination, collaboration, data interoperability, and regional synthesis

CalCOFI est. 1949

SCCWRP Established 1969

OAP OCEAN ACIDIFICATION PROGRAM

CeNCOOS CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

ACCESS

CALIFORNIA OCEAN PROTECTION COUNCIL

OAH Research, Monitoring, and Synthesis Projects

- OAH Monitoring off Northern California (Humboldt State)
- Assessing the Potential for Rapid Adaptation in Rockfish (CSUMB)
- California OAH Portal to Enable State-wide Status and Trends (CenCOOS)
- Multi-stressor Tools to Interpret Effects of Acidification, Hypoxia, and Warming on Southern California Current Marine Calcifiers (SCCWRP)

CALIFORNIA OCEAN PROTECTION COUNCIL

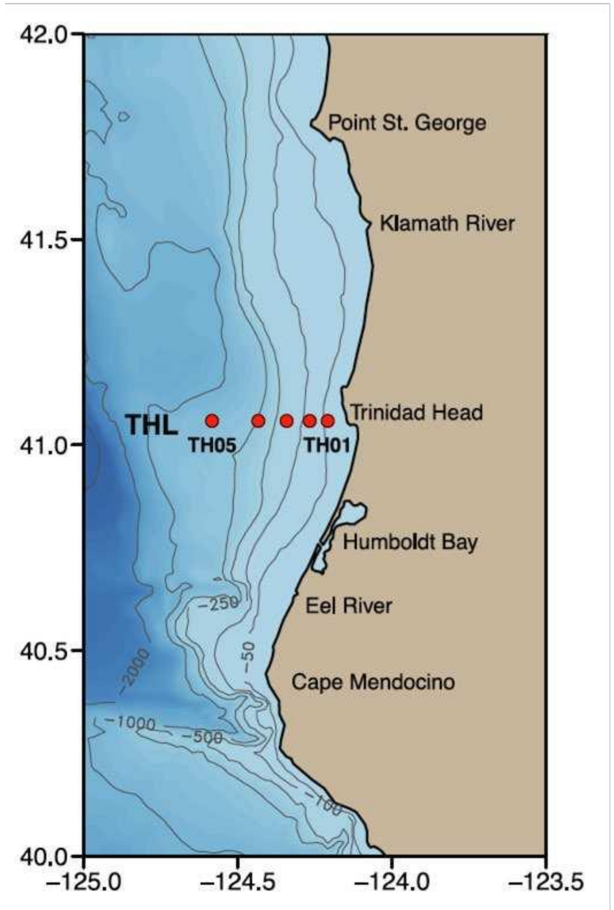
OAH Research, Monitoring, and Synthesis Projects

OAH Monitoring off Northern California (Humboldt State)

- Establish Trinidad Head Ocean Observing Node (THOON)
- Implement routine OAH measurements
- Develop real-time statistical forecasts of OAH exposure

Assessing the Potential for Rapid Adaptation in Rockfish (CSUMB)

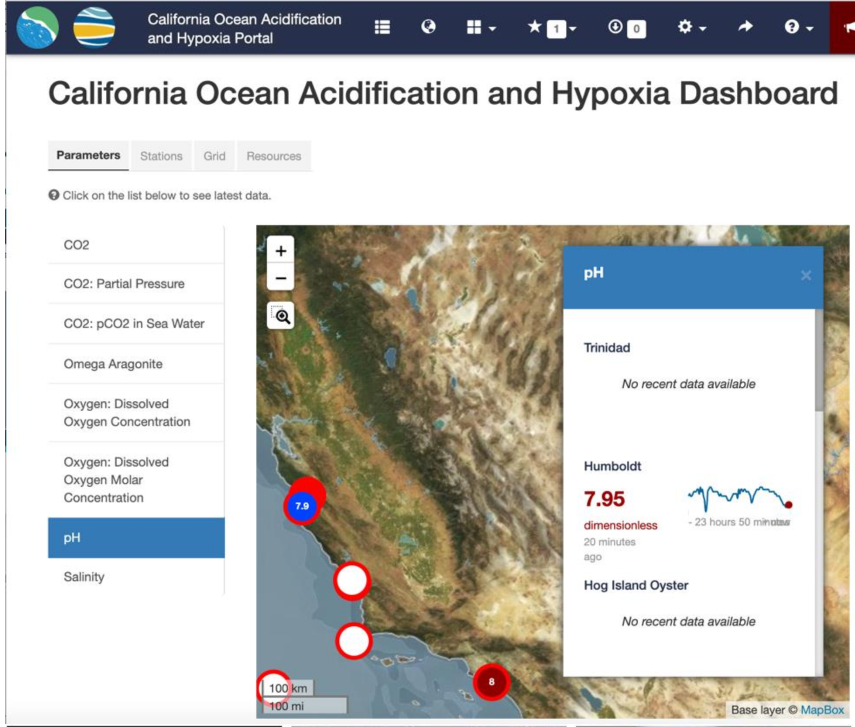
- Investigate influence of adult environment on offspring
- Stock assessment model



OAH Research, Monitoring, and Synthesis Projects

California OAH Portal to Enable State-wide Status and Trends (CenCOOS)

- Repository of OAH data and synthesis products
- OAH Portal oah.caloos.org

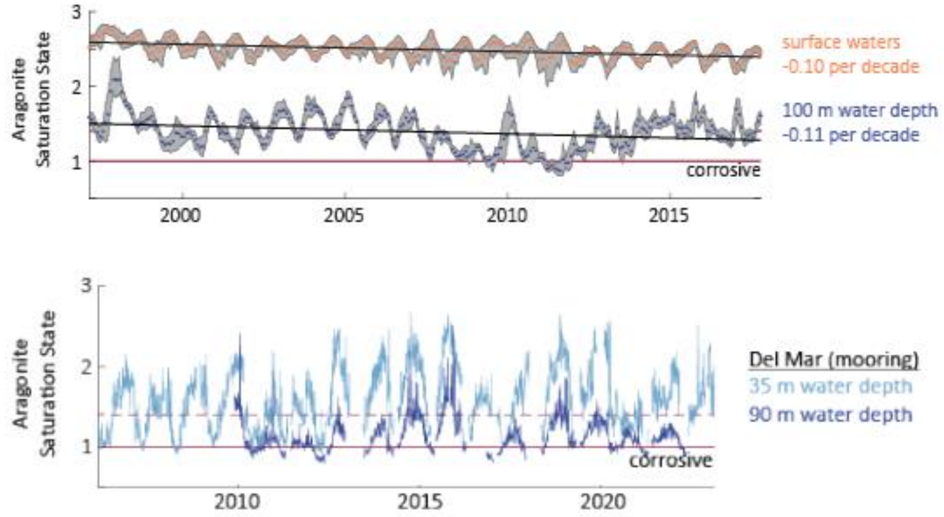


Multi-stressor Tools to Interpret Effects of Acidification, Hypoxia, and Warming on Southern California Current Marine Calcifiers (SCCWRP)

- Develop interpretation and tools for current and future
- Develop mechanics and indices
- Evaluate marine calcifier habitat compression

CALIFORNIA OCEAN PROTECTION COUNCIL

Annual State of the Coast and Ocean Report



Coast and Ocean Report Card

Fall 2024
Public and tribal engagement

February 2025
Draft report card presented at OPC meeting

Winter-Spring 2025
Development of indicators and metric

December 2025-2026
Final Report Card

Virtual Office Hours

Monday, October 28
Wednesday, November 6
12-1pm
Opc.ca.gov/annual-reports

CALIFORNIA OCEAN PROTECTION COUNCIL

Support Ocean Health Through a Sustainable Blue Economy

Objective: Develop an Aquaculture Action Plan

California envisions a sustainable and robust commercial aquaculture industry that is ***informed by best available science****; compatible with wild fisheries; guided by comprehensive planning, permitting, and collaboration; causes minimal harm to the environment; protects public access; supports living wages and equitably grows the state's economy.*

CALIFORNIA OCEAN PROTECTION COUNCIL

GUIDING PRINCIPLES FOR SUSTAINABLE MARINE AQUACULTURE IN CALIFORNIA

VISION

California has a tremendous opportunity to advance sustainable marine aquaculture in a way that serves as a model for other states around the nation. We envision a robust, sustainable commercial aquaculture industry that is informed by best available science; compatible with wild fisheries; guided by comprehensive planning and collaboration; causes minimal harm to the environment; provides local, safe and healthy food production; supports living wages and equitably grows the state's economy; partners with California Native American Tribes; and protects public access.

COLLABORATING AGENCIES

California Coastal Commission
California Department of Fish and Wildlife
California Department of Food and Agriculture
California Department of Public Health
California Fish and Game Commission
California Natural Resources Agency
California Ocean Protection Council
California State Coastal Conservancy
California State Lands Commission
State Water Resources Control Board

Guiding Principles for Sustainable Marine Aquaculture

1. Develop and Utilize Best Available Science
2. Ensure Aquaculture Sustainability
3. Build Governance and Management Partnerships
4. Ensure Effective Aquaculture Planning
5. Develop and Implement Efficient and Effective Aquaculture Oversight
6. Protect Public Health and Food Safety

CALIFORNIA OCEAN PROTECTION COUNCIL

Aquaculture Action Plan

Goals:

- Improve California's aquaculture governance framework through increased interagency coordination and transparency
- Ensure environmental sustainability and public safety
- Identify pathways to facilitate expansion of sustainable marine aquaculture

Working draft expected in 2025 with a robust tribal consultation and public engagement process to follow

CALIFORNIA OCEAN PROTECTION COUNCIL

CALIFORNIA OCEAN PROTECTION COUNCIL

Thank you!

Katie Cieri, Sustainable Fisheries and Aquaculture Program Manager

Katie.cieri@resources.ca.gov

CALIFORNIA OCEAN SCIENCE TRUST

Ocean Science Trust: **Navigating Science-Policy Linkages to Support California on OAH and Aquaculture**

Anthony Rogers, OST

October 2024

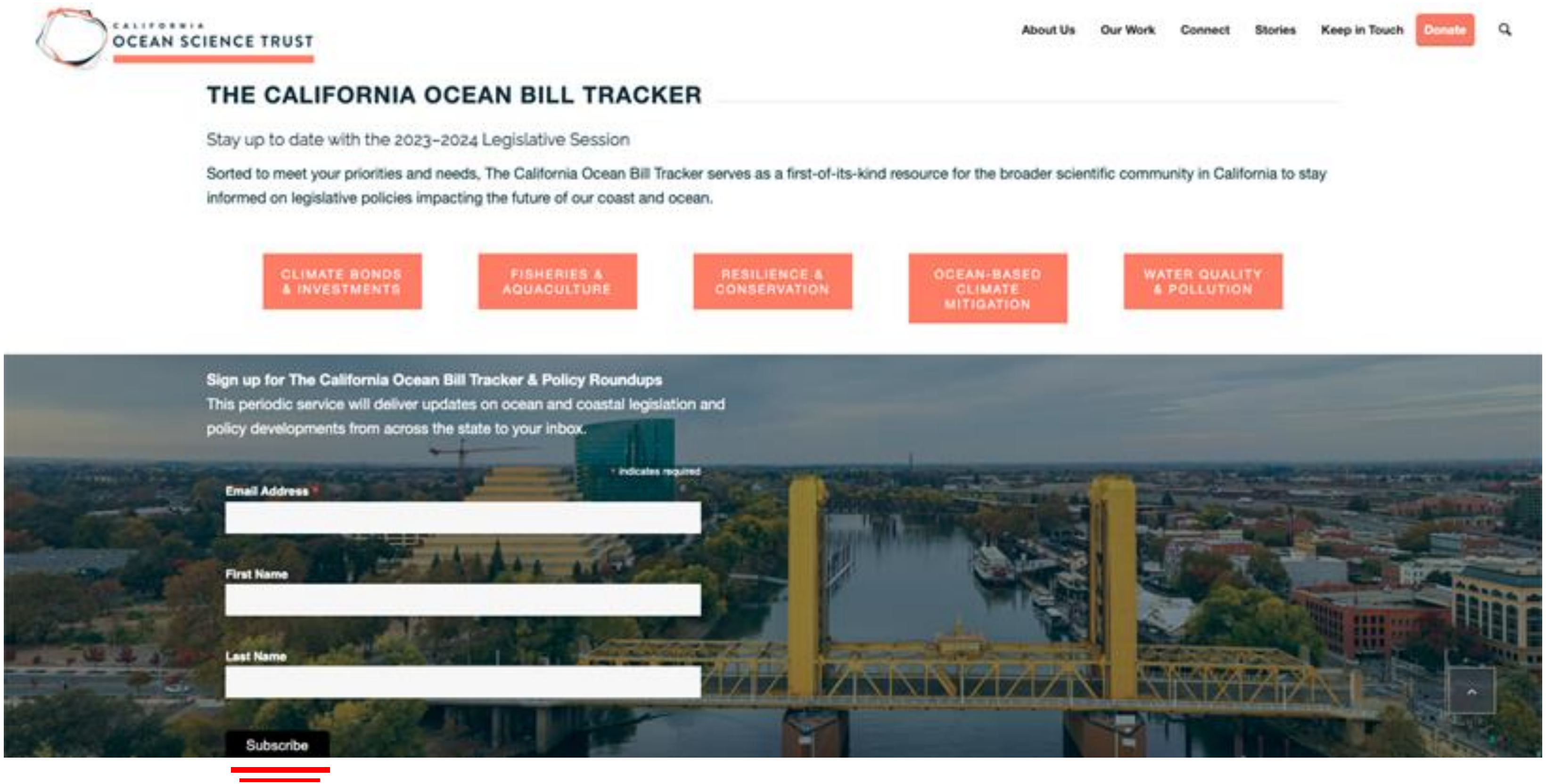
California Ocean Science Trust

- **Mission:** To bridge the gap between cutting-edge research and sound ocean management
- 501(c)3 **non-profit** created by CA Legislature
- **Linked to the state** and academia, created in recognition of the value of independent science
- **We convene experts** to deliver science advice in service of California's ocean and coastal goals

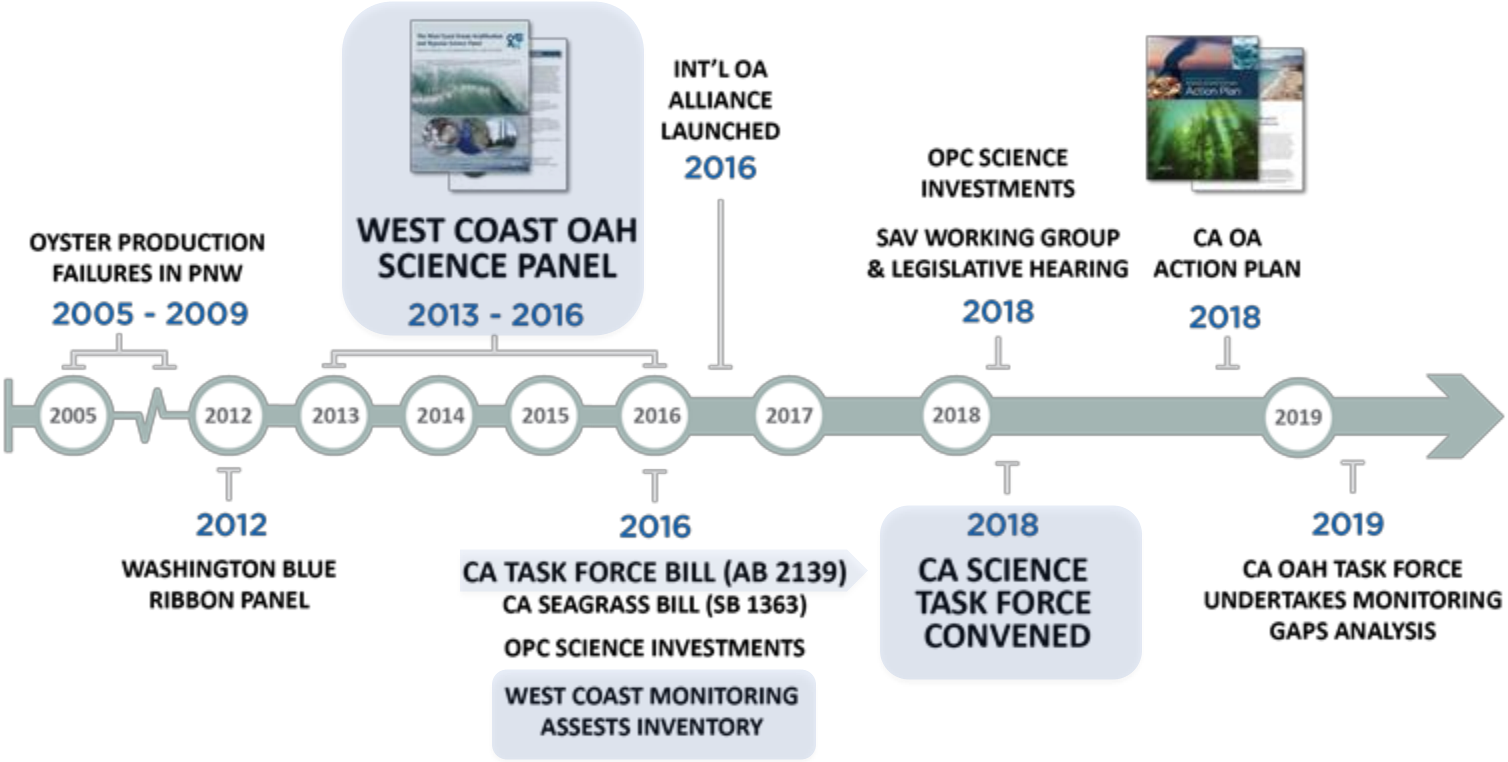
CALIFORNIA OCEAN SCIENCE TRUST

www.oceansciencetrust.org

California Ocean Bill Tracker



WEST COAST OCEAN ACIDIFICATION POLICY MILESTONES



Background: Building a West Coast Monitoring Network

West Coast OA & Hypoxia Science Panel *(2013-2016)*

- Recommendation to build/maintain rigorous monitoring network
- Developed a monitoring framework

Task Force advising

Monitoring Framework

OAH Panel, 2016

1. Define management needs
2. Assess existing monitoring efforts
3. ***Align existing assets with needs***
4. ***Evaluate and prioritize needs for new investment***
5. Enhance consistency among programs through training and quality assurance.
6. Commit to sustaining time-series data and data portals
7. Communicate info widely

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OST's Role in Current Work

- Coordinate
  - Project partners
  - Agency partners

- Convene
  - Meetings, workshops
  - Advisory Board

- Communicate
  - Policy memos

CALIFORNIA OCEAN SCIENCE TRUST

Opportunities Within Existing Policies to Support Shellfish Growers' Adaptive Capacity to Ocean Acidification on the U.S. West Coast

Wolters et al. 2024 *(In Process)*

- Looked at alignment between existing state & federal policies (e.g. legislation, action plans, task forces) and adaptive capacity strategies of shellfish growers
- Compiled a dataset of written policies related to OA through searching legislative databases and reviewing OA action plans and task force documents from federal and state levels (California and Oregon)

Examples of existing state and federal policies that align with & support grower-identified adaptive strategies.

Guiding document	Potential Adaptive Capacity Alignment
Executive Order 13921 (2020)	Requires the National Oceanic and Atmospheric Administration (NOAA) to identify and address aquaculture permitting barriers.
Infrastructure Investment and Jobs Act (2022)	Allocated $3.9 million to the West Coast Ocean Alliance (WCOA). Funds will be used to create an aquaculture inventory and an ocean health dashboard and data portal to aid in decisions about new siting, or relocation of current farms, and provide an accessible data portal for real-time ocean health information.
Oregon's H.B. 2784 of 2017, California's Fish and Game Code §15502 et seq. 2022	Ongoing efforts to simplify permitting through the designation of lead agencies and reduction of administrative barriers.
2018 State of California Ocean Acidification Action Plan 5.1 (CA) 2018 OAH Report Action 2019 OAH Action Plan Steps 4.2.2, 4.2.b	Both plans focus on networking (connecting industry, community, academic, and agencies) and shellfish industry engagement (promoting partnerships, monitoring capacities, and science-based practices) to help shellfish growers quickly adapt to OA conditions.[6,7] This includes establishing advisory boards, sharing information, and providing technical support to communities affected by OA.

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Key Takeaways (Wolters et al. 2024)

- Evolution of policy over time
  - Focus on science & monitoring → focus on direct action to aid communities in responding to OA via permitting, networking, and education.
- There are opportunities to support and advance adaptive strategies…

  …without new policy change

  …from within existing policies

  …with new policies
- Policy not necessarily the avenue for every solution
  - e.g. networking within the shellfish industry; academic partnerships

Thank you!

Our Team

- Anthony Rogers, Strategic Initiatives Director
- Heidi Waite, Science Officer
- Emma Stone, Administrative Coordinator

Shout Outs!

- Dom Kone
- Erin de Leon Sanchez

CALIFORNIA OCEAN SCIENCE TRUST

www.oceansciencetrust.org

Discussion

Identifying Opportunities & Actionable Recommendations to Advance Adaptive Capacity: Science, Policy, Communication

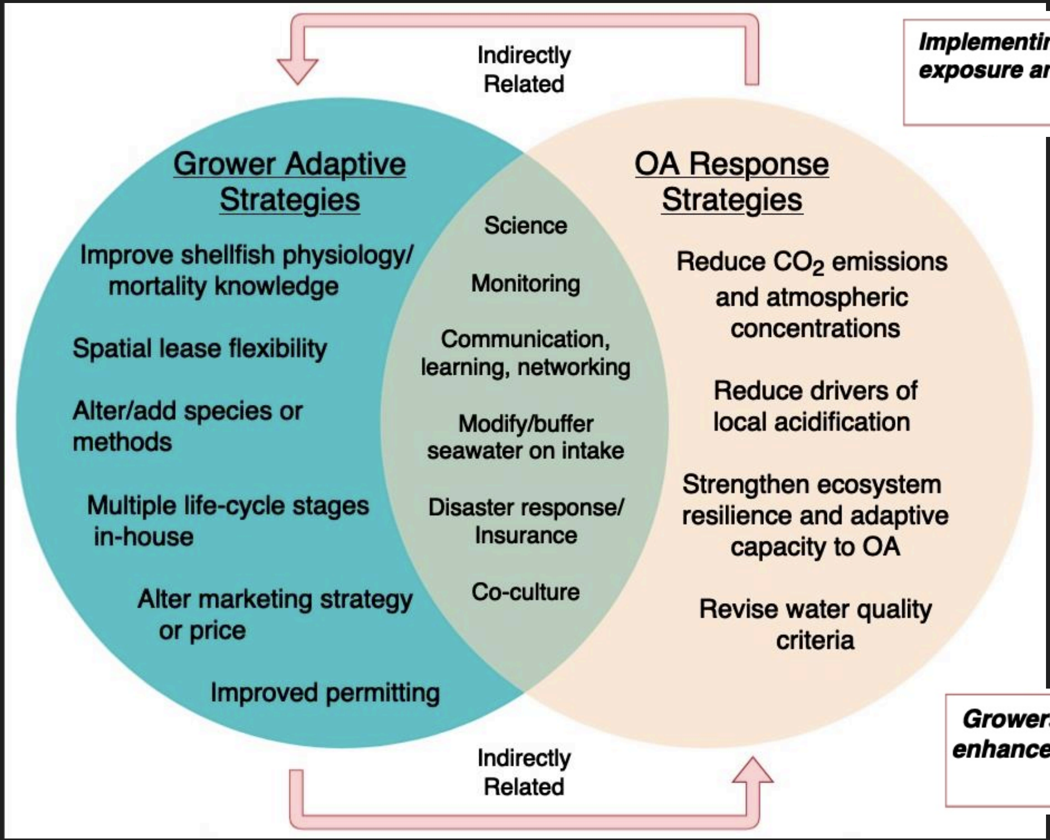
Illuminate potential opportunities, barriers, and needs for:

- Exploring and advancing adaptive strategies
- Better collecting and connecting data/scientific understanding of environmental change to growers and decision-makers
- Elevating the needs and perspectives of growers to decision-makers

<u>Outcomes</u>

- Recommendations to be incorporate into policy briefs
- Identifying key knowledge gaps, which if filled, can enhance adaptive capacity and resilience

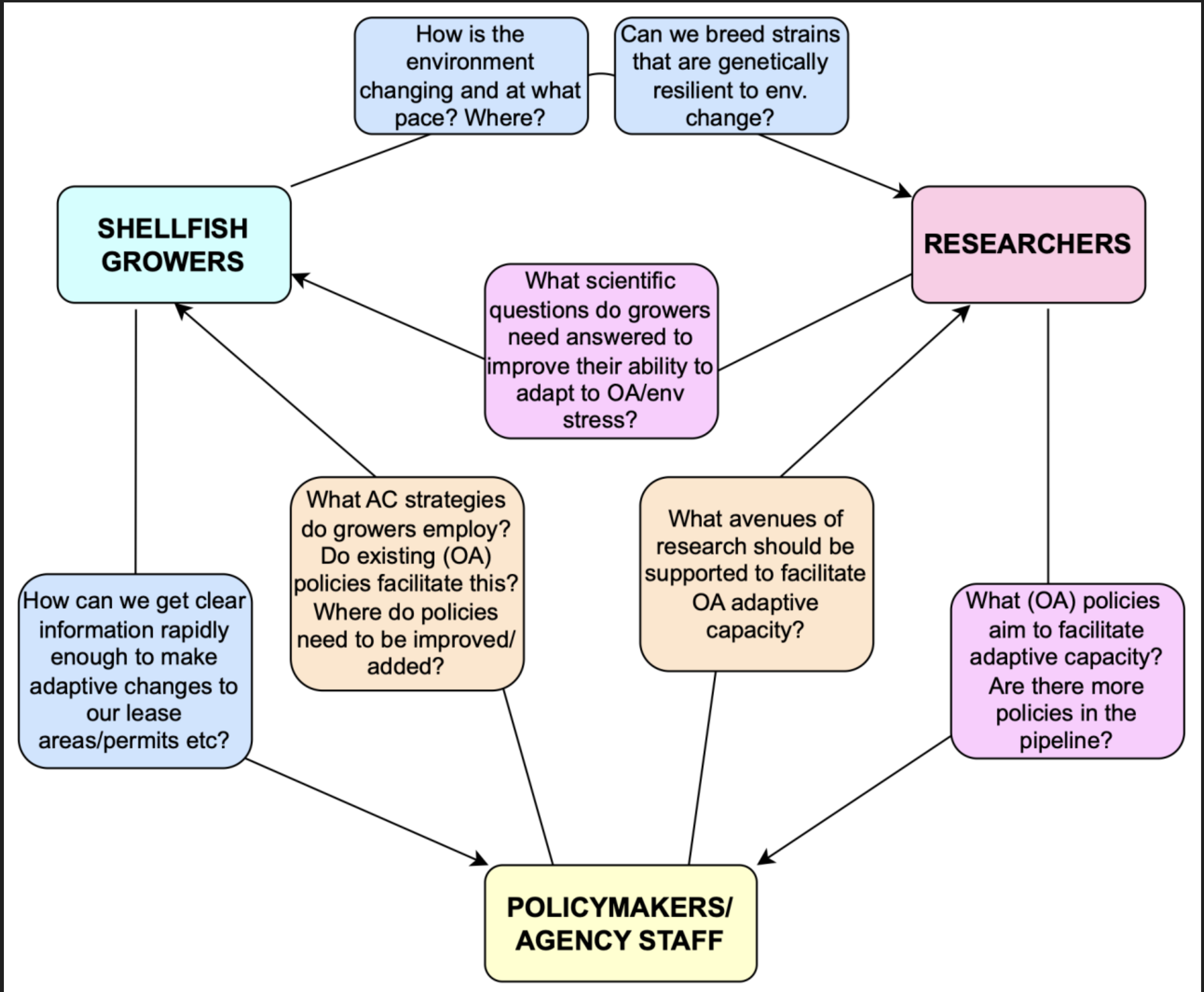
Framing: OA in the context of other stressors



Implementing 'orange' OA strategies reduces growers' exposure and vulnerability to OA or periods of low pH, enhancing overall resilience

Growers' ability to pursue 'blue' adaptive strategies enhances overall resilience, improving their ability to weather OA or periods of low pH.

BALANCING STAKEHOLDER & RIGHTSHOLDER NEEDS



Different barriers and solutions will exist between groups

OA Science and Monitoring

Many growers believed OA was a 'hatchery problem' – how will this change (and how well do we detect it) currently and in the future?

- Tipping points? Will OA be the first tipping point?

How well are existing tools working how? How can OA monitoring become more directly relevant to growers (e.g., locations, scale, format, forecasts)?

Is OA research being conducted matching the needs of growers? Other coastal industries/communities?

Adaptation: Barriers and Solutions

What are the key stressors and accompanying strategies for adaptation (to OA and other stressors)?

Nimble, flexible operations are generally more adaptive – what are key barriers to adequate response times? Are some operations more capable/favored in adaptive potential?

What are the priorities, and challenges in addressing aquaculture adaptation from policy perspectives? How does this link with OA?

How do we balance/prioritize proximate versus distant stressors of varying impact?

How do we fund and support resilience and adaptation in coastal resource dependent communities from an agency-level?

THANK YOU!

Please reach out with any questions, feedback, or comments regarding the workshop

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