Contributed Talks

Session 1: Speed Talk Session I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Pycnopalooza! A case study in the rapid mobilization to document and capture sunflower star recovery
Karm, R.H.[1*]; Fett, D.[1]; Kim, A.[2]; Carr, M.H.[3]; Schiebelhut, L.M.[4]; Hughes, B.B.[1]

1- Sonoma State University 2- Moss Landing Marine Labs - Sunflower Star Laboratory 3- University of California, Santa Cruz 4- Sunflower Star Laboratory/Clovis Community College/University of California, Merced

Top predator recovery is rare, and often follows reintroductions. Rarer is natural predator recovery, especially at initial stages, which can go undocumented. Here, we describe efforts to characterize natural recovery of the sunflower star (*Pycnopodia helianthoides*) in California. Beginning in 2013, sea star wasting rapidly decimated *Pycnopodia* populations along the Pacific coast, leaving the species functionally extinct in CA with little evidence of recovery. In 2025, Sonoma State researchers identified a single location supporting multiple adult and juvenile *Pycnopodia*. Recognizing the urgency of documenting these sightings we developed a protocol to document the ecology of this potential recovery. We then launched “Pycnopalooza,” a collaborative field effort to test this approach and collect baseline data. This 1 d event brought together over 25 people and eight research, academic, and tribal groups. Teams systematically searched the site and conducted surveys to assess abundance, size distribution, and habitat associations to document the characteristics of this emerging population. In total we observed ~18 stars (one wasting), surveyed 12 stars, and collected genetic samples. This effort highlights the importance of rapid mobilization to document rare and urgent ecological events, such as top predator recovery, and the value of large-scale collaboration. The detection of multiple *Pycnopodia* across life stages provides a unique opportunity to inform conservation strategies and understand population dynamics of an imperiled species.

Exploring the occurrence of a sea star wasting pathogen across multiple hosts using whole genome sequencing
Schiebelhut, L.M.[1*]; Gehman, A.M.[2]; Pedraza-Marrón, C.R.[3]; Prentice, M.B.[2]; Dawson, M.N.[3]

1- Clovis Community College 2- Hakai Institute, The University of British Columbia 3- University of California, Merced

Beginning in 2013, sea star wasting (SSW) decimated populations of sea stars on the Pacific Coast of North America to different degrees, contributing to altered coastal ecosystems. Levels of recovery vary over a decade later. Recent research has identified a pathogenic causative agent of sea star wasting (*Vibrio pectenicida* strain FHCF-3). Here, we re-analyze whole genome sequence (WGS) data — generated using short read and/or long read technologies — to survey the occurrence of *V. pectenicida* across multiple species of asteroids with differing susceptibilities to SSW (e.g. *Pycnopodia helianthoides*, *Pisaster ochraceus*, *P. brevispinus*, *Leptasterias aequalis*, *Henricia leviuscula*, and *Dermasterias imbricata*). Where possible, we compare *V. pectenicida* occurrence and depth of coverage from before to after the major wasting event, as well as between wasting and apparently non-wasting individuals. We also survey common asteroid prey species for *V. pectenicida* (e.g. *Lottia scabra*, *Mytilus californianus*, *Strongylocentrotus purpuratus*, and *Tetraclita rubescens*). Documenting the historical occurrence, distribution, and taxonomic host breadth of this pathogen is important for contextualizing future conservation interventions.

Novel origins of marine eusociality: Evolutionary insights from Indo-West Pacific
Hultgren, K.M.*

Seattle University

Eusociality is the pinnacle of animal social living, yet in the marine realm, it has only been documented in sponge-dwelling snapping shrimps in the genus *Synalpheus*. Although eusociality has independently evolved at least four times among Caribbean *Synalpheus* species, its occurrence in the diverse shrimp fauna of the Indo-West Pacific remains poorly understood. Here we use multiple methods –including museum studies, extensive literature reviews, and targeted field expeditions—to search for new eusocial shrimp species outside of the Caribbean. We document at least three additional evolutionary origins of eusociality in the Indo-West Pacific, including new species in Australia and Madagascar. Two of those species were described from existing museum collections, underscoring the continued importance of such resources during a time of funding uncertainty. Preliminary findings suggest that many of these new species share the ecological, morphological, and genomic hallmarks of eusociality previously identified in Caribbean *Synalpheus*.

An unlimited salad bar: Are intertidal ecosystems resilient to large increases in herbivory?
Haupt, A.J.[1*]; Haberman, I.[2]; Amador, L.[3]; Calbow, R.[1]

1- CSU Monterey Bay 2- Hakai Institute 3- University of Maine

Herbivores play an important role structuring ecosystems by consuming foundation species. Kelp forests have seen a drastic increase in urchin populations and loss of kelp. Many studies have documented the rise of urchins and development of barrens in the subtidal and less attention has been paid to urchins in the intertidal - there is less known about the impact of potential increases in herbivory on intertidal communities. CSUMB classes monitored densities of urchins and algal communities across the Monterey Peninsula from 2017 - 2023. We combined these data with nearby subtidal data to see how the increased herbivory impacts intertidal ecosystems compared to the subtidal. We found that urchin populations increased in both intertidal and subtidal ecosystems, and there have been dramatically higher increases in the intertidal than the subtidal. In the subtidal kelp forest ecosystems this led to loss of kelp forest habitat and drastic changes in associated algal communities. Whereas in the intertidal ecosystems the impact of the large increase in herbivory was much more muted suggesting that intertidal habitats may be more resilient to increases in herbivory than subtidal ecosystems. This could be because intertidal areas aggregate drift algae that supplements food for herbivores or the type of algae growing in the intertidal is more resilient. The intertidal has the potential to serve as a reproductive refuge when subtidal urchins in barrens have low gonad quantity. Understanding urchin intertidal dynamics will be important for forecasting changes in kelp forests.

Kelp needs your help: Santa Monica Bay AAUS volunteer diving opportunity
Taylor, S.J.[*]

The Bay Foundation

The Bay Foundation’s track record of collaboration with scientific organizations, public programs, commercial fisherman, and citizen science projects is extensive, and one of our most impressive successes is evident in the incorporation of AAUS certified volunteer scientific divers into our kelp restoration project. TBF’s Palos Verdes Kelp Forest Restoration project aims to enhance the sub-tidal habitat of Palos Verdes by the management of purple sea urchin (Strongylocentrotus purpuratus) barrens. The goal is to reduce populations of S. purpuratus to natural densities (associated with stable giant kelp communities in southern California) to catalyze recruitment and development of giant kelp and other macroalgae. To date over 80 acres of reef has been restored, with an observed increase in red urchin gonad biomass, an increase in community diversity, and a significant increase in kelp canopy within restored sites. The success of this project has been no minor undertaking, and the continued expanse has been particularly influenced by the presence and growth of our volunteer AAUS scientific diving program. TBF has developed a volunteer roster of around 70 active AAUS scientific divers and we hope to continue to expand. Volunteer divers have been incredibly influential on the progress of this project, helping clear two acres of urchin barrens from July 2024 to June 2025.

Evaluating the effects of urchin removals on kelp canopy recovery

Zepp, A.*; Contolini, G.; Gómez, J.; Hohman, R.; Mayock, L.; Mears, T.; Vargas, J.; Velázquez, M.; Vidušić, E.

Greater Farallones Association and Greater Farallones and Cordell Bank National Marine Sanctuaries

Within the Greater Farallones National Marine Sanctuary (GFNMS), bull kelp *(Nereocystis luetkeana)* densities have declined by more than 90%, leading to severe reductions in habitat complexity and ecosystem services. These events have transformed once-dense bull kelp forests into extensive urchin barrens. To address this collapse, Greater Farallones Association, in partnership with the Greater Farallones and Cordell Bank National Marine Sanctuaries, initiated purple urchin removal efforts at several sites, including Timber Cove in Sonoma County. Subtidal survey data, kelp canopy survey estimates, and urchin removal records were used to examine kelp forest dynamics before, during, and after purple urchin removals at Timber Cove. Trends across these datasets were compared to evaluate how reductions in urchin density influence kelp canopy recovery. This study provides insight into the short-term ecological responses to active restoration and highlights the role of sustained urchin management in rebuilding resilience of bull kelp forests within GFNMS.

Breaking the ice: First successful settlement of cryopreserved *Pisaster brevispinus* larvae

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1- Sunflower Star Laboratory 2- San Diego Zoo and Wildlife Alliance

Since 2013, sea star wasting disease has devastated sea star populations along the Pacific coast. Cryopreservation and biobanking technologies have proven to be useful tools for conservation by providing a safety net for threatened and endangered species and are becoming more widely applied for use in the preservation of marine invertebrate species. In February 2025, the Sunflower Star Laboratory thawed, reanimated, and settled cryopreserved larvae of pink sea stars (*Pisaster brevispinus*) - the first demonstration of this process in Asteroidea. This milestone provides proof-of-concept for using frozen larvae as a conservation tool for sea stars including the critically endangered sunflower sea star (*Pycnopodia helianthoides*). While sperm has been successfully cryopreserved and thawed to produce viable offspring, oocyte cryopreservation remains far less reliable. Larval cryopreservation offers an alternative by preserving both maternal and paternal genetic information and bypassing the developmental bottlenecks associated with fertilization and early embryo sensitivity. In our pilot study, larvae reared in beakers at 12-14C and fed a monoculture diet (*Rhodomonas sp.*) reached settlement at 49 days post-fertilization. Identifying viable foods for early post-settled juveniles remains the greatest challenge. By refining and sharing these methods, we aim to aid in establishing cryopreservation and culturing protocols and biobanking of genetically diverse lineages, to create accessible and scalable tools for marine invertebrate conservation.

Reproductive traits of purple sea urchins across kelp forest and barren habitats in Central California

† Rivas, S.F.[1*]; Smith, J.G.[2]

1- Coastal Science and Policy Program, UC Santa Cruz / Conservation and Science Division, Monterey Bay Aquarium 2- Department of Ecology and Evolutionary Biology, UC Santa Cruz / Conservation and Science Division, Monterey Bay Aquarium

The reproductive traits (e.g., gonad condition, spawning viability, sex ratios) of purple sea urchins (*Strongylocentrotus purpuratus*) are important for population viability and may have direct demographic consequences on the persistence and recovery of kelp forests. In kelp forest restoration, herbivore suppression via sea urchin removal or culling in place are globally implemented approaches; however, concerns remain that culling in place may inadvertently result in spawning. Little is known about how reproductive capacity, gamete output, and sex ratios (i.e., potential for successful spawning) vary between sea urchin barrens, with high urchin densities, and forested states, often with low urchin densities. While urchins from barrens experience low food availability and reduced gonadal condition, on a per-area basis, fecundity may be equivalent or similar to kelp forests. In this study, we sampled *S. purpuratus* from replicate barrens and forests in Monterey, CA to determine sex ratios, fecundity,

and gamete cell counts. As expected, sea urchins from barrens had a lower gonad index than those in forests. However, the density (spawning mass per m^2) of spawning mass was similar between barrens and kelp forests when assessed on a per-area basis (i.e., total spawning mass per area, rather than individuals). By characterizing habitat-specific differences in reproductive traits, this study offers critical insights to understanding the mechanisms driving urchin barren persistence and kelp forest resilience, informing evidence-based restoration strategies.

Session 2: Speed Talk Session II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Petrolisthes cinctipes **(porcelain crab) exhibits consistent thermal tolerance throughout embryonic development**

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1- California State University, Northridge 2- San Francisco State University 3- Colorado College

Intertidal organisms are hypothesized to be vulnerable to atmospheric and marine heat waves given their exposure to marine and terrestrial habitat. For brooding intertidal organisms, extreme heat stress can begin at the embryonic stage, requiring thermal protection in early life stages. *Petrolisthes cinctipes* embryos from the mid-intertidal of Northern California demonstrate high thermal tolerance, however, it is unclear to what extent the timing of acute thermal stress during an 11-week ontogenetic period affects physiology. We tested the hypothesis that physiological responses to acute heat stress may be dependent on the developmental week of *P. cinctipes* embryos. From June to August 2024, we applied a 32°C (LT50) heat shock for 1h on 7 groups with 12 embryos each, where the groups represented a different developmental week from 3-9 weeks. We imaged each embryo once a week for 8 weeks and quantified percent yolk cover, embryo area to determine growth rate, and hatch success, then compared each group of embryos to 12 control embryos from the respective brood that we did not heat shock. We expected higher mortality, lower growth rate, and increased yolk consumption in individuals heat shocked in weeks 7-9 given the transition from the embryonic to the larval stage. Contrary to our predictions, we found heat shock did not affect yolk consumption, growth, or hatch success compared to controls or throughout development. Our results suggest that *P. cinctipes* exhibits consistent thermal tolerance against acute heat shock throughout embryonic development.

Understanding the effects of submarine groundwater discharge on phytoplankton productivity, biomass, and community composition in coral reefs

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1- Pepperdine University 2- UC Santa Barbara

Submarine groundwater discharge (SGD) can be a significant source of inorganic nutrients in high volcanic islands, altering productivity and community composition of nearshore coastal ecosystems. In Maunalua Bay, on the southeastern side of O‘ahu, our team has been documenting the effects of SGD on coral reefs for the past 10 years. We have studied how SGD can affect macroalgal productivity and community composition. The goal of this project was to see how fine-scale changes (i.e., meters) in SGD affect the biomass, productivity, and community composition of phytoplankton. We collected phytoplankton samples across the reef, at the top and bottom of the water column, during high and low tides to capture the spatially variable SGD. We conducted in situ productivity experiments using ^{13}C-bicarbonate enrichments to measure phytoplankton C-uptake rates across an SGD gradient at low and high tides. We found that salinity had a significant relationship with C-uptake ($p<0.01$). We filtered samples for phytoplankton biomass quantification across the reef and will be analyzing the phytoplankton by sequencing 18S regions. Determining how SGD affects phytoplankton productivity and community composition will give us a more complete understanding of the community-level carbon cycling in these dynamic systems.

Pismo Beach sand dynamics: A drone study of 2024–25 winter swells

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California Polytechnic State University San Luis Obispo

Sandy beaches are dynamic ecosystems that undergo constant physical change, shaped by both natural forces and human impacts. Seasonal patterns typically remove sand during winter swells and restore it in the summer, but climate change is increasing the frequency and intensity of winter storms, accelerating erosion in many coastal areas. Extreme swell events paired with king tides in January 2022 and 2023 dramatically reshaped parts of Pismo Beach. To better understand patterns of sand movement, I conducted a year-long study from May 2024 to April 2025 using drone-based structure-from-motion photogrammetry at three sites across Pismo Beach. This emerging, cost-effective technology allowed me to estimate monthly changes in sand volume and elevation. The 2024–2025 winter storms were milder than previous years, which is likely why the change in the amount of sand did not seem to fluctuate greatly beyond seasonal expectations. My presentation will explore both the capabilities and limitations of the drone technology and methodology I used, and will highlight its potential for broader application in coastal monitoring and management.

Effects of low pH on the metabolic physiology of red abalone grown in an Integrated Multi-Trophic Aquaculture system

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1- Moss Landing Marine Labs 2- California Sea Grant, Moss Landing Marine Labs 3- San Jose State University

Red abalone (*Haliotis rufescens*) are ecologically important in kelp forests and are also farmed for human consumption. However, they are sensitive to climate stressors, such as ocean acidification, which is projected to lower pH within the next 100 years. Co-culturing abalone with seaweeds in Integrated Multi-Trophic Aquaculture (IMTA) systems may help to mitigate these climate stressors, as seaweeds uptake carbon dioxide through photosynthesis, raising system pH and creating a more suitable habitat for abalone to grow. We examined the pH buffering effect of red seaweed dulse (*Devaleraea mollis*) on abalone metabolic physiology, while further improving the IMTA system design. Our experimental design consisted of 3 pH levels simulating current (pH ~8.0) and future projected pH levels after 50 (pH 7.5) or greater than 100 years (pH 7.2). After 7 months, we coupled growth measurements and respirometry with indicators of oxidative stress to understand ocean acidification impacts on metabolic physiology. Results showed that red abalone grew nearly twice as fast in the ambient conditions compared to the lowest pH treatment. Preliminary results suggest higher respiration rates and indicators of oxidative stress in abalone grown in low pH conditions, which may be a signal of higher metabolic demand. This information will increase understanding of the broad physiological changes that both wild and farmed abalone will experience under changing ocean conditions.

Investigating mollusk shell use in California least tern nests

Limon, G.A.*; Zacherl, D.; Hoese, B.

CSU Fullerton

Southern California is home to an array of shorebird species who play important roles in coastal ecosystems. The California Least Tern (*Sterna antillarum browni*) is an endangered species in southern California due to loss of nesting site availability by human encroachment. Conservation efforts have focused on restoring breeding grounds for the Least Tern by clearing vegetation and providing nesting material. Previous literature has documented the use of mollusk shell as part of Least Tern nests, but there is a lack of knowledge regarding the characteristics of the shells. To address this issue, we investigated if California Least Terns prefer particular mollusk shells when nesting. Nests were surveyed from the 2024 breeding season at the Chula Vista Wildlife Reserve in San Diego, CA and the Seal Beach National Wildlife Refuge in Seal Beach, CA. Collected samples were then processed and analyzed to investigate any difference in shell usage between sites. Current results have reaffirmed mollusk shell fragments in Least Tern nests but have not shown a preference for certain mollusk shell fragments. Determining if

the California Least Tern prefers certain mollusk shell characteristics will help in conservation efforts employing shell enhancement and availability at breeding sites. Establishing suitable nesting grounds is essential to ensuring effective recovery of the species.

Novel methods for studying digestion in large pelagic sharks

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1- Moss Landing Marine Labs 2- California State University Monterey Bay

Digestive processes are poorly understood in elamobranchs, especially in animals that cannot be kept in captivity. Field methods used for studying digestion are expensive and disruptive. Marine scientists instead use biologgers, which can measure trends inside of free swimming animals, but cannot explain the molecular and physiological drivers of these trends. To further understand digestion in large sharks, researchers require better techniques to measure processes in the gastrointestinal environment. We present a novel biologger system capable of collecting fluid samples over time inside the stomach of an adult White Shark (Carcharodon carcharias). The sampler system requires no animal handling, which reduces cost, danger, and handling stress associated with typical field methods. Samples collected so far have provided further insights into the digestive and metabolic processes of a top marine predator. We have identified previously unpublished elements of the white shark's gastric environment, including pH and microbes. This method may provide further information about the White Shark's diet, metabolic adaptations, and energy budget. Combined with onboard temperature and activity data, this will help construct a preliminary model of digestive processes inside of the largest macropredatory fish. The methodology we have developed may be applicable to other top marine predators that cannot be handled using currently available methods.

Redefining participation in coastal management: Indicators from Central California MPA case study

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Coastal and ocean ecosystems around the world face mounting pressures that threaten marine biodiversity and the social, cultural, and economic benefits that oceans provide to society. As local and national governments seek to protect critical habitats and enhance ecosystem resilience, MPAs have emerged as one of the primary tools used to advance ocean conservation and sustainable resource management. There is growing recognition of the need to carefully consider local social-ecological context and center equity in MPA design, implementation, and governance. This research used a community-based approach that methodically captured diverse stakeholder priorities, which have been understudied. Looking at Central California citizen input from survey data, this study examined management perceptions of: user groups (activities participated in), frequency of coastal users, race, gender, community vulnerability status, and income groups. We explored the intersections of these groups in an attempt to answer three questions: What are the marine management priorities of all respondents in Central California?, What are the marine management priorities between and amongst different demographic and user groups?, and What are the current perceptions of current management strategies in California? Hierarchical cluster analysis points us to recognize the differences in priorities amongst demographic and user groups to better inform resource managers to create a more comprehensive and equitable management plan for the future of coastal ecosystems and society alike

Do interactions with damselfish alter coral thermal tolerance and microbiomes?

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1- UC Davis 2- Duke University 3- Kōrero O Te 'Ōrau

Corals provide habitat for diverse marine life, including fishes that reside permanently within colonies. These organisms can promote coral growth and survival by enhancing nutrient availability and water flow, yet their effects on the coral microbiome and links to fitness remain poorly understood. Here, we tested how the presence of the damselfish *Dascyllus aruanus* affected the physiology, thermal tolerance, and microbiome of the coral species *Acropora humilis* and *Pocillopora verrucosa* in Rarotonga, Cook Islands. We found that corals with fish present (FP) had greater chlorophyll a content than fish-absent (FA) corals, but FP and FA corals showed similar thermal tolerance, measured by declines in photosynthetic efficiency and chlorophyll a content after acute heat stress. These results suggest that while FP corals have higher Symbiodiniaceae densities, the thermal sensitivities of the symbionts are similar between FP and FA corals, likely due to a common source population. 16S rRNA sequencing revealed the enrichment of taxa associated with nitrogen cycling in FP corals compared to FA corals, potentially driven by nutrient availability differences. Overall, our results show that *D. aruanus* presence alters both coral microalgal and bacterial microbiomes, but these changes have minimal effect on coral fitness, in contrast to previous reports finding reduced bleaching susceptibility. Identifying whether these interactions vary under prolonged stress will be critical for understanding the broader ecological role of fish–coral–microbe associations.

Session 3: Behavioral Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Garter snakes that vary in chemical prey preference use different aquatic prey capture tactics
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1- University of California at Santa Cruz/Stanford University 2- University of California at Santa Cruz

Garter snakes are semi-aquatic obligate carnivores with diverse dietary breadths and behavioral adaptations for foraging at the water’s edge. In this study, we tested the chemosensory prey preference and aquatic prey capture ability in two garter snake species, the Lake Chapala garter snake (Thamnophis eques obscurus) and checkered garter snake (T. marcianus). Using number of tongue flicks, number of attacks, and attack latency as proxy for interest in terrestrial and aquatic prey extracts presented, we verified dietary preferences reported in the literature describing T. e. obscurus as an obligate forager and T. marcianus as a facultative aquatic forager. We then categorized strike mode and quantified several metrics describing prey capture efficiency at two treatment depths: number of strikes, prey capture latency, prey transport time, total time spent foraging underwater and gape angle at two different depth treatments. Our prey preference tests revealed that T. e. obscurus had a stronger preference for aquatic prey and at the shallower depth used mostly forward strikes, was more accurate at striking live mosquito fish, and was faster at prey capture. Increased depth resulted in longer foraging times and prey capture latency, larger gape angles in both species, and T. marcianus using forward strike modes. Our work provides insight into the adaptability of naïve individuals garter snakes in aquatic prey capture contexts.

Habitat complexity impacts client diversity not cleaning behaviors of Labroides dimidiatus on reefs of Moorea, French Polynesia
† Evans, L.E.[1*]; Manriquez, E.D.[2*]; Sisneros, S.D.[1*]

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Cleaning mutualisms on coral reefs reduce individual and population parasite loads, promoting client fish health, diversity, and abundance. On Pacific reefs, blue streak cleaner wrasses, Labroides dimidiatus, service clients at discrete cleaning stations associated with the physical structure of coral reefs. However, global stressors are reducing reef structural complexity, and this loss of structural complexity could potentially alter the important mutualism. We made video recordings of cleaner wrasses and client behaviors at 29 unique cleaning stations on the reefs of Moorea, French Polynesia, and then measured rugosity, length, width, height, and depth at each station. Linear regression of 4 common cleaning behaviors (Bites, Cheats, Poses, Long Interactions) analyzed using BORIS (Behavioral Observation Research Interactive Software) and structural complexity showed no

significant relationships (p >0.5). However, species richness of clients was significantly higher at cleaning stations with a higher height (linear regression, p = 0.003) and deeper depth (linear regression, p= 0.029). Cleaning behavior (i.e. biting) also varied based on client species, with certain species showing significantly different numbers of bites compared to other client species (ANOVA, p = 0.00074). Results indicate that continued loss of structural complexity in coral reef systems may fundamentally alter cleaning mutualisms, potentially leading to higher individual and population parasite loads and poorer overall health of fish communities.

Handle witih care: Ecological and ethical impacts of handling *Cryptochiton stelleri* in the intertidal
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Gumboot chitons (*Cryptochiton stelleri*) are grazers in the rocky intertidal, where their feeding behavior and strong site fidelity influence algal composition and community structure. Individual chitons are frequently handled by scientists, students, and the public, yet the physiological and ecological consequences of such interactions–which may disrupt their microhabitat occupation, feeding rates, or attachment ability, resulting in mortality or broader ecological shifts–remain largely unstudied. This project seeks to characterize the microhabitat occupation of *C. stelleri* at three sites along Cape Arago in Coos Bay, Oregon and investigate the effects of human handling on their feeding rates, attachment ability, and righting ability in a laboratory experiment. This study was part of an honors thesis exploring the ethics of handling marine invertebrates. We used Uniform Point Contact surveys to quantify the benthic community in a $1m^2$ area associated with n=21 chitons in the field. Handled chitons displayed significantly lower feeding rates and longer time spent righting and reattaching. These results suggest that handling *C. stelleri* affects their behavioral ecology, demonstrating the necessity of considering and managing human-animal interactions in intertidal ecosystems. These findings also highlight the importance of weighing the scientific benefits of hands-on interaction against possible impacts, advocating not for the elimination of handling but for more deliberate, ethically informed approaches to working with marine invertebrates.

Anthropogenic debris increases antagonistic behavior in dusky gregory damselfish, *Stegastes nigricans*
† Arroyo, K.P.[1*]; Baehrel, T.[2*]; Lamadieu, D.[3]; Ridley, K.S.[4*]

1- UC Berkeley 2- University of French Polynesia 3- Hampton University 4- North Carolina Agricultural and Technical State University

Coral reef ecosystems are increasingly threatened by anthropogenic stressors. In particular, plastic pollution can cause entanglement injuries, habitat smothering, and can be consumed when mistaken for food. Although physical impacts of plastic pollution have been studied, the behavioral effects on fish communities remain largely unexplored. We examined the behavioral responses of *Stegastes nigricans*, a territorial herbivorous damselfish, to plastic trash that can enter coastal waters in Mo'orea, French Polynesia. We conducted 109 thirty-minute experimental trials, video recording behavioral responses (circling, hovering, biting, charging, removing, camera interaction, and "ambient activity") to three different sized empty chip bags and two experimental controls, one with nothing and the other a common seaweed. Results revealed that fish exhibited significantly (p = 0.002-1.000) higher levels of aggressive behaviors, inspecting, biting, charging and removing all items placed in their territories. We also observed a trend of increased interactions with the smallest trash, which we believe is due to the fact that this trash is smaller than the fish. The presence of trash amplified overall aggressive behavior, demonstrated by increased aggression towards objects outside of the territory, like the camera, raising concerns that fish may spend excessive time reacting to trash instead of engaging in essential activities like growth and reproduction. This study highlights the need to expand on behavioral studies on the threat plastic waste poses to fish and other marine life.

Session 4: Pollution and Toxicology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Assessment of harmful algal distribution along the U.S. West Coast via microscopy

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1- University of California, Irvine 2- CSS-Inc 3- NOAA, NCCOS, Hollings Marine Laboratory

This study looked at the distribution of species within the genus Dinophysis along the U.S. West Coast. Dinophysis is a genus of marine dinoflagellates known for producing lipophilic toxins that accumulate in filter feeders and cause Diarrhetic Shellfish Poisoning (DSP). DSP has a gastrointestinal impact on humans and has caused the closure of shellfish fisheries along U.S. Coasts since 2008. While several species have been well documented to produce these toxins, toxin production has not been observed or is poorly studied in others. In addition, the taxonomic standing of many of these species has been changing in recent years, making it important to assess this taxa at the species level. Using current taxonomic classifications, this study focused on D. acuminata, D. norvegica, D. acuta, D. fortii, D. caudata, P. rotundatum, and P. oxytoxoides. NOAA citizen scientists collected 125 mL water samples via net tows in California and Alaska. At Hollings Marine Laboratory, subsamples were studied using light, electron, and automated microscopy. Individual Dinophysis species were identified morphologically from the imagery generated. Using NOAA Phytoplankton Monitoring Network's database, images from past records of western U.S. Dinophysis sightings were used to identify species and expand the level of identification in these records. The data collected from both methods were used to map the distribution of Dinophysis species along the West Coast using GIS. Knowing these species distributions will help with assessing the risks of future DSP poisonings along the West Coast.

Assessing the variability in types and abundance of microplastics among seasons in the Morro Bay Estuary

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Microplastics (plastic particles < 5mm) are pervasive throughout global ecosystems, water, sediments, and aquatic and terrestrial organisms. For the past four years, the Adams laboratory team at Cal Poly, San Luis Obispo, has been measuring microplastics (MPs) in sediments, oysters, and now seawater of the Morro Bay Estuary. We continued our MP monitoring efforts by examining the concentrations and types of MPs (fiber, angular, or other) in seawater every two weeks at six field sites within the Estuary watershed. We hypothesized that MP prevalence would vary among sites and seasons and that fibers would be the most commonly identified type of MP. We isolated MPs from samples using filtration and digested organic material using KOH. We stained and identified plastics using fluorescence microscopy. We did not find significant differences among sites in either sediments or seawater ($p = 0.6947$). Nevertheless, the concentration of MPs varies significantly by sample season ($p = 0.0499$). There was also a significant interaction between the sampling season and location ($p = 0.0015$), indicating the types of MPs in the water column vary by location over time. These results indicate that different sources or weather variations are contributing to MP pollution among sites and seasons. Therefore, we may be able to identify specific types of MP origins and work to reduce contamination from these sources in the Bay.

Development of ecological resources at risk spill response information for offshore California

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1- Research Planning, Inc. 2- RPS

Using the best available data on ecological resources is critical to advance oil and chemical spill preparedness and develop spill response plans. In 2018, the Bureau of Safety and Environmental Enforcement (BSEE) launched a project to develop offshore response information for government contingency plans for federal waters in areas with oil and gas infrastructure. As part of this project, in 2024 we created an offshore Environmental Sensitivity Index (ESI) atlas and narrative profiles of taxa present for federal waters of Central and Southern California. Spatial and temporal distribution data of offshore ecological resources were collected through extensive correspondence and data sharing with federal and academic resource experts for each of the following elements: benthic resources,

birds, herpetofauna, marine mammals, fish, and invertebrates. The data sources used for many of these taxa are the result of leading-edge models derived from extensive survey datasets that have only recently become available, including spatially explicit models and density estimates. Model data were supplemented with the best available survey data and expert knowledge as needed to ensure full coverage of sensitive resources. All datasets were processed and presented in the NOAA ESI data standard. Narrative profiles including distribution maps and taxon-specific spill response information were created as reference materials for taxa mapped in the ESI atlas. We will present a summary of the ESI development process, including data sources used and examples of resulting maps and profile products.

Increasing temperatures magnify the uptake of tire-wear contaminant 6PPD-Q in juvenile coho salmon (*Oncorhynchus kisutch*)

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1- University of Washington 2- NOAA, retired 3- NOAA 4- University of Washington, USGS

Urbanization and climate change are two of the greatest threats to freshwater ecosystems. While their isolated impacts are well studied, their combined effects are increasingly concerning. Pacific salmon (*Oncorhynchus* spp.) are culturally, ecologically, and economically important, yet many populations remain threatened despite recovery efforts. Coho salmon (*O. kisutch*) are especially vulnerable to urban stormwater runoff, with pre-spawn die-offs up to 90%. The driver of this mortality syndrome is the globally ubiquitous tire-wear chemical 6PPD-Quinone (6PPD-Q). Additionally, warming surface waters are intensifying physiological stress in salmon. Although both climate change and urbanization independently elevate extinction risk, the interactive effects of temperature and 6PPD-Q remain poorly understood. To address this, we exposed juvenile coho to environmentally relevant 6PPD-Q concentrations (~50 ng/L) across a temperature gradient (8-14°C). Water chemistry analyses and state-space modeling showed uptake at 12 and 14°C was nearly 50% faster than at 8 and 10°C. Combining these results with future stream temperature projections for Puget Sound, we find juvenile salmon will increasingly face conditions that accelerate 6PPD-Q uptake, even under moderate warming scenarios. By linking contaminant uptake with rising temperatures, our work highlights emerging threats to salmon survival and critical challenges for conservation.

Session 5: Aquaculture I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

The secret sauce: A nutrient-by-nutrient approach to a new media recipe for the red alga *Asparagopsis taxiformis*

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As one of the largest sources of anthropogenic methane emissions, ruminant livestock represent a key target for climate change mitigation. The red alga *Asparagopsis taxiformis* is a promising approach for methane emission reduction, utilizing natural bioactive compounds (i.e. bromoform) that inhibit the process of methanogenesis in ruminants. However, large-scale cultivation of *A. taxiformis* is constrained as its growth, photophysiology, and metabolite production are strongly correlated to nutrient availability and uptake ratios. Determining how nutrient dynamics influence the physiological performance of this alga is vital to understanding its role in marine ecosystems as well as its potential as a methane mitigation strategy. In this study, we examined how manipulating essential macronutrients influences the growth and secondary metabolite production of *A. taxiformis*. Specifically, we evaluated performance across a gradient of both nitrogen(N) and phosphorus(P) concentrations. We found that growth and bromoform production responded strongly to both N and P concentrations, with evidence of an optimal

range beyond which performance declined. Our work aims to identify the environmental conditions that promote increased growth rates, bromoform production, and photophysiological health of *A. taxiformis*, while also informing sustainable strategies for large-scale cultivation.

Oceanographic variability across Gulf of Alaska mariculture sites

† Greene, S.[1*]; Jones, A.[2]; Crimp, J.[2]; Eckert, G.[2]

1- University of Alaska Fairbanks 2- Alaska Sea Grant

Mariculture is a growing industry in Alaskan communities that can complement commercial fishing as an economic driver. To support industry development, we need localized approaches to farm site selection based on environmental factors influencing crop production. Oceanographic conditions affect growth duration, crop health, and economic output for the farmer. We analyzed oceanographic variability at nine kelp and oyster farms across three Gulf of Alaska regions: Kodiak, Kachemak Bay, and Prince William Sound. In-situ sensors located on partner farm sites collected hourly measurements of salinity, temperature, dissolved oxygen, turbidity, and chlorophyll fluorescence. Using principal component analysis (PCA), ANOVA of PCA variance, and analysis of similarities (ANOSIM), we found that Kachemak Bay and Kodiak consistently grouped together, while Prince William Sound separated distinctly . Higher temperatures and lower salinities drove this separation year-round, with other variables contributing seasonally. Multivariate analyses indicated oceanographic variability across sites within regions. Our results provide insight into environmental drivers of productivity at these farms to inform future farm siting decisions, and provide partner and prospective farmers with environmental data at farm sites across the Gulf of Alaska.

Secondary extensive aquaculture: Harvesting macroalgae in California oyster farms

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1- UC Santa Cruz 2- Hog Island Oyster Co. 3- CA Sea Grant, CalPoly SLO 4- UC Santa Barbara 5- Grassy Bar Oyster Co. 6- UC Berkeley

Macroalgal recruits in shellfish aquaculture are considered fouling organisms; however several of these estuarine seaweed species can have significant ecological or commercial value. Increasing commercial demands for seaweeds coupled with the high costs and permitting barriers for new aquaculture sites in California call for cooperative research to identify the potential benefits of harvesting seaweed from existing aquaculture production gear. Here, we study the community structure, yield, and quality of macroalgae associated with the three primary gear types for Pacific Oyster (*Magallana gigas*) culture in California. We assessed these metrics across the three main growing areas for oyster aquaculture in California (Humboldt, Tomales, and Morro Bays) to directly inform shellfish growers who may want to consider secondary harvest of seaweeds. Monthly harvests from the past year show distinct seasonal and regional algal communities associated with culture gear. Quality analyses give insight into opportunities for food and agricultural markets. This research will support important management decisions from the individual farm level to sustainable fisheries and aquaculture policy in the state and beyond.

The effects of effluent source, aeration, and exchange rates on growth, productivity, nutrient quality and nutrient removal rate of *Ulva australis*, *Devaleraea mollis*, and *Gracilaria vermiculophyla* in an IMTA system with white seabass (*Atractoscion nobilis*)

† Rapp, M.[1*]; Edwards, M.[1]; Huo, Y.[2]; Drawbridge, M.[2]

1- San Diego State University 2- Hubbs

Aeration is a key factor in successful seaweed tumble culture, enhancing both growth and bioremediation by thinning the diffusive boundary layer (DBL), allowing better nutrient uptake and fragmentation. However, it also represents a major operational cost. Similarly, seawater exchange rate is crucial, as it controls the inflow of fish effluent, thereby affecting nutrient and CO_2 concentrations. *Ulva australis, Devaleraea mollis* (dulse), and *Gracilaria vermiculophyla* are promising seaweed species in integrated multi-trophic aquaculture (IMTA) due to their ability to

remove nutrient wastes and their commercial value in food, feed, biofuel, and pharmaceuticals. This study aimed to examine the effects of aeration and exchange rate on their performance and cost-effectiveness in IMTA systems. The experiment was conducted in an IMTA system using white seabass (Atractoscion nobilis) effluent fed into cylindrical seaweed tanks. Each seaweed species underwent trials with four treatments: two aeration levels (15 and 50 L air min^{-1}) and two exchange rates (1 and 7.5 L min^{-1}), with three replicates per treatment. Half of the tanks received ambient lagoon seawater; the rest received white seabass effluent. Preliminary results showed no significant growth differences based on aeration or exchange rate. However, *U. australis* and *D. mollis* grew significantly better in fish effluent compared to ambient seawater, while *G. vermiculophyla* showed no difference. All species significantly reduced TAN levels when exposed to fish effluent.

Session 6: Conservation and Restoration I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Genomic assessment informs management of endangered northern tidewater gobies following Palisades Fire

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Following the 2025 Palisades Fires, endangered northern tidewater gobies (*Eucyclogobius newberryi*) were rescued from Topanga Lagoon and held in captivity until conditions improved. Given the species' distinct genetic subdivision between systems, additional genomic assessment was required to mitigate genetic risks in the event translocation was necessary. To this end, we sequenced individuals from Topanga Lagoon, the site most impacted by the fire, as well as individuals from four other Southern California lagoons: Rincon Creek in the adjacent Conception management unit, and Ventura River, Ormond Lagoon, and Zuma Lagoon from the LA/Ventura unit. Of these sites, Zuma, which was recently founded from an unknown origin population, was of particular interest. In principal component and ADMIXTURE analyses, sites form cohesive clusters – Rincon is the most distinct, while the LA/Ventura sites form two distinct groups: Zuma/Topanga, and Ventura/Ormond. Analysis of runs of homozygosity suggest that Rincon, Zuma, and to a lesser extent Topanga are more bottlenecked than Ventura and Ormond, with Zuma exhibiting an additional component of recent mating between close relatives. These trends are consistent with the relatively recent founding of Zuma from Topanga Lagoon, as well as its subsequent establishment as a distinct population. Ultimately, these results informed the release of the captive gobies back into Topanga and may influence future decisions as populations such as Zuma are affected by natural and/or anthropogenic extirpation.

Incorporating acoustic recording units into coastal ecosystem monitoring protocols

Boehmer, D.[*]; Carroll, H.; Whitecraft, C.

California Sea Grant

Birds provide essential ecological services to nearly every ecosystem, including coastal wetlands. Despite their ecological importance, many local and regional wetland monitoring protocols either overlook or entirely exclude birds as a metric. This gap stems from limited training among coastal ecosystem monitors (who often come from marine science backgrounds) and the substantial time and resources required for effective bird monitoring. This project investigates the use of acoustic recording units (ARUs) as a passive, cost-effective method to monitor avian communities alongside established regional wetland monitoring efforts and hyper-local, long-term studies. ARUs were deployed at 6 sites during both spring and fall monitoring events to assess bird species richness as a functional indicator for the Estuarine Monitoring Protected Area Program More recently, ARUs have been installed around newly restored habitats adjacent to Sweetwater Marsh in Chula Vista, CA, to track avian, community-level trends over time. ARUs offer a scalable, low-impact approach to collecting bird data; reducing field effort while

enhancing ecological insight. By setting the recording schedule outside of typical survey hours (morning), ARUs also allow for the documentation of species that may otherwise by missed by traditional surveys. The data gathered will inform assessments of ecosystem health, monitor recovery trajectories, and provide valuable information to stakeholders. Additionally, ARUs can help land managers meet grant or mitigation compliance requirements with minimal added effort. Broad adoption of ARUs in coastal monitoring programs could enable consistent, comparable datasets across temporal and spatial scales, ultimately strengthening conservation outcomes.

Geospatial evaluation of sea urchin population with AI for the sake of marine forest, a comparative analysis

† Perez, D.F.*

Claremont Graduate University

Sea Urchin Mapping & Kelp Forest Restoration - Uncontrolled sea urchin growth threatens kelp forests, a vital component of marine ecosystems. This project maps and monitors urchin populations in rocky coastal habitats using drone imagery, 3D surface modeling, and spatial analysis. High-resolution images are processed into topographic models to detect and map clusters, while different measurement methods are compared to address challenges such as manual counts, terrain, and underwater visibility, ultimately providing insights on the data. We tested two techniques: drone captures and handheld photogrammetry. Using Pix4D, we generated map layers with color, topographic, and geographic information, followed by further processing in ArcGIS to integrate additional visual features. Blackshark AI software was then used to train an agent capable of detecting sea urchin clusters, allowing for comparative analysis between methodologies. This transdisciplinary project demonstrates how AI can support ecological monitoring while engaging the community to inform decisions. It shows how spatial technologies and visual storytelling can transform scientific data into accessible knowledge. By blending marine biology, geospatial analysis, human-centered AI, and education, the project offers a replicable model for monitoring coastal ecosystems and advancing conservation through collaboration across the sciences and humanities.

Protecting clams through microhabitat refugia: Supporting indigenous food sovereignty amid climate change and predator recovery

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1- Simon Fraser University 2- Ka:yu:'k't'h'/ Che:k'tles7et'h' First Nations

Extreme heat events and sea otter recovery are well known to drive swift and profound negative effects on nearshore shellfish. This is particularly the case for littleneck clams (ḥičin, *Protothaca staminea*), a culturally important food source for coastal Indigenous communities. According to Indigenous Knowledge Holders, a solution may lie in the use of intertidal boulders as microhabitat refugia, which have been observed to provide protection from both predation and extreme temperatures. In collaboration with Ka:'yu:'k't'h'/Che:k'tles7et'h' First Nations on the west coast of Vancouver Island, we tested the utility of boulders as predator and thermal refugia. First, we conducted boulder-clam population surveys at five beaches to examine how clam size and density vary with boulder density, otter predation activity, and temperature. We then tested the effects of boulders on sediment temperature and clam heat shock protein expression during a simulated heat wave. We found that higher overall boulder density decreases otter predation activity and that boulders reduce the degree hours sediment spent over 18°C, the upper limit of clams' optimal temperature threshold. However, we did not detect a difference in clam size or density between boulder and control plots. Together, these findings suggest boulders offer an accessible, low cost approach to reducing predation and climate impacts on clams. Interfacing Indigenous Knowledge with Western science can support the recovery of clam populations and Indigenous food sovereignty amid co-occurring stressors.

Session 7: Conservation and Restoration II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Evaluating the recovery of functional fish habitat in Oregon's restored eelgrass beds

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Native eelgrass (*Zostera marina*) beds provide key ecosystem services, including nursery habitat for ecologically and commercially important species. However, eelgrasses and the services they provide are increasingly threatened by coastal development. In Oregon, eelgrass restoration has included both compensatory mitigation and enhancement projects aimed at reversing habitat loss. Post-restoration monitoring is crucial to determine "success," but it typically emphasizes bed extent and shoot density while overlooking habitat function, which must be assessed to fully evaluate restoration outcomes. To address this gap, we developed field-based methods to compare habitat functionality across restored and natural eelgrass beds. Since 2024, we have conducted monthly monitoring at two restored sites in Coos Bay (Valino Island, enhanced in 2020, and the Southwest Oregon Regional Airport site, mitigated in 1989) and at natural seagrass beds. We analyze metrics such as species abundance and feeding guilds using mixed-effects models to determine whether restored beds support fish communities similar to those in natural eelgrass. Preliminary results reveal contrasting trends: the older mitigation site shows reduced fish diversity and abundance, whereas the newer enhancement site supports more robust fish communities, potentially due to quicker recovery. Continued monitoring will help define timelines and benchmarks for functional recovery. Ultimately, our findings aim to inform eelgrass restoration by emphasizing functional outcomes and guiding conservation efforts.

Happy as a clam: Modelling butter clam population dynamics to support indigenous food sovereignty

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1- Simon Fraser University 2- Ka:yu:'k't'h'/ Che:k'tles7et'h' First Nations 3- UC Berkeley 4- Nhydra Ecological Research

Models are useful tools for informing restoration and management actions, but they encompass underlying assumptions that are often incompatible with values held by Indigenous Peoples, such as balance and reciprocity. Within their territories, the Ka:'yu:'k't'h'/Che:k:tles7et'h' First Nations (KCFN) are working to restore balance in the relationships between sea otters, people, and shellfish. Butter clams (ẏaʔis, *Saxidomus gigantea*), a culturally important shellfish, presently occur at low densities and small sizes, primarily due to predation by sea otters. In collaboration with KCFN, we created a size-structured butter clam population model to simulate proposed stewardship actions, such as clam garden construction and reduction of sea otter predation. This model will inform KCFN's actions to restore abundant clam populations that can support food security for both people and sea otters. To inform the model, we conducted field surveys to assess current clam densities and growth rates, and sourced published data to estimate other key biological and demographic rates. We found that each stewardship action impacts different size classes of clams, and that when simulated individually, each action increases clam densities 3-5 times within 10 years. Further, when actions were applied together, the complementary effects shorten the time estimated to achieve densities that support food security by 20 years. Our results underscore the importance of incorporating context-specific interactions and place-based value systems to create legitimate and useful ecological models.

Understanding precision and directional bias of fisheries abundance estimates across 24 commonly used salmonid survey methods

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1- University of Washington 2- Oregon State University

The effectiveness of fisheries management and conservation policies depends on surveys designed to estimate the abundance of target species over time. A variety of survey methods are employed for these purposes, each characterized by some inherent level of precision and potentially directional bias. While low levels of precision in survey methods lead to low confidence in point estimates of population abundance or forecasts, directional bias presents a more pernicious problem as it may lead to the mismanagement of imperiled species, invasive species, and commercially valuable populations, due to over- or under-estimation of their numbers. We estimated levels of precision and relative bias associated with 24 survey methods commonly used by the Oregon Department of Fish and Wildlife to estimate the abundance of 68 populations of Chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*), and steelhead trout (*O. mykiss*), from 1980 to 2022. We used multivariate autoregressive state-space models (MARSS), which distinguish observation (sampling) error from process (environmental) error and assign separate variance parameters to each. We found that, while some survey methods are generally more precise than others (dam counts, weir counts, and redd counts are highly precise), the same survey methods can have very different levels of precision and biases when applied to different species (for example, area under the curve population inference is less precise and downward biased when applied to Chinook compared to coho).

Coral reef restoration efforts succeed in restoring reef fish communities

† Lippert, M.[1*]; Goodman, M.[2]; Rassweiler, A.[1]; Lester, S.[1]

1- Florida State University 2- University of Washington

The Caribbean has experienced dramatic decreases in coral cover, causing severe reef degradation and loss of reef community structure, ecosystem function, and ecosystem services. As a result, coral outplanting efforts – where selected corals are fragmented, grown in a nursery, and deployed on reefs - have become a widespread approach for attempting to restore reefs and their functionality. While coral outplanting can be an effective measure to restore specific coral species, the extent to which outplanted reefs will support fish communities comparable to those on wild reefs, and the timeframes that might be required for recovery, are broadly unknown. This study examines how reef fish communities differ between wild patches and restored patches ranging from 0–12 years old of the endangered staghorn coral (*Acropora cervicornis*). Staghorn coral is a key Caribbean reef-building coral whose loss has led to large declines in reef function, fish habitat, and coastal protection. We found that fish communities on newly restored staghorn patches do not resemble those on wild patches, while most of the oldest restored patches are indistinguishable from wild patches, suggesting coral outplanting is also recovering reef fish communities. We also found that older patches support significantly more fish biomass than younger patches, and comparable biomass to wild patches by the time they are 10 years old. These results have important implications for restoration strategies, conservation goals, and the ability of coral restoration to result in broader community recovery.

Removal of long spined sea urchins (*Centrostephanus rodgersii*) promotes rapid recovery in temperate reef assemblages in Northeastern New Zealand

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University of Auckland

As oceans warm, the ranges of many marine species are shifting, with profound ecological consequences. The subtropical sea urchin Centrostephanus rodgersii is a well-known range-extender that has devastated kelp forests in Tasmania, creating urchin barrens by overgrazing reefs in high densities. Over the past 25 years, C. rodgersii populations have irrupted across northeastern New Zealand, with barrens now widespread, including inside marine reserves such as the Poor Knights Islands. Given the lack of likely predators and ongoing warming, novel management interventions are needed. Diver removal of C. rodgersii has been proposed as a potential tool, but its feasibility and outcomes remain uncertain. In 2023, we collaborated with the Department of Conservation and Te Whānau a Rangiwhakaahu to conduct experimental removals of C. rodgersii at the Poor Knights Islands. Urchins were removed from 30 × 20 m barren patches at three sites, and reef recovery was monitored for two years. Following removals, kelp and diverse understory assemblages rapidly re-established. Two years post removal,

mean kelp cover increased from 7.5% to 69.0%. These results demonstrate that barrens can recover when grazing pressure is reduced, though replicability at larger scales remains uncertain. Additionally, ~130,000 urchins were removed across larger barren sites in May 2025. Post-removal surveys indicate divers can effectively reduce urchin densities below recovery thresholds, though low numbers of urchins are consistently missed. Our findings provide the first experimental evidence that targeted re

Valued coastal and ocean species for California communities: Implications for coastal management and the MPA system

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1- California Marine Sanctuary Foundation 2- CSU San Marcos 3- Univ. Washington 4- UC Santa Cruz 5- California Marine Sanctuary Foundation, Channel Islands National Marine Sanctuary

California's pioneering Marine Life Protection Act (1999) helped establish one of the most comprehensive marine protected area (MPA) networks in the world, serving as a model for other regions. The design of the network was driven by ecological and scientific criteria. Although stakeholder input was incorporated, decision-making was shaped mainly by large economic stakeholders, such as commercial fisheries and the tourism industry. Other communities across the state were left unheard in shaping policies that affect their access to the ocean and reflect their values. Today, there is growing recognition that integrating community perspectives in MPA management strengthens stewardship and involvement, and ensures that cultural, recreational, and economic values are included.To examine the priorities of Californians, we conducted a statewide survey that reached > 4,000 people (2024-2025). We identify the marine species that Californians most valued, and consider how this varies across prioritized activities (e.g., fishing, walking and running at the beach, family gatherings, and demographics). For example, fishers might prioritize commercially important or subsistence species as a food resource (e.g., red sea urchin, abalone), while other groups may emphasize species of cultural significance or charismatic importance (e.g., whales, sea otters). We will discuss how our findings will inform policy recommendations and support MPA management in better integrating community priorities into coastal management in California.

Comparative differential gene expression of three sea star species with varying susceptibility to sea star wasting disease

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Sea star wasting disease (SSWD) has caused widespread mortality among many sea star species along the North American west coast since its initial outbreak in 2013/2014. Sea star species vary in vulnerability, though it is unknown why. We used three species of varying susceptibility to SSWD, from highest to lowest - *Pycnopodia helianthoides*, *Pisaster ochraceus*, and *Dermasterias imbricata*. One individual of each species was co-housed in replicate tanks. Half (n=8) of the tanks were exposed to a live source of SSWD, and half (n=8) were a control group exposed to a heat-killed control of the source of SSWD. By the end of the experiment, all SSWD-exposed *P. helianthoides* and some SSWD-exposed *P. ochraceus* progressed through disease signs to mortality. None of the exposed *D. imbricata* showed any signs of disease. Coelomocytes - the cells responsible for launching innate immune response - were sampled throughout the experiment. RNA was sequenced from coelomocytes from two time points from control and exposed sea stars of each species. Differential gene expression analyses were performed to identify genes related to immune response within each species, and compared across all three species. Species-related differences in gene response were identified that may relate to differences in susceptibility to SSWD. This work provides groundwork to identify genes related to resistance that can be targeted for conservation breeding and in protecting resistant wild populations.

Digitizing the ecological zones of California's sandy beaches to assess sea level rise vulnerability
† Miller, J.K.[1*]; Cook, T.[1]; Coates, S.[2]; Cummins, G.[2]; Jongsomjit, D.[2]; Neuman, K.[2]; Reiter, M.[2]; Dugan, J.[1]; Marraffini, M.[1]

1- UC Santa Barbara 2- Point Blue Conservation Science

Sandy beaches are inherently dynamic environments, yet climate change and sea level rise (SLR) are rapidly intensifying changes to beaches, with growing threats to their endemic biodiversity. As beach ecosystems change, their biota are expected to experience shifts in distribution and abundance. Quantifying the extent of this change and the amount of beach habitat lost to SLR is challenging. To better understand how beach ecosystems will change with climate change, we developed spatial layers that delineate sandy beaches in a format suitable for SLR ecological vulnerability assessments by combining ecologically relevant habitat delineations and existing datasets of SLR scenarios (USGS CoSMoS) for the California coast. We delineated key ecological zones using three habitat-based criteria: a 0% vegetation line separating the wave-swept intertidal zone and incipient dunes, a 50% vegetation line separating sand-dominated habitat and vegetated dunes where plant cover exceeds 50%, and a landward non-erodible boundary line indicating the maximum landward extent available for beach retreat. For each ecological zone, we calculated potential loss of area to sea level rise under three climate change scenarios (50cm, 100cm, and 200cm SLR). Our results show losses in all zones, particularly for beaches backed by seawalls or bluffs. These estimates provide a much needed quantification of the ecological vulnerability of California's sandy beach ecosystems to SLR and climate change that will form the basis of new habitat distribution models for indicator species including fish and birds.

Interacting threats of climate change and invasive species on at-risk native salmon population
† Doran, N.C.[1*]; Scheuerell, M.D.[2]

1- The University of Washington 2- U.S. Geological Survey

Urban freshwater ecosystems are impacted by multiple anthropogenic stressors resulting from climate change, urban development, and introduced species. Interrogating how these stressors may interact and feedback on one another is a challenge faced by environmental scientists. Conservation managers, in particular, are often faced with making decisions to support at-risk populations without complete information on both the system and the consequences of their management actions to that system. Our study uses a combination of applied ecological approaches to develop an understanding of Lake Sammamish, an urban lake in western Washington that is home to a threatened, native kokanee population (Oncorhynchus nerka) and several introduced piscivores. This knowledge is integrated into an individual-based model of predator-prey interactions between yellow perch (Perca flavescens) and kokanee throughout the lake's stratification period. In the future, this model will be used in collaboration with managers and Tribes in the Lake Sammamish watershed to simulate the consequences of potential management actions on the yellow perch population and kokanee survival.

Session 8: Fisheries, Reproduction, Dispersal, and Recruitment I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

How low can you go? The impact of low nutrients on thermal performance and blade shape in giant kelp,*Macrocystis* spp. gametophytes and juvenile sporophytes
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University of California, Berkeley

Marine heat waves are becoming more common off the west coast of North America, and have caused the collapse of kelp forests. Upwelling caused by the California current, leads to tight coupling of temperature and nitrates, with high temperatures leading to low nitrate concentrations (<1uM NO_{3-}) and vice versa. This coupling is not ubiquitous throughout the range of giant kelp(*Macrocystis* spp.), and disruption at any stage of *Macrocystis*

spp. life cycle due to lack of nutrients, or high temperature, can impact eventual adult sporophyte recruitment. The aim of this project is to look at the interaction between temperature and nutrients on the reproductive stages of *Macrocystis* spp.*Macrocystis* spp. sori were collected from the Santa Barbara LTER and the impact of temperature on spore germination into gametophytes and then into juvenile sporophytes was assessed. Results suggest that above 16C, there are few gametophytes, and no sporophytes, indicating a thermal limit to what spores and gametophytes can survive. The interaction between temperature and nitrate availability on young sporophytes growth was also assessed. Spores were cultured and after sexual reproduction occurred, juvenile sporophytes were exposed to a range of temperatures and range of NO_3- treatment groups(1uM, 0.1uM and control) in artificial seawater. Sporophytes are tolerant of a wider range of temperatures than gametophytes, but sporophyte blade morphology is disrupted in low nutrient treatment groups, potentially leading to reduced adult recruitment.

Evaluating spatiotemporal overlaps between Columbia River Basin Chinook and key food web components as drivers of marine survival

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1- University of Washington School of Aquatic and Fishery Sciences 2- NOAA Northwest Fisheries Science Center 3- Cooperative Institute for Marine Ecosystem and Resources Studies, Hatfield Marine Science Center, Oregon State University 4- Pacific States Marine Fisheries Commission 5- U.S. Geological Survey Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, University of Washington

Predicting fisheries recruitment is a notoriously complicated endeavor. Recruitment studies have historically focused on predicting recruitment using univariate indicators, such as by regressing recruitment on PDO, SST, or indices of copepod biomass. However, these correlations often break down, as the relationships between these indicators and the processes that they are proxies for are not static. Addressing the mechanistic drivers of recruitment, such as predation and growth, may prove more fruitful. Interior Columbia River Basin Chinook Salmon, and the associated long-term fisheries-independent surveys that monitor them and their communities, present an opportunity to dive deeper into these dynamics. In this study, we used spatiotemporal models to model the degree of overlap in space and time between juvenile salmon and their predators and prey to examine if this overlap predicts marine survival. We used data from the Juvenile Salmon and Ocean Ecosystem Survey to model the distribution of salmon during their early marine residence. Other surveys with similar temporal and spatial coverage, such as the Collaborative Pre-Recruit Survey and the At-Sea Hake Survey, were used to model the distributions of other members of the food web. PIT tag data was used to monitor the marine survival of individual juvenile salmon. We discuss the challenges with integrating data from disparate surveys as well as ecological insights into the drivers of recruitment for these populations.

Evaluating the effect of artificial light at night (ALAN) on predation risk in an urban lake

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Daily light fluctuations signal periods of foraging and refuging in aquatic ecosystems. Artificial light at night (ALAN) augments natural light cycles by extending twilight and increasing nocturnal light levels. Elevated light levels in the open water environment increase visual predator efficiency which can result in reduced survivorship of important fish species. We investigated the connection between artificial light, planktivore behavior, and predation pressure in Lake Washington, WA. Nighttime ambient light level was quantified using a hyper-spectral instrument under clear and cloudy skies. We then converted measured light and water transparency into estimates of predation risk as functions of clouds, season, location and depth using visual foraging models that were previously parameterized for predatory salmonids. We identified the depths of planktivores (e.g. juvenile salmon) in several locations of varying light level and overall depth via hydroacoustics. These data allowed us to quantify predation risk at depths and areas where salmon rear and migrate. Understanding in-situ fish behavior in tandem with anthropogenic stressors can lead to effective mitigation efforts to increase salmon survivorship in our waterways.

Upwelling effects on rockfish reproductive dynamics: Implications for fisheries management in California

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1- Moss Landing Marine Laboratories 2- California State University Monterey Bay

Climate change is altering the California Current Ecosystem by changing the timing and intensity of upwelling, which brings nutrient rich but hypoxic and acidified waters to the surface. These changes may negatively impact fish physiology, bioenergetics, and reproduction. Rockfishes invest heavily in reproduction, producing large broods that require months of development. Some species produce multiple broods in productive years to enhance success. Since reproductive phenology aligns with upwelling, we predict species may adjust strategies with increased fecundity in productive years. We examined fecundity and reproductive timing by quantifying egg production and developmental stage in three species differing in brood capacity—Gopher Rockfish (single brooder), Starry Rockfish (potential multibrooder), and Rosy Rockfish (multibrooder)—while accounting for maternal size. Specimens were collected in 2023 (transition to El Niño; weaker upwelling) and 2024 (transition to La Niña; stronger upwelling). Across all species, fecundity and gonadosomatic index were higher in 2024, but liver energy reserves were lower, suggesting a reproduction–storage tradeoff in La Niña years. Multi-brooding occurred only in Rosy Rockfish during the La Niña year. All species spawned earlier in 2024, while delayed release in 2023 left many unreleased at the April fishery opening, despite closures meant to protect spawning. These findings show how environmental variability shapes rockfish reproduction, with consequences for stock productivity and management of long-lived, commercially important species.

Are sea otters to blame? Investigating spatial changes in Southeast Alaska's dungeness crab fishery

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1- University of Alaska Fairbanks 2- Alaska Department of Fish and Game

Sea otters (*Enhydra lutris*) are an apex predator capable of reducing the abundance of their invertebrate prey. As the sea otter population in Southeast Alaska has grown following reintroduction efforts in the 1960s, concerns have emerged around potential negative impacts to invertebrate fisheries. However, despite a large adjacent sea otter population, Southeast Alaska's commercial Dungeness crab (*Metacarcinus magister*) fishery has appeared resilient at a regional scale, with some of the highest regional catches occurring in the last ten years. Here we investigate the hypothesis that the commercial Dungeness crab fishery has appeared resilient due to spatial shifts in fishery effort, effectively muting the negative effects of sea otter predation. Our objectives are to 1) characterize fine-scale spatial changes in the commercial Dungeness crab fishery over the past ~35 years and 2) test whether sea otters can be attributed to any observed changes. Our approach utilizes commercial Dungeness crab fishery data from the Alaska Department of Fish and Game and sea otter population estimates from US Fish and Wildlife Service. Understanding which factors influence fishery behavior is an important step in crafting effective management strategies, particularly in systems with potential competition between fishers and marine mammals.

Impacts of climate variability on the Peruvian hake fishery (*Merluccius gayi peruanus*): A modeling approach

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Peru is one of the most marine biodiverse countries, yet only 12 fishery management frameworks exist. One of them is the Peruvian hake fishery management regulation, which applies to both industrial and artisanal fleets. Since the fishery began in 1967, the average annual total catch has been 37,000 tons. However, the fishery collapsed in 2003, leading to a closure and a declaration of the fishery as "under recovery." This status prohibited new entrants, including artisanal fishers, who have since struggled to gain formal access. Annual catch quota for Hake is based on population assessments using the extended survivor analysis method, informed by data from annual fishery-independent surveys conducted since 1997. These cruises also collect physical, chemical, and biological seawater data, along with atmospheric information across the main distribution area (7°S-3°S; 82°W–

79°W). Yet, this environmental data has not been incorporated into stock assessments or projections. This research aims to integrate environmental variables that influence hake abundance and affect its long-term sustainability. It will estimate reference points by evaluating how environmental variation constrains hake abundance. The study will analyze the relationship between abundance (CPUE) and environmental drivers. Significant variables will be incorporated into an adapted Schaefer biomass model to assess how environmental conditions shape abundance and available biomass. The framework will also support projections of future catches, maximum sustainable yield and its associated fishing effort.

Investigating the oceanographic drivers of gopher rockfish recruitment to forecast recruitment dynamics under climate change

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To anticipate climate change impacts on fisheries, it is critical to understand how fish populations may respond to future ocean conditions. Recruitment, shaped by survival of early life stages, is highly sensitive to environmental drivers. This study examines recruitment dynamics of gopher rockfish (*S. carnatus*), a spring-spawning nearshore species in the California Current System. Using stock assessment estimates of recruitment variability, we evaluated relationships between recruitment and regional biogeochemical variables (oxygen, pH, primary production, temperature), physical drivers (meridional wind stress, Coastal Upwelling Transport Index, sea level height), and large-scale climate indices (PDO, NPGO, ONI). The PDO emerged as the most consistent predictor, particularly during gestation and early larval period in March. Higher recruitment was seen in positive PDO phases, which correlated to warmer, more stratified conditions with elevated oxygen and pH. Partial least squares regression identified the February to July average CUTI value as a strong predictor, with higher recruitment during relaxed upwelling seasons. Potential shifts in recruitment were forecasted using modelling outputs from a regional ocean modelling system, downscaled from three Earth System Models, for oxygen, pH, and temperature. Forecasts suggest ocean warming may enhance recruitment, ocean acidification may reduce it, and oxygen may increase recruitment variability. This research highlights how shifts in regional drivers could alter productivity, informing future fisheries management.

The relative impacts of climate change, fisheries management, and market forces on the distribution of California fishing grounds

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UC Santa Barbara

The distribution of fishing effort is molded by diverse processes including resource distribution, fishery economics, management regulations, market forces, and other factors. Determining the relative contribution of these synergistic factors is challenging but essential to understanding redistribution of fishing grounds in the future and the implications of these shifts for both livelihood and adaptive fisheries management. We examine the relative impacts of management, market factors, and climate variability on the distribution of nine state-regulated fishing métiers (relevant port-gear-species combinations) on the California Coast. We measure how fishing grounds changed from 1980-2024 (varies slightly based on fishery) and the relative role of management, market forces, and climate variability in these influences. While situated in the California context, this study provides a template for understanding the contributions of complex bioeconomic factors in shaping the distribution of fishing effort and for leveraging this understanding to make predictions about the future.

Physics to fish: Habitat structure for bigeye tuna, *Thunnus obesus*, across an ecological gradient in the North Pacific Subtropical Gyre

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1- Texas A&M University- College Station 2- NOAA Pacific Islands Fisheries Science Center

This research investigates ecosystem structure across an environmental gradient in the North Pacific Subtropical Gyre (NPSG), the largest ecosystem on Earth. The NPSG hosts complex subsurface features that influence biological productivity. We aim to identify key drivers of fishery output across the gradient to better predict fishery health and response to environmental variability. In summer 2022, a multidisciplinary survey was conducted aboard NOAA Ship Oscar Elton Sette along 150°W from 30°N to 10°N. Biological and oceanographic data were collected and analyzed using R, applying statistical techniques to examine links between biogeochemistry and ecosystem structure. Results show clear latitudinal transitions: the north has a deeper mixed layer and oxygen minimum (~500 m), cooler sea surface temperatures (SST), and a deep chlorophyll maximum. The south shows a shallower mixed layer, warmer SSTs, a shallower oxygen minimum (~150 m), and a surface-intensified chlorophyll maximum. Chlorophyll and zooplankton biomass increases southward, shifting toward larger size fractions. The increase in lower trophic productivity didn't correspond with higher fishery output. Data suggest that shoaling oxygen minimum in the southern NPSG may constrain foraging depth and habitat availability for higher trophic levels, potentially decoupling fish abundance from primary productivity on a regional scale. In return, highlighting oxygen availability as a key limiting factor for fishery yield.

Session 9: Intertidal Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Identifying the distribution, morphology and reproductive strategies of California native Sargassaceae brown macroalgae

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UC Los Angeles

Southern California is home to endemic brown macroalgae in the Sargassaceae family within the order Fucales. *Stephanocystis dioica* has a geographical distribution between Pt Conception and Baja California and *Sargassum agardhianum* has historically resided from Malibu to San Diego. Brown macroalgal research tends to focus on our charismatic kelps or the two successful invasive Sargassum species. Little is known about the current distribution of *S. agardhianum*, its reproductive strategies, or embryo development. Moreover, there is a lack of methods focused on cultivating embryos of our local Sargassaceae species in a lab. We mapped the present range of these algae through extensive searching in the field, revealing one remaining population for *S. agardhianum* on the mainland of LA County, potentially due to anthropogenic factors such as habitat destruction, pollution, and climate change. We documented the morphology and histology of their reproductive life stages, and have created a preliminary protocol for cultivating embryos of *S. dioica*. Abiotic factors influencing species distribution were documented, along with population communities and seasonal patterns during the reproductive season. Neither of these species have been evaluated for conservation, and seem to reveal potentially different statuses and opportunities. *S. agardhianum* is a great candidate for conservation and restoration, while *S. dioica* can be suitable for aquaculture. Understanding information about these algae are necessary for these potential future endeavors.

Thermal stress induced gene expression during the maternal-to-zygotic transition of the purple sea urchin (*Strongylocentrotus purpuratus*)

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Sonoma State University

California's marine heatwaves are becoming frequent and severe, stressing benthic invertebrate embryos such as the purple sea urchin. These embryos rely on timed molecular processes to survive making early development vulnerable. The maternal-to-zygotic transition (MZT) is a critical event of early development as control shifts from the maternal to zygotic genome. Environmental factors, like thermal stress, affect fitness of developing embryos

during MZT, impacting subcellular processes to invoke the heat shock response (HSR). HSR protects protein stability against a variety of stressors by inducing the activation of heat-shock genes that produce heat-shock proteins. Heat shock protein-90 (HSP90), a highly conserved molecular chaperone, stabilizes client proteins, and is vital during MZT, as its inhibition disrupts embryo viability. HSP90 has shown decreased protein abundance in two-celled purple urchin embryos compared to those at early blastula and gastrula when reared at 13°C stages. In contrast, urchins reared at 18°C were unaffected by any heat shock treatment. The objective of my project is to measure hsp90 gene expression by rearing urchin larvae at 13 and 18°C and subjecting them to a 1-hour heat shock to determine if transcriptional responses during MZT follow a similar pattern, since gene expression tends to respond at a faster rate and may signal stress earlier. Understanding how acute heat stress disrupts hsp90 expression during MZT will provide insight into how marine heatwaves may influence early developmental resilience and survival in intertidal organisms.

Shoreward bound? Testing possible spillover phase shift effects from subtidal kelp forests to the rocky intertidal

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Oregon State University

In the past decade, the Northeast Pacific experienced combined effects from a marine heatwave, sea star wasting disease, and the collapse of nearly three-quarters of canopy-forming kelp. These events may have influenced foraging behavior of subtidal populations of the purple sea urchin, *Strongylocentrotus purpuratus*, by both bottom-up and top-down processes. Urchins that once remained cryptic and sedentary, are now actively foraging on any available kelp, shifting the community to an urchin barren. Since subtidal communities are adjacent to intertidal communities, there may be a spillover effect as subtidal kelp-dominated states shift to alternative urchin barren states. That is, newly active urchins may migrate shoreward along rocky bottom pathways in search of kelp. To test this, I set up a series of low zone intertidal transects to look at patterns in urchin-dominated communities at ten sites on the Oregon coast. I predicted that abundance of non-cryptic urchins will be higher at sites where there is likely to be higher urchin migration via rocky bottom pathways and reduced drift kelp subsidy. In addition, I predicted lower intertidal kelp canopy at sites with greater abundance of non-cryptic urchins due to active grazing. Results are consistent with this hypothesis; non-cryptic urchins are more abundant inshore of sites with offshore urchin barrens. Hence, spillover effects may alter kelp abundance at connected intertidal sites.

Species diversity and the maintenance of ecosystem function in an increasingly variable world

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1- California State University, Long Beach 2- University of Miami 3- Stanford University

Both the mean and variance of global temperatures are increasing, alongside declining species diversity across many ecosystems. While there is widespread recognition that climate change and biodiversity loss can both alter key ecosystem processes, we lack a well-developed framework to assess the relative magnitudes of these effects or their interaction. We used a novel experimental technique to manipulate temperature variability in the rocky intertidal zone while holding the mean constant. We quantified effects of increased thermal variation on survival and growth of a guild of grazing limpets and productivity of their microalgal food. Experimental plates assigned to one of four monoculture treatments held four similarly sized marked limpets of the same species, whereas high-diversity plates had a single individual of each species. Under natural temperature variation, limpet growth rates did not differ between single- and multi-species treatments. However, under high variation, limpets on high-diversity plates grew 40% faster than expected – a positive diversity effect. One explanation is complementarity of resource use. Hotter plates had less microalgae, increasing the potential importance of competition for food. Scanning electron microscopy (SEM) suggests species feed on different components of the microalgal community, reducing negative effects of competition on high-diversity plates. Our results suggest that biologically diverse communities may be a key factor in maintaining trophic transfer of energy and other ecosystem functions under future environmental change.

Using autonomous drones as a tool to study the impact of sea level rise on rocky intertidal communities

† Bible, O.*; Garza, C.

University of Washington

Sea level rise is an increasing threat to many coastal ecosystems. Among those communities, the rocky intertidal zone is particularly susceptible to the impacts of sea level rise. However, current survey methods may not be able to capture data across the spatial and temporal scales needed to detect the impact of sea level rise on these communities. Uncrewed aerial vehicle (UAV) surveying is a tool employed to detect these impacts. UAVs rapidly capture large areas of spatial data at high resolution with minimal ecosystem disruption compared to traditional surveying methods. I aim to understand if UAV surveying is a valuable supplement to point-contact surveying when quantifying the distributional effects of sea level rise for the mussel *Mytilus californianus* and the seastar *Pisaster ochraceus*. In this study, I compared UAV-collected imagery with existing Multi-Agency Rocky Intertidal Network (MARINe) point-contact survey data at the same sites. I conducted spatial analyses on site photomosaics and digital surface models (DSMs) derived from UAV surveys and compared results to the point-contact survey data. These include an object-based classification for *M. californianus* and *P. ochraceus*. Also, I constructed general additive models (GAMs) to predict *M. californianus* habitat location. Results indicate that although depicting organisms found within crevices, such as *P. ochraceus*, appears to be a limitation, there is a promising place for UAV surveying in rocky intertidal research in conjunction with machine learning-based analyses.

The polychaete communities of five Southern California estuaries: A spatial-temporal analysis.

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1- Universidad Autónoma de Baja California 2- The University of Texas at Austin 3- Southern California Coastal Water Research Project 4- California State University

Estuaries provide essential ecosystem services but face continuous anthropogenic stress. We studied the benthic polychaete communities in sediment samples (intertidal and subtidal) and their potential relationship to nutrient concentrations (Ammonia, Phosphate, Nitrite, Nitrite + Nitrate, and Urea). We sampled five Southern California estuaries during the spring and fall of 2021 as part of the Estuarine Marine Protected Area Monitoring Program. The results show differences across seasons ($p = 0.0027$) and sites ($p = 0.0003$). Additionally, Batiquitos Lagoon and Newport Bay had the highest polychaete abundance, diversity ($H' = 1.631, 3.666$), and richness ($S = 17, 28$), with *Capitella capitata Complex*, *Polydora nuchalis*, and *Exogone lourei* as the dominant species. These species also exhibited temporal variation in the other estuaries (Goleta Slough, Ventura River, and Malibu Lagoon). Diversity (H' 3.905) and richness peaked in the fall (S: 32). The feeding guilds of subsurface and surface deposit feeders were dominant. Nevertheless, Newport Bay guilds were more heterogeneous, harboring carnivores, herbivores, and omnivores. Despite variations in abundance and feeding guilds, we did not find a statistically significant relationship between the polychaete communities and nutrient concentrations (CCA, $p = 0.1217$). Future studies should consider sediment variables, such as grain size, carbon content, dissolved oxygen, and salinity, to assess climatic and stochastic changes.

Buried alive - Quantifying impacts of post-fire debris flows on the habitat, population, and recovery of endangered black abalone

† Bragg, W.K.*; Cox-Ammann, K.N.; Fletcher, N.C.; Raimondi, P.T.

UC Santa Cruz

Research on the emergent ecological effects of global environmental change has largely focused on incremental environmental shifts and their effects on species persistence. Increasingly, there is recognition that environmental extremes can strongly influence species response. As extreme events grow more frequent, they increasingly overlap and co-occur, producing unprecedented stressors. Studying the ecological effects of such largely unpredictable, compounded extreme events is inherently challenging but of critical importance to resource management and conservation. Here we identify one such driver of marine change via terrestrial compound

extreme events (fire + flood = debris flow). Recognition of the potential for fire-induced marine impacts allowed our team to assess *in situ* baseline conditions that were later combined with data from aerial imagery and long-term monitoring to quantify impacts. We attribute a median loss of 59.6% of the regional baseline population of endangered black abalone (*Haliotis cracherodii*) and 21% of its rocky intertidal habitat to this one event, highlighting the potential of novel extreme events to disrupt ecological processes. In light of climate model predictions for increasing frequency and intensity of extreme events, this work serves as a model for producing meaningful quantification of impacts under unpredictable and uncontrollable events. We encourage an expansion of long-term monitoring and similar creative use of multi-faceted data to assess impacts in the face of extreme events that challenge traditional approaches.

Too hot to hunt? Acute ocean warming weakens top-down control of an intertidal foundation species
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1- CSU Northridge 2- UH Manoa

As ocean warming and acidification escalate and change organismal physiology, communities will shift in response. In the California rocky intertidal, organisms regularly experience vast changes in abiotic conditions (e.g., pH and temperature) and are vulnerable to the effects of climate change. Here, we aimed to understand the physiological responses of the California mussel (*Mytilus californianus*), and a whelk (*Nucella emarginata*) to future climatic conditions. We assessed individual metabolic rates, including respiration and calcification, after four weeks of exposure to a range of eight pH_Ts (7.2-8.0) at two temperature levels (18, 22°C). Whelks and mussels responded differently to the effects of warming and acidification. The predatory whelk was more sensitive to ocean warming than the mussel, with lower respiration, calcification, and shell growth rates at 22°C, indicating thermal stress. Warming also reduced the probability of whelks actively drilling mussels for consumption, which could indicate weaker top-down effects under warm conditions. Neither the mussel nor the whelk was affected by changes in pH. These results suggest that there are differential responses to climate change across trophic levels, which could impact ecosystem functioning.

The effect of beach slope on pismo clam presence in Orange County, California
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1- UC Irvine 2- Get Inspired

The Pismo clam (*Tivela stultorum*) is a native California mollusk that resides on sandy beaches along the coast from Stinson Beach, California to Magdalena Bay, Baja California. Pismo clams bury themselves in sand and are believed to favor gently sloping beaches. Many cities along the coast of California are known to create sand berms to combat coastal erosion. Minimal consideration has been given to how these berms, which create steeper beaches, affect Pismo clams. No current study exists as to how beach slopes may affect clam populations. Within our study, we examine Pismo clam abundance along varying sloped beaches throughout Orange County to assess how slope impacts clam presence to provide guidance for future restoration efforts and beach maintenance. More than forty Pismo clam surveys have been conducted using the Alongshore Raking Method (ARM) in Orange County. During these surveys, slope measurements are taken along the midpoint and a relative slope value (RSV) is assigned to each beach ranging from -2 to 16 RSV. Within beaches surveyed along the Orange County coast, Pismo clam abundance was not found to be correlated with relative slope. However, the low density of clams along the coast may be confounding this result.

Session 10: Evolutionary Biology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Patterns of variation in California stickleback across dynamic habitats
† Wise, C.M.[*]; Ferranti, D.A.; Rennison, D.J.

UC San Diego

A central goal of evolutionary biology is to understand the drivers of adaptation and diversification in natural ecosystems and how ecological and evolutionary processes interact to shape these patterns. Threespine stickleback (*Gasterosteus aculeatus*), an anadromous fish species that repeatedly colonized freshwater habitats following the Last Glacial Maximum, provide a powerful model for studying adaptive divergence. Most prior research has focused on the adaptation and diversification of Northern Pacific populations, where freshwater lake adaptations are well-documented. In contrast, California populations inhabit highly dynamic bar-built estuaries and lower reaches of rivers that experience seasonal fluctuations in salinity, water flow, and predator communities, likely imposing selective pressures distinct from northern lake environments. These habitats cycle between sandbar formation and periods of ocean breaching, shifting conditions from flowing, brackish water to pond-like freshwater, causing rapid changes in the selection regime. This raises the question, what are the patterns of divergence in California stickleback populations and how do they align with broader-scale patterns observed in northern populations? To address this gap, we conducted a landscape-level survey of California stickleback, characterizing patterns of genetic and phenotypic variation and their relationship with ecological factors. These analyses provide insights into the factors driving adaptive divergence in California populations.

Impacts of a chromosomal inversion on eelgrass performance during a simulated marine heatwave
† Erickson, K.L.*; Bay, R.A.

UC Davis

Within a species, individuals differ in their environmental optima and that variation fuels adaptation across spatial and temporal environmental gradients. In recent decades, the availability of genomic data has allowed an increased understanding of the underlying genomic basis of adaptation. Chromosomal inversions have been shown to have substantial eco-evolutionary consequences in natural systems; however, their impact on linkage disequilibrium impede the use of traditional association tests to identify specific genes or variants that contributes to functional and fitness differences. A large chromosomal inversion polymorphism was found to covary with temperature within eelgrass (Zostera marina) populations in Tomales Bay and Bodega Bay, California. We ran a mesocosm experiment to test how plants with three inversion genotypes (ancestral, derived and heterozygous) performed in ambient vs marine heatwave conditions. We collected trait data along with tissue samples for transcriptome sequencing to understand which genes in the inversion might contribute to differential fitness across temperature treatments. This study demonstrated how inversions impact expression more strongly through cis-regulation than trans-regulation and uncovered candidate causal genes that underlie eelgrass local adaptation to temperature.

Response to temperature differs among clones of pitcher plant rotifers
† Mendelson, A.A.*; terHorst, C.P.

California State University, Northridge

Evolution plays a key role in directly altering ecology in natural communities. As the environment changes rapidly, populations that are unable to acclimatize or move must evolve to avoid extinction. Genetic variation in responses to environmental change provide the fuel for natural selection to act. Here, I report on a high diversity in temperature response among clones of the Bdelloid rotifer Habrotrocha rosa, indicating the potential for rapid evolution in natural communities. Habrotrocha rosa live in the water filled leaves of the carnivorous purple pitcher plant (Sarracenia purpurea) and compete for resources primarily with other bacterivores, including ciliates in the genus Tetrahymena. To reproduce, H. rosa lay eggs that develop without fertilization via apomixis, a form of obligate parthenogenesis. Because this process lacks recombination, all offspring are full clones of their mother. The trait diversity of natural populations of H. rosa is unknown. In a temperature response experiment, clones of H. rosa isolated from field samples of leaf water were grown in microcosms at 25C and 30C for 42 days. Population growth rate and dry mass, both components of fitness and key traits in temperature response, were estimated for

each clone. Rotifer clones had different growth rates in response to temperature, supporting the potential for rapid evolution in natural populations. A separate, ongoing evolution experiment will aim to investigate evolution-mediated indirect effects of temperature on competition between H. rosa and a natural competitor, genus Tetrahymena.

Competitive interactions and cave colonizations in North American blind cavefishes

† Zhong, J.J.*; Betancur-R., R.

UC San Diego

Cave colonization, which has occurred independently numerous times, offers an excellent framework for testing macroevolutionary hypotheses related to habitat transitions. The North American blind cavefishes (Amblyopsidae) comprises nine species that span the cave-adapted continuum: six obligate troglobites, two facultative troglobites, and one non-cave spring dweller. We estimated phylogenies using 818 ultraconserved element loci with both concatenation-based maximum likelihood and multi-species coalescent approaches. We also used ROADIES, a recently proposed method that integrates single- and multi-copy gene trees from raw genomic assemblies. Our analyses align with recent work showing that facultative cave-dwellers are nested among obligate species and that the surface lineage is sister to all subterranean taxa. We used a time-dependent evolutionary model to test whether the diversification of other freshwater North American fish clades (darters, sunfishes, minnows, killifishes, and bullhead catfishes) coincides with the timing of amblyopsid cave colonization. Based on historical diet and biogeographical reconstructions across drainage basins using BioGeoBEARS, along with morphospace analyses of body shape, we evaluated if cave invasions are linked to ecological release following competition with incumbent surface-dwelling species. Our results suggest that darters, minnows, and killifishes were more likely ecological competitors driving cave colonization than bullhead catfishes or sunfishes, highlighting the complexity of competition as a driver of cave invasions.

Population structure and genetic divergence in marine threespine sticklebacks along the western coast of North America

† Ferranti, D.A.*; Wise, C.M.; Rennison, D.J.

UC San Diego

Adaptive evolution facilitates the colonization of new habitats and persistence of populations in a world increasingly marred by anthropogenic activity. Characterizing the processes that affect genetic variation in natural populations is key to understanding the dynamics of rapid adaptation to shifting fitness landscapes. To investigate the forces that shape genetic variation in natural populations, we use threespine stickleback (*Gasterosteus aculeatus*) collected along the western coast of North America, from British Columbia to southern California. Although threespine stickleback have been used as a model system to examine rapid adaptation from a marine anadromous form to a freshwater ecotype, little attention has been paid to the marine ecosystem, which is often assumed to represent a static, panmictic population. Here we present an analysis of threespine sticklebacks sampled from 125 sites to determine patterns of population structure, genetic diversity, and migration. Our results show a split between two primary marine genetic clusters, a California cluster and a northern cluster, with a mixture zone at the California-Oregon border. We hypothesize that California populations generally represent a resident estuarine ecotype whereas northern fish represent the classical anadromous ecotype. Furthermore, we find population structure and differentiation even at small spatial scales in the Salish Sea and Pacific Ocean around Vancouver island. These findings provide insight into the evolution of a species across a range of thousands of kilometers.

Comparing patterns of speciation in depth-separated rockfish (Genus Sebastes) sister species pairs

† Pilcher, J.*; Alter, L.

CSU, Monterey Bay

Speciation is the evolutionary process responsible for generating biodiversity, which is critical for ecosystem structure and function. Using Sebastes as a model clade, this project seeks to identify patterns of speciation across environmental and temporal gradients in depth-separated sister species pairs. Low coverage (~5X) whole genome sequencing will be performed for ~20 individuals of each species. Genetic population structure for each species will be evaluated, regions of genomic divergence will be identified between the species pairs, and demographic history, including divergence times, of the species pairs will be reconstructed. The function of regions of genomic divergence will be determined and contextualized based on historic paleoceanographic conditions, providing insight into the selective forces acting on the species pairs during the process of speciation. Findings will provide insight into the genomic mechanisms of sympatric speciation and the selective environmental pressures that influence speciation.

Population genetics of the Southern Californian *Anthopleura elegantissima* holobiont

† Olivares-Cordero, D.[1*]; Ortega, D.[1]; Ordoñez, G.[1]; Brazil, C.[2]; Lee, S.[3]; Whitaker, S.[4]; Ruggeri, M.[5]; Kenkel, C.[1]; Elder, H.[6]

1- University of Southern California 2- Loyola Marymount University 3- University of Miami 4- National Parks Service - Channel Islands 5- Oregon State University 6- Australian Institute of Marine Science -AIMS

As climate change accelerates it is important to understand how climate driven factors affect mutualistic species independently and in concert. At a genomic level, the influence of a microbial symbiont, along with environmental stressors could interact to influence the genetic structure of its hosts. In coastal settings, a foundational nutritional symbiosis (a lifelong mutualism between partners) occurs between *A. elegantissima* anemones and dinoflagellate photosymbiont, *B.muscatinei*. Therefore understanding the way host, symbiont or holobiont populations differentiate is important. Here we study the population genetic structure of *A. elegantissima* and its symbiont *B. muscatinei* in Southern California to test what role increased sea surface temperatures across Southern California sites have in influencing the genetic structure of the holobiont. We tested this idea by 2-bRAD sequencing 568 *A. elegantissima* samples and 94 *B. muscatinei* samples from 8 Channel Island and 7 mainland sites in Southern California. We expected *A. elegantissima* populations to have similar population structure between mainland and island sites due to their high dispersal capabilities. Additionally, we expect *B. muscatinei* populations to be differentiated by differences in sea surface temperature between northern and southern sites. Overall, the findings of this study will provide insight on symbiotic organism population genetics.

The convergent evolution of the pelvic suction disk: a unique key innovation in spiny-finned fishes

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UC San Diego

The pelvic suction disk is a rare innovation that allows fishes to cling to rocks and other substrates in high-energy habitats, but its broader evolutionary role has remained unclear. Using a time-calibrated phylogeny of 961 percomorph species, including 146 newly sequenced taxa and the most comprehensive dataset for snailfishes, we show that the suction disk evolved independently three times across spiny-finned fishes. Once lost, the disk has never been regained, with multiple independent losses restricted to snailfishes, highlighting strong evolutionary asymmetry. Comparative models demonstrate that pelvic-fin evolution is best explained by an irreversible loss framework, with the suction disk representing a one-way trajectory. Trait correlations reveal consistent associations between the disk and scale loss, dorsoventral body depression, increased body width, and complex teeth, suggesting that the disk acted as a key innovation that facilitated subsequent morphological shifts. Morphospace analyses show that disk-bearing lineages converge on a broad and distinctive region, while evolutionary rate models identify two- to fivefold faster body-shape evolution in clingfishes and cyclopteroids. Diversification analyses reveal heterogeneous but often elevated rates, including a clear burst in rock-climbing gobies. Together, these results demonstrate that the suction disk repeatedly opened new ecological opportunities, driving phenotypic novelty and, in some clades, accelerated diversification. Our study highlights how a single morphological innovation can reshape evolutionary t

Investigating the response of *Glycymeris septentrionalis* (Bivalvia) and *Terebratalia transversa* (Brachiopoda) to euxinia: Implications for mass extinctions

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In the wake of the end-Permian mass extinction, bivalves replaced articulate brachiopods as the dominant benthic marine filter-feeders, despite morphological and ecological similarities. Several factors have been suggested as drivers of the extinction's selectivity, including competition, ocean acidity, CO2 poisoning, and differing reproductive potential. The spread of sulfidic water (euxinia) has been proposed as a general kill mechanism but its physiological selectivity has not been investigated. Survival studies of the co-occurring bivalve Glycymeris septentrionalis and articulate brachiopod Terebratalia transversa from San Juan Island, WA, were carried out in controlled anoxic and euxinic environments at 13.7, 16, and 22 °C. In colder conditions without sulfide, brachiopods exhibited greater survival than bivalves, but at higher temperatures, bivalves generally outperformed brachiopods, and by a greater margin in euxinia. The alignment between physiological tolerance in experimental settings and survival patterns in the paleontological record indicates that euxinia may have played a role in end-Permian extinction severity and selectivity, serving as an additional stressor in already warm, oxygen-depleted oceans.

Session 11: Coral Reef Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Demographic patterns of 1000 corals across a decade

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Coral populations persist as a result of colony-specific processes of survivorship, growth, and recruitment, which together define demographic trends. Many recent studies have provided documentation of demographic patterns under extreme external forcing, such as responses to marine heat waves, which can be linked with mass mortality. However, such descriptions fail to provide insights into the baseline demographic patterns of the coral populations. Recent technological advances have enhanced our capabilities to examine colony-specific change across reefs. In this study, we used large-area imagery products and *TagLab*, an AI assisted software, to track 1000 coral colonies spanning a 10-year interval across five geographies: Curacao, Florida Keys, Maui, Millennium Atoll, and Palmyra Atoll. Most recorded colonies survived and continued to grow through multiple transition periods in the study. Additionally, radial growth rates were variable among major coral taxa and regions, yet showed notable similarities in shape of statistical distributions. This study highlights the variability of baseline coral growth and survival, emphasizing the importance of ecosystem monitoring during our generation of rapid global change.

Initial changes in benthic community structure on Caribbean fire coral skeletons after heatwave-driven mass mortality

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Marine heatwaves (MHWs) are common destructive events that push marine organisms to the upper limits of their thermal tolerances and increase their risk of mortality. Decades of disturbances have depleted the shallow reefs of St. John (United States Virgin Islands) of scleractinian (stony) corals, leaving large colonies of the hydrozoan fire coral *Millepora* dominating the benthic community. In August 2024, dead *Millepora* were uncommon on these reefs, but by March 2025, 89% of *Millepora*colonies had been killed by a MHW that brought the hottest October in the 36 years since monitoring in this location began. This fire coral graveyard extended along 43 km of shoreline, leaving dead-in-place *Millepora* colonies with intact branches that were swiftly colonized by ephemeral hydroids, turfing

algae, and peyssonnelioid algal crusts. Invertebrate communities inhabiting *Millepora* colonies changed after 9 months following colony death, largely through a decrease in abundance of mobile scavengers (e.g., hermit crabs) and an increased abundance of filter feeder worms and sponges. Among these organisms, bioeroding sponges are likely to accelerate the loss of biogenic structural complexity by weakening *Millepora* skeletons and making them more susceptible to breakage in storms. Despite their survival through previous disturbances, decimation of the fire coral biotope in St. John reveals that *Millepora*-dominated reefs are at risk of biodiversity loss as the 4th global coral bleaching event (2023-present) impacts reef ecosystems worldwide.

Exploring drivers and impacts of the reef boring urchin, Echinometra, on reefs of the Indo-Pacific

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Organisms such as sea urchins may contribute to resilience in anthropogenically impacted systems. Sea urchins can play a role in maintaining coral reef resilience through grazing, compensating for herbivory loss due to declines of herbivorous fishes. Additionally, these bioeroders can establish microhabitats for corals and enhance reef topographic complexity, supporting biodiversity. However, widespread die offs have left primarily urchin-grazed systems more vulnerable to state change and benthic community instability as algae dominates the benthos. Conversely, high urchin density can cause core reef substrate to degrade, resulting in possible reef structural collapse and fragmentation. We quantified urchin density (Echinometra spp.) across three Society Islands of French Polynesia and on Palmyra Atoll, exploring drivers and indicators of resilience across a gradient of anthropogenic disturbance. Fishing protection was associated with a decline in urchin density, exhibiting within-island variability with densities ranging from <1 +/- 0.05 individuals m^{-2} to >11 +/- 3.68 individuals m^{-2}, showing overall decline from historic records. Urchin density was associated with an increase in small coral abundance, suggesting their role in contributing to coral establishment on future reefs. This work illustrates the importance of understanding how sea urchins may shape reef trajectories through grazing and bioerosion, and how resilience indicators can be utilized to guide conservation and restoration.

The effect of community diversity on thermal stress tolerance of coral reefs in Okinawa, Japan

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Biodiversity in coral reefs may be impacted by thermal anomalies, leading to changes in community composition and ecosystem functioning. Seasonal storm activity, while potentially damaging to coral reef structure, can help to maintain lower sea surface temperatures (SST) within ideal coral tolerance ranges in summer months. Okinawa, Japan, a region typically experiencing seasonal typhoons, endured higher than average SST on coastal coral reefs in 2024 due to storm trajectories shifting northward, leading to a massive coral bleaching event. In this study, we observed the physiological response (gross photosynthesis [GP] and respiration [R]) of coral reef communities to these elevated SST to understand the impact of thermal anomalies on common coral species as well as the potential buffering effect of community diversity on physiological performance. We collected duplicate fragments from 10 common coral taxa near the Okinawa Institute of Science and Technology Marine Science Station to measure the paired individual rates of GP and R. We then placed those 10 individuals in community assemblages to measure paired community rates across the two temperature treatments. Of the 10 species, *Porites rus*, Tabular *Acropora*, and *Favites complanata* all experienced greater rates of GP and R in elevated temperatures. When comparing the cumulative rates of fragments to their measured community performance, GP and R were greater in assembled communities, indicating a synergistic effect of diversity on community ecosystem functioning. Additionally, there was no temperature effect on the GP rates of assembled communities, suggesting that community diversity may buffer the effects of thermal anomalies on coral reefs.

Quantifying the effect of taxonomic composition and thermal history on bleaching resistance across Pacific Island Reefs

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Climate change is increasing the intensity and frequency of coral bleaching events, but some corals can be resistant to the negative effects of warm-water events. Here we explore the bleaching response observed at 32 reef sites across 16 uninhabited Pacific islands experiencing levels of thermal stress between ~0.2 - ~11°C wk. We assessed the bleaching response of ~50,000 coral colonies across the 32 photographically archived 100 m^2 plots and compared the bleaching response to the relative thermal stress at the time of sampling. There was a positive relationship between relative thermal stress and percent benthos represented by bleached corals (p=0.000358). However, the positive trend between relative thermal stress and bleaching captured appreciable variability. Some sites had anomalously low bleaching relative to statistical expectation, with reefs in the Phoenix Islands, exposed to ~6-11°C-weeks, having a similar bleaching response observed on reefs exposed to only ~1-2°C-weeks. We explored candidate hypotheses of thermal tolerance to better describe statistically anomalous sites, and Montipora sp. was found to be a thermally tolerant taxon, with less bleaching in regions with higher Montipora sp. cover. The data also suggests that enduring past thermal stress can influence future thermal thresholds across these 16 Pacific islands. In an era when thermal stress events are becoming increasingly prevalent, it is essential to account for potential adaptive and acclimatization capacities of species to changing conditions if we are to understand the future of coral reefs.

Impact of nutrients on marine macroinvertebrates in Mo'orea's coral reefs

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Coral reef ecosystems provide critical ecological, cultural, and economic benefits but are increasingly threatened by a suite of disturbances, including nutrient enrichment, overfishing, and climate change. Mobile and sessile marine macroinvertebrates perform critical ecosystem functions, including grazing, filter feeding, and nutrient recycling, making them valuable indicators of reef health, yet most studies documenting impacts of anthropogenic stressors largely focus on fish, coral, and algae. This study investigated the influence of nutrients on macroinvertebrate diversity and community structure in coral reefs of Mo'orea, French Polynesia. We recorded invertebrate diversity and abundance at seven reef sites spanning high- and low-nutrient conditions using belt transects replicated six times per site. We then compared biodiversity indices (Simpson,Shannon) and feeding guild composition to nutrient levels based on previous studies as well as a bioassay using algal growth as a proxy for nutrient availability. Although nutrient levels were not a significant predictor of macroinvertebrate diversity (ANOVA, p=0.4247), there were trends in species and feeding guild distribution and abundance across sites, suggesting local ecological drivers beyond nutrient enrichment. These results highlight the complexity of reef community responses to environmental stressors and provide a baseline for future monitoring of invertebrate assemblages in Mo'orea.

Spatial patterns and geo-ecological implications of *Acropora palmata* mass mortality as a result of the 2023 global heatwave

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In 2023, a global marine heat wave caused the fourth and worst mass coral bleaching event which was particularly devastating for Caribbean reefs. To date, the extent of bleaching and mortality of the primary Caribbean reef-builder, *Acropora palmata*, as well as the associated geo-ecological implications, remain unknown. We took aerial

images with a commercial drone before, during, and after the marine heatwave to analyze the spatial patterns of *A. palmata* bleaching and mortality at the reefscape scale in Puerto Morelos, Quintana Roo, and calculated the implied loss in the calcification potential of the reef. Following, we extended our analysis to the Greater Caribbean using satellite-derived thermal stress estimates to predict the mortality of the species throughout its shallow-water distributional range. In Puerto Morelos, the extreme thermal stress (> 14 DHW) caused 100 % *A. palmata* mortality (1,193 m^2) which translates to an overall loss of calcification potential of 21,400 kg $CaCO_3$ per year. Nearly 70 % of reef crests throughout the Greater Caribbean experienced thermal stress levels equal to or greater than Puerto Morelos which implies a catastrophic mass mortality event for the species and a drastic reduction in reef-building processes. Science-based and inclusive monitoring, restoration, and conservation, in combination with actions against climate change, are required to ensure the future of *A. palmata* in our lives.

Assessing the biodiversity-biomass hypothesis in coral reef fish assemblages across a latitudinal gradient in the Western Pacific

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Scripps Institution of Oceanography

Biodiversity is widely hypothesized to enhance ecosystem function, yet the extent to which regional biogeography contextualizes this relationship within coral reef fish assemblages is less understood. Reef fish assemblages spanning latitudinal gradients allow for an examination of how the biodiversity-biomass hypothesis operates in complementary systems. Here, we investigated variation in fish biomass and biodiversity metrics over 1330 km and 6° of latitude at eight islands (Dongsha, Taiwan, Orchid, Green, Yaeyamas, Miyako, Keramas, Okinawa) within the tropical Western Pacific. We found that islands with higher species richness generally supported greater biomass, but that the strength of this relationship varied among trophic groups, suggesting that correlations between biomass and biodiversity may be mediated by trophic structure. Biomass was also negatively correlated with components of beta diversity, suggesting that islands with more homogeneous fish assemblages supported greater, and less variable, fish biomass. Still, compositionally distinct assemblages of fish were identified between islands, highlighting persistent regional differences in fish communities. Collectively, these results support aspects of the biodiversity–biomass hypothesis while addressing the influence of regional variability. In examining how biodiversity varies with estimated biomass values across a latitudinal gradient, we provide insight into the ways in which community composition may be linked to ecosystem function and variation within coral reef fish assemblages.

Galápagos coral growth and symbiont dynamics during the 2023–24 El Niño

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1- California State University, Monterey Bay 2- Galapagos Science Center 3- Duke University

Climate change has driven extensive coral bleaching and mortality, yet certain corals can persist after repeated marine heatwaves. The Galápagos Islands, where extreme variability creates a natural laboratory for studying resilience, harbor corals that survived even after the severe 1982–83 and 1997-98 El Niño events. This study examines coral thermal tolerance at a restoration site during warming and cooling phases of the 2023–2024 El Niño. Survival and growth were quantified using structure-from-motion photogrammetry. Symbiont composition and genotype were assessed as potential drivers of thermal tolerance. Clonal fragments were monitored within the Reef Revival nursery (Isabela Island, Galápagos) and at two nearby outplanting sites. Coral growth varied within and between sites, with 96% of colonies growing faster at the more protected site (Bahía): Pocillopora corals showed significantly higher growth rates (2.96 cm/year; ANOVA, $p < 0.05$) compared to the exposed site (2.10 cm/year). These differences likely reflect variation in wave energy, substrate slope, or other ecological influences. Unexpectedly, no widespread bleaching was observed despite the predicted El Niño. Ongoing genetic analyses will elucidate how genotype and symbiont composition contribute to interindividual differences in growth. Uncovering

the mechanisms underlying growth and thermal tolerance is essential for optimizing site selection, fragment survival, and genotype choice. Identifying thermally resilient corals will strengthen restoration strategies in the Galápagos and beyond.

Session 12: Special Session I: Restoring resilient kelp forests: science, practice, and policy

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Multispecies modeling of kelp, urchins, dungeness crab, and sea otters: Insights for Oregon kelp forest management

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Kelp forests are foundational ecosystems along Oregon's nearshore reefs, supporting biodiversity and providing key services to coastal communities. Bull kelp (*Nereocystis luetkeana*), the dominant canopy-forming species, is increasingly threatened by marine heatwaves and intense grazing by sea urchins. To enhance kelp forest resilience, managers are considering interventions such as urchin culling, kelp out-planting, and sea otter (*Enhydra lutris*) reintroduction. Each of these actions has the potential to strengthen kelp recovery but may trigger unintended changes within the food web. In particular, sea otter reintroduction could influence populations of commercially important species such as Dungeness crab (*Metacarcinus magister*), yet the magnitude and direction of these effects are uncertain. To explore these dynamics, we developed a discrete-time, spatially-implicit, multispecies matrix model of kelp forest community interactions. The model incorporates predator switching between sea urchins and Dungeness crab as a function of prey availability, and kelp density. Our findings suggest that interactions between management strategies have a strong influence on outcomes, with integrated approaches (e.g., combining kelp restoration with sea otter reintroduction) helping to mitigate potential trade-offs while supporting overall ecosystem resilience. This work highlights the value of multispecies modeling for evaluating alternative management strategies.

Weighing restoration decisions for bull kelp and giant kelp: When, how much, and what to outplant?

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Implementing restoration entails many decisions including which life stages to reintroduce, when to intervene, and how long to intervene. Current bull kelp and giant kelp restoration efforts in California were spurred by the co-occurrence of a disease outbreak and marine heatwave in 2014-16. Bull kelp is an annual species that potentially maintains a germ bank. Giant kelp, a perennial, accrues age structure in its adult populations. With climate change, disturbances that lead to population decline might become more frequent and intense. However, both species' natural ephemerality can obscure signals of decline that would otherwise alert managers and restoration practitioners to intervene. We asked how kelp life history and climate scenario affect decisions about life stage at reintroduction and intervention cue, threshold, and wait time. To address these questions, we built and parameterized a stage-structured model for bull kelp and giant kelp, in which we simulated restoration approaches under a range of climate scenarios. We found that regardless of climate scenario or species, life stage at reintroduction was the most important determinant of population biomass, ahead of intervention cue, threshold, and wait time. Population biomass and persistence probability for both species benefited more from outplanting microscopic life stages than approaches that involved only juvenile outplants and/or drift supplementation. These results highlight the importance of microscopic life stages for kelp population recovery.

Carbon storage in kelp forest restoration: Comparing active sea urchin removal and marine protection in Aotearoa New Zealand

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Understanding the ecosystem benefits of kelp recovery is key to assessing restoration methods. In northeastern Aotearoa New Zealand, overgrazing by sea urchins (kina, *Evechinus chloroticus*) has decimated kelp forests (*Ecklonia radiata*), creating widespread urchin barrens with reduced biodiversity and ecosystem services. Here, we present the first assessment of carbon storage in actively restored kelp forests, comparing experimental urchin removals with passive recovery inside the long-protected Cape Rodney to Okakari Point (Goat Island) Marine Reserve. Experimental removals across 1.6–2 ha (~4–5 acres) resulted in rapid canopy re-establishment within two years without any kelp seeding or translocation. Yet after four years, urchin barrens are beginning to reform without continued urchin control or predator protection. In contrast, recovery inside Goat Island Marine Reserve was slower (15–25 years) but more durable, with trophic cascades restoring predators for large-scale, self-sustaining kelp forests. These contrasting methods highlight key restoration trade-offs: active interventions accelerate kelp recovery and carbon storage but are labour-intensive, spatially limited with temporary benefits; while passive recovery through marine protection is slower but has longer lasting effects. Our findings suggest that combining active and passive approaches may maximize immediate carbon benefits and long-term ecosystem resilience.

Looking into the crystal ball: Forecasting future kelp hotspots and coldspots in California

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California suffered a loss of kelp during a prolonged marine heatwave in 2014–2016. A decade later, many areas have yet to recover and instead, remain locked in urchin-dominated states. This is especially concerning because projections indicate warming by up to 3°C and more frequent marine heatwaves by the end of the century. Current restoration efforts now focus on “tipping” these systems back to kelp forested states, arguably a greater challenge than preventing collapse in the first place. Leveraging dynamically downscaled Earth System Models (ESMs), we forecasted kelp abundance of giant and bull kelp to 2100 using boosted regression trees trained with drivers including temperature, nitrate, wind stress, and urchin density. Our projections revealed persistent hotspots where kelp is likely to endure, coldspots where long-term loss is expected, and transitional zones with temporal oscillations between persistence and loss. These patterns varied across the three ESMs, illustrating a range of potential futures. Environmental drivers influenced annual forecasts with cool, nutrient-rich, low-urchin years aligning with higher kelp densities and warm, nutrient-poor years aligning with lower kelp densities. Given the emergence of novel environmental conditions far outside historical ranges in the latter half of the century, we encourage re-evaluations of kelp forecasts towards mid-century as climate trajectories become clearer. Identifying potential long-term kelp refugia provides the foundation to guide proactive restoration and management for existing or restored kelp forest

Mapping kelp from above and below: Integrating kelp censuses, drones, and hydrographic surveys to track natural recruitment patterns

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In August 2014, Hurricane Marie—though 900 miles away—generated 15-foot waves that devastated Catalina Island’s coastline, destroying piers and uprooting kelp forests. This disturbance coincided with a prolonged marine heatwave and strong El Niño conditions (2014–2016), compounding the damage. In the absence of giant kelp, invasive Sargassum horneri and native understory algae proliferated, delaying kelp recovery at many locations. After a nine-year absence, kelp began naturally recruiting at our study sites in summer 2023, coinciding with the

launch of our restoration grants. We quickly shifted from active restoration to detailed mapping, documenting when and where kelp returned to capitalize on this rare natural recovery event. Distinct patterns of early recruitment emerged. Patterns show that: shallow cobble zones often host the first recruits; north-facing, near vertical rock supported some of the first groupings of multiple adult plants; stable rock “islands” within shifting cobble provide early strongholds for recruitment; while solid unmovable lower-relief rocks—despite appearing suitable—were slowest to recover due to dense understory algae. We integrate diver-based kelp censuses, drone imagery, and hydrographic surveys within a GIS framework to track kelp recruitment and overlay it with environmental variables including depth, slope, rugosity, and substrate (cimikelp.org/our-maps). This multi-pronged mapping approach provides a powerful tool for understanding kelp recovery dynamics and guiding restoration planning across similar sites on Catalina Island.

From collapse to comeback: Evaluating combined techniques for rapid kelp forest recovery

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1- The Nature Conservancy 2- Moss Landing Marine Laboratories 3- Sonoma State University 4- Ocean Protection Council 5- California Department of Fish and Wildlife 6- F/V Crazyhorse and California Sea Urchin Commission 7- Reef Check Foundation

In under a decade, Bull kelp in northern California has declined to less than 10% of historical levels due to multiple stressors, including urchin predator loss and a marine heatwave. A kelp refugia site in Mendocino resisted collapse until 2022, when urchin overgrazing began. By 2023, 91% of the ~15-acre habitat was lost, severely impacting biodiversity. Building on years of learning, we applied a spatially strategic approach of both grazer suppression and kelp enhancement activities across the recently deforested site. In 2024, commercial urchin harvesters were tasked with protecting the small remnant forest at the site, resulting in > 23 tons of purple urchin harvested of varying size structure and a 172% increase in kelp canopy cover. In areas furthest from remnant kelp, we piloted deployment of nine Arrays to Recover Kelp Ecosystem Vegetation (ARKEVs) to enhance spore supply, and future kelp generations. Given successful kelp survivorship, growth, and production of reproductive sori, we estimate that 80 trillion spores were released in summer 2024 from the ARKEVs. In spring 2025, we continued grazer suppression throughout the site and scaled kelp enhancement activities by deploying 50 ARKEVs, while also adding drift kelp subsidies to reduce active urchin grazing. This combined effort of grazer suppression and kelp enhancement yielded a 700% increase in kelp canopy cover at the site by early summer 2025. Our results suggest that in a spore limited and urchin barren context, a combined approach can accelerate kelp ecosystem recovery of an annual foundation species.

From concept to canopy: The role of Arrays to Recover Kelp Ecosystem Vegetation (ARKEVs) in kelp restoration

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1- Moss Landing Marine Laboratories 2- Oregon Kelp Alliance 3- Sonoma State University 4- Moss Landing Marine Laboratories, Sunflower Star Laboratory 5- The Nature Conservancy 6- California Sea Urchin Commission, F/V Cyndi Lynn

A dramatic loss of bull kelp (>90%) occurred in Northern California and Oregon following sea star wasting disease, the 2014-2016 marine heatwave, and subsequent outbreaks of purple sea urchins. In response, various restoration techniques have been developed and tested to aid recovery of this annual kelp species, particularly within the challenging conditions of exposed open coast environments. Here we describe the design and application of Arrays to Recover Kelp Ecosystem Vegetation (ARKEVs)—a modular, scalable, and robust outplanting system that is easily deployed and retrieved from a small vessel without requiring permanent underwater infrastructure. In 2025, ARKEVs were deployed in Oregon and Northern California, with each region customizing the tool to local conditions—revealing its adaptability for kelp recovery. Our results indicate outplanted bull kelp can experience

high survivorship (~50% after 1 month), especially when ARKEVs are deployed early (i.e., spring vs. summer), rapid growth to a surface canopy, and continuous production of reproductive sori with viable spores in as early as 45 days. ARKEVs also provide broader ecological benefits, including enhanced fish recruitment and the generation of natural drift kelp that suppresses grazing of remaining sea urchins and gastropods. These breakthroughs in restoration success enabled a synthesis of lessons learned from ARKEV design and deployment, culminating in the development of resources (e.g., blueprints and how-to guides) to facilitate broader implementation of this novel technique for kelp restoration.

San Diego, you're a site for sori: Future-proofing kelp forests at the regional scale using local perspective of drivers and population structure

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Given the limitations of global-scale, one-size-fits all prescriptions for kelp forest loss, informing restoration at the local scale may be advantageous. This study identifies the unique suite of ecological, physiological, and genetic factors that could be driving loss and recovery of giant kelp (*Macrocystis pyrifera*) in San Diego. Our work examines the spatial dynamics of *M. pyrifera* forests along ~140 km of local coastline using in situ surveys and measurements paired with four decades of satellite imagery from the Santa Barbara Coastal Long-Term Ecological Research (SBC LTER). We analyze changes in kelp canopy distribution, abundance, and persistence across spatial and temporal scales to provide historical context for local kelp loss and investigate potential factors that may be influencing these trends. Results show strong evidence of *Macrocystis* loss in the region, with patterns suggesting a potential influence of climate change and ocean warming on kelp canopy dynamics. These findings motivate our ongoing research that explores potential variability in thermal tolerance and genetics among kelp collected across San Diego County, and whether these traits affect survivorship in experimental restoration. This research will help identify key sites for future restoration efforts and determine if thermal tolerance and genetic variability exist within local populations.

After the hammers stop: Kelp persistence at Tanker Reef, Monterey Bay, CA

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1- Monterey Bay National Marine Sanctuary, NOAA 2- California Department of Fish & Wildlife

From April 2021 - 2024, a temporary sport fishing regulation exempted divers from purple and red urchin bag limits at Tanker Reef in Monterey Bay, CA. Agency divers (CDFW & MBNMS) tracked changes to both purple and red urchins, and giant kelp adults and juveniles, in the culled "grid" and a nearby non-culled control, counting all urchins and kelp found in 30x2 m transects, with 18 replicates at each site.October 2021 - October 2022 (peak culling), total purple urchin counts averaged ~1700 at the grid and ~5500 at the control. After the hammers stopped in July 2023, total purple urchin counts from August 2023 - April 2025 (post-culling) averaged ~5400 at the grid and ~6600 at the control. Purple urchins 1-3 cm in diameter contributed significantly to the tripling in the grid. Red urchin total counts during peak culling averaged 59 in the grid and 156 at the control. Post-culling total red urchin counts averaged 225 at the grid and 287 at the control.Adult giant kelp total counts during peak culling averaged 172 in the grid and 5.2 at the control. Post-culling total adult giant kelp counts averaged 139 at the grid and 6.6 at the control. Kelp at the control site varied little over the 4 years, while kelp at the grid began with 21 individuals, averaged 172 (range 49 - 298) during peak culling and post-culling declined to 139 (on average, range 87 - 186).Nearly two years after the hammers stopped, adult giant kelp persisted in the grid, even in the face of increasing urchin counts. However, it is unclear how long this may last.

Session 13: Conservation and Restoration III

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Restoring eelgrass in tidal creeks to mitigate erosion and enhance biodiversity
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Seagrass restoration efforts have been climbing in response to the loss and recognized value of these coastal ecosystems. Elkhorn Slough, CA has been an ideal test site for refining seagrass (*Zostera marina*, hereafter eelgrass) restoration best practices. Despite being a highly eutrophic estuary with substantial hydrological alterations and high erosion rates, the distribution and extent of eelgrass in Elkhorn Slough has been increasing over the past thirty years. Our small-scale eelgrass restoration efforts have hastened the recovery of eelgrass in the system toward historic levels. We have expanded our restoration efforts into tidal creeks, where much of the coastal erosion occurs in the system and biological monitoring is sparse. Our more recent restoration seeks to evaluate whether restoring eelgrass mitigates erosion or enhances biodiversity in restored and natural tidal creeks. We transplanted 23 blocks across 6 natural or restored creeks. Each block had a 0.25 m^2 high density and low density restored plot and nearby bare plot. We assessed whether relative erosion rates differed in areas of the creeks with versus without restored eelgrass. We also assessed whether biodiversity (fish, invertebrate) was enhanced with the restoration of eelgrass in tidal creeks. Goal-driven experimental restorations such as ours that assess ecosystem function are necessary if we are to advance restoration acreage targets and re-build resilience across habitat types within highly modified estuarine systems.

Does conditioning of captive-bred juvenile white abalone alter their shelter seeking behavior?
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Captive breeding of threatened species like abalone (*Haliotis* spp.) is a common tool to help restore populations via outplanting of laboratory-reared juveniles. However, captive-bred juveniles typically experience high predation mortality shortly after stocking due to behavioral differences between captive-bred and wild conspecifics (the domestication effect). Using captive-bred juvenile white abalone (*Haliotis sorenseni*) from multiple breeding pairs and age classes, we tested whether different types of behavioral conditioning promote shelter-seeking behavior that may allow juveniles to better avoid predators. We conducted a series of repeated stressor trials in which juvenile white abalone were repeatedly disturbed (touching of the shell with tongs) across three treatments, in addition to a non-manipulated control: 1) no predator cue present, 2) predator cue present, and 3) predator cue present every other trial. We recorded whether abalone moved to the shelter provided in the mesocosm, as well as time-to-shelter for those individuals that moved to shelter before the end of the eight-minute trial. We found that age was the most important indicator of whether an abalone seeks shelter, with younger abalone more likely to seek shelter than older abalone. Additionally, abalone in the non-manipulated control group were most likely to seek shelter; however, abalone in this group took longer to reach shelter than abalone in the stressor treatments.

Projected decline of habitat refugia for red abalone (*Haliotis rufescens*) across California
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Red abalone (*Haliotis rufescens*) are large, herbivorous gastropods once abundant along the California coast, but now increasingly threatened by climate-driven stressors such as ocean warming, acidification, and deoxygenation. Localized climate refugia, where conditions remain within physiological limits, may serve as critical safe havens for this sedentary species. We developed a mechanistic ecophysiological framework to identify and project climate

refugia for red abalone by integrating empirically derived tolerance thresholds for bottom temperature, dissolved oxygen, and pH with dynamically downscaled Earth System Model projections. Using eight biologically relevant stress definitions representing key life processes (e.g., growth, reproduction, disease resistance), we mapped potential refugia for mid-century (2020–2050) and end-of-century (2070–2100) periods under the Representative Concentration Pathway 8.5 (RCP8.5) scenario. Results show a significant statewide decline in suitable refugia, with northern California experiencing significant losses—an area already impacted by kelp forest decline. By the late century, few areas consistently meet multiple physiological thresholds, especially as upwelling-driven stressors intensify. To support proactive, climate-smart conservation, we created an interactive RShiny tool to explore refugia patterns, and an R package for replicating and applying this framework to other species. Protecting remaining refugia will be essential to support the persistence and resilience of red abalone in a rapidly changing ocean.

Forecasting the ecological dynamics of southern sea otter restoration to the San Francisco Estuary
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The southern sea otter (Enhydra lutris nereis) is a keystone predator that has been extirpated from much of its historical range in Northern California and Oregon. Where otters have returned, either through natural recolonization or targeted restoration, they often drive dramatic shifts in food web structure. Theory-driven models used to forecast the ecological impacts of predator reintroduction are often limited by sparse or short-term datasets. In contrast, long-term, multi-trophic monitoring programs—such as those in the San Francisco Estuary—provide a powerful foundation to empirically reconstruct underlying food web dynamics and explore how reintroducing sea otters could reshape those interactions. Here, we leveraged 35+ years of monitoring data to construct multivariate autoregressive state-space (MARSS) models that analyze historical community dynamics and project population trajectories under multiple sea otter reintroduction scenarios. Our models revealed strong trophic interactions at the base of the food web, including a cascade initiated in part by a bivalve invasion that has substantially reduced food availability. However, otter predation that targets benthic invertebrates like clams and crabs has the potential to upend this cascade and reverse population declines for forage fishes. These results provisionally suggest that reintroduction of sea otters could fundamentally restructure estuarine communities to the benefit of finfish and provide a tool to anticipate and proactively manage the impacts of sea otter reintroduction in the San Francisco Estuary.

They not like us? Support for conservation and mitigation across a changing coast and world
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Broad public acceptance of conservation efforts is critical for the success of various interventions, from in- and out-of-kind mitigation to the establishment of protected areas. Building on nearly two decades of CSUCI's Coastal Public Opinion Survey, we combined recent (2023-2025) survey results with our evolving framework for out-of-kind mitigation across California. Our findings suggest that traditional concerns—such as restoration proximity and ecosystem type substitution—remain important, but are increasingly overshadowed by broader social dynamics. Specifically, recent lived experiences (from COVID to the LA Wildfires of 2025) are complicating and depressing public engagement with nature and their confidence in traditional resource management. At the same time, rising affordability pressures—from housing costs to insurance premiums—diminish public enthusiasm for investment in traditional environmental stewardship. Finally, increasing political polarization amplifies divisions over the value of nature and our efforts to restore it, with trust in management varying strongly across demographic and ideological lines. This storm of cultural stressors is exerting growing influence over public perceptions of restoration value and management legitimacy, underscoring the need for adaptive frameworks that integrate ecological metrics with social realities. Efforts which acknowledge this reality and explicitly incorporate ecosystem services alongside traditional ecological structure and function concerns appear more likely to gain public acceptance and support.

Kiln to kelp forest: Optimizing *Macrocystis pyrifera* sporophyte growth on ceramic tile for experimental kelp restoration

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The success of kelp forest restoration efforts is likely dependent on using surfaces that promote the settlement and growth of selected kelp taxa. Ideal settlement surfaces would be composed of naturally sourced (non-plastic) material while maintaining enough structural integrity to facilitate robust sporophyte growth. Current restoration efforts have used varieties of twine, “green gravel” or different types of natural rock surfaces on which to settle kelp with varying levels of success. Here, we used ceramic tiles as a substrate as they can be intentionally designed, standardized, and secured to bedrock at restoration sites. We used three clay types (terracotta, reclaimed stoneware, and sandy sculptural clay) and three gametophyte application methods (pouring, using an airbrush, and a pressurized spray bottle). This design allowed us to compare substrate suitability for the settlement and growth of *Macrocystis pyrifera* gametophytes, as well as the consistency of gametophyte application across the surface. Sporophyte growth rate, density, and attachment strength were tracked using image analysis, informing which combination of clay and application methods was most successful. The best performing clay type and most consistent application method were then used to explore how gametophyte settlement density affected fertilization and subsequent sporophyte development. These findings help provide insights into optimal gametophyte settlement density on ceramic substrate for *M. pyrifera* restoration efforts.

Developing long-term monitoring strategies for urban forests: Ground and UAV-based assessment of a modified Miyawaki forest

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Urban forest restoration repairs ecosystem services, but is challenging due to anthropogenic stressors and competing demand for space. Monitoring urban restoration is essential in evaluating current projects and informing future ones, but it is time and resource intensive. Miyawaki forests, often called microforests, are small, multilayer, biodiverse, densely planted areas that are well-suited for urban environments. The Miyawaki method differs from traditional restoration in mediterranean climates as it involves the simultaneous introduction of all species and a dense planting format. The method has had success in tropical and cold temperate environments but has not been thoroughly tested in a mediterranean climate. We focused on developing time and cost effective monitoring for the Ascot Hills Microforest (AHM), a modified Miyawaki forest in east Los Angeles, using Unoccupied Aerial Vehicles (UAVs) while also assessing the Miyawaki method in a mediterranean climate. The AHM includes 850 plants making up four strata in a 930m2 area. To monitor growth of the AHM, we used ground-based bi-monthly height measurements of 200+ plants and UAV flights every four months. Comparisons between ground and UAV derived height indicate that the accuracy of UAV height may differ between strata. Other results include further analysis of the accuracy of UAV height and a comparison of growth between the AHM and nearby control sites. Findings from this study will help assess the Miyawaki method in a mediterranean climate and inform the cost-effective monitoring of urban restoration projects.

Session 14: Kelp Forest Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Changing baselines in kelp trophic ecology around the North Pacific

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There is an increasing number of regional studies on the trophic ecology of kelp around the North Pacific and its change through time, with a focus on secondary consumer redundancy and its impacts. We review and summarize this wide range of arguments through space and time. We consider physical processes such as coastal maturation and climate change, the role of extinction, indigenous exploitation, and the changing cultural aspects of Western exploitation of system components. Through this, we explore multiple deeper baselines for kelp forest structure. Archeological evidence reveals that human exploitation of key taxa in the kelp ecological system preceded Western impacts. Early anthropogenic extirpation/extinction of both the flightless duck *Chendytes* and the sea cow likely impacted the kelp trophic system, while archeological and trade records clarify the succession of impacts on sea otter, abalone, sheepshead, and lobster. A range of complex interactions involving prey switching, supplementation, and competitive interaction of otters, killer whales, and humans beginning in the indigenous period has also become evident. Chinese market demand began to penetrate the North Pacific kelp system in the 15th century, with Russians and Americans serving these markets with a range of key kelp system taxa until the 20th century. Most recently, the disease of sunflower sea stars and the interactive roles of climate and fisheries management through marine protected areas (MPAs) have increasingly structured kelp system trophic ecology.

Effects of increasing temperatures on consumer-mediated nutrient dynamics: Implications for giant kelp growth

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Kelps are an important foundation species that provision food and habitat to support high biodiversity. However, kelps face increasing challenges in a changing climate, including a limited supply of nutrients from physical processes, such as the nitrate supplied by upwelling. These limited nutrients can be supplemented by the excretion of nitrogenous waste products, primarily ammonium and urea, from associated kelp forest consumers. Although rising ocean temperatures are a cause of stress to giant kelp (*Macrocystis pyrifera*), potential positive effects on fish excretion rates might help offset the negative effects of warmer ocean waters. To test the effects of rising temperatures on consumer-mediated nutrient dynamics, we subjected juvenile blue rockfish (*Sebastes mystinus*) to five different temperature treatments (9, 12, 15, 18, 21 C) and measured the effects on excretion, metabolism, food consumption, and growth. We observed a non-linear response to temperature from all physiological variables, with each one peaking at different “critical” temperatures between 15-18 C , including a 25% percent increase in ammonium excretion at 15 C compared to 9 C. The increased nutrient excretion by kelp forest fishes as ocean temperatures rise implies greater consumer-derived nitrogen availability for giant kelp, which may provide nutritional relief at least in the early stages of climate change. The next step is to test how kelp growth is modified as a function of temperature and fish-derived nutrient excretion.

Giant kelp growth and survival in a naturally recovering kelp forest

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Competition for space and survival from predation among newly settled individuals shapes population dynamics, connectivity, and community assembly. In kelp forest ecosystems, which have experienced dramatic declines in parts of California, the recovery of forests from kelpless urchin barrens is driven by the settlement and subsequent survival of recruits. In this study, we asked how the survival of giant kelp recruits in a former urchin barren varies as a function of kelp size, intraspecific competition, and grazing by purple sea urchins. We monitored 40 permanent, $1m^2$ quadrats at Hopkins Marine Station in Monterey, CA, for over a year as the area naturally transitioned from an urchin barren to a kelp forest, quantifying urchin density, size, and behavior, and the growth and survival of every giant kelp individual. Prior to recovery, 36% of urchins were exposed (i.e. actively grazing), whereas after recovery began, 1% remained exposed. During recovery, we found strong size-dependent survival of new kelp recruits: small individuals (<10cm) had a ~46% chance of survival each month, while large individuals (>1m) had a ~93% chance. Survival rate decreased with conspecific density, but not urchin density, suggesting that once a barren has

started transitioning to a forest, mortality from competition is stronger than from grazing. This study broadens our understanding of how ecological forces shape the natural recovery process of kelp forests and can inform kelp restoration by providing guidance on ideal outplant and urchin density thresholds in urchin barrens.

Community structure and seasonal dynamics of fishes in Oregon's kelp forests

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Among the most productive ecosystems on Earth, kelp forests are prime examples of imperiled habitats that are critical to numerous marine species. In the California Current (CC), they provide vital habitat for many nearshore fishes, including key fishery species such as rockfishes, salmonids, lingcod, and cabezon. Multiple stressors including marine heatwaves, intense storms, and loss of keystone species have caused major recent declines of kelp forest habitat. Despite robust monitoring efforts in other regions of the CC, subtidal surveys in Oregon mainly target invertebrates and algae, yet monitoring of fish communities remains limited. This is alarming considering Oregon has lost more than two-thirds of its kelp canopy (primarily composed of bull kelp, *Nereocystis leutkeana*) since 2010. There is an urgent need to monitor kelp persistence *and* to better track fish community responses to both overall declines and seasonal fluctuations in canopy cover. To address this, we are comparing temporal changes in fish communities using novel community composition data collected through three *in-situ* diver survey methods (visual, environmental DNA, and stereo-video) at three nearshore sites. Initial findings support higher diversity in kelp forests, though abundance is more variable and may depend on site-specific factors. Fish assemblages and abundance also differ seasonally, reflecting the natural winter decline of kelp. This study provides critical insights into how kelp forests sustain Oregon's nearshore fish communities.

Kelp on the move: Feeding fish beyond the forest?

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Kelp forests and offshore rocky reefs in southern California are critical habitats that support biodiversity and ecosystem functioning. Although kelp forests have been widely studied, the extent to which kelp-derived organic matter subsidizes adjacent offshore fish communities remains unclear. This study assessed the contribution of kelp-derived organic matter to fish diets by analyzing bulk stable isotope signatures of fish tissues, kelp, phytoplankton, and particulate organic matter. Surveys were conducted within and offshore of the Point Loma Kelp Forest (PLKF), incorporating spear- and rod and reel fishing, kelp and kelp detritus abundance assessments, and sampling of plankton and particulate organic matter. The study aims to clarify how kelp-derived organic matter contributes to fish diets across habitats and to provide insights into ecosystem connectivity. These findings will inform conservation and management strategies by highlighting the potential role of kelp forests in supporting adjacent marine ecosystems.

A novel urchin barren formation mechanism in Aotearoa New Zealand

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Understanding how sea urchins form urchin barrens is important for managing the ecological effects of fishing on kelp forests. Some sea urchin species create dense 'feeding fronts' at the edge of kelp forests, while others form small patches within the forest that can coalesce over time into large barren areas. In Aotearoa New Zealand, urchin barrens are extensive in some regions but comparatively little is known about how kina (the common sea urchin *Evechinus chloroticus*) form barrens and the densities required to do so. Following recent kelp restoration efforts at Te Hauturu-o-Toi (Little Barrier Island) in northeastern New Zealand, we have an ideal opportunity to examine barren formation as kina numbers increase within a restored kelp forest. After observing several barren patches emerge, we monitored six of them using photogrammetry and field surveys to track their expansion and

associated kina densities over time. Patch sizes consistently and rapidly increased, and began coalescing over a six-month period. While high kina densities are needed to initiate patch formation, typically at barren margins, lower densities can sustain and expand these patches as mini 'feeding fronts' push outward. This patchwork formation suggests that kina barrens may form at lower densities than previously expected. These novel insights into kina barren dynamics will help guide future kelp forest restoration and management efforts.

Sea otter behavior and prey composition across alternative reef states in Monterey, CA: Applying ecological theory to kelp forest restoration

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Due to a myriad of factors, giant kelp (*Macrocystis pyrifera*) abundance along the California coast has decreased in select areas, leading to the formation of lower-diversity ecosystems dominated by purple sea urchins (*Strongylocentrotus purpuratus*), known as "urchin barrens." Sea otters (*Enhydra lutris*) can be effective urchin predators in kelp forest states. However, in Monterey, sea otters' top-down influence in urchin barrens are limited due to the low energetic value of sea urchins and abundance of other habitat types, limiting their influence in these areas. From 2021-2023, sea urchin culling at Tankers Reef, a former barren site in Monterey Bay, was conducted to promote kelp recovery, and sea otters' response to state transitions is less known. This study combined long-term kelp canopy data (2010-2024), historical sea otter foraging records (2017-2024), and direct behavioral observations (June – October 2024) at five rocky reef sites to evaluate the role of sea otters in three alternative subtidal reef states. Results indicated that sea otters exhibit behaviors and prey selection patterns at Tankers Reef, similar to those in established kelp forests. This study contributes to growing literature advocating for the use of ecological theory in ecosystem restoration approaches and offers a glimpse into the dynamic between keystone predators and changing ecosystems.

Kelp recruitment and chlorophyll dynamics along the Oregon coast

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Intertidal kelp are foundation species that support diverse marine ecosystems, yet the recruitment of juvenile kelp can be highly variable and influenced by multiple environmental factors. One such factor is nutrient availability, often estimated using chlorophyll concentration as a proxy. In 2024 and 2025, I investigated how chlorophyll *a* concentrations relate to kelp recruitment along the Oregon coast. To assess patterns of kelp establishment, I recorded the number of juvenile kelp from six species at multiple coastal sites. I also collected water samples from each site to measure chlorophyll *a* levels. These samples were processed using fluorometry, allowing for comparisons between kelp recruitment success and local nutrient conditions. Preliminary results suggest that sites with higher chlorophyll concentrations did not always correspond to greater kelp recruitment, highlighting the complexity of environmental drivers influencing early kelp life stages. Factors such as temperature variability, nutrient availability, and local hydrodynamics may mediate recruitment success in ways not captured solely by chlorophyll *a* levels. This work contributes to a broader understanding of the ecological factors shaping kelp population dynamics and coastal resilience, and provides a foundation for future studies examining how environmental variability affects the persistence of kelp forests in the northeastern Pacific.

Session 15: Intertidal Ecology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Assessing seasonal changes in Lottia gigantea population size, density, and abundance and the indirect effects on local biodiversity

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Community composition on intertidal rocky shores is rapidly changing in response to climate change. Identifying what key organisms remain and how they interact can help capture change in ecosystem functioning. The owl limpet (Lottia gigantea) is a fierce territorial species and facilitator commonly found along the rocky shores of California. Understanding how owl limpets respond to warming is critical for predicting changes in biodiversity in rocky intertidal ecosystems. In this study, we quantified owl limpet population size range and abundance across seasonal temperature regimes and tested if the presence of owl limpets affected local biodiversity in Cabrillo National Monument, San Diego, California. We are testing two hypotheses: 1) population dynamics of limpets differ seasonally, with the highest rate coinciding with seasonal upwelling during the spring months, and 2) mobile and sessile species richness and abundance will be lower in the presence of a territorial limpet. During the months of September 2023-June 2024 I measured owl limpet shell length and tabulated the total number of individuals along seven belt transects (140 m2 in total). I also measured species composition of mobile and sessile organisms around a subset of limpets (n=84). Our results showed a difference in population dynamics by season. Results also showed that species richness and abundance of mobile species was significantly higher in the presence of limpets. These results can help identify species richness, density, and abundance of warm adapted species that are present after documented change.

Ocean acidification effects on the growth of the invasive European green crab, *Carcinus maenus*

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Marine invertebrates may experience variations in ocean acidity in their natural environment. This potentially can alter their survival and growth rate. Our research investigated the potential effects of increased ocean water acidity on the growth of the invasive European Green Crab, *Carcinus maenus*. All specimens were collected from a site in Stinson Beach, California and transported to an aquatic lab at Dominican University of California. After separation into two groups, the specimens were monitored for eight weeks in individual containers with recirculating chilled seawater at 18.8°C. The experimental group was periodically exposed to acidified ocean water unlike the control group. The effects of exposure were investigated using growth rate, evaluated through measurements of carapace dimensions and body mass. In both treatments, at least 75% had an increase in carapace dimensions and body mass. However, the increase in carapace was more for the control while the body mass increase was higher in the experimental group. These results imply the European Green Crab may be resilient to being physically stressed by ocean acidity, making their exoskeletons stronger to adapt to changes in their environment.

Fight or flight: Examining the behavioral and physiological trade-offs of intertidal ectotherms under stressful temperatures

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1- San Diego State University / CSU COAST 2- San Diego State University

As climate change continues to progress, ectothermic organisms are at particular risk to elevated temperatures since they rely on access to thermally favorable habitats to moderate their body temperatures. Faster organisms may rely on behavior to cope with elevated temperatures, while slower organisms may have to rely more on a physiological response. However, the role of movement speed in how different species cope with thermal stress has not been studied. The goal of our study was to compare the responses to temperature of intertidal ectotherms in four mobility groups: (fast moving crustaceans such as *Pachygrapsus crassipes* and *Ligia occidentalis*; intermediate-speed snails such as *Tegula funebralis* and *Nucella ostrina*; slow-moving limpets, *Lottia scabra* and *L. digitalis*; and sessile *Balanus glandula* and *Mytilus californianus*). In the field we measured body and environmental

temperatures using species-specific biomimetic models. In the lab, we quantified aerial respiration rates and upper thermal limits. We then combined these data to calculate thermal safety margins. We found that the faster species relied more on behavior and consequently, had lower thermal limits and narrower thermal safety margins while the other three mobility classes were more similar to each other. Our findings indicate that mobility is an important characteristic when considering how organisms cope with elevated temperatures and lay the groundwork for understanding how communities may respond to climate change.

A comparison of three intertidal biosurveying methods: Conventional quadrat surveying and eDNA metabarcoding of sediment and water

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Environmental DNA (eDNA) metabarcoding offers a powerful tool for ecosystem and biodiversity monitoring, helping address some of the logistical and observational limitations of conventional surveying techniques. However, few comparisons have investigated how sampling from different environmental matrices can affect species detection, with even fewer in an intertidal environment. Understanding how eDNA detections are influenced by sample type is vital for designing targeted, effective eDNA biomonitoring projects. This study analyzes the spatial resolution and organism detection achieved from three surveying approaches in a marine environment: sedimentary eDNA, water eDNA, and a visual quadrat survey. Over five dates in May 2025, eDNA surveying was conducted concurrently at three tidally-separated pools along the Hewatt-Sagarin Transect, a 108-meter rocky intertidal section in Pacific Grove, CA; on the first sampling date, paired quadrat surveying was also conducted. DNA was extracted from the water and sediment samples, amplified with a well-established metazoan assay, sequenced, and taxonomically assigned, enabling comparison with organism observations from the visual quadrat surveys. We found both convergences and divergences across our three surveying approaches, in terms of specific species detected as well as more broad spatial and temporal patterns. Characterizing these variations in detection highlights the benefits of utilizing multiple surveying techniques in tandem and helps optimize eDNA sampling design for intertidal biomonitoring.

Limpet grazers impact the community structure of the high intertidal

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Rocky intertidal communities have served as critical testing grounds for ecological theory for decades, in part due to the distinct zonation that separates the ecosystem into three major regions: high, mid, and low intertidal zones along an elevational gradient. The high intertidal along the Oregon coast is primarily composed of barnacles, fucoid algae, red macroalgae, and small molluscan grazers. Community composition in the intertidal has been shown to depend on top-down drivers, yet in the high zone, the relative impacts of three common limpets, *Lottia pelta*, *L. digitalis*, and *L. paradigitalis*, on community structure remains unclear. To assess the impacts of each of these species in Oregon's high intertidal, I conducted a multi-year field exclusion experiment to quantify impacts of each species, alone and collectively, on high intertidal community composition. Results show that limpets drove community composition, with the most abundant limpet species, *Lottis digitalis* having the greatest effect. Macroalgal canopy coverage was higher in the absence of limpets, meaning that grazers, either through direct or indirect effects, play a role in the success of macroalgae in the high intertidal. The effects of limpets were consistent through time, supporting previous research suggesting that limpets are key to determining the success of primary space occupiers in the high zone. This relationship may be altered as climate change worsens, leading to significant shifts in high zone community structure.

Marine heatwave and keystone predator loss drive broad-scale decline and hinder recovery of a rocky intertidal kelp

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Human activities are increasingly driving the co-occurrence of multiple ecological stressors, resulting in interactive and cumulative impacts that can reshape ecosystem dynamics and accelerate population declines of climate-sensitive species. Here, we use over two decades of rocky intertidal monitoring across 17 sites spanning over 1,200 km of coastline to assess how two unprecedented stressors—a multi-year marine heatwave and the disease-driven loss of a keystone predator (*Pisaster ochraceus*)—impacted populations of the canopy-forming intertidal kelp *Postelsia palmaeformis*. We show that *Postelsia* experienced rapid and severe declines during the 2014-2016 northeast Pacific marine heatwave, with an average population decline of 50%, multiple site-level extirpations, and particularly striking losses in the southern portion of the species' geographic range. Concurrently, *Pisaster* declines triggered mussel bed expansion into habitats previously occupied by *Postelsia*, further inhibiting kelp recoveries. Our findings reveal how converging stressors can drive persistent, broad-scale ecological shifts through both direct and indirect pathways. These results also highlight the critical role of long-term, spatially extensive monitoring in detecting and understanding global change impacts and provide a foundation for guiding *Postelsia* conservation and restoration efforts.

Mysteries in the mesenteries: Trophic role of intertidal sea anemones

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Suspension-feeding invertebrates are often spatially dominant in benthic community assemblages. Considering this—and in light of their prolific feeding activities—their role as consumers, and likewise, structuring agents, may be greatly underappreciated. However, the nature of the prey items consumed, along with the impacts that suspension-feeding has on prey populations, are poorly understood for many taxa. Here, we characterize the natural diets of three common Eastern Pacific intertidal sea anemone species (*Anthopleura* spp.) and show that they function as microphagous predators to a greater extent than previously recognized. Analyzing gastrovascular contents reveals the regular presence of postlarval invertebrates (e.g., mussel plantigrades, juvenile crabs), small epibenthic invertebrates (e.g., ostracods, amphipods), and invertebrate larvae (e.g., cyprids, cyphonautes) in all studied anemone species. This includes prey in large anemones which have been characterized as macrocarnivorous. Additionally, experiments to quantify anemone digestion rates indicate a rapid prey degradation and high turnover. Altogether, our data reveal that previous studies have underreported the consumption of smaller prey items, possibly due to inadequate sampling efforts, rapid digestion, or spatiotemporal variation in prey availability. Predation by sea anemones may be a major source of mortality for recruiting and juvenile stages, as well as for other microinvertebrates in the rocky intertidal zone.

The effects of macroalgal diets on the feeding rates of Strongylocentrotus purpuratus

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Primary producers from diverse macroalgal groups (*Rhodophyta, Chlorophyta*, and *Phaeophyceae*) are important food sources for invertebrate herbivores and detritivores. Recent climate changes and predator dynamics have affected available macroalgae in NE Pacific nearshore environments. In Oregon, nearshore macroalgae declines have accompanied precipitous purple sea urchin (*Strongylocentrotus purpuratus*) population increases. This study investigates urchin-algae trophic dynamics by comparing lab feeding rates, size changes, and gonad growth in spring and summer 2024 trials for purple sea urchins fed seven common Southern Oregon macroalgae: *Egregia menziesii, Corallina vancouveriensis, Nereocystis luetkeana, Ulva lactuca, Mazzaella splendens, Sargassum muticum*, and *Desmarestia ligulata*.In spring 2024, linear mixed models found significantly higher dry weight consumption for urchins fed *E. menziesii* versus *C. vancouveriensis* ($p=0.0001$), with consumption rates changing significantly across days ($p=0.0208$). ANOVA showed *E. menziesii*-fed urchins had significantly greater wet weight increases, but gonad indices didn't differ significantly ($p=0.41$).In summer trials, urchins fed *D. ligulata* consumed

significantly more than those fed *N. luetkeana* blade or *S. muticum* (p=0.0002 and <0.0001), but less than those fed *N. luetkeana* stipe (p<0.0001). All fed groups gained significantly more weight than unfed controls, with *N. luetkeana* stipe showing greatest gains. *D. ligulata*-fed urchins had higher gonad i

Session 16: Community Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Comparing the trajectories of parasite community change for native and invasive fishes in Gambusia affinis's native (Pearl River, LA) and invasive (upper Rio Grande, NM) ranges

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The enemy release hypothesis posits that invasive species are often successful due to a lack of "enemies", tending to be less heavily parasitized in their introduced range than in their native range and carrying a lower parasite burden than native species. However, it is difficult to compare parasite burdens of hosts living in vastly different ecosystems due to high spatial variability in parasite communities. In order to combat this problem, this study uses the parasite burden of native fishes as a baseline for comparison of the Western Mosquitofish (*Gambusia affinis*) in its native (the Pearl River in Bogalusa, Louisiana) and invasive (the Rio Grande in Albuquerque, New Mexico) ranges. Specimens used were collected over a 42 to 79 year time period, which allows for an analysis of *G. affinis* in its invasive range throughout time: from just after the point of introduction to 79 years invaded, to understand how its parasite community shifts. We found that *G. affinis*'s parasite burden significantly increased through time compared to native Rio Grande fishes, but we did not see a significant difference in overall parasite abundance of *G. affinis* compared to native fishes in its invasive range. These results suggest that the enemy release hypothesis is applicable to the initial stage of an invasion, but invasive species may accumulate parasites through time until they have equivalent numbers of "enemies" as native species.

How's the weather in there? Impacts of extreme weather events on parasitism in riverine fishes

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Extreme weather events (EWE) have increased in frequency and magnitude due to anthropogenic climate change. These extreme weather events, including hurricanes, floods, and droughts, can cause outbreaks of parasitic diseases in humans, but little is known about how these events impact parasite abundances in wildlife populations. Fish serve as hosts for several parasite groups and therefore represent an excellent model to understand parasite responses to EWE. We expected that parasites with complex life cycles and sensitive free-living larval stages would decrease in abundance after EWE, while spore-forming and direct life cycle parasites might withstand such conditions. We dissected 1,188 preserved fish across 7 fish species collected between 1963 and 2005 from the Pearl River in Louisiana and examined them for metazoan parasites. We also identified EWE that affected this river system during the focal time period, including 25 hurricanes. We evaluated the effect of EWE disturbances on parasite abundance using generalized linear mixed models, finding that direct life cycle parasites are negatively affected by hurricane events on short time scales. By quantifying the impact of extreme weather events on parasitism in wildlife populations across this 42 year period, we are building an understanding of how these manifestations of anthropogenic climate change affect wildlife populations.

Invertebrates assemble! Trends in invertebrate assemblages associated with four prevalent intertidal kelps along the Oregon coast

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Oregon State University

Kelp communities along the Oregon coast have persisted for decades in a stable state, structuring the low rocky intertidal zone. These kelps provide complex habitat and drive local primary productivity, impacting overall community structure and function. More recently, Oregon's low zone kelp communities have begun to exhibit slower rates of recovery from disturbance, indicative of an approaching ecological tipping point. While significant research has been dedicated to understanding the climate vulnerability of these habitat-forming macroalgae, we lack specifics on the invertebrate assemblages associated with Oregon's intertidal kelps. This study represents the first comprehensive assessment of invertebrate assemblages associated with four dominant species of intertidal kelp along the Oregon coast: *Hedophyllum sessile*, *Postelsia palmaeformis*, *Lessoniopsis littoralis*, and *Alaria marginata*. Each of these species differ in size, morphology, and complexity producing observed differences in associated invertebrate assemblages (PERMANOVA, d.f. = 3, F = 108.81, p = 0.001). Invertebrate assemblages associated with each species were further modulated by site-specific differences along a geographic gradient. These findings provide important baseline data on invertebrate biodiversity patterns associated with Oregon's intertidal kelp that may be further utilized to understand how climate-driven changes in kelp abundance may impact the structure and function of Oregon's rocky intertidal communities.

Biofouling communities on Oregon offshore buoys: Potential for a locally novel ecosystem

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As offshore energy industries expand worldwide, new habitats are created for marine life. Oregon's active wave energy climate is particularly suitable for wave energy development, but the addition of new substrates to the environment may have unintended consequences for the region's ecological dynamics. Biofouling organisms (e.g. mussels, barnacles, bryozoans), potentially including invasive species, may use wave energy buoys as habitat. Buoys may also alter recruitment dynamics as larvae from rocky reefs may use them as stepping stones. As no wave energy buoys are yet deployed, we describe biofouling communities on much smaller offshore oceanographic buoys on the Oregon central coast. Higher biomass and greater diversity were observed on buoys from shallower deployment sites (25 & 45 m) compared to deeper deployment sites (70-80 m). Biomass was higher on more complex (e.g. mesh) substrates compared to smooth surfaces within individual buoys, and species composition varied substantially with the depth on the structure. These data are important for understanding the impacts of biofouling on both wave energy buoy performance and local ecological dynamics prior to the deployment of arrays of multiple devices.

Marine heatwave impacts on fish diversity mitigated within Southern California estuaries

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Marine heatwaves can have significant impacts on coastal communities and are expected to increase in frequency and severity with climate change, threatening ecosystem structure and biodiversity. Coastal fish communities in particular are hard hit, seeing large reductions in populations often attributed to losses of suitable spawning habitat during recent warming events. Estuaries provide critical nursery habitat to these coastal fish populations, however, our understanding of how these marine heatwaves impact these systems is limited. Assessing population responses during times of elevated temperatures in these areas is critical to projecting impacts of future events. To address this, we analyzed fish population data at 4 estuaries across southern California over a 13 year period (2012-2024) to evaluate responses to a recent warming event (2014-2018). Community abundance varied by estuary, but we did not see patterns of reduction. Diversity remained the same or increased across all sites during

times of elevated temperatures, notably driven by changes in native species distributions rather than additions of tropical species. These results suggest that impacts were mitigated in these estuarine areas when compared to hard hit open ocean communities within the region, and highlight the need to better understand the dynamics of these warm water events.

Host diversity and community composition alter microbiome structure

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Microbial dispersal between animal hosts, mediated through shared environments, is a potentially important yet understudied process shaping microbiomes in hosts and the environment. In diverse or densely populated host communities, inter-host microbial dispersal may influence both host-associated and free-living microbiomes. Yet, empirical evidence of these dynamics remains limited. In this study, we manipulated the composition and diversity of zooplankton hosts in outdoor aquatic mesocosms to test how variation in host density and diversity alters host-associated (zooplankton) and environmental (water) microbiomes over time. Microbiomes were differentiated among host taxa, the environment, and changed over time. We found that microbial diversity in hosts and the surrounding water was not sensitive to host density and biomass. However, host Shannon diversity had species-specific, non-uniform effects on host microbiome diversity and increased the diversity of environmental microbes. Host community beta diversity was a significant driver of microbiome beta diversity, indicating that microbial dispersal among hosts in varying communities modifies microbiome composition. These effects were stronger on hosts, with time driving beta-diversity in environmental microbiomes. Our study highlights the role of inter-specific microbial dispersal in shaping the structure of host-associated microbiomes, with potential consequences for host ecology.

Juvenile white shark aggregations exert top-down fear effects on mobile prey species

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Predators regulate prey populations and drive heterogeneity in prey distribution through both direct consumption and indirect “fear” effects. Juvenile white sharks (JWS) represent a top predator in Southern California coastal ecosystems, acting as generalists that consume various benthic teleosts and benthic elasmobranchs. JWS form nursery aggregations of up to 40 individuals that often persist for several years. However, the effect that JWS aggregations have on the nearshore prey community are not well understood. We monitored JWS aggregation sites and non-aggregation sites using a multi-method approach, including acoustic telemetry for JWS density, and beach seines, baited remote underwater videos (BRUVs), environmental DNA (eDNA) metabarcoding, and aerial drone surveys for the nearshore fish community. JWS have top-down effects on the nearshore fish community, specifically reduced local relative abundance of several mobile prey species at aggregation sites. Round stingrays and California halibut were less abundant at aggregation sites across methods. Bat rays followed a similar trend for other survey methods, except that more bat rays were caught in beach seines at the aggregation site than the non-aggregation site. Bat rays may reduce their exposure to predation by inhabiting shallower surf-zone habitat when JWS are abundant. Our results represent a reinforcement of long-standing theory in predator-prey relationships using a novel combination of methods in a challenging environment to measure such patterns.

Three decades of intertidal community change on San Juan Island, Washington

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Long-term community datasets are rare but valuable for studying ecosystems under climate change. They can be used to detect climate-driven shifts that may otherwise be overwhelmed by natural variability on shorter time scales. We quantified the changes in community composition that have occurred over 30 years in the intertidal zone of San Juan Island, Washington. Surveys included the identity and density of all algae and invertebrates as well as bare space in the mid and low intertidal zones. All sites and zones changed between surveys. We found that the magnitude of change was greater in the mid zone compared to the low zone and that the north side of the island, which generally has higher temperatures, had a greater magnitude of change than the cooler west side. Much of the difference in magnitude between areas of the island was driven by changes in the mid zone. In mid zones across the island, we observed decreases in algal crusts and increases in barnacles. On the warmer north side of the island, we detected substantial decreases in *Fucus* and increases in bare space, but on the west side, *Fucus* cover increased and bare space did not change. We also detected increases in *Fucus* in the low zone in areas where it had declined in the mid zone, indicating that the vertical range of this species has moved downward. This pattern of greater change in higher thermal stress habitats is consistent with climate change predictions, and the shifting range of *Fucus* is likely to have community-wide impacts on other species that rely on it for shade. These

Session 17: Coral Reef Ecology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Trophic Dynamics of Coral Reef Herbivores and Detritivores Across Shifting Resource Landscapes
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Coral reef herbivores and detritivores–including parrotfishes, surgeonfishes, chubs, and sea cucumbers–play key roles in regulating algal and cyanobacterial community dynamics and are vital food and income sources. However, overfishing can jeopardize their ecological functions. Moreover, uncertainty about whether nominal herbivores target algae or incidentally graze it while seeking protein-rich bacteria and detritus complicates predictions of trophic dynamics under reef change. To evaluate how their foraging roles and nutritional targets vary among species on a Caribbean reef, we combined behavioral surveys with bulk and compound-specific stable isotope analysis. We also assessed intraspecific dietary plasticity by surveying the most abundant parrotfish and surgeonfish across five sites spanning coral-dominated to degraded reefs dominated by algae and cyanobacteria. We found that while some species have more generalized diets, others are specialists that may provide unique functions in controlling reef benthic cover and utilize distinct nutritional resources. Some species also foraged more on algae and cyanobacteria at sites where they were more abundant. Isotopic data suggest most species assimilate both resources, but to varying degrees. Improved understanding of herbivore and detritivore trophic roles is critical as algal and cyanobacterial cover have risen ~3- and 20-fold on Caribbean reefs since the 1970s. This research can help inform species-specific and ecosystem-based management strategies to sustain resilient, coral-dominated reefs while meeting community needs.

Analyzing Crustose coralline algae (CCA) secondary metabolites to develop a chemical toolkit for coral reef restoration efforts
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Crustose coralline algae (CCA) produce secondary metabolites that serve as chemical cues to trigger coral larval settlement and metamorphosis, as well as drive microbial community growth, structure and function. Characterizing secondary metabolites expands our understanding of the chemical diversity within coral reefs with implications for active restoration technologies like encapsulating active metabolites into bioengineered substrates. In this study, metabolites released by CCA were collected in microbially reduced seawater and introduced to reef water microbial communities to analyze the resulting microbial metabolite composition. As a result, we observed over 800 metabolites accumulating during the microbial feeding experiment. In silico annotation identified 1,4-Dihydroxy-2-naphthoic acid (DHNA), a bacterially derived compound associated with *Bifidobacterium*, which is previously unexplored as a Beneficial Microorganism for Corals (BMC). Euphorbia steroid, a prenol lipid, was also detected and may aid larval settlement by providing energy for post-settlement metamorphosis. This pipeline, developed from capturing metabolite exudation to compound-specific characterization, can streamline the identification of potential individual cues that induce coral larval settlement. By advancing our understanding of CCA secondary metabolites, we can create a chemical toolkit that supports future restoration efforts by improving settlement strategies and further the development of biohybrid materials.

A RAD approach to addressing the *Porites* species problem on Maui

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Many reef-building corals present a continuum of phenotypic traits which make studying demography challenging. Across the Hawaiian Archipelago, this phenomenon is especially pronounced within the Porites genus, which exhibits non-discrete morphologies, variable pigmentation, and differences in corallite size and microstructure. These traits complicate species identification and make long-term monitoring of community composition and species-specific responses to disturbance difficult. Traditional molecular identification methods do not provide sufficient resolution as Porites spp. genomes are highly conserved, known to hybridize, and lack fully annotated references. Here, we use ezRAD, a form of restriction-site associated DNA sequencing (RADseq), to investigate species boundaries, reproductive strategies, and intraspecific relatedness of Porites compressa and Porites lobata populations across Maui. Additionally, this study leverages a decade-long monitoring program that utilizes structure-from-motion photogrammetry and large-area imaging technology to map genetic structure onto 3D models of coral reefs. By integrating genomic and spatial datasets, this project provides new insights into the genetic structure of Porites populations and demonstrate an approach for linking community-scale monitoring with fine-scale genetic resolution. Beyond these biological insights, this work highlights the effectiveness of ezRAD for coral population genomics, demonstrating its value as a scalable tool for characterizing connectivity and fine-scale genetic variation in Porites.

Consumer pressure increases coral lesion severity over four years

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Corals are crucial foundational species in tropical ecosystems. However they face increasing threats from climate change, nutrient pollution, and overfishing. These stressors may be related to emergent coral diseases, which are becoming increasingly common, but we know little about their causes or effects on coral health. To explore how nutrient enrichment and reduced fish consumer pressure (i.e., simulated overfishing) influence the severity and

prevalence of a coral disease, we tracked Pavona corals in a manipulative experiment that crossed fish exclusion with nutrient enrichment for four years in Moorea, French Polynesia. We tracked red lesions in Pavona, which we propose are the result of a marine fungal disease. We characterised the severity of lesions annually as the percent of each colony with red discoloration and tracked colony survival. Our results show that higher consumer pressure (i.e., more “natural” conditions) led to increased lesion prevalence and severity, while nutrient enrichment had no detectable effect. Plots with more macroalgae also had higher lesion prevalence and larger corals were more likely to have lesions, consistent with trends in other coral diseases. Although many colonies with lesions survived, greater lesion severity was associated with an increased likelihood of mortality, suggesting lesions have adverse effects on coral fitness. These findings provide insight into how fish communities, nutrient enrichment, and increasing macroalgal abundances affect coral lesions, with implications for predicting coral reef responses to global change.

Successional algal communities alter biogeochemistry of seawater after coral bleaching posing implications on reef recovery

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Marine heatwaves drive coral bleaching that can lead to the mortality of reef-building corals. In 2019, the forereef of Moorea, French Polynesia experienced widespread coral loss following a severe bleaching event. Exposed coral skeletons provide open substrates that are rapidly colonized by opportunistic organisms such as algae, bioeroders, and invertebrates. These successional communities, often dominated by fleshy algae, can disrupt biogeochemical cycling and alter reef microbial dynamics. Turf algal and Lobophora variegata-dominated assemblages comprised a significant proportion of the post-bleaching benthos in Moorea. A controlled mesocosm experiment was used to quantify organic matter production and examine how each assemblage modulates fluxes of key nutrients across inorganic and organic pools. Both successional communities enriched seawater with dissolved organic nitrogen. Turf algae depleted nitrate and phosphate and exuded elevated quantities of dissolved organic carbon into the seawater. Lobophora-dominated assemblages, despite exhibiting the highest oxygen release attributed to photosynthesis, did not draw down inorganic nutrients relative to controls. Our working hypothesis suggests that the abundant suspension feeders and bioeroders present within the successional community drive nitrate and phosphate release via remineralization. Together, these results show that algal communities drive distinct transformations of limiting nutrients, providing new mechanistic insights into sustained algal growth and modified nutrient cycling that can alter reef recovery.

Micro-neighbors doing baby corals favors: exploring the influence of substrate biofilm on the development of coral recruit microbiomes

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Corals host a dense and diverse microbial community of endolithic fungi and algae, dinoflagellate algae, archaea, viruses, and bacteria deemed the coral “holobiont”. This microbial consortium is reflective of a coral’s surrounding biogeochemical environment and plays a key role in health and resilience. One major driver in this environment is community composition, where benthic reef organisms influence water and biofilm microbiomes, which importantly act as settlement cues for coral larvae. Unlike adult conspecifics, coral recruits begin life nearly aposymbiotic, with little known on drivers of holobiont development. This study examines the benthic “neighbor effect” at the settlement scale, comparing the capacity of biofilm to influence early life history coral microbiome development. Settlement substrates were conditioned for six weeks in flow-through aquaria with crustose coralline algae (CCA), *Dictyota*, or ambient seawater to establish a healthy “calcifying reef”, “fleshy algal reef”, or control biofilm respectively. Settlement was scored after one week, and bacterial microbiomes of coral larvae and settled recruits

were analyzed via 16S rRNA gene amplicon sequencing. Biofilm communities were found to be distinct and to strongly influence coral settlement. CCA and *Dictyota* biofilms incurred high settlement, with *Dictyota* biofilms hosting the highest settlement. Further, biofilm was found to influence coral microbiome development, with the enhancement of several putative coral bacterial associates specific to respective biofilm treatment.

Shifting benthic community composition indirectly alters coral host and endosymbiont physiology through biogeochemical feedback loops

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Coral reefs are among the world's most diverse ecosystems, and substantially contribute to ocean productivity and the carbon budget. However, local and global disturbances leading to significant losses in coral cover may directly change the dynamics of organic and inorganic carbon cycling on reefs. Little is known about how altered community states indirectly affect organismal processes through changing the biogeochemical environment. In a 25-day mesocosm experiment, we examined how different communities that arose from disturbances in Mo'orea, French Polynesia (coral-dominated, algae-dominated, rubble/CCA-dominated) alter net community production (NCP) and calcification (NCC). We found that communities have significantly different rates of NCP and NCC, not only due to community composition, but to the indirect effect of NCP on NCC via changes in inorganic carbon production. NCP had significant positive relationships with both pH and dissolved organic carbon (DOC), and pH had a significant positive effect on NCC. pH had weak positive effects on chlorophyll-a and respiration rate of Porites rus. Due to the interconnectedness of coral physiology and metabolism, we note that changes to chlorophyll-a content and respiration rate can have cascading effects on the holobiont. Overall, we show that disturbance events can alter biogeochemical feedback loops: Community metabolism from different community states alters organic and inorganic carbon and the new biogeochemical environment further alters coral physiology, which will ultimately scale up to affect community metabolism.

Tropical seaweeds shift trait distributions along proposed environmental gradients associated with a submarine groundwater seep

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Coral reefs are among the most biodiverse ecosystems on earth, yet are rapidly declining due to human impacts. Submarine groundwater discharge (SGD) into reefs is a globally occurring but understudied phenomenon that creates gradients in pH, nutrients, and salinity, offering a model system to study benthic community responses to environmental change. To assess how SGD shaped macroalgal functional responses and ecological strategies, we used a trait based approach to quantify seven traits across twenty sites spanning a ~140m gradient from a SGD seep in Mo'orea, French Polynesia. As a first step, we examined community differences at the extreme ends of the gradient while awaiting biogeochemical data. Principal Component Analysis visualized that communities nearest the seep exhibited higher surface area:volume ratios, one resource acquisition strategy, but reduced toughness and tensile strength. Communities farthest from the seep were taller, a second resource acquisition strategy, but also had greater resistance to herbivory (toughness) and physical disturbance traits (tensile strength). Univariate analyses confirmed these trends, with toughness, height, tensile strength, and wet weight:height all increasing with distance, while surface area:volume declined, suggesting that SGD creates localized gradients that shape macroalgal strategies. The integration of biogeochemical measurements will be critical to confirm underlying mechanisms, clarify how persistent gradients shape trait distributions, and predict algal-dominated reef communities' functions under changing conditions.

Session 18: Population Biology and Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Examining aquatic invertebrates in the Snohomish Estuary

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The Snohomish River estuary in Washington state has undergone a series of dike breach restoration projects aimed at reestablishing tidal connectivity across the lower estuary. Because of these projects, much of the lower estuary is now accessible to juvenile salmonids and ought to be productive rearing habitat with invertebrate prey for forage. This study aimed to assess prey availability at restored sites and better understand the tidally-driven flux of invertebrates. We sampled invertebrate assemblages in emergent marshes during the spring outmigration period for juvenile salmonids in 2024 and 2025. Invertebrate samples were collected during ebb tides using neuston nets at the water surface and just above the substrate. On the ebb tidal scale, abundances of marine invertebrates increased as channels dewatered. Invertebrate ash-free dry weight was also measured as a proxy for energy availability, which increased toward the end of the ebb tide at all sites. During both sampling years, we observed an increase in larval and terrestrial insects in May and June as well as a decrease in the density of marine invertebrates in June. Total energy loss from a reduced abundance of marine invertebrate prey was not fully offset by the increase in insect prey, suggesting that prey may become limited towards the end of the outmigration season. Energetic capacity of prey is an important attribute of habitat restoration for juvenile salmon and should be considered in addition to habitat availability.

Impacts of physical extremes on the reproductive output and dispersal of *Stephanocystis osmundacea*

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Canopy-forming seaweeds like *Stephanocystis osmundacea* (Chainbladder kelp) provide critical structure and function in nearshore rocky habitats, and contributions vary with depth due to environmental gradients. I investigated how depth influences reproductive output and dispersal within a population at Stillwater Cove, Carmel Bay, CA. I hypothesized deeper depth leads to decreased overall biomass and lower output than at shallow depths during the reproductive season. I predicted deep individuals, with reproductive fronds extending higher in the water column, would disperse propagules farther than shallow individuals. I conducted a 15-month subtidal survey at a shallow (4m) and deep (18m) site, measuring vegetative base and reproductive frond size metrics. A physical-biological dispersal model estimated zygote trajectories using survey and hydrodynamic data (ADCP, ADV). Shallow individuals consistently had greater and taller base blades, and higher reproductive frond counts and biomass. However, the longest individual fronds (up to 12 m) occurred at depth. Dispersal modeling revealed zygotes released from deeper individuals traveled farther and upcoast, while those from shallower individuals remained largely within Stillwater Cove. Results suggest while shallow individuals invest more biomass into reproduction, deeper individuals may enhance gene flow across populations via longer-distance dispersal. Depth gradients shape morphology, reproduction, and connectivity in this population, with implications for population persistence and their ecological role in the system.

Does the herbivorous opaleye (*Girella nigricans*) feed opportunistically or does it specialize on certain algae?

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CSU Northridge

Nearshore reefs in southern California support a high diversity of macroalgae but relatively few species of herbivorous fish that graze on it. One exception is the opaleye (*Girella nigricans*), a common and abundant fish whose dietary preferences are not well understood. In this study, we evaluate whether *G. nigricans* feeds opportunistically on the available macroalgae or specializes on a particular species. We do this by comparing the composition of macroalgae in the environment to the contents of its stomach. Six individuals of *G. nigricans* were collected from each of nine locations along the leeward side of Santa Catalina Island where the biomass of five common macroalgal species was quantified using underwater transects. The gut contents of *G. nigricans* indicate that this species eats a variety of algal species, with *Macrocystis pyrifera* being the most frequently consumed one, suggesting that *G. nigricans* may be a specialized forager with a preference for *M.pyrifera*. Understanding the drivers that influence the dietary preference of *G. nigricans*s may offer insight into its ecological role, dietary energetics, and its potential response to environmental change.

Cellular warfare: Density-dependent cues influence cnidocyst length in the sea anemone *Anthopleura sola*
† Stinnett, J.G.*; Kaulback, C.S.; Ramamurthy, S.V.; Kuris, A.M.; Oakley, T.H.

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Competitive interactions are often mediated by specialized traits. In the solitary sea anemone *Anthopleura sola*, acrorhagi—specialized structures used in territorial aggression—vary widely in size, number, and arrangement among individuals. Furthermore, the sizes of cnidocysts (stinging organelles) within the acrorhagi can also vary in size. However, the underlying mechanisms which are responsible for the maintenance of this morphological variation are poorly understood. Here, we investigate whether acrorhagial traits are shaped by social cues, namely the local density of conspecific competitors. In high- and low-density populations of *A. sola*, we quantified body weight, number of acrorhagi and acrorhagial cnidocyst length. We found that not only does the number of acrorhagi increase disproportionately with body weight in high-density populations, but the mean size of cnidocysts within the acrorhagi is larger in high-density populations. We are also exploring associations between acrorhagial characteristics and cnidocyst length. Our results show that a social cue, like population density, can influence trait variation at both cellular and organismal levels. The characteristics of ecologically important traits like acrorhagi may therefore play key roles in shaping individual success across variable environmental conditions.

Winners and losers: Species-specific responses of understory kelps to “The Blob” marine heatwave in California
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Scripps Institution of Oceanography, UC San Diego

Rising ocean temperatures and marine heatwaves (MHWs) are threatening marine ecosystems worldwide. Many ecologically important species, such as habitat-forming macroalgae, cannot survive the intensity or duration of these thermal events. Identifying which species decline in abundance during MHWs and which exploit newly available niches is key to predicting kelp forest community responses. We analyzed 15 years of benthic algal swath data from subtidal surveys across ten regions, from Central to Southern California to assess changes linked to “The Blob” heatwave, a massive marine heatwave that lasted from 2014-2016 along the coast of North America. Four time periods were examined: a Pre-Heatwave baseline(2009–2013), Heatwave (2014–2016), Initial Recovery (2017–2019), and Delayed Recovery (2020–2023). During “The Blob”, the abundance common understory kelps such as Pterygophora californica and Laminaria setchellii declined, while thermally-tolerant species in Southern California, including Eisenia arborea and invasive Sargassum horneri, increased. As seawater temperatures began to cool, some negatively impacted species showed signs of recovery and some opportunistic species experienced declines. This pattern suggests that the opportunistic species may struggle to compete with the re-established understory kelps. This study improves our understanding of how California kelp forests respond to MHW’s. Importantly, this work highlights species-specific patterns of loss, persistence, and recovery offering insights into how future warming events may reshape coastal ecosystems.

Ghost shrimp burrow structure & behavior differ between populations and impact adjacent communities

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The burrows and behavior of ghost shrimp (*Neotrypaea* spp.) directly affect co-occurring fauna through sediment reworking and bioturbation, and indirectly by altering biogeochemical processes. Despite strong ecosystem engineering, their influence beyond estuaries is poorly understood. The discovery of a dense *N. gigas* population on the central Oregon midshelf provides the first opportunity for direct comparison of burrow structure and behavior between estuary and offshore *Neotrypaea* populations. Based on both resin casts and multi-day “ant-farm” observations, offshore shrimp built shallower, shorter, predominately Y-shaped burrows and spent more time ventilating towards the top of their burrows, differing from the larger, multi-branched burrows of estuary shrimp that devoted more time excavating and compacting sediment in deeper sections. These patterns suggest an offshore, suspension-feeding phenotype leveraging near-bed flow, contrasting with deposit-feeding estuary shrimp. Despite lower per-capita excavation offshore, the high density and greater interaction at the sediment-water interface suggests substantial cumulative turnover and irrigation potential. Box core sampling at offshore ghost shrimp beds reveal shifts in invertebrate community composition; we link these to observed structural and behavioral patterns.

Biogeographic variation in reproductive strategy in a range-expanding marine gastropod

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Although species geographic distributions are increasingly shifting poleward with climate change, the processes that facilitate or impede range shifts are poorly understood. More extreme environmental conditions near poleward range boundaries often impose reproductive constraints, which may limit fitness and future range expansion. However, few studies evaluate the extent to which adaptive evolution and/or phenotypic plasticity might mitigate the effects of reproductive constraints and contribute to successful range shifts. We examined reproductive trait variation across the geographic range of *Acanthinucella spirata*, an intertidal muricid gastropod that has recently expanded poleward along the coast of California, USA. We found that, compared to the range core in southern California, *A. spirata* from cooler range-edge populations in northern California allocated more nutrition to developing embryos and had larger offspring at hatching, which may lead to greater juvenile growth rates and survival. Furthermore, range-edge *A. spirata* populations had lower fecundity, highlighting a potential tradeoff between offspring size and number. Some trait differences between range-core and range-edge populations persisted in an 18-month common-garden experiment, supporting the hypothesis that such traits are potentially under selection. This study suggests that life-history adaptations in range-edge populations are an important and understudied mechanism that may contribute to species’ range expansions.

Agent-based models can predict population consequences of offshore wind noises on Gulf Of Maine harbor porpoises

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Marine mammals are increasingly exposed to anthropogenic noises, like those from the offshore wind activities, necessitating the development and refinement of tools to predict the effects of noise on their populations. Agent-based models (ABMs) are an effective tool that can simulate realistic movements and behaviors of animals to quantify population consequences of disturbance. In this study, we used the Europe-based ABM ‘DEPONS’ to (1) evaluate the effectiveness of the model in a new environment (the Gulf of Maine, USA and Bay of Fundy, Canada) and (2) develop estimates of the population dynamics of local harbor porpoises (*Phocoena phocoena*) interacting with noises from floating offshore wind farm construction and operation. Our new, local model produced realistic population dynamics, enabling proof-of-concept estimates of population effects from reduced foraging success. Modeled porpoise movements appeared visually similar to those of real, satellite-tracked porpoises, but mean

home range sizes and maximum net squared displacement differed. Construction and operational noise, simulated separately, caused minor population declines (0.19% and 0.67%, respectively). Operational noise effects started small and increased over time, whereas construction effects did not change substantially over the impact period. Additional model calibration is needed, ideally based on more tagging data. Once calibrated further, the model can be used to estimate the cumulative impacts of a variety of noises on harbor porpoises off the East Coast and inform management.

Session 19: Intertidal Ecology III

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Monitoring the impact of the Portuguese Bend landslide on rocky intertidal habitats in Rancho Palos Verdes

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The historic Portuguese Bend Landslide located on the Palos Verdes Peninsula reactivated in 2023, resulting in a rapid increase in land movement, impacting roads, utilities, and residential areas. The coastline along the margin of the landslide is also heavily affected and rapidly evolves, with significant changes to shoreline profile and habitat distribution. The once subtidal rocky habitat has now been uplifted and exposed, and a wave-cut platform has expanded seaward. This platform is largely composed of soft mudstone and bentonite, which has both bulged upwards and rapidly erodes. The result has been a significant die-off of now stranded low tide and subtidal benthic communities, and the colonization of newly exposed hard substrates. This project involves documenting changes in the physical shoreline and the diversity and composition of rocky intertidal communities over a six-month period. Fifteen fixed transect locations, oriented perpendicular to the shoreline, extend between Inspiration Point and Portuguese Bend Beach.These have been monitored monthly, with the shore profile measured and photo quadrats captured every three feet across the intertidal zone. Over 1600 quadrats have been analyzed for habitat characteristics and organism coverage. Results show that red and brown algal species have declined and are replaced by the green algae Ulva. In contrast to the control site, grazers are nearly absent. While the landslide has greatly impacted the people of the Palos Verdes Peninsula, its impact on coastal ecosystems has also been profound.

Recovery on the rocks: The role of substrate in the recovery of sea stars post sea star wasting disease

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In 2013 Sea Star Wasting Disease decimated sea star population across, but not all species were affected equally. Ochre stars saw dramatic decreases while the bat star did not. Currently across the Monterey Peninsula there has been some recovery of ochre star populations, however this recovery is highly variable across space. Could variation in species recovery be driven by differences between sites? To assess differences in sea star populations and between sites, we surveyed sea star populations, substrate, and sessile invertebrate/algal cover across seven sites along the Monterey Peninsula. At each site we conducted six swath surveys paired with five quadrats. We counted all adult sea stars and estimated substrate type and cover using quadrats. We found higher populations of bat stars at sites with diverse substrate types and lower mussel abundance. Whereas ochre star populations were higher at sites with more continuous rock and higher mussel cover. Substrate variation leads to a variation in sessile invertebrate populations, which could play a role in recovery of ochre star post SSWD. Ochre star food availability could be a driver for the variation in population recovery. Bat stars were not as affected by SSWD and

have a more diverse diet and are therefore less reliant on the substrate type of their environment. Ochre star is an important keystone species in rocky intertidal communities and understanding how substrate and food availability impacts their recovery will inform predictions about intertidal communities post SSWD.

Over 120 years of episodic range extensions of nearshore marine invertebrates in the Northeastern Pacific
† Sevigny, J.*; Walker, E.; Lipsey, B.; Tran, T.; Fredston, A.

UC Santa Cruz

Marine invertebrates like pelagic red crabs, by-the-wind sailors, and jumbo squid have made headlines along the West Coast of North America for their seemingly unusual and sporadic appearances far beyond their typical ranges. Such range extensions are often by southern, warm-water species commonly found off Baja California. Their presence in colder, northern waters has been linked to El Niño events, which can alter ocean temperature and circulation patterns in ways that facilitate episodic northward range extensions. We investigated whether these anomalous extensions are unique to a handful of species or are more widespread among marine invertebrates. We conducted a systematic literature review of peer-reviewed articles and reports from the California Cooperative Oceanic Fisheries Investigations to construct a database of historical range extensions of marine invertebrates. Across almost 500 source documents, we identified 147 range extensions of 64 species dating back to 1903. We found that these episodic range extension events are significantly associated with El Niño, and that further extensions occurred during stronger El Niño events. Twenty-two percent of the range extensions were during the 2014-2016 large marine heatwave—far more than in the years preceding or following it. By synthesizing over a century of science on the geographical distributions of marine invertebrates, this study provides insight into the frequency, drivers, and biological characteristics of episodic range extensions across the California Current ecosystem.

The impact of predation and upwelling on invertebrate recruitment in a tropical rocky intertidal system
† Sellke, S.N.*; Menge, B.A.

Oregon State University

Tropical intertidal systems have low rates of invertebrate recruitment and low overall biomass despite having relatively high biodiversity. Past research, including environmental stress models, indicate that predation may be an important factor influencing recruitment and community composition in these areas, but research in tropical intertidal regions has been sparse. In addition, the impact of upwelling on invertebrate recruitment in this system remains unknown. To understand the impacts of predation and upwelling on recruitment and community compositions, I performed a predator exclusion experiment in the Gulf of Panamá. During recruitment season (dry season), I tracked the composition of the recruit community in areas with upwelling and downwelling. Midway through the wet summer season, I found that predation was somewhat important in determining recruitment and community composition in this region, with crabs and small fish being the most important predators and large fish having no impact on the success of invertebrate recruits. However, during the dry spring recruitment season, predation was not important in determining recruit community. There was evidence that upwelling was important for recruit community composition during dry upwelling season, but that difference disappeared outside of upwelling season. These results indicate that predation may not be as important for community composition as expected, and more research is needed to understand how these results may fit into our current environmental stress models.

Stable yet shifting: A rare look at the long-term dynamics of the infauna community of intertidal sponge *Halichondria panicea*
† Parker, E.G.*; Menge, B.A.

Oregon State University

Sponges provide many important ecosystem services, including providing habitat for other species. While many studies have identified and quantified the diversity of sponge infauna, next to nothing is known about the stability or dynamics of these communities over time. Here, we had the unique opportunity to revisit colonies of the breadcrumb sponge (*Halichondria panicea*) at two sites on the central Oregon coast that were originally sampled in the mid-1960s. We compared the infauna community composition across years and sites, sponge morphology, and host-richness relationships. We found that sponge infauna communities differ by site and have shifted since the 1960s. We also found a positive relationship between sponge thickness and infauna richness for 2025 that was not present in the 1960s data. However, sponge thickness has not significantly changed overall and within site variation is high, so this system may be relatively stable over larger spatial scales. This study is among the first to examine the long-term stability of sponge infauna communities, and contributes to our growing knowledge of these cryptic communities globally.

Indigenous tending practices improve recovery and persistence of a cultural keystone seaweed (*Pyropia*)
† Miller, K.A.[1*]; Hapner, N.[2]; Macias, A.[2]; Gomes, A.[2]; Chaves, J.[2]; Rosellini-Scott, E.[2]; Banuelos, E.[2]; Morgan, M.[2]; Gomes, S.[2]; Austin, E.[2]; Smith, J.E.[3]

1- Simon Fraser University 2- Kashia Band of Pomo Indians 3- UC San Diego

Pyropia is a cultural keystone for coastal Indigenous Nations from Baja to Alaska, and many of these communities have long expressed concerns regarding decreasing abundance, distribution and seasonal instability of this important intertidal seaweed. In California specifically, the distribution and abundance of Pyropia mirrors the geographic displacement of Indigenous caretakers from their coastal territories and resultant interruption of traditional caretaking activities. While globally there is growing recognition of the important role of Indigenous stewardship in supporting healthy and resilient coastal ecosystems and communities, here in California, it is rare for marine research to include the consent, knowledge, and partnership of Indigenous nations. To address this inequity, the Kashia Band of Pomo Indians (KBPI) co-developed a traditional harvest experiment with researchers at Simon Fraser University and UC San Diego to understand how Kashia practices affect community-identified bio-cultural indicators and standard metrics of seaweed resilience. Results of the experiment implemented on the Kashia Coastal Reserve through the growing season of 2024 and 2025, suggest that Kashia caretaking improves post-harvest recovery and persistence of Pyropia over all other harvest levels. This collaborative research approach helps inform how revitalizing past and present Indigenous caretaking practices can restore and even confer resilience to traditional food systems and communities along the coast of California in an era of accelerating climate change.

Small but mighty? Investigating the keystone role of recruit and juvenile Pisaster ochraceus in the mid-intertidal zone
† Pethick, N.[*]; Menge, B.A.; Gravem, S.A.

Oregon State University

The keystone species concept originally developed by Robert Paine in the 1960s fundamentally altered the way ecologists thought about drivers of community diversity and stability and has proven to be highly generalizable to both marine and terrestrial ecosystems. However, modern ecological research has shown that the role keystones inhabit is context-dependent. We were interested in the role of juvenile and recruit *Pisaster ochraceus* in the mid-intertidal zone, and whether they exhibit a keystone role similar to that of adult *Pisaster* in the lower zone. To test this, we capitalized on demographic shifts following the Sea Star Wasting Disease epidemic of 2014 where populations transitioned from adult-dominated to recruit-dominated and then juvenile-dominated over time. We predicted that observed shifts in *Pisaster* population structures from adult dominated to recruit dominated regimes would lead to stronger top-down effects in the mid-intertidal, because small sea stars tended to be higher on shore. We measured yearly prey recruitment in control versus predator exclusion plots over 12 years (2011 to 2023) at 6

sites to measure the sea star effect. Despite observing general declines in prey at four of our six study sites, our data suggests that *Pisaster*'s effect is fairly weak in the mid-intertidal and shows little relationship with *Pisaster* size.

Exploring geographic variation in performance during an ongoing range-shift

† Walkes, S.A.*; Bay, R.A.; Sanford, E.

University of California, Davis

Recent evidence suggests that climate-driven range shifts are often punctuated by extreme events. Biogeographic theory predicts that poleward range edges are set by physiological costs associated with cold environments. Therefore, expanded edge populations may encounter a harsh thermal environment once the extreme event subsides, potentially imposing performance costs or selection. The giant owl limpet *Lottia gigantea* expanded into Northern California during the 2014-2016 marine heatwaves and provides an opportunity to assess selection and performance across the range of a shifting species. Our studies of growth rates in the field suggest that performance peaks in the expanding edge, raising the possibility that range edge limpets have undergone rapid adaptation to tolerate cold environments. To test this hypothesis, we held limpets from 5 populations spanning the range core and edge in a common garden laboratory environment. We held limpets on individual tiles continuously sprayed with 10ºC or 15ºC seawater, and measured growth rates as a metric of performance. Across populations, growth rates declined by ~33% in response to 10ºC temperatures. Surprisingly, this response was consistent across populations, and growth rates at both temperatures peaked at the lowest latitude site, inconsistent with a pattern of rapid local adaptation to temperature in the range edge. We suggest that, despite an emphasis on temperature in biogeography, other environmental parameters, such as primary productivity, may have equally important effects on performance for expanding species.

Session 20: Ecosystem Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Linking environmental drivers with functional traits and ecosystem functions of the temperate eelgrass, *Zostera marina*

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1- UC Santa Barbara 2- San Francisco State University

Functional traits have been widely used in terrestrial angiosperms to investigate large-scale patterns of variation within and across species. However, this approach remains rare in seagrass research. By measuring functional traits, we can gain valuable insights into how abiotic and biotic factors shape seagrass morphometry, biogeochemistry, and overall meadow structure and function. This enhances our understanding of current seagrass meadow dynamics, and may improve our ability to predict future responses to environmental stressors such as rising ocean temperatures, nutrient enrichment, and reduced light availability. We conducted extensive sampling in five *Zostera marina* meadows along a latitudinal gradient in California; measuring meadow characteristics (water depth, shoot density), functional traits (shoot area, biochemical composition), as well as meadow functions of productivity and sediment organic carbon. Through these measurements, we provide a comprehensive assessment of linkages between abiotic drivers, within-species trait variation, and connections with key ecosystem functions for the temperate eelgrass, *Zostera marina*. We found that sediment organic carbon varied greater within meadows than across meadows, and was primarily driven by grain size and estuarine setting. Differences in seagrass production and morphology were site-specific, and driven by environmental variation. These data contribute to our understanding of drivers of variation in California estuarine eelgrass beds and their associated functions.

Inducible chemical defense observed in the methane mitigating red seaweed *Asparagopsis taxiformis* in response to grazers

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The sub-tropical red macroalga, Asparagopsis taxiformis, has been identified as one of the most effective tools for reducing enteric methane production in ruminant animals when used as a feed additive. The primary anti-methanogenic compound produced by this alga, bromoform, is hypothesized to function as an anti-herbivory and antimicrobial agent. However, little is known about the chemical ecology of A. taxiformis or how bromoform production responds to environmental stressors such as grazing. In this study, we investigated both direct and indirect effects of two grazers—Gammaridae amphipods and Turbo fluctuosa snails—on the growth and bromoform production of A. taxiformis. Although Gammaridae amphipods did not graze on A. taxiformis, their chemical cues triggered a significant decrease in the bromoform content in algal tissue by about 0.4%. This suggests that A. taxiformis exhibits an inducible chemical defense response by releasing bromoform into water rather than sequestering it in its tissue. In contrast, T. fluctuosa actively grazed on A. taxiformis at rates of 2.55 ∓ 0.4 mg h-1 but did not elicit a statistically significant bromoform response within the 48-hour experimental window. These findings highlight the specificity of grazer-induced responses in A. taxiformis and provide insight into ecological factors influencing bromoform production.

Eelgrass bed morphology impact on sediment characteristics in central and south Puget Sound region

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WA Dept. of Natural Resources

The Washington State DNR's Acidification Nearshore Monitoring Network (ANeMoNe) monitors intertidal eelgrass (*Zostera marina*) beds in Puget Sound. Previous monitoring found that our sites are unique in eelgrass density and sediment characteristics. The current study aimed to address the interrelationship of sediment and eelgrass among sites, to better understand what eelgrass needs to thrive in an increasingly human impacted environment. For this study, we hypothesized that eelgrass densities could help to explain the sediment grain size and carbon content at our study sites, given the ability of eelgrass's rhizome growth and shoots to influence surrounding sediment stability and water movement, respectively. At four sites, we performed loss on ignition carbon content and grain size distribution analyses on samples collected within eelgrass beds that were also sampled for density and morphology. Eelgrass surveys and sediment sampling were completed at the start (May) and towards the end (July) of the growing season. We found grain size distribution varied across sites and seasons. Site specific differences may be explained by larger environmental forces. For instance, at the site closest to a river delta, the influence of riverine flow on sand deposition or silt and clay scouring may outweigh that of eelgrass. At our most urban site, ship activity may be causing more sediment movement independent of eelgrass abundance or size. Taken together, these results are informing best practices for science-based management of increasingly impacted critical coastal habitats.

Effects on habitat characteristics on planktivore and predator density on Southern California artificial reefs

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Southern California artificial reefs (ARs) have historically been constructed to increase recreational fishing opportunities. More recently, ARs have also been built for habitat restoration and compensatory mitigation. Habitat complexity, vertical relief, and heterogeneity are characteristics linked to increased fish abundance and production on ARs. My project assesses the relationships among these habitat characteristics and densities of a planktivore, Blacksmith (*Chromis punctipinnis*), and a predator, Kelp Bass (*Paralabrax clathratus*), on ARs in southern California. Blacksmith play an important role in nutrient transfer, by providing ammonium and nitrogen, boosting the

primary production on reefs, and can connect planktonic food resources to secondary production, as they can be potential prey for Kelp Bass, an important recreational fishery species. High-resolution sonar data (30 cm cell size) were collected at 15 AR complexes between Santa Monica Bay and the US-Mexico border. Sonar data were analyzed to map and characterize the habitat of AR modules. Slope and rugosity metrics were calculated from bathymetry rasters using the MultiscaleDTM package in R. The mean and Gini coefficient (heterogeneity) of cell values for relief, rugosity, and slope were calculated for each AR module. These AR habitat metrics were then compared to SCUBA or stereo-ROV fish survey data, with the results of this project contributing to the development of AR assessment metrics, future design criteria, and informing the state's development of its California Artificial Reef Plan.

Advancing rapid quantification of *Microcystis* colonies in freshwater systems using digital holography
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Monitoring harmful algal blooms (HABs) requires accurate, real-time quantification of the cyanobacteria *Microcystis aeruginosa*, but current methods struggle to quantify colonies in situ. We establish an empirical relationship between colony volume and cell count using digital holography, a non-invasive imaging technique that captures colonies in three dimensions. Colonies from two distinct freshwater systems, Lakes Erie and Okeechobee, were imaged holographically and validated using flow cytometry. Morphological traits including volume, solidity, and hole ratio were incorporated into statistical models. Colony volume significantly predicted cell counts ($p < 0.001$), with a stronger relationship in the denser Lake Erie strain ($R^2 = 0.70$). Solidity differed significantly between strains ($p < 0.00001$), and a significant interaction between volume and strain affirmed that morphology influences predictive strength. Holography and flow cytometry showed strong overall agreement ($r = 0.75$), with an average percent difference of 35%. Since lasso regression identified colony volume as the dominant predictor, we derived a preliminary predictive equation for the Lake Erie strain to estimate cell count from colony volume, enabling direct quantification from holographic images. Our findings demonstrate that with trait-based calibration, holography can be used to rapidly estimate *Microcystis* cell abundance from holography in situ. This approach advances scalable tools for HAB surveillance, supporting real-time water quality monitoring and public health responses.

The impact of a Pacific Herring spawning event on seagrass-associated pipefish in Sitka, AK
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New College of Florida

Each year, ecologically, culturally, and economically significant Pacific herring spawn en masse, with Sitka Sound in southeastern Alaska hosting some of the largest spawning events. During these events, their eggs coat kelp and seagrass over miles of shoreline, often blanketing seagrass beds. Two poorly studied fish species, the bay pipefish, *Syngnathus leptorhynchus*, and kelp pipefish, *Syngnathus californiensis*, offer unique examples of how fishes experience these spawning events. Little is known about the movement patterns of these syngnathids, but they are unlikely to leave during the spawning period. To assess the impact of herring spawns, we surveyed pipefish twice monthly using a pushnet at two sites in Sitka Sound, AK. We hypothesize that this period leaves pipefish with potentially limited food access and increased exposure to predation stress, which will be reflected in reductions in pipefish health metrics. We compared metrics for each species between the pre-spawn period, the mid-spawn period, and the post-spawn period in order to determine whether there are changes in pipefish health associated with the Pacific herring spawning event.

Can fish keep supplying micronutrients in changing coastal ecosystems?
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As marine heatwaves accelerate the restructuring of coastal ecosystems, we need tools that capture not only what is lost but also what still functions. A central question is whether fish communities can continue to sustain key ecosystem processes while providing essential micronutrients to people despite significant ecological change. We present a trait-based framework to evaluate the functional resilience of fish communities through both ecosystem functioning ("Nature for Nature") and their nutritional potential ("Nature for People"). Our approach integrates species traits, productivity dynamics, and species-specific micronutrient profiles to detect early signs of functional decline. Using long-term data from post-heatwave kelp forests in Baja California (2017–2024), we show how fish communities responded to habitat shifts. Macroinvertivore biomass declined over time, largely due to reductions in body size, leading to contraction of functional trait space. To assess nutritional potential, we linked fish community composition with estimated supply of calcium, iron, zinc, and vitamin A. Although micronutrient availability remained relatively stable across regions, weak biomass–productivity coupling suggests limited capacity to buffer future ecological change. By moving beyond taxonomic metrics, our framework demonstrates how trait-based indicators can connect ecosystem dynamics with nutritional outcomes. We argue that this approach provides a scalable tool to guide ecosystem-based management and promote climate-resilient and nutritious coastal fisheries.

Beyond interpolation: reconstructing missing ecological data with dynamical systems
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1- Scripps Institution of Oceanography 2- Boston University

Missing values are ubiquitous in ecological time series, and how these data gaps are handled can significantly influence downstream analysis. But many common gap-filling methods rely on assumptions that ecological data frequently violate, producing estimates that are statistically plausible but mechanistically inaccurate.To address this, we developed a novel gap-filling method based on empirical dynamic modeling (EDM) that is robust to common challenges in ecological data, including high observational noise, low sampling frequency, and nonlinear dynamics. Rather than using points nearby in time, our approach infers missing values using nearby system states on a reconstructed attractor. This approach leverages the dynamic coupling between variables from a shared system, and can reconstruct values of one variable where others have been observed.In tests using model data and an empirical plankton time series, our EDM-based method consistently outperformed standard techniques like linear interpolation, k-nearest neighbor imputation, and multiple linear regression. This work provides a robust option for repairing gaps in noisy, nonlinear ecological time series in a way that is faithful to the underlying dynamics.

Session 21: Behavioral Ecology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

When dinner fights back: Inferring white shark behavioral adaptations from prey handling injuries
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1- California State University Monterey Bay 2- California White Shark Project 3- Stanford University 4- Stanford University & Oregon State University

Adult white sharks (*Carcharodon carcharias*) are known to have a preference for pinniped prey, while juveniles initially forage primarily on fishes. To study this ontogenetic diet transition, we analyzed the presence and frequency of injurious scars associated with handling pinniped prey on sharks of varying size classes (200-600cm TL). These prey-handling injuries include scratches from claws, and puncture wounds inflicted by defensive bites. Video data were collected by a multi-institutional group of researchers in central California since 2006 from Monterey Bay, Point Reyes, Año Nuevo, and Southeast Farallon Island. Multiple trained student assistants

analyzed each video to score scar type, color, and body location. These data were used to assess the association between an individual shark's size and sex, and the frequency of prey-handling scars. Results indicate the highest injury rate occurs around the size at which white sharks first begin consuming pinnipeds, and declines as the sharks grow. Furthermore, at larger sizes male sharks appear less likely to incur these prey-handling injuries than female sharks. Further analysis of these shark scars may provide a more complete understanding of their ontogeny and predator/prey dynamics.

Behavioral and interspecific drivers of burrowing in the salt marsh crabs *Leptuca crenulata* and *Pachygrapsus crassipes*

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Burrowing crabs are ecosystem engineers in tidal marshes. They impact the stability of tidal creeks by influencing sediment turnover, erosional processes, and vegetation. Yet, little is known about the burrowing behavior of California's marsh crabs or how interspecific interactions shape that behavior. Through lab and field experiments, I quantified the burrow morphologies of Leptuca crenulata and Pachygrapsus crassipes and examined changes in their burrowing behavior in response to intra- and interspecific interactions. In lab experiments, 100% of L. crenulata individuals constructed burrows within 24 h, averaging 2.3 burrows per crab over 5 d, with consistent burrow sealing during low tides. Field caging experiments revealed that L. crenulata burrowed less when predatory P. crassipes were present. However, when L. crenulata were given 48 h to burrow before P. crassipes was introduced, burrow rates remained high. In contrast, P. crassipes did not construct burrows under any lab or field treatment. When provided with artificial burrows of varying sizes, P. crassipes failed to use or enlarge burrows. However, the depth of artificial burrows was significantly shallower with P. crassipes present compared to control treatments lacking crabs, indicating that P. crassipes facilitates deposition within existing burrows. These findings suggest that burrows are an integral feature of the biology of L. crenulata, whereas P. crassipes only utilizes burrows sporadically. Burrow-related interactions between these species are best characterized as predator-prey rather than commensal.

Cracking an underwater code: Novel ethogram development for Harbor Porpoises (*Phocoena phocoena vomerina*) in the Salish Sea

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1- Colorado College, Pacific Mammal Research 2- Pacific Mammal Research

An ethogram is a foundational tool in the field of behavioral ecology used to categorize behaviors. By developing an ethogram for a specific community , we can conduct further behavioral analyses and compare the behaviors of geographically distinct populations. We can then begin to understand that species on a deeper level, improving conservation and management strategies. We present a novel ethogram for a community of resident harbor porpoises, (*Phocoena phocoena vomerina*), found in Burrows Pass off Fidalgo Island in the Salish Sea. The ethogram consists of 4 behavioral states that include 30 behaviors. It was developed using photo and observational data collected over 10 years, and drone footage collected over the past year. Drone footage was critical for describing many behaviors which could not otherwise be distinguished at the surface. This ethogram is critical to provide common terminology between researchers. This allows for in depth analysis of activity budgets and behavioral patterns within and between populations or communities, and will improve our understanding of this vastly understudied species.

Daily activity routines of an endothermic predator, the juvenile white shark, at the cold edge of their shifted range

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1- Moss Landing Marine Laboratories, California State University, Monterey Bay 2- Moss Landing Marine Laboratories 3- California State University, Monterey Bay

Previous research has documented a shift of the northern range limit of juvenile white sharks (*Carcharodon carcharias*) from southern California to the Monterey Bay in response to ocean warming. How this endothermic predator selects fine-scale habitat at the cold edge of its range is still unknown. The high spatial and temporal variability of temperature and other environmental conditions in the Monterey Bay, due to oceanographic phenomena such as upwelling shadows, provides a natural experimental setting. We utilized subsurface temperature sensors and high-resolution sea surface temperature satellite data to identify potential drivers of juvenile white shark habitat selection assessed from aerial surveys versus acoustic tag detections at receivers just offshore of a surface aggregation site. Resulting diel patterns in habitat utilization and differences in thermal selection during near-shore surface swimming compared with adjacent offshore forays illustrated contrasting functional behaviors of basking for thermoregulation and foraging in cooler waters, respectively. Our results highlight the importance of multiple sampling methodologies for evaluating behavioral and movement responses to environmental drivers.

Population model predicts limited capacity for male promiscuity to mitigate sea turtle population decline due to increasing incubation temperatures

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1- COMES, Oregon State University 2- Florida State University 3- University of Massachusetts Amherst

As climate change increases nesting beach temperatures, sea turtle populations are producing increasingly feminized hatchling cohorts. How this affects population dynamics depends on male breeding ecology. We used a two-sex, age-structured population dynamics model to estimate population persistence and growth of a green turtle (Chelonia mydas) population over 100 years under scenarios with a variety of total incubation temperature increases, thermal reaction norms (the relationship between temperature and clutch sex ratio), and male promiscuity. We included temperature-dependent hatchling emergence success and demographic and environmental variability at the year, individual, and clutch levels. Incubation temperatures that maximized reproductive output were higher for scenarios with higher male promiscuity and a wider TRT, and consistently produced feminized clutches. Scenarios with higher male promiscuity only improved population persistence and growth for scenarios with a narrow TRT and low total temperature increases. Sample outputs showed that hatchling abundance was reduced due to low emergence success before a lack of mature males led to declining reproductive success, with no effect of mating function in scenarios with a wide TRT or high total temperature increases. Future research should therefore prioritize quantifying the effect of temperature on emergence success before thermal reaction norms and then male breeding ecology, to best assess and predict population vulnerability to climate change and maximize the benefits of conservation actions.

Constellation: Caged sunflower sea stars reduce localized purple urchin density and grazing in Oregon urchin barren

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1- University of Oregon 2- Oregon State University

The sunflower sea star (*Pycnopodia helianthoides*) is a predator of urchins, which are capable of driving kelp deforestation. Following dramatic population declines due to sea star wasting disease, *Pycnopodia* has been largely absent from West Coast ecosystems. As *Pycnopodia* populations recover, they may help facilitate kelp forest recovery by both consuming urchins and altering their grazing behavior through a ‘landscape of fear’ effect. Recent research in Alaska found that temporarily caged *Pycnopodia* reduced red urchin density and grazing rates within 2-4m. Based on this, our study aimed to assess the longer-term effects of *Pycnopodia* on purple urchin behavior and grazing in Oregon. We translocated 24 *Pycnopodia* to an urchin barren dominated by purple sea urchins in Port Orford, Oregon. Stars were enclosed in 12 acrylic cages: 6 served as controls without stars, while the remaining 6 each contained 4 *Pycnopodia*. Prior to translocation, roving dive surveys were conducted to confirm the absence of these stars at the site. Subtidal urchin densities were quantified weekly within 4m of the cages over 6 weeks. Each week, pre-weighed kelp samples were deployed to half of the cages for 24 hours to

measure grazing, enabling a kelp versus *Pycnopodia* presence factorial design. Grazing rate and urchin density declined up to 1.5m away from the star for 1 month. This work suggests that reintroducing *Pycnopodia* to urchin barrens may reduce grazing pressure, potentially facilitating kelp forest resilience and recovery.

Site fidelity and movement patterns of fishes associated with offshore platforms in the Arabian Gulf
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1- California State University at Long Beach 2- University of Copenhagen 3- Qatar Foundation 4- Qatar University 5- TotalEnergies 6- Federal University of Rio Grande de Norte

In the Arabian Gulf, extreme summer heat creates uniformly high temperatures in shallow waters, limiting cooler refuges for fish due to the region's shallow depth. This unique thermal environment likely influences the movement strategies of fish, with species exhibiting varying degrees of residency or mobility. In this study, we used acoustic telemetry to monitor the movements and behavior of benthic and pelagic fishes associated with offshore platforms in the Arabian Gulf from June 2023 to May 2024. A total of 109 individuals, representing 15 pelagic, benthic, and bentho-pelagic species were surgically implanted with transmitters with 25% at three platforms. Fifty-three percent of benthic fishes showed high residency to platforms while only 2% of pelagic fishes exhibiting this same affinity. Among fishes equipped with pressure-sensors, pelagic individuals (n=4) used predominantly the upper portion of the water column, while benthic/bentho-pelagic species (n=9) used significantly deeper portions of the water column. Both groups showed distinct changes in depth use across seasonal temperature differences. Additionally, 12 individuals were detected at more than one platform and the likelihood of inter-platform migrations increased with size of individuals. These findings demonstrate that many benthic/bentho-pelagic species and some pelagic species exhibit high residency at platforms throughout different seasons, with vertical depth movements influenced by seasonal water column water temperatures, and that platforms within this oil field potentially form a network of habitat.

Pill bugs or lil' slugs? Mimicry drives isopod invasion of San Francisco Bay wetlands
† Yarbrough, S.G.[*]; Krug, P.J.

California State University Los Angeles

Identifying mechanisms that promote the invasion of wetlands remains a major conservation imperative. The isopod *Pseudosphaeroma* sp.A from New Zealand is found on piers in bays and harbors across California. In the past 20 years, we found this species has expanded to emergent tidal marsh but only in San Francisco Bay, where the most abundant surface invertebrates are now P. sp.A (4,000 isopods/m2) and native, chemically defended sea slugs (*Alderia* spp.) We hypothesize this niche shift resulted from the evolution of Batesian mimicry in marsh isopods, which more closely resemble *Alderia*than pier isopods based on trait-table scoring. Mimetic isopods were strongly attracted to *Alderia* mucus while pier isopods either avoided slug slime or had no preference over snail mucus. We tested whether arrow gobies (*Clevelandia ios*) distinguished marsh from pier *Pseudosphaeroma* or control isopods (*Sphaeroma*), after learning to associate the appearance of repellent sea slugs with their bad taste. Fish offered slugs for a week learned to reject or avoid *Alderia*, while naïve fish became faster at consuming control prey. Slug-conditioned fish consistently attacked non-mimetic isopods more frequently than marsh isopods, indicating mimics benefit when visual predators have experienced slug defenses. These ecological interactions highlight the need to consider not only physical disturbance and competition but also behavioral and evolutionary mechanisms when predicting ecological impacts of non-native species in California wetlands.

Session 22: Physiological Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Correlation between tidal state and behavior of bottlenose dolphins

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Orange Coast College

The Ocean Animal Response and Research Alliance (OARRA) conducted live animal surveys of the Southern California coast from Marina Del Rey to Dana Point from 2020 to 2025. They recorded sightings of bottlenose dolphins and the animals' observed behavior. I compared the information from these surveys to tidal data sourced from NOAA. The comparison suggested bottlenose dolphins exhibit traveling behavior most during flood and ebb tides and feeding during flood and slack tides. OARRA uses the observations made during their live animal surveys to anticipate unusual mortality events. A correlation between dolphin behavior and tides may may provide another early warning sign.

Water temperature as a physical driver of strobilation in Pacific sea nettle (*Chrysaora fuscescens*) scyphistomae

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Sea nettle (Chrysaora fuscescens) blooms have become more erratic over the past two decades in their timing and frequency in central California waters, mirroring a global trend of heightened variation of jellyfish populations. Climate change is impacting the physical factors that influence strobilation, the process by which reproductive polyps (scyphistomae) asexually reproduce, releasing larvae that lead to jellyfish blooms upon maturation. Scyphozoans can delay certain phases of their reproductive cycle by responding to temperature, salinity, and chemical signals. I hypothesize that C. fuscescens blooms in Monterey Bay are initiated by upwelling, a process that significantly reduces water temperatures for hours to days at a time. I have stocked 3 replicate microcosms with 10 mature C. fuscescens scyphistomae into three temperature treatments (10°C, 15°C, and 18°C) and compared strobilation timing across the treatments. To determine if temperatures associated with upwelling can induce strobilation, I will present results of an ANOVA with the one-tailed hypothesis that strobilation would begin sooner in the cold treatment than in the other treatments. Understanding the drivers of C. fuscescens blooms in Monterey Bay is essential as they are a critical food resource for endangered leatherback turtles. Responses to cues are likely unique for each species and geographic location. Future studies should explore drivers of blooms for populations of concern, which can become so dense that they dominate ecosystems, interrupt fishing operations, and clog intakes for industries.

Photoperiod and temperature regulation of gametogenesis and reproductive capacity in the purple sea urchin (*Strongylocentrotus purpuratus*)

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1- UC Berkeley 2- Kashia Band of Pomo Indians 3- UC Davis 4- CA Sea Grant 5- Moss Landing Marine Lab 6- AquaRange Research LLC 7- US Fish and Wildlife Service 8- Moss Landing Marine Labs

Recent explosions in purple urchin (*Strongylocentrotus purpuratus*) in northern California have decimated kelp in the region, transforming kelp forests into urchin barrens. One tool to facilitate kelp forest conservation is the advancement of urchin gonad enhancement aquaculture. Barren habitats lack adequate nutrition in the wild for urchin to produce market-quality gonad, or 'uni', disincentivizing urchin commercial harvest. A potential solution to overcome this issue combines fisheries with aquaculture such that emaciated wild urchin can be collected and fed in captivity to produce high quality uni. While potential exists for urchin aquaculture to promote kelp forest health, there is a gap in knowledge in optimal environments to maximize uni production in a cultured setting. We conducted experiments to test which temperature (12, 14, 18, 20ºC) and light (24 hr, 16 hr, 8 hr, 0 hr) regimes produced was optimal uni. At high temperatures, individuals exposed to 'winter' light regimes (8 hours) produced

larger gonads compared to those in darkness, whereas individuals in cool temperatures showed no differences in gonad size across light treatments. When assessing gametogenesis in cool temperatures, egg production was significantly lower in 24 hour light compared to 16, 8, and 0 hour light treatments. However, egg production was similarly low across all light treatments in high temperatures. Our experiments demonstrate gonad production and gametogenesis are under photoperiod control in warmer temperatures, potentially explained by seasonal cues controlling gametogenesis.

Effects of ocean acidification on the energetics and larval development of a coastal fish

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CSU Long Beach

Ocean acidification (OA) can cause a variety of detrimental effects on the physiology and ecology of larval fishes. Despite a preponderance of negative effects, studies of how OA influences mortality and growth have produced mixed results. These patterns emphasize the need for more comprehensive studies that examine mechanisms linking OA stress to endpoints such as growth and mortality. We tested the effects of OA on energy intake, as measured by feeding rate, and energy expenditure, as measured by respiration, then compared these results to growth and development of larvae of a coastal fish, the California Grunion. We found that feeding rates significantly decrease under increasing levels of pCO2. Coupled with minor effects on metabolic rate, these results suggest an energy deficit under higher levels of CO2 stress. Paradoxically, we also found strong evidence of faster growth in both mass and length when developing under OA conditions. To explore the consequences of these results, we examined development via allometric analysis of organ growth. We found that the relative growth of the eyes, stomachs, and tails of larvae were significantly slowed when larvae developed under high pCO2 conditions. Together, these results suggest that ocean acidification conditions can give rise to both less energy overall and a greater allocation of resources towards somatic growth. The effects of these shifts are likely to have cascading effects on recruitment success.

Effects of pregnancy on biochemical indicators of gopher rockfish (*Sebastes carnatus*) exposed to upwelling stress

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1- California State University Monterey Bay, Moss Landing Marine Laboratories 2- Moss Landing Marine Laboratories 3- California State University Monterey Bay

Seasonal upwelling exposes nearshore fish to periodic ocean acidification (OA) and hypoxic (H) conditions. Climate change is expected to increase the frequency and severity of these events. In this study, we examined the accumulation of sublethal biomarkers that could serve as early indicators of physiological stress associated with exposure to OAH stress: Hypoxia Inducible Factor 1-alpha [HIF-1α], L-Lactate, Insulin-like Growth Factor-1 [IGF-1], and cortisol. We exposed gestating adult gopher rockfish, whose reproductive season coincides with spring upwelling, to varying levels of OAH and assessed biomarker concentrations in gill and muscle tissue following parturition. Our data indicate that HIF-1α increased as OAH intensity increased in fish with a successful parturition, activating hypoxia pathways. No significant differences were detected in L-Lactate and cortisol concentrations in white muscle tissue in response to OAH. Fish with successful parturitions tended to have higher cortisol and IGF-1 levels compared to those experiencing atresia (egg resorption), though these results were not significant. Our results suggest that HIF-1α may be a useful biomarker of chronic OAH stress while the other biomarkers may be suitable for acute stress. Future work will evaluate these biomarkers in wild fish across upwelling and ambient conditions and test whether reproductive stage modulates expression levels. Given the energetic costs of pregnancy and mounting a stress response, these results may be useful for predicting the impact of climate change on rockfish physiology.

Using eDNA to investigate the effects of hypoxia on copepods in Olympic Coast National Marine Sanctuary

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1- NOAA Pacific Marine Environmental Laboratory, Reed College 2- NOAA Pacific Marine Environmental Laboratory, UW Cooperative Institute for Climate, Ocean, & Ecosystem Studies 3- NOAA Olympic Coast National Marine Sanctuary 4- NOAA Pacific Marine Environmental Laboratory

Hypoxic events are increasing in severity and duration in Olympic Coast National Marine Sanctuary (OCNMS). Hypoxia can have lethal and sublethal effects on marine life with potentially severe consequences for marine ecosystems. Understanding the effects of hypoxic events is critical as OCNMS habitats support recreation, fisheries, and four sovereign tribal communities: the Hoh Tribe, Makah Tribe, Quileute Tribe, and Quinault Indian Nation. We focus on understanding the impacts of hypoxia on copepods, which are an important food source for fish such as juvenile salmon and vital indicators for changing ocean conditions. Here, I pair three summers of mooring-based autonomous environmental DNA (eDNA) samples and dissolved oxygen (DO) data at one site in OCNMS to track changes in copepod prevalence across DO levels. Most copepod species were more frequently observed at higher dissolved oxygen levels. Importantly, southern and smaller copepods were detected proportionally more in hypoxic conditions than northern copepods. Copepods were classified as northern (cold-water) and southern (warm-water) following the established NOAA NWFSC biological indicators analysis. These results also suggest allometric scaling of hypoxia tolerance as previously suggested by metabolic theory and previous experimental studies. Our results demonstrate the value of co-located autonomous eDNA and hydrographic moorings for capturing changes in marine ecosystem dynamics and highlight a need to better understand foundational zooplankton species specific responses to seasonal hypoxia.

Adept-o kleptos: Comparative kleptoplastic abilities in two Californian sea slugs

† Eddy, B.M.[*]; Krug, P.J.

California State University Los Angeles

Sea slugs in clade Sacoglossa can retain ingested chloroplasts intracellularly (kleptoplasty), where plastids last for ~2 weeks (short-term retention) or over 1 month (long-term retention). We assessed the fitness benefits of kleptoplasty in *Elysia hedgpethi* and *Placida* cf. *dendritica*, which feed on *Codium fragile*. We used a 2×2 design of high/low light and fed/unfed conditions to determine the effects of photophysiology on slug growth and grazing rate. We measured quantum yield of photosystem II (F_V/F_M), the first time either species has been assessed using PAM fluorometry. Food and high light had additive or synergistic benefits for slug weight. In the dark, grazing rates more than doubled for *E. hedgpethi* and increased ~50% for *P.* cf. *dendritica* compared to light x fed treatments, showing fitness benefits of photosynthesis. Starved *E. hedgpethi* maintained a strong photosynthetic signal for >1 month, much longer than prior reports, suggesting that this species is comparable to the only other four long-term retaining *Elysia*. Starved *Placida* sustained a photosynthetic signal for 11 days despite a rapid decline after 3 days, much longer than other members of family Limapontiidae, all of which are thought to be non-retentive. These findings suggest that *P.* cf. *dendritica* is the first limapontiid exhibiting functional kleptoplasty. Understanding the benefits of kleptoplasty in these organisms will improve our understanding of the evolutionary origin of photosymbioses.

Juvenile pinto abalone (*Haliotis kamtschatkana*) survival, feeding intensity, and metabolic activity during ecologically relevant thermal fluctuation

† Kohl, A.W.[*]; Nyland, H.; St. Carrell, A.E.; Donovan, D.A.

Western Washington University

Pinto abalone, native to the Salish Sea, are locally endangered following decades of overexploitation. Variable success of hatchery-based recovery efforts implicates site-specific environmental factors as a cause of outplant failure. We examined the effect of fluctuating temperature, within outplant-site relevant bounds, on the survival, growth, feeding, and oxygen consumption of abalone from three genetically distinct hatchery families. We exposed abalone to temperatures fluctuating 10-14-10°C at a rate of 1°C d^{-1} (n = 36), 11-13-11°C at a rate of 0.5°C d^{-1} (n = 36), or a constant 12°C control (n = 36) for four fluctuation cycles. We hypothesized a negative relationship between fluctuation amplitude and abalone growth, survival, and feeding, but we found no effects of temperature

fluctuation, nor any influence of hatchery family. To examine if juvenile abalone metabolically acclimate to fluctuating temperature, we compared daily oxygen consumption of fluctuation-experienced abalone from the 10-14-10°C treatment (n = 8) and fluctuation-naive abalone from the 12°C control (n = 8) over one full cycle of 10-14-10°C at a rate of 1°C d^{-1}. Oxygen consumption did not significantly differ between fluctuation-experienced and -naive abalone, indicating no metabolic acclimation to fluctuating temperature. Our findings of no impact of thermal fluctuation on juvenile pinto abalone survival, growth, or feeding, and no metabolic acclimation, strongly suggest that variability in outplanted abalone survival is not driven by site temperature variability.

Session 23: Conservation and Restoration IV

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Supernova: The first trial reintroduction of wild sunflower sea stars to Oregon's struggling kelp forests
Gravem, S.A.[1*]; Rough, M.E.[2]; Schnerle, K.[3]; Laforte, T.[4]; Rumsey, K.[4]; Hamilton, S.L.[5]; Calvanese, T.[5]; Galloway, A.W.E.[3]

1- Cal Poly SLO, Oregon State University [OSU], Oregon Kelp Alliance [ORKA] 2- OSU, University of Oregon [UO], ORKA 3- UO, ORKA 4- OSU, ORKA 5- ORKA

Sunflower sea stars *Pycnopodia helianthoides* have been largely absent from the US West Coastline for a decade. In the interim, their purple sea urchin prey increased dramatically, followed by a crash in bull kelp forests. The Oregon Kelp Alliance is using a multi-pronged approach to recover kelp, with one trial strategy being *Pycnopodia* translocations. We collected 24 young *Pycnopodia* (7-15cm diam) in Southern Oregon in spring 2025 followed by a 1-month quarantine at Oregon Coast Aquarium. We redeployed them in 6 underwater cages in summer 2025 for 6 weeks with no mortality nor signs of sea star wasting. We fed them purple sea urchins, which they readily consumed. In September, we will relocate them to Nellie's Cove, our Reef Check monitoring and restoration site, which has transitioned from kelp forest to urchin barren in recent years. We will perform a point-release of all stars after a caged 48-hour acclimation. We will track the escape rates of the stars for 1 week and measure the effects of caged and then actively roaming seastars on sea urchin density. We will also test whether we can re-identify individuals from underwater photos. This pilot soak and release will test whether active stars cause stronger effects on urchins than caged stars, and help determine whether reintroductions of sunflower sea stars is a feasible and useful conservation strategy.

Identifying the causative agent of sea star wasting disease
Prentice, M.B.[1*]; Crandall, G.[2]; Chan, A.M.[3]; Davis, K.M.[1]; Hershberger, P.K.[4]; Finke, J.F.[1]; Hodin, J.[5]; McCracken, A.[6]; Kellogg, C.T.E.[7]; Clemente-Carvalho, R.B.G.[8]; Prentice, C.[8]; Zhong, K.X.[3]; Harvell, C.D.[9]; Suttle, C.A.[3]; Gehman, A.L.M.[7]

1- The University of British Columbia, Hakai Institute 2- University of Washington 3- The University of British Columbia 4- US Geological Survey, Western Fisheries Research Center, Marrowstone Marine Field Station 5- Friday Harbor Laboratories 6- University of Vermont 7- Hakai Institute, The University of British Columbia 8- Hakai Institute 9- Friday Harbor Laboratories, Cornell University

Beginning in 2013, an epidemic of sea star wasting disease (SSWD) swept the Pacific Coast of North America, devastating asteroid populations within a few years. Across the two dozen asteroid species afflicted by SSWD, the sunflower sea star (*Pycnopodia helianthoides*) has experienced the greatest losses. More than 90% of the global population of *P. helianthoides* has been lost in the last decade, and the species is now functionally extirpated from the southern portion of its range. The rapid disappearance of *P. helianthoides* enabled a trophic cascade involving unchecked population growth of their sea urchin prey which then overgrazed kelp forests along the coast. Key to the recovery of *P. helianthoides* and kelp forest ecosystems is the identification of the causative agent for SSWD. In this talk we present the results of controlled exposure experiments on *P. helianthoides* and genetic datasets generated from samples therein to identify *Vibrio pectenicida* strain FHCF-3 as a causative agent of SSWD. We

induced disease and subsequent mortality in exposure experiments using coelomic fluid from wasting sunflower sea stars, with no mortality in controls. Deep sequencing of diseased sea star coelomic fluid samples revealed a dominant proportion of reads assigned to the bacterium *Vibrio pectenicida*. Fulfilling Koch's postulates, *V. pectenicida* strain FHCF-3, cultured from the coelomic fluid of a diseased sunflower sea star, caused disease and mortality in exposed sunflower sea stars, demonstrating that it is a causative agent of SSWD.

On the road from wasting to recovery: Sunflower sea star eDNA characterization and survivorship studies in California.

Kidd, A.[1*]; Kim, A.[1]; Lev, K.[2]; Krol, L.[2]; Goodall, A.[2]; Freiwald, J.[3]; Gold, Z.[4]; Shea, M.[5]; Burge, C.[6]; Anoush McHugh, T.[7]

1- Sunflower Star Laboratory 2- California Academy of Sciences 3- Reef Check/Sunflower Star Laboratory 4- NOAA Pacific Marine Environmental Lab 5- Stanford University 6- California Dept of Fish & Wildlife 7- The Nature Conservancy

The sunflower sea star (*Pycnopodia helianthoides*) was once one of the most abundant and ecologically important predators in nearshore ecosystems from Alaska to Baja California. Following the outbreak of Sea Star Wasting Disease in 2013, populations of this keystone species collapsed by more than 90% across much of its range, destabilizing coastal food webs and reducing the resilience of kelp forests. Since its listing in 2020 as Critically Endangered by the IUCN, sunflower sea stars have rarely been observed in California. Monitoring population trajectories and in situ star health is therefore critical for evaluating the species' future and informing restoration strategies. California field experiments using sunflower sea stars cultured at the California Academy of Sciences and Sunflower Star Laboratory were catalyzed through the Pacific Coast Ocean Restoration initiative and the Association of Zoos and Aquariums SAFE program. The results inform applied monitoring and restoration strategies: 1) methods and execution of laboratory and fieldwork to characterize the fate and transport of sunflower sea star environmental DNA in a coastal ecosystem, 2) growth and survivorship of sunflower sea stars cultured under two rearing conditions, submerged in oyster baskets in the nearshore environment, 3) pre and post health assessments, incorporating *Vibrio pectenicida* detection, to compare with levels from naturally occurring sea stars within and adjacent to the field site. While science and policy challenges remain, a first step is to demonstrate it is even possible.

Ocean acidification mediates trophic cascades in eelgrass habitat

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1- San Diego State University 2- San Francisco State University

Stressors such as ocean acidification (OA) may threaten foundation species such as eelgrass (*Zostera marina*), one of the world's most widespread marine macrophytes. OA may directly affect eelgrass physiology, but also may indirectly affect eelgrass via modified species interactions among producers, herbivores, and predators, particularly if trophic cascades mediate eelgrass growth and survival. We used a mesocosm experiment to test whether OA affects the growth and survival of eelgrass by interfering with trophic cascades that dictate the competitive balance between eelgrass and epiphytic algae. We also tested whether OA alters crustacean grazing rates on eelgrass or alters fish predation on crustaceans. Using an Arduino-based pH monitoring and control system, in month-long trials we exposed experimental communities (fish predators, crustacean herbivores, eelgrass, and algae) to ambient seawater or to seawater with pH maintained at 0.3 units below ambient. Contrary to expectations, predation enhanced eelgrass growth and survival, primarily by limiting herbivore damage to eelgrass, and OA enhanced predation on crustaceans and positive indirect effects of predators on eelgrass. High rates of herbivory on eelgrass corresponded to changes in amphipod community composition. Our study demonstrates that OA can mediate direct and indirect processes that affect eelgrass survival.

Marine protected areas and the California public: Access, awareness, and priorities

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1- California Marine Sanctuary Foundation, Channel Islands National Marine Sanctuary 2- California Marine Sanctuary Foundation 3- Univ. Washington 4- UC Santa Cruz 5- UC Santa Barbara 6- CSU San Marcos

Coasts and oceans provide countless benefits to coastal communities. These spaces improve our health and well-being, support ocean activities, connect us with nature, and provide an uplifting place for communities to come together. Thus, it is incredibly important to ensure that all coastal communities can access coasts and oceans, and the benefits that they provide. In California access to and protection of the ocean is supported through mandates such as the California Coastal Act (1972), the Marine Life Protection Act (1999), and the National Marine Sanctuaries Act (1972). We are conducting a large-scale survey across coastal California counties (2024-2025; >4,000 respondents to date) which evaluates public awareness of MPAs, including their existence and the role of science in their management. Additionally we evaluated geographic access to coastal areas, including state marine protected areas (MPAs) and National Marine Sanctuaries (NMS). We find that awareness of MPAs and NMS is low among the general public, but varies across demographics. Access to MPAs varies across the state, but many MPAs have limited or no access, limiting public benefits and interactions. However, we found that Californians highly value their connection to the ocean, and prioritize the protection of threatened marine life. We encourage expanding MPA benefits to include non-consumptive users through expanding public access and public education to increase connections between the general public, oceans, and MPAs.

A new method for identifying discrete clusters of multiple time series

Scheuerell, M.D.[1*]; Ward, E.J.[2]; Holmes, E.E.[2]

1- USGS/University of Washington 2- NOAA Fisheries

Identifying patterns in nature is a common first step toward understanding the underlying processes that generate them. In many cases, various clustering algorithms or dimensional reduction techniques can be used to create groups with similar characteristics, but they often require subjective decisions about the number of groups or aggregations. For information collected over time, various forms of factor analysis have been developed to model time series as mixtures of some hidden states (eg, DFA, MAFA) but interpreting the combinations of loadings and states can be challenging. In other cases, hypotheses about possible groupings can be generated a priori and evaluated against one another using model selection criteria, but the number of possible models can quickly become quite large. We developed a Bayesian method for identifying discrete clusters of time series that does not require user supervision. When applied to community data, prior information about diets or known covariance among species and the environment can be used to help identify similar patterns. We demonstrate the efficacy of the method on simulated data with varying ratios of observation (sampling) and process (environmental) variances indicative of ecological data.

Get to work: Updates on Oregon’s expanding kelp forest restoration program

Hamilton, S.L.[1*]; Calvanese, T.[1]; Hendrickson, C.[1]; Hollingshead, D.[2]; Gravem, S.A.[3]; Galloway, A.W.E.[4]

1- The Oregon Kelp Alliance 2- Reef Check Oregon 3- Cal Poly San Luis Obispo 4- The University of Oregon

In 2025 the Oregon Kelp Alliance (ORKA) began work on a NOAA funded kelp forest restoration and preservation project. In this presentation, we overview ORKA’s 2025 restoration activities and the lessons learned from this work. In 2025 ORKA concentrated effort at three sites, including work to suppress urchin populations, boost kelp spore production, and support sunflower sea star recovery. We worked with commercial urchin divers and volunteer divers to cull purple and red urchins under a new Letter of Authorization (LOA) permit from Oregon Department of Fish and Wildlife (ODFW). Under this LOA, more than 250,000 urchins were culled across our three sites. We also found that this new LOA permitting structure allowed for dramatically increased efficacy of commercial diver work compared to previous year’s efforts. At two sites we employed kelp enhancement, in the form of refillable spore bags as well as Arrays to Recovery Kelp Ecosystem Vegetation (ARKEVs). The ARKEVs had high survival and growth rates when deployed early in the season, mirroring findings using this technique from northern California. Finally, at one site we collected and translocated 24 sunflower sea stars. Additionally, we

submitted a proposal to ODFW for captive breeding of sunflower sea stars in Oregon in partnership with the Oregon Coast Aquarium and the Oregon Zoo. Looking to the future, ORKA's 2026 efforts will expand to include a kelp forest 'preservation' site where we will work with community members to preserve an extant kelp forest believed to be at-risk of degrading into an urchin barren.

Session 24: Intertidal Ecology IV

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Polychaete communities are influenced by environmental variables and seasons in two coastal lagoons within the Pacific coast of Baja California, Mexico

Araujo-Leyva, O.R.[1*]; Moriel, M.[2]; Lorda, J.[1]; Stein, E.D.[3]; Walker, J.B.[3]; Withcraft, C.[4]; Beas, R.[1]; Ruiz-Mejía, S.[1]

1- Universidad Autónoma de Baja California 2- The University of Texas at Austin 3- Southern California Coastal Water Research Project 4- California State University

Wetlands are productive coastal ecosystems that have been significantly impacted by a range of anthropogenic activities. Using organism like polychaetes in coastal monitoring provides valuable insights into local benthic environmental factors. The binational efforts to monitor Mexican estuaries using standardized protocols remain limited. In this study, we analyzed polychaete assemblages from intertidal sediment cores collected in spring and fall of 2022 from the Northwestern coast of Baja California: Estero de Punta Banda (EPB) and Bahía San Quintín (BSQ), and used environmental variables to determine if the polychaete communities differed between estuaries and seasons, and if they correlated with environmental factors. Ammonia concentrations differed between estuaries during spring, and nitrate and Particulate Organic Carbon concentrations during fall. Polychaete assemblages differed significantly between estuaries and seasons, with ordination analyses clustering stations primarily by season. In spring, dominant families were Nereididae, Magelonidae, and Paraonidae in EPB, and Spionidae, Cirratulidae, Nereididae, and Syllidae in BSQ. Fall dominance shifted to Syllidae, Nereididae, and Capitellidae in EPB, and Spionidae, Cirratulidae, and Syllidae in BSQ. Our findings suggest that seasons strongly influence estuarine polychaetes communities primarily through key environmental shifts. Additionally, our results highlight that estuarine polychaetes reflect regional environmental dynamics by correlating with variables associated with nutrient enrichment

Deeper eelgrass meadows are refugia from disease and environmental stressors

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1- Cornell University 2- University of Oregon 3- Western Washington University

Eelgrass *(Zostera marina)* creates valuable, biodiverse habitats worldwide, but is at risk from environmental stressors and disease. We surveyed intertidal and subtidal meadows for seagrass wasting disease in the San Juan Islands, WA, USA in summers 2017-2019 to determine how disease varied with depth, temperature, and salinity. We expected reduced disease in deeper meadows with more stable environmental conditions compared to shallower, intertidal meadows with greater thermal and salinity variation. Using a machine-learning algorithm to detect and quantify disease, we measured high disease and large density changes, particularly in the warmer 2018 summer. Daily mean *in situ* and remote-sensed temperatures captured exposure to warming, though *in situ* temperatures better identified site-specific, seasonal thermal ranges. Subtidal meadows experienced nearly 14°C cooler maximum *in situ* temperatures compared to intertidal meadows. Disease severity was 2.24 times greater in shallow, intertidal meadows compared to deeper, subtidal meadows. Thus, subtidal meadows can serve as valuable refugia against environmental and pathogenic stressors. Lower eelgrass densities were also associated with increased severity, suggesting a link between disease and meadow patchiness. Temperature and salinity were key predictors of higher disease: prevalence and maximum sea surface temperatures covaried, as did severity and salinity range, suggesting these environmental factors may differentially influence disease risk and progression.

Impact of nutrient enrichment on anti-herbivory defenses and herbivore activity in an intertidal seaweed

Bittick, S.J.[1*]; Gowton, C.M.[2]; Kenny, S.R.[1]; Patel, S.[1]; Roe, J.[1]; Young, E.R.[1]

1- Loyola Marymount University 2- University of British Columbia

Silvetia compressa is a brown macroalga and habitat forming species in the rocky intertidal habitats of California. It has recently been on the decline and the focus of habitat restoration activity in Southern California. One human impact that causes changes to these seaweed communities is nutrient enrichment, which can impact the prevalence of anti-herbivory defenses. *Silvetia* contains a variety of anti-herbivory defenses including production of phenolic and siliceous compounds. Our experiment examined the impact of increasing nutrient concentrations and a gradient of herbivory pressure on the presence of phenols and silicon in *Silvetia*. Algae were grown for 10-days in tanks under 4 differing nutrient regimes and then exposed to 3 levels of herbivory pressure by crabs for an additional 10-days to examine herbivore response to nutrient enrichment. Algal growth, phenol and silicon concentrations were measured before and after each stage of the experiment. Nutrients increased phenol and silicon concentrations, but crab herbivores still preferred algae grown under high nutrient concentrations. This suggests that allocation of nutrients to defense production may not sufficiently deter herbivores and herbivory on this alga may increase as human-caused nutrient enrichment increases in rocky intertidal environments. This information can be applied to *Silvetia* restoration and conservation efforts as lower nutrient concentrations may favor persistence of this seaweed overall, while increased nutrient concentrations favor more ephemeral algal species.

Linking benthic composition to microbial ecology and nutrient cycling in isolated SoCal rocky intertidal tidepools

Renssen, B.O.[*]; Nixon, E.N.; Mullenmeister, C.A.; Wegley Kelly, L.

Scripps Institution of Oceanography, UC San Diego

Pacific rocky intertidal ecosystems are undergoing significant declines in foundation species such as mussels, anemones, and macroalgae due to climate change and habitat disturbance. These changes in benthic community structure alter the physical and biological processes that govern isolated tidepools. Microbiota are central to nutrient cycling and ecosystem metabolism, yet their role in shaping intertidal biogeochemistry remains poorly understood. This study investigates bacterial assemblage and biogeochemical dynamics across isolated tidepools with contrasting benthic communities at the Scripps Coastal Reserve in San Diego, CA. Utilizing benthic community surveys, inorganic nutrient measurements, and 16S amplicon gene sequencing, we explore the influence of benthic community structure on microbial processes throughout the tidepool isolation period. Results suggest nitrate and phosphate concentrations to vary with benthic community composition, indicating that microbial remineralization modifies local nutrient availability. Additionally, microbial families such as *Flavobacteriaceae*, *Cyanobiaceae*, and *Thiotrichaceae* are consistently enriched in tidepools relative to adjacent coastal seawater, highlighting the role of benthic foundation species in creating unique microbial niches. This work advances our understanding of how changing benthic communities reshape microbial ecology, nutrient cycling, and ecosystem metabolism in rocky intertidal habitats.

Recipient community structure affects prey preferences of a range-shifting predator

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University of California, Irvine

Global biodiversity is undergoing a grand reshuffling with species across taxa and biomes shifting their ranges in response to climate change. Research on the ecological impacts of range-shifting species has prioritized linking the traits of the range-shifting species themselves to impacts, with studies giving more limited attention to the characteristics of the recipient community. We used the range-shifting predatory whelk *Mexacanthina lugubris* as a case study to investigate how community structure might influence range shift impacts. Specifically, we hypothesized that *Mexacanthina lugubris'* consumptive effects on a single prey species would be modified by the

presence (or abundance) of a second prey species. We tested this hypothesis via a field experiment in southern California, where we caged whelks at a gradient of densities and observed their predation on mussels, barnacles living on bare rock, and barnacles living on mussels over eight weeks. Our findings demonstrate that the composition and structure of the recipient community (i.e., the presence of mussels) can mitigate the overall impact of the range-shifting predator by altering prey accessibility. This context-dependent attenuation of predator effects highlights a form of apparent facilitation among prey and underscores the importance of considering recipient community traits when assessing or managing the ecological consequences of range-shifting species.

Surfgrass vs kelp: Higher thermal tolerance and increased canopy cover in surfgrasses after disturbance
Zuelow, A.N.*; Henkel, S.K.

Oregon State University

Egregia menziesii, feather boa kelp, and *Phyllospadix* spp., surfgrasses, are canopy-forming foundation species that intermingle in the low intertidal in Oregon. Long term PISCO data from Oregon show flips in dominance of the taxa which we hypothesize is correlated to oceanographic conditions as thermal stress negatively impacts the performance of kelps. We quantified temperature effects on photosynthetic rates of these macrophytes as well as understory community differences between the genera before and after disturbance. First, we held individuals in 13°C or 15°C water for 28 days and saw little to no significant differences in photosynthetic output. Next, new individuals were started at 15°C, half were maintained at 15°C while the other half experienced 1 degree increase for 7 days to 22°C. In the second experiment, temperature increases resulted in steep declines in net photosynthetic rate in *Egregia*, but not *Phyllospadix*. In the field, *Phyllospadix* plots had lower understory diversity than *Egregia* plots. Two years after canopy manipulation, *Egregia* rarely grew into *Phyllospadix* plots while *Phyllospadix* grew into plots where *Egregia* had been removed. Further, understory diversity dropped in *Egregia* plots regardless of manipulation type while *Phyllospadix* plots maintained similar diversity trends to initial. Overall, *Phyllospadix* displayed a stronger ability to maintain photosynthetic abilities in extreme warming events and better ability to rebound canopy cover than *Egregia*.

Competition along the pacific coast: Comparing the physiological responses of mytilus congeners to multiple stressors
Alcantar, C.Y.[1*]; Vasquez, M.C.[2]

1- CSU Long Beach 2- Loyola Marymount University

Global changes have increased seawater temperatures and precipitation events, which may influence the distribution and species dynamics of intertidal mussels along the Pacific coast, USA. While ecological interactions between the heat-tolerant invasive species, *Mytilus galloprovincialis* and the native species, *M. trossulus* have been studied, little is known on the role of multiple stressors in shaping these observed demographics. Thus, the purpose of our study was to conduct a comparative analysis of the cellular and whole organism responses of *M. galloprovincialis* and *M. trossulus* to multiple abiotic stressors. Mussels were acclimated to hyposaline conditions (20, 28, 34 psu) for 7 days, followed by an acute heat shock (17, 20, 25˚C) and mussel metabolic rate determined. Both species had a significant effect of temperature, with *M. galloprovincialis* showing synergistic effects under the most extreme treatment combination. *M. trossulus* was sensitive to heat stress and showed no significant metabolic responses under hyposalinity. Additionally, we investigated differences in thermal performance and relative Hsp70 protein abundance between the two *Mytilus* congeners. Thermal performance curves revealed that *M. galloprovincialis* exhibited 10˚C higher thermal optimum and upper critical limits than its congener, which are consistent with observed levels of Hsp70 protein abundance. Our study suggests species-specific physiological responses to multiple stressors may link thermal tolerance and observed geographic distributions.

Session 25: Kelp Forest Ecology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Evaluating the spatial-temporal dynamics of kelp-encrusting bryozoans across the British Columbia coast

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1- University of Victoria 2- Simon Fraser University

Canopy-forming giant kelp (Macrocystis tenufolia; previously pyrifera) and bull kelp (Nereocystis luetkeana) are foundation species that support some of the most structurally complex coastal ecosystems worldwide. Off the Central Coast of British Columbia (BC), Canada in 2015, Heiltsuk (Nation) Coastal Guardian Watchmen observed a large-scale outbreak of kelp-encrusting bryozoans in their territory. These observations coincided with a marine heatwave, supporting the notion that bryozoan outbreaks are temperature-induced and potentially linked with climate change. Encrustation by bryozoans poses a suite of threats to kelp forest resilience; however, there is limited knowledge on the seasonal and environmental factors that influence bryozoan presence, abundance, and distribution across BC's canopy-kelp forests. In partnership with Coastal First Nations, the Government of BC, and the Hakai Research Institute, we surveyed 20 kelp forests across BC, spanning a latitudinal gradient of ~1000 km. To evaluate the spatial-temporal dynamics of bryozoans, we collected data using remote sensing techniques, oceanographic sensors, and ecological surveys in 2024 and 2025. Our work aims to guide conservation and management efforts including defining the quality of juvenile salmon migration routes, planning for sustainable wild kelp harvest, and identifying priority areas that could benefit from kelp forest restoration.

Beyond the visual: Detecting ecosystem transitions through soundscapes

† Shenasa, A.M.A.*; Heneghan, S.M.; Nielsen, L.R.; Seida, E.M.

UC Santa Cruz

Understanding how ecosystem states shift and identifying early signs of those transitions are critical for effective conservation. In kelp forest ecosystems, the collapse into urchin barrens represents a well-documented phase shift, yet transitional states and their early detection remain poorly understood. This study evaluates whether passive acoustic monitoring can capture signals of such transitional dynamics by analyzing soundscape data alongside ecological indicators, including kelp density, urchin density/biomass, and crustose coralline algae percent cover. In Sitka Sound, Alaska, surveying of 3 kelp forest and 3 urchin barren sites revealed that both ecological and acoustic data reflected clear binary ecosystem states, and passive acoustic classification aligned with traditional habitat characterizations. Furthermore, acoustic indices modeled as continuous variables captured gradients in urchin metrics, reflecting varying ecosystem conditions. These results suggest that soundscapes can capture both distinct ecosystem states and intermediate conditions, offering scalable, non-invasive methods for early detection of ecological change. Overall, this work highlights the potential of passive acoustics to complement traditional surveys and improve the detection of ecosystem transitions in marine environments.

Synthesizing disparate data for a comprehensive view of floating kelp distribution in Washington state, USA

McKenna, G.E.*; Claar, D.C.*

Nearshore Habitat Program, Washington State Department of Natural Resources

Understanding the current distribution of floating kelp forests is critical for tracking changes to these ecologically, economically, and culturally important ecosystems. It informs management efforts in response to threats from urbanization, climate change, and other environmental stressors. However, current floating kelp spatial datasets represent a diverse patchwork of surveys from varied time periods and with varied spatial resolution, making comparison and change analysis difficult. Here, we present a recent effort to integrate multiple datasets to comprehensively map kelp canopies in Washington State, USA. By synthesizing remote sensing data, in-situ boat-based surveys, and historical records to 1-km coastal line segments, we created a novel spatial dataset that describes the statewide distribution of floating kelp. Analysis of the most recent survey data shows that the proportion of floating kelp-containing shorelines is highest in the Western Strait of Juan de Fuca, followed by the North Coast, Eastern Strait of Juan de Fuca, and San Juan Islands. While a long time series of data exists in most

of these areas, the San Juans has relatively few years of data. Proportional kelp presence is much lower throughout the rest of the State, including Puget Sound, and temporal data availability for these areas is similarly sparse. The dataset produced through this effort has enabled new approaches for statewide analyses and status reporting for floating kelp forests, and the synthesis methodology developed is deployable to other regions and species.

PurpleCline: The size class of purple sea urchins affects their behavioral response to young sunflower sea stars

† Rumsey, K.J.[1*]; Rough, M.E.[2]; Galloway, A.W.E.[2]; La'Forte, T.F.[1]; Sridhar, N.[3]; Kroeker, K.J.[3]; Gravem, S.A.[4]

1- Oregon State University 2- University of Oregon 3- UC Santa Cruz 4- Cal Poly SLO & Oregon State University

After the 2013 sea star wasting disease epidemic decimated sunflower sea star (*Pycnopodia helianthoides*) populations, purple sea urchin (*Strongylocentrotus pupuratus*) abundance increased, leading to kelp forest decline. Reintroducing *Pycnopodia* to kelp forests may help control urchin populations and aid kelp recovery. Since raising young *Pycnopodia* for reintroduction is logistically easier, it is important to understand the size-dependence of urchin responses to small *Pycnopodia* that are too small to consume larger urchins. In four laminar flow tanks (200×60cm), each divided into 20 cells (in a 10x20cm grid), we evenly distributed either 220 small (<2cm) or 20 large (4–6cm) urchins and 20 kelp pieces. We added caged juvenile *Pycnopodia* (3.8-5.1cm diameter) to the center of 2 of the tanks, resulting in an urchin size by *Pycnopodia* treatment factorial design. We measured urchin behavior (percent on kelp, wall, or bottom) and population grazing rates on kelp in each cell over three days. When stars were present, small urchins avoided the kelp and bottom, were more abundant on the walls, ate less kelp and responses were stronger downstream of the stars. In contrast, large urchins showed no clear tank-wide changes in behavior or grazing responses but they tended to eat less kelp downstream with *Pycnopodia* present. Our work suggests that juvenile *Pycnopodia* re-introduction may have some benefits to kelp forest recovery through their effects on purple urchin behavior and grazing, with stronger effects on small urchins.

"With fronds like these, who needs enemies?": Associational seaweed defense reduces sea urchin grazing on bull kelp

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Cal Poly Humboldt

Understory seaweeds in the order Desmarestiales can deter herbivores by physically limiting their mobility through wave-mediated 'whip-lash' and by acting as a less palatable food source. These characteristics may afford the use of acidweed (*Desmarestia* spp.) as a deterrent to sea urchin grazing in aid of current bull kelp (*Nereocystis luetkeana*) restoration efforts. Here, we combined field surveys and short-term field and laboratory experiments to test the efficacy of acidweed as a purple urchin (*Strongylocentrotus purpuratus*) deterrent. In the field, we conducted transect surveys to assess the association between acidweed and bull kelp, and experimentally tested the effect of acidweed and algal mimics on purple urchin abundance in and around circular bull kelp 'hoop' plots in northern California. In lab, we compared urchin grazing rates on acidweed, the kelp *Pterygophora californica*, and bull kelp. In the field, we found a strong positive association between acidweed and bull kelp abundance, and that acidweed and algal mimic barriers reduced the number of urchins entering, and in proximity to, experimental bull kelp plots compared to control plots. In lab, urchins consumed acidweed and *P. californica* at roughly half the rate of bull kelp. Our results suggest that acidweed could be an effective deterrent to sea urchin grazing, at least over shorter time scales and during critical growth periods for bull kelp. Acidweed may therefore have value in restoration, as a biological deterrent to grazing sea urchin fronts.

Spatial population models reveal tradeoffs involved in making spatial shifts in marine reserves to improve kelp forest resilience

Hopf, J.K.[1]; Giraldo-Ospina, A.[2]; Caselle, J.E.[2]; Kroeker, K.J.[3]; Carr, M.H.[3]; Botsford, L.W.[4]; Hastings, A.[4]; White, J.W.[1*]

1- Oregon State 2- UC Santa Barbara 3- UC Santa Cruz 4- UC Davis

Heatwaves have become widespread stressors affecting marine ecosystems, so it is urgent to consider management tools that support resilience of sensitive ecosystems such as kelp forests. There is empirical and theoretical evidence that kelp forests in marine reserves fare better during heatwaves, because reserves protect predators of the urchins that graze forests during heatwaves. In California, downscaled climate forecasts predict that some marine reserves are more likely to experience frequent heatwave stress than others, leading to suggestions for reconfiguring the reserve network to place more reserves in climate refugia. We evaluated the potential consequences of such changes using a spatially explicit model of the kelp-urchin-predator system. The model included an idealized coastline with 16 habitat patches, all linked by larval dispersal of the three species. A fraction of the patches were in no-take reserves and the rest were harvested, and the patches had differential probability of heatwave disturbances. We found that expanding reserve areas in refugia, or moving reserves from high-disturbance habitats to refugia, improved the long-term persistence and resilience of kelp forests. However, these benefits came with short-term risk: because fishing removes large fish in newly opened reserves faster than large fish can accumulate in new reserves, there is a period of vulnerability following reserve reconfiguration. This type of analysis can be used to bracket the range of possible actions to be considered in a future analysis of the actual California reserve network.

Session 26: Broadening Participation in Ecology I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Reviving a legacy: The historic *Western Flyer* as a platform for modern marine science, education, and outreach

Christensen, R.V.*; Johnson, J.C.

Western Flyer Foundation

The Western Flyer Foundation is a marine science research and education nonprofit inspired by the friendship of ecologist Ed Ricketts and author John Steinbeck. In 1940, they chartered the fishing vessel *Western Flyer* to conduct intertidal surveys across the Gulf of California, culminating in their seminal work, *Sea of Cortez* which inspired a generation of environmental stewards. Now, meticulously restored by the Western Flyer Foundation, the *Western Flyer* is more than a historic vessel: it is equipped for modern oceanographic and ecological monitoring, with an onboard microscope lab, conductivity-temperature-depth (CTD) profiler, multi-sensor flow-through system, custom meteorological array, echosounder, and ROV. Through our integrated research and education programs, we engage students from high school through university, along with scientists, artists, naturalists, and historians, providing them with unique at-sea interdisciplinary experience. In a landmark voyage, we recently returned the vessel to the Gulf of California for the first time in 85 years, engaging with local Mexican communities and scientists to build lasting international partnerships for marine research and education. Here, we will present the unique mission of the vessel, share initial research and educational outcomes from our programs, and outline opportunities for collaboration. We seek to leverage this historic platform to broaden participation, collect meaningful long-term data, and effectively share our findings with both the scientific community and the public.

A guide to conducting anti-racist conservation research

Olsen, A.Y.*; Blackhorn, K.

Seattle Aquarium

Conservation research is rooted in racism and white supremacy culture, with many examples of historic wrongdoings of white saviorism. There is a gap in both published guidelines and established community practices regarding how to conduct conservation research in a reciprocal and respectful manner. For this talk, I provide

guidance for researchers, facilitators, and practitioners to approach program and project development with an anti-racist lens by asking reflective and critical questions throughout the process.

A recipe for marine STEM student success and personal growth in the nation's largest public university system

Paganini, A.*; Kamer, K.

California State University Council on Ocean Affairs, Science & Technology, CSU COAST

With support from the National Science Foundation and Alfred P. Sloan Foundation, the California State University Council on Ocean Affairs, Science & Technology (CSU COAST) is assessing the impact and effectiveness of multiple undergraduate support strategies in marine STEM within the California State University (CSU) system—the nation's largest and most diverse public university. Across four distinct programs within the CSU, we use well-established high-impact practices such as hands-on experiential learning and inclusive mentoring to support student development. Additionally, we have developed a series of personal growth and career development workshops designed to help students fully engage in these experiences and build strong, productive mentoring relationships. Regardless of each program's specific focus, the personal growth and career development programming remains consistent, demonstrating that a curated set of modules can be effectively applied across multiple initiatives. In this talk we will discuss the student development curriculum and the impact of the different programs on students' scientific identity, sense of belonging, and career goals within the broad, multidisciplinary field of marine STEM.

Breaking down financial barriers to ocean and coastal fieldwork

Jassowski, K.; Paganini, A.*; Kamer, K.

CSU COAST

Ocean and coastal research often involves field work, which can be transformative and increase students' confidence, scientific identity, retention, and academic performance. However, extra costs associated with these experiences can be prohibitive, placing these opportunities out of reach for many low-income students. To address this barrier, the California State University Council on Ocean Affairs, Science & Technology (CSU COAST) launched a novel program in 2022 to provide financial support to students, enabling them to engage in ocean and coastal field experiences in equitable and inclusive ways. Awards through the Undergraduate Field Experiences Support Program can be used to purchase personal gear, travel to field sites, and enroll in field courses. The program prioritizes students with financial need and limited research experience. Over 80% of awardees reported that their field experiences strengthened their identity as marine scientists, increased their sense of belonging, and contributed to their academic and professional development. For 60% of participants, this was their first significant field experience, and more than half identified as members of historically underrepresented groups. This type of financial support is especially impactful in broadening participation at institutions like the CSU, which serve large populations of students from historically excluded backgrounds. While this program is focused on ocean and coastal science, the model is applicable to any discipline where fieldwork is critical.

Baja Californian kelp forests: From exploration to restoration

Beas-Luna, R.[1*]; Torres-Moye, G.[1]; León-Cortez, J.D.[2]

1- UABC 2- Frente de Permisionarios de Baja California

Early human settlers and pre-Hispanic indigenous coastal communities that lived on what is now known as the Baja California Peninsula in Mexico lived for thousands of years in an environment with a relatively stable climate and abundant natural resources. For several centuries (XV-XIX), European sailors, explorers, and missionaries invaded, settled, and gradually increased the exploitation of coastal resources. During the 20th century, more intense changes took place. For example, the Mexican Revolution (1910-1920) and subsequent land and fisheries reforms led to the rise of industrialized and diverse coastal fisheries. These fisheries of high-value species (e.g.,

abalone & lobster) relied heavily on kelp forest ecosystems. Over the past decade, the collapse of kelp forests in this region has been extensively reported. However, the history of the environmental shifts and human activities on longer time scales has received less attention. Thus, we outline how historical events at different scales (millennia, centuries, decades) hindered the forests' resilience and contributed to a biogeographical dichotomy along the Peninsula. And finally, we present the efforts of the fishermen-government-academy alliance, emerging projects, and recent plans for kelp forest protection and restoration.

A sea change for science: #BetterPublishing
Dawson, M.N.*

University of California, Merced

The current, predominantly for-profit model of scientific publishing is broadly considered to be deeply flawed. Dissatisfaction with the system is evident in critiques from early career and underrepresented researchers, a wave of editorial board resignations, growing coverage in both academic and journalistic publications, and a rise in alternative publication strategies. This presentation will introduce the session including outlining the current publishing ecosystem and efforts to develop strategies that better support the research community, emphasize quality over quantity of papers, and are more accessible and equitable. Multiple initiatives are laying the foundation for a sea change in the way the community approaches publishing that will support researchers across different career stages and institution types. However, to realize this vision, the scientific community and its allies must purposefully and publicly develop a mission around publishing and adopt a suite of best-practices that will promote and sustain affordable, ethical, equitable publishing for the future.

The ocean's menagerie: Spineless superpowers from sponges to sea stars
Harvell, C.D.*

University of Washington

The ancient marine invertebrates that dominate our west coast biodiversity hold vast biological powers that defy our scientific understanding. This talk, based on my new book, The Ocean's Menagerie, celebrates invertebrate biodiversity and explores impressive adaptations of major invertebrate groups with a perspective on the biological mysteries still to solve. Sponges producing life-changing cancer drugs, corals building castles, jellies making light, nudibranchs stealing harpoons and sea stars opening mussels. After 700 million years of evolution, will these biologies withstand or change in the face of unprecedented climate change?

Session 27: Physiological Ecology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Molting mechanics: Characterizing surface temperatures during the initial molt of northern elephant seal pups
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California Polytechnic State University, San Luis Obispo

A vital life history stage for many animals is molting, or renewal of the outer layer (feathers, hair, skin, or shell). Like other pinnipeds (seals, sea lions, walrus), northern elephant seal (*Mirounga angustirostris*; NES) pups are born with lanugo (neonatal fur) that they molt into a juvenile coat after weaning. The transition between pelts is likely to affect the thermoregulation of these pups. One thermoregulatory strategy available to NES is to increase blood flow to specific body regions (called "thermal windows") to help dump excess heat. The goal of this study was to examine whether NES pups use thermal windows to facilitate their natal molt. To investigate this, we used a thermal imaging camera to take thermograms of molting NES pups at the Piedras Blancas rookery. We recorded concurrent environmental variables (wind speed, air temperature, solar radiation, and substrate temperature) to

determine which factors impacted molting pup thermal profiles. We found that pup thermal windows were not associated with molted regions; thermal windows were found primarily in low insulation areas (head and flippers) and randomly along the trunk. Wind speed negatively affected the presence of thermal windows, whereas ambient temperature and solar radiation positively impacted overall surface temperature. This is the first study to investigate thermoregulation during the natal molt in northern elephant seals. Future work will compare these results to the molt of older age classes.

Blood physiology of Atlantic guitarfish

Powers, K.A.[1*]; Macdonald, C.[2]; Cartolano, M.[2]; Jerome, J.[2]; Pate, J.[3]

1- California State University Northridge 2- University of Miami 3- Marine Megafauna Foundation

Atlantic guitarfish (*Pseudobatos lentiginosus*) are a vulnerable batoid species found in the Western Atlantic, with populations declining due to bycatch in commercial fisheries and habitat loss. Despite their Vulnerable status, limited information exists on their biology and physiology. This study assessed Atlantic guitarfish stress physiology, collecting blood samples from individuals in Palm Beach County, Florida. Lactate levels, a key indicator of stress, were measured using a point-of-care (POC) device and validated against laboratory plasma assays. The POC consistently overestimated lactate concentrations but did so in a predictable manner, allowing calculation of a correction factor to improve accuracy. Lactate levels averaged 0.90 mmol/L, suggesting these small-bodied guitarfish show similar stress levels to other batoids. Sea surface temperature was identified as a significant predictor of lactate levels, suggesting potential physiological vulnerabilities under warming ocean conditions. Results provide novel insights into the stress physiology of understudied Atlantic guitarfish.

Physiological and molecular sensitivity of early-life stage dungeness crabs and red sea urchins to ocean acidification and hypoxia

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1- University of Southern California 2- Cooperative Institute for Marine Resources Studies, Hatfield Marine Science Center, Oregon State University 3- Washington Department of Ecology

Ocean acidification and hypoxia (OAH) frequently co-occur in productive coastal regions such as the California Current System (CCS), where anthropogenically driven intensification of upwelling, warming, and eutrophication has exacerbated these stressors. While the individual effects of acidification and hypoxia have been investigated, their synergistic impacts, particularly in early developmental stages, remain poorly understood despite their critical role in fishery recruitment. This work integrates the physiological and transcriptomic responses of two commercially and economically relevant invertebrates, the Dungeness crab (*Metacarcinus magister*) and red sea urchin (*Mesocentrotus franciscanus*), to a range of OAH conditions reflecting ecologically relevant current and projected conditions along the CCS. Sea urchin larvae exhibited skeletal dissolution, with dramatic shifts in larval morphology and gene expression detected at the pH/DO transition of 7.71/3.71 mg/L to 7.27/2.72 mg/L. In crabs, we observed carapace dissolution, increased mortality, and the upregulation of calcification and glycolytic genes, suggesting a compensatory response under metabolic stress. Together, our results identify species-specific molecular markers and physiological thresholds of OAH stress, providing further insight into potential recruitment bottlenecks under future multistressor conditions. These findings offer comparative, mechanistic indicators of early-life stage vulnerability, with implications for understanding species resilience and informing fishery management.

Survival on the rocks: How shore height shapes metabolism, stress tolerance & behavior in acorn barnacles

Hardy, K.M.[*]; Horn, K.M.; Dotterweich, M.M.; Anderson, K.N.

Cal Poly - SLO

The rocky intertidal is a natural laboratory for examining how environmental heterogeneity shapes physiological diversity. Sessile invertebrates such as the acorn barnacle (*Balanus glandula*) experience tidal height–dependent variation in abiotic and biotic stressors, from thermal, oxygen and desiccation extremes in the high zone to increased predation and competition in the low zone. Over the past several years, my lab has investigated the extent to which intertidal position influences metabolic capacity, stress tolerance and behavior in *B. glandula*. Initial work revealed that low-shore barnacles exhibited elevated lactate dehydrogenase (LDH) activity, higher baseline D-lactate levels and reduced cirral activity relative to high-shore conspecifics, indicating a greater reliance on anaerobic capacity. Thereafter, we consistently observed superior stress resilience in high-shore barnacles. Individuals from the upper intertidal survive significantly longer during thermal stress, anoxia stress and air emersion. Parallel experiments also found that high-shore barnacles have metabolic rates that are less sensitive to rising temperatures and they deploy stronger antioxidant defenses than their low-shore neighbors. Together, these results underscore the emergence of distinct 'metabolic phenotypes' shaped by tidal position and local environmental conditions. This work advances our understanding of how microhabitat variation drives physiological diversity and provides critical insight into how intertidal species may cope with intensifying climate-driven stress events.

Salt fat acid meat: Using lipids and proteins to investigate ocean acidification tolerance in a cold-water, solitary coral

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Cal Poly Humboldt

In the face of a rapidly changing climate, assessing organismal responses to future stressors in the context of current, natural exposure to stress could provide key insights to understanding marine ecosystem resilience. We used *Balanophyllia elegans*, a cold-water, solitary, azooxanthellate coral as a model to better understand how varying oceanographic conditions across its range have shaped its ability to tolerate and potentially adapt to current and future ocean acidification conditions. We collected *B. elegans* individuals across 2,500km of their range and subjected them to a factorial combination of pCO_2 and feeding regime treatments to investigate source-specific responses to low pH and food-availability. Source-specific tolerance to these stressors will be discussed in terms of lipid analysis and proteomics, the latter of which will combine the first proteome developed for *B. elegans* with the widest sampling range to date of any stress experiment using this species. Overall, survivorship was high for corals from all source locations and across all treatments. However, coral condition, behavior, and planulation varied among source locations. These results demonstrate source-specific variation in responses and tolerance to low pH and food-availability, a pattern that could inform future conservation and restoration approaches. Such source-specific responses highlight the importance of multi-source studies for predicting a species' ability to navigate future climate changes.

Combined effects of ocean climate and spatiotemporal variability on calcification-related physiology in juvenile California purple urchins

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UC Santa Barbara

Purple urchins (*Strongylocentrotus purpuratus*) are impactful native herbivores within California coastal systems but are threatened by acidifying ocean conditions because of their calcium carbonate ($CaCO_3$) body structures. Our project examines the calcification trends of two separate purple urchin populations over the last two decades in the face of increasing ocean acidification (OA) and extreme climate anomalies that may serve as proxies for future climatic impacts. We utilize a combined morphometrics-elemental analysis approach to determine the $CaCO_3$ content of juvenile purple urchins, which are especially susceptible to ocean acidification because of their high-Mg calcite dominant mineralogy. We analyzed specimens from a twenty-year sampling archive of the Santa Barbara Coastal Long Term Ecological Research project at Fort Bragg/Mendocino and Gaviota Pier, which experience vastly differing upwelling regimes along the California coast (i.e., low to high pH). Our findings

demonstrate notable variability in calcification metrics at both inter and intra-site scales, and are assessed alongside contemporaneous environmental data (sea surface temperature, net primary productivity, etc.) derived from remote sensing technologies to assess the potential for relative population vulnerability to changing ocean conditions. We contextualize our results in past climatic events, such as the extreme El Niño periods of 1996-1997/2015-2016 and the La Nina period of 1998-1999, which may act as analogs for future climatic scenarios.

Impacts of variable food availability on zooplankton energetics, growth and reproduction
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A common belief in ecology is that more resources will lead to higher overall fitness. In part, this occurs because abundant resources drive somatic growth, leading to higher overall survival and fecundity. However, resources commonly fluctuate in natural environments, and how much energy animals invest into growth and reproduction is a function of their age and stage. While immature animals invest heavily in somatic growth, mature animals invest more in reproduction. Thus, understanding how resource availability impacts energy investment before and after maturation will produce a more ecologically relevant and nuanced understanding of how resources shape fitness. To test this hypothesis, *Daphnia* neonates from 3 iso-female lines were reared in 3 algal food treatments (high, medium, low). On day 9, *Daphnia* were transferred into either into the same or a new food environment. We then conducted a standard life table assay and measured body size, reproduction, and survival. Preliminary analyses suggest growth until maturation is not influenced by resource availability, but total growth is influenced by both the pre- and post- maturation environments. This suggests a delayed impact of pre-maturation resource availability on growth. Finally, we find that total reproduction is driven exclusively by the post-maturation food environment, and that increased investment in somatic growth following maturity is negatively correlated with lifetime reproduction. Together, these results suggest a complicated relationship between resource availability and lifetime fitness.

Session 30: Kelp Forest Ecology III

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Spatial and temporal variation in kelp communities across the Salish Sea
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Reef Check Foundation

Puget Sound has seen an 63% decrease in Bull Kelp (*Nereocystis luetkeana*) compared to the earliest baseline in 1878, with individual sub-basins showing up to 96% loss. Much less is known about the status of understory kelp species and associated communities across the region. To address this data gap and leverage the citizen science dive community, Reef Check's kelp forest monitoring expanded into Washington in 2022. Monitoring sites were selected in partnership with other kelp monitoring efforts to establish a baseline subtidal dataset for kelp forest communities. Several sites are co-located with environmental sensors to investigate the stressors that may be causing kelp decline. Analysis from the first years of surveys show distinct regional kelp forest communities of fish, invertebrates and kelps within the sub-basins of Puget Sound. Kelp communities north of Admiralty Inlet had the greatest species richness and richness generally decreased with distance from the ocean inlet at the Strait of Juan de Fuca (SJDF). Invertebrate communities in the SJDF and San Juan Islands were dominated by echinoderm species including sea urchins whereas Central and South Puget Sound were dominated by crab species including high densities of kelp crabs. Similarly, fish communities were more similar between the SJDF and San Juan Islands and between the South and Central basin, respectively, suggesting they are associated with the distinct kelp and invertebrate communities found in each basin.

Impacts of ocean warming across the life cycle of kelp
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1- Oceans Department, Hopkins Marine Station, Stanford University 2- University of Washington, Friday Harbor Labs 3- Stanford University 4- University of Washington, Friday Harbor Labs and Soka University

Climate change is threatening kelp forests, with globally distributed kelp forest declines linked to rising ocean temperatures. Studying the physiological impacts of marine heatwaves across the life cycle of kelp is critical to manage, conserve and restore kelp forests. Bull kelp (*Nereocystis luetkeana*) have declined at locations within the Salish Sea that experience elevated summer seawater temperatures and low nutrients. We conducted experiments culturing bull kelp microscopic gametophytes and sporophytes from 7 different populations across 7 different temperatures (10-22°C), and we monitored in situ water temperatures at each site. We found that daily maximum temperatures in the kelp bed reached the thermal limits of gametophyte growth (18°C) and sporophyte production (16°C) at multiple sites. Second, we experimentally evaluated the impacts of ocean warming and nitrogen depletion on adult sporophyte blades of *N. luetkeana* and *Saccharina latissima* Regardless of nitrogen levels, blades incubated at 21°C had low or negative growth rates and showed signs of stress, including elevated respiration rates. Finally, we are conducting experiments with microscopic life stages of the giant kelp, *Macrocystis pyrifera*, to better understand how the duration and intensity of marine heatwaves impacts the survival of gametophytes and juvenile sporophytes. Taken together, the duration and intensity of elevated ocean temperatures relative to the seasonality of kelp reproduction and growth must be monitored to guide kelp forest conservation and restoration actions.

The hitchhikers guide to invasion: Native invertebrates as vectors of marine invasion
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University of California Santa Barbara

Invasive species in marine systems have been shown to alter predator-prey relationships, decrease biodiversity, and outcompete native foundational species. In temperate marine ecosystems, invasive algae have been shown to be capable of outcompeting native, structure-forming algae and negatively impacting native marine communities. We explored whether a native marine snail, *Megastraea undosa*, is capable of facilitating the recruitment and survival of the invasive algae *Sargassum horneri* by providing open substrate for settlement and growth when there is increased competition for space on surrounding reefs. We collected observational data across a network of temperate marine protected areas, quantifying the amount of invasive algae growing on both snails and on natural substrate. Our models show that *S. horneri* densities were several hundred to several thousand-fold higher on *M. undosa* shells compared to natural reefs across all MPA zones. This indicates that snails likely act as a key vector for *S. horneri* persistence, even in highly protected areas. We also found clear differences in *S. horneri* density on *M. undosa* across varying levels of protection. This study provides insight on previously unrecognized *S. horneri* settlement dynamics and will help inform future management strategies aimed at mitigating invasive impacts in kelp forest ecosystems.

Before and after a marine heatwave: Fish community changes in Northern and Central California
Bauer-Civiello, A.*; Abbott, D.*; Friewald, J.*

Reef Check

California’s kelp forests declined dramatically after the 2014–2016 marine heatwaves, with a 96% loss in Northern California and gradual declines in Central California. Ten years later, natural recovery has not occurred. Kelp forests support key fisheries and coastal economies, yet long-term impacts on fish communities remain poorly understood. Using Reef Check data (2007–2024), we evaluated fish species densities, diversity, richness, and evenness with linear mixed-effects models and compared community composition before and after the heatwave using nMDS and PERMANOVA. Most species’ densities declined in the 10 years following the heatwave. Shannon diversity (–0.018 yr^{-1}, t = –9.66), evenness (–0.012 yr^{-1}, t = –7.45), and richness (–0.026 yr^{-1}, z = –9.15) all declined significantly, with modest site-level variation, indicating consistent regional trends. PERMANOVA showed significant community shifts 10 years after the heatwaves, explaining 11% of variation in Northern CA (F = 4.07, R^2

= 0.108, p = 0.01) and 16% in Central CA (F = 7.62, R^2 = 0.164, p = 0.001) after controlling for site variability. Shifts in Northern CA were driven primarily by blue rockfish, black rockfish, kelp greenling, and striped perch, with rarer species such as kelp rockfish and cabezon contributing. In Central CA, blue rockfish, senorita, kelp rockfish, striped perch, and lingcod explained most dissimilarity. These results demonstrate persistent, region-wide restructuring of fish assemblages correlated with kelp loss, underscoring potential long-term ecosystem impacts of marine heatwaves.

Timing is everything: Marine heatwaves and the phenology of reproduction cycles in kelp forests of the Santa Barbara region

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1- University of California, Santa Barbara 2- University of Washington

Marine heatwaves (MHWs) are of increasing concern due to the emerging ecological and socioeconomic impacts on coastal marine ecosystems. Leveraging the data of the Santa Barbara Coastal Long-Term Ecological Research project, we analyzed the MHW event metrics observed in the kelp forest ecosystem and across Santa Barbara Channel, CA, USA. We found two important trends: (1) a significant positive trend in the number of MHWs recorded, and (2) the duration and intensity of the events were increasing over time. In addition, MHWs were detected year-round, suggesting that marine organisms have exposure risks regardless of their phenology. Exposure at one life history stage may also have a legacy effect on the subsequent, implying little temporal refuge. From an environment-organism interaction perspective, we noted that MHWs frequently also occur on the benthos (aka bottom marine heatwaves) and these events align with gametogenesis in some benthic marine invertebrates and in zoospore formation and release in giant kelp. We will discuss what the data we have about timing of reproduction interacts with the timing of MHWs on a seasonal basis.

Kelp carbon pathways in Aotearoa New Zealand: Productivity, stressors, and the role of restoration

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University of Auckland

Kelp forests are among the most productive ecosystems in Aotearoa, fixing on average ~1500 g C m^{-2} yr^{-1}—up to five times greater than their standing stock biomass. Much of this production is exported as particulate and dissolved organic carbon (DOC), with DOC emerging as a potentially persistent carbon pool. However, stressors strongly constrain this function. Increased turbidity can reduce productivity by more than 90%, while fishing pressure alters trophic dynamics, promoting urchin grazing and canopy loss. Rising temperatures further accelerate decomposition, shortening the lifespan of kelp-derived carbon. Degradation studies reveal rapid turnover of most material (half-life ~50 days), yet consistent recalcitrance (~20%) indicates that a fraction of kelp carbon persists and may contribute to long-term storage. These findings highlight both the variability and uncertainty that surround kelp carbon sequestration, shaped by local environmental conditions and reef state. Despite these challenges, kelp restoration and protection offer clear pathways to enhance productivity, re-establish export into persistent pools, and restore broader ecosystem services. In the Hauraki Gulf Marine Park alone, standing stock carbon has been valued at ~$NZ 7.9M, highlighting the potential for restoration finance. As evidence accumulates, it is clear that kelp forests cannot be treated as simple carbon offsets, but their recovery in Aotearoa can make measurable contributions to carbon sequestration alongside critical biodiversity, fisheries, and cultural benefits.

Irruption of native sea urchin signals impending region-wide collapse of kelp forests

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University of Auckland

The effects of climate change are increasingly evident within marine environments, with ocean warming now a major driver of ecological collapse. The temperate, kelp-dominated reefs of northeastern New Zealand have warmed over the past 25 years, during which populations of the native, subtropical sea urchin *Centrostephanus rodgersii* have increased by up to 1400%. This raises serious concerns for kelp forests ecosystems already impacted by overfishing of key predators and overgrazing by the endemic urchin *Evechinus chloroticus*. Largest increases and highest densities of *C. rodgersii* are occurring near the continental shelf, where the influence of the warm East Auckland Current is strongest. Increases have also occurred within marine reserves where large lobster, a potential predator, remain rare despite protection. Although rapid population growth is yet to led to an increase in barren extent, *C. rodgersii* forms barrens at lower densities, and across a wider depth range, than *E. chloroticus*. This is particularly alarming for deeper kelp forests, below ~10 m, which historically found refuge from grazing impacts. *C. rodgersii* are now regularly found in deeper forests at warmer locations, with early signs of overgrazing (incipient barrens) common. If current growth rates continues, density-related tipping points will be reached at many warmer locations within 15 years, causing region-wide collapse of deeper kelp forests. A brief window exists to address this issue before *C. rodgersii* populations reach a catastrophic tipping point.

An overview of the trends and persistence of kelp in Haida Gwaii, BC
Mora-Soto, A.[1*]; Gendall, L.[2]; Reshitnyk, L.[3]; Crawford, S.[4]; Bregulla, H.[4]; Lee, L.[5]; Burton, J.[5]; Hessing-Lewis, M.[3]; Costa, M.[1]

1- University of Victoria 2- University of Victoria, University of Western Australia 3- Hakai Institute 4- Council of the Haida Nation 5- Gwaii Haanas, Parks Canada

Satellite remote sensing mapping can be a tool for effective monitoring of the kelp ecosystem. In this research, the extents of floating kelp canopies from 2016 to 2024 were mapped around the Haida Gwaii archipelago of British Columbia to evaluate their short-term trends and long-term patterns of persistence. Kelp areas were additionally compared with trends in seasonal Sea Surface Temperature (SST) and Marine Heatwaves (MHW). Average summer SST was < 15 °C and MHW were relatively moderate; however, we detected 19% of coastal segments showing decreasing trends coinciding with the distribution of cumulative intensity of MHW. Additionally, 75% of the historic baseline coincides with highly persistent kelp areas. Overall, this research indicates general stability and some decreasing trends that could be reversed in the future with the expansion of the current marine protected area network.

Session 31: Conservation and Restoration V

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Gaviota Coast abalone restoration project
Campbell, P.[*]

The Bay Foundation

On May 19, 2015 a pipeline owned by Plains All American Pipeline burst near Refugio State Beach releasing approximately 100,000 gallons of crude oil into the surrounding nearshore environment. A settlement in 2020 was released with compensatory restoration funds for injury to subtidal habitats as described in the ‘Damage Assessment and Restoration Plan’. As part of the compensatory mitigation, the Gaviota Coast Abalone Restoration project was identified as a preferred project to compensate for subtidal injuries. Wild abalone were once abundant along the southern California coast, but populations of all the common southern California species were impacted by habitat loss, Withering Syndrome disease, and serial depletion by commercial and recreational fishing. It is highly unlikely that abalone populations in California will recover without intervention. Beginning in the spring of 2024 the project partners including a total of 13 scientific divers from The Bay Foundation, Paua Marine Research Group, Rincon Consultants, and NOAA conducted a total of 57 habitat and wild live abalone surveys in which 1000’s of square meters of underwater habitat was assessed for its quality to outplant juvenile abalone. In August,

2024, and August, 2025, of a total of 10,000 individual juvenile red abalone raised at The Cultured Abalone Farm, were outplanted across four sites that were selected in July 2024 and June, 2025. Since then, teams of scientific divers have regularly returned to all four outplant sites to perform the required post-outplant non-invasive abalone surveys.

Weaving indigenous knowledge with western science and technology: Co-designing a large Marine Respected Area in the Western Pacific

Crane, N.L.[1*]; Rulmal, J.M.[2]; Paddack, M.J.[3]; Bernardi, G.[4]

1- Society for Conservation Biology/One People One Reef 2- One People One Reef/Falalop CAP 3- Santa Barbara City College/One People One Reef 4- University of California Santa Cruz

As ecological and cultural change advance rapidly, collaboration is essential to co-develop solutions to environmental challenges. Science and technology provide ever more powerful tools to assess and monitor ecological systems, and can support the often rich and well-informed practices of local and indigenous peoples. Key elements of these collaborations include local leadership in establishing objectives, data sovereignty, framing approaches around traditional practices, and the development of equitable partnerships. There remains a gap in implementing novel tools and information in remote regions where indigenous communities steward critical marine habitat. One People One Reef is a collaboration between outer island communities in Micronesia and western science teams to weave together knowledge systems into local action for conservation. By pairing conventional surveys, cutting-edge “omics” data, high-resolution imagery, and traditional knowledge and practices, we are gaining a richer, multilayered picture of reef health. We integrate these social and environmental datasets into a layered visualization platform that supports local communities to identify critical areas for management and restoration and enhance traditional stewardship. This work has produced a draft of the largest marine respected area in the region, based on traditional practices and frameworks. Leading with the local cultural and ecological context can support management and restoration plans that promote equity, sustainable local use, and management by local leaders rather than external drivers.

Cooperative natural resource management in a mixed private-public wetland

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1- Chapman University 2- National Oceanic and Atmospheric Administration

Natural resource governance, especially in the case of issues that transcend the physical boundaries of land ownership, is challenging to coordinate among groups with varied interests. The California Delta is rife with sociopolitical challenges due to the high economic, ecological, and cultural value of the space. Suisun Marsh within the CA Delta faces substantial barriers to cooperative natural resource management because of its unique composition of landowners, which include state and federal entities, but also over 100 private duck clubs that have occupied the space since the early 1900s. We set out to characterize – and attempt to mend or strengthen – inter-individual relationships and communications among private and public landowners to facilitate the management of a rampant invasive species, Phragmites australis, which threatens wetland functions that matter to all parties, but in different ways. We observed a gap in literacy about Phragmites, leading to limited trust in only one perceived “governmental” body and few opportunities for community-led management. We also learned how researcher team composition (including their attitudes and even attire) and the use of specific language could impact project outcomes in a strategic way. This project was the first commissioned by the state to address the social aspects of natural resource management in a holistic manner alongside ecological outcomes: our findings provide valuable insight for future socioecological work in areas where political stakes are high and potential negative ecological outcomes are even more dire.

Monetizing nature? Scaling seagrass restoration to meet climate resilience goals

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1- Windward Sciences 2- UC Santa Barbara 3- UC Davis 4- San Francisco State University

A myriad of commitments from global (e.g.,Paris Agreement NDCs) to regional (e.g.,30x30 Initiatives) scales call for coastal restoration to meet carbon and biodiversity goals. Meeting goals requires rapid scaling of the pace, success, and ability to quantify restoration outcomes. Here, we evaluate the success of seagrass restoration on the US West coast and examine the role carbon credits might play in advancing this success, finding that over 30 years, 32%–60% of restored seagrass plots were unsuccessful. This percentage is highly dependent on how success is defined, typically only assessing structural rather than functional success (Ward & Beheshti, 2023). Models estimating potential support from carbon credits shows that restoration size and approach matter tremendously. Even if successful, seeding 6 Ha of seagrass could generate <$1,189 over 10 years (39.6±6.2 TCO2eq), while a conserving 100 Ha of seagrass and underlying sediment could generate up to $1.53 million (21,910±2196 TCO2eq) (Ward et al. 2025). However, carbon sequestration represents only one ecosystem function currently monetized through carbon markets, overshadowing holistic resilience benefits provided by intact seagrass meadows. Ongoing research in Elkhorn Slough evaluating multiple metrics of structural and functional success highlights the complex timelines of recovering ecosystem functions after restoration, and the challenges in monetizing nature. This collective work lays a foundation for how to make progress towards ambitious targets for restoration of seagrass meadows and other coastal ecosystems.

From ashes to recovery: Wildfire-responsive management of the endangered tidewater goby

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1- California State University, Channel Islands 2- University of California, Los Angeles 3- Resource Conservation District of the Santa Monica Mountains 4- U.S. Fish and Wildlife Service

In January 2025, the Palisades Fire caused extensive impacts to the Topanga Canyon watershed, sending ash, fire retardant, and a range of fire-related debris and contaminants into Topanga Lagoon, a critical habitat for the endangered northern tidewater goby (*Eucyclogobius newberryi*) and other sensitive native species. Anticipating heavy post-fire runoff and degraded water quality, over 700 tidewater gobies were rescued and transported to two public Aquarium partners for temporary holding while their lagoon habitat recovered. During this period of managed care, aquarium conditions were carefully controlled to maintain survival and health, enabling the successful reintroduction of the population six months later once habitat conditions at Topanga Lagoon stabilized. This rapid response built on lessons from previous wildfires that revealed the heightened vulnerability of bar-built estuaries to fire-driven disturbance and the urgent need for preparedness. Genomic assessments further informed recovery planning by clarifying relationships among populations and supporting management decisions aimed at maintaining genetic integrity during reintroduction. This case illustrates how wildfire increasingly threatens coastal ecosystems and demonstrates the value of readiness, cross-sector collaboration, and evidence-based planning for the long-term conservation of vulnerable lagoon-dependent species.

Working to recover abalone species to kelp forests in the Santa Monica Bay

Sverdrup, C.[*]

The Bay Foundation

The Southern California White Abalone Restoration Project developed by the National Marine Fisheries Service is part of a statewide collaboration dedicated to the restoration of federally endangered white abalone (Haliotis sorenseni) to the rocky reef habitats of southern California. White abalone once played a key role as grazers and ecosystem engineers ranging from Point Conception, CA to Baja California, Mexico, and are a NOAA “Species in the Spotlight”, one of 10 species considered among the most at risk of extinction. Without concerted efforts to encourage abalone restoration, the disappearance of most species of abalone from the southern California coast is likely. The Bay Foundation and its partners are undertaking a large effort to actively restore abalone as part of the giant kelp forest community to ensure that spatial and temporal stability is restored to this key coastal ecosystem and associated economies The Bay Foundation will partner with NOAA, UC Davis Bodega Marine Lab, Southern California Marine Institute, California Department of Fish and Wildlife, Paua Marine Research Group, The Cultured Abalone Farm, and others to spawn wild and captive, white abalone, and outplant the resulting individuals in

several areas off Palos Verdes, Los Angeles and Point Loma, San Diego. Currently, this project supports five white abalone restoration sites: three sites located in Palos Verdes, Los Angeles and two sites located in Point Loma, San Diego. The first Palos Verdes and Point Loma sites were established in 2018, with two additional sites established in 2022, and the mo

Landscape drivers of taxonomic, phylogenetic, and spectral plant diversity across wetlands of the conterminous United States

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Wetlands support a high diversity of organisms and provide ecosystem services critical to human well-being, yet they remain understudied and underprotected compared to many terrestrial ecosystems. To inform the cost-effective and enduring conservation of wetland sites, it is crucial to identify diversity indicators sensitive to plant functions, while examining the response of these indicators to site characteristics and landscape stressors. To advance this capacity, we compared the taxonomic, phylogenetic, and spectral diversity of vascular plants across 1,061 wetland sites monitored by the National Wetland Condition Assessment of the US Environmental Protection Agency. We estimated the spectral diversity of these wetland sites based on the multivariate dissimilarity in the spectral signature of individual pixels included within each wetland site. We then leveraged open-source geospatial data to measure the response of these various diversity indicators to site (e.g., wetland type, elevation, water quality) and landscape characteristics (e.g., connectivity, climate, proximity to higher density areas). Preliminary results suggest that indicators of spectral diversity are more sensitive to dissimilarity in species composition within each site, while taxonomic and phylogenetic diversity are more strongly correlated to the maximum greenness of each wetland site. Preliminary results also suggest that phylogenetic diversity might be more strongly impacted by site and landscape stressors than taxonomic diversity, while spectral diversity responds strongly to habitat heterogeneity.

Lessons learned from 25 years of monitoring the world's largest artificial reef

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1- UC Santa Barbara 2- UC Santa Cruz 3- UC Los Angeles

Wheeler North Reef (WNR; 151 ha) is the largest artificial reef of its kind. Built in three phases (experimental, mitigation, remediation), the artificial reef was created as mitigation for kelp forest losses associated with operations of a coastal power plant. Rigorous long-term monitoring is an important element of the mitigation project and ensures the artificial reef meets its intended goal of supporting a kelp forest community similar to that of nearby natural reference reefs. Investigations from each reef phase addressed several unknowns related to the ecological dynamics of artificial reefs. From the experimental reef, we found that all substrate types and covers tested supported kelp forest communities comparable to reference reefs and that kelp dispersal and colonization was widespread, forming dense surface canopies across the 3.5 km reef within three years of construction. From the mitigation reef, we found that the artificial reef contributed to fish production, fauna on the artificial reef rapidly resembled that of natural reefs, and rising densities of sea fans did not exclude kelp. From the remediation reef, we demonstrated that expanding reef size increased the likelihood that the project would meet requirements for sustained fish standing stock. This work highlights the use of this large-scale mitigation project as a premier case study for kelp forest resource management. Notably, lessons learned from the long-term monitoring and adaptive management of WNR are providing California state agencies with valuable science-based guidance on coastal restoration.

Session 32: Fisheries, Reproduction, Dispersal, and Recruitment II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

[Re]defining stock structure to support groundfish management along the US west coast

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Effectively balancing harvest and conservation depends on how well management areas align with the spatial scale of key biological and ecological processes. When the degree of population connectivity is unknown or unaccounted for, we risk misidentifying the spatial extent of a “stock”. Although legislation requires that the spatial extent of federally-managed stocks be clearly defined, stock-specific boundaries often default to predefined fishery management units and/or political borders. We synthesized the best scientific information available (BSIA) related to population connectivity for 86 federally-managed groundfish species. We compiled species-specific information about habitat use, larval dispersal, adult movement, spatial variation in life history traits, and genetic differentiation along the US West Coast. We then synthesized information to infer individual stock components and compare the spatial extent of those stock components to existing fishery management units. Most inferences about stock structure aligned with the existing spatial scale used for management decisions. A few key exceptions, however, suggest misidentification of stock components. These potential misalignments between biological or ecological processes and management scales can reduce the effectiveness of public policy and lead localized depletion or under-utilization of the resource. Careful consideration of population connectivity and continued reevaluation of BSIA to define stock components is crucial for developing management strategies that promote long-term sustainability.

A histological investigation of size at maturity for white seabass (*Atractoscion nobilis*)

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1- California Department of Fish and Wildlife 2- Pflieger Institute Environmental Research

White Seabass (Atractoscion nobilis) are a popular target of sport and commercial fisheries throughout California, with most catch occurring off southern California. They are the largest sciaenid or croaker species found in the state, and range from Mexico to as far north as Alaska during warm water events. White Seabass are multiple batch spawners, with an extended spawning season from March to September that peaks in May and June. The current minimum size limit of 28 inches is based on the macroscopic maturity of just 33 southern California females from 1930, necessitating maturity to be reassessed histologically from a larger sample size while incorporating considerations for spatial variability. Gonad samples from 139 females were collected during the 2017-2022 spawning seasons across southern California for comparison against 253 samples collected from the San Francisco Bay area. A combination of macroscopic and histological criteria were used to assign females to one of six reproductive phases: immature, developing, spawning capable, actively spawning, spent and resting. These assignments were used to generate multiple maturity curves, with functional maturity ogive suggesting 50% of female white seabass reach maturity around 34.8 inches TL, with 95% of examined individuals becoming mature by 38.4 inches. These findings suggest that white seabass begin contributing to the population at a larger size than previously estimated and the existing minimum size limit (28” TL) may not allow for all females to spawn at least once before being taken by fisheries.

Temporal variation in coral population dynamics and mesoscale hydrodynamic variability mediate inter-island larval connectivity.

Srednick, G.[*]; Davis, K.A.

Stanford University

On isolated coral reefs, larval connectivity of coral populations is mediated by the timing of biological processes, ecological dynamics, and intra- and interannual variation in hydrodynamic conditions. Spatiotemporal variation in coral responses to chronic and acute disturbances can lead to heterogeneous population distributions. Together, heterogeneity in coral population dynamics and larval dispersal across local and distant, intact and disturbed reefs may influence the timescales of connectivity and capacity for metapopulation resilience. To test this hypothesis, we

combine analyses of coral metapopulation dynamics with hydrodynamic modeling and Lagrangian particle tracking to generate a process-based assessment of connectivity on Moorea's north shore. Ten-month larval dispersal simulations coupled with a 19-y recruitment time series revealed local (within Moorea's north shore) vs. regional (inter-island) connectivity mediated by annual mesoscale variability. We reveal that reef habitats in Moorea are supplied by locally spawned larvae independent of mesoscale variability, whereas when mesoscale variability is weaker larvae have a greater likelihood of being delivered from distant reefs and/or islands (10 to >100 km away). These findings underscore the importance of considering temporal and ecological contexts of larval connectivity in nearshore environments, and how interactions between ecosystem states and hydrodynamics influence emergent trends in reef resilience.

Feasibility of using a random stratified survey design for assessing biomass of dungeness crab in Puget Sound, WA

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1- Port Gamble S'Klallam Tribe 2- Pacific Northwest Crab Research Group 3- Washington Department of Fish and Wildlife

Crustacean fisheries are the fastest growing wild stock fisheries in the world, with total global landings nearly doubling over the past three decades. In Washington state's inland waters, the harvest of Dungeness crab (*Metacarcinus magister*) provides critical commercial, recreational, and subsistence opportunities. The 1994 Rafeedie decision (US v. Washington) reaffirmed the tribal treaty right to half of state shellfish resources requiring co-management of fisheries between the Tribes and the State of Washington. With little contemporary biological data, Washington's co-managers are unable to develop adaptable management strategies within the ecological and hydrographic complexity of Puget Sound. In an effort to develop surveys that can inform stock assessments, we tested the feasibility of using a random stratified sampling regime to determine crab biomass within a discrete management area. We employed tribal fishers and used commercial crab fishing gear to survey Dungeness crab biomass in March and June of 2025. Commercial crab pots were soaked for 24 hrs. at randomly selected sites distributed across 3 depth bins. Results indicate that this survey provides valuable data on crab abundance and that fisher knowledge is critical for timely and successful operations. However, utilizing treaty commercial fishers presents scheduling restrictions and gear type limited our ability to access all available crab habitat. Future work will focus on refining methods appropriate and achievable for surveying Dungeness crab biomass within commercial fishing grounds.

Fish density and size gradients reveal pervasive 'fishing the line' effects across the largest scientifically-designed network of marine protected areas

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Marine protected areas (MPAs) conserve marine ecosystems and provide fisheries benefits via export of offspring and adults. While reserve size and age influence MPA effectiveness, less is known about how spillover and fishing pressure interact to shape spatial gradients in biomass and size structure across boundaries. Using data from a scientific hook-and-line program across a 1,300 km MPA network in California, USA, we documented pervasive edge effects near MPA borders. Consistent with fishing-the-line behavior, fish biomass per unit effort (BPUE) declined from MPA centers across boundaries, reaching lowest levels 2–3 km outside before rising again. Abundance and biomass were often twice as high in reserve cores than adjacent sites. Edge effects intensified over 15 years following MPA establishment in central California, implicating fishing and protection duration. MPA size and fish mobility further modulated effect strength, with limited-mobility species most affected. Despite declines near borders, larger fish above maturation size were caught up to 4–5 km outside, indicating spillover

maintained size structure in high-harvest zones. Size declined more slowly with distance from larger MPAs, suggesting greater spillover potential. Because edge effects extended ~2 km inside reserves, realized biomass gains are lower than predicted without accounting for boundary fishing. Strong edge effects highlight both the costs and fisheries benefits of spillover from MPAs.

Fishing and warming drive contrasting trends in two spiny lobster species on North-eastern New Zealand reefs

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University of Auckland

Fishing and warming are concurrent drivers of distributional change in marine species. Understanding the relative impact of each driver is critical for effective management. Long-term monitoring of north-eastern New Zealand reefs has revealed opposing trends in two spiny lobster species: the cool-water *Jasus edwardsii* and warm-water *Sagmariasus verreauxi*. Legal and sub-legal sized J. edwardsii have significantly declined from peak densities in the mid-1990s both inside and outside marine protected areas. In contrast, densities of sub-legal S. verreauxi have increased since 2017, coinciding with a period of warming but following widespread reductions in J. edwardsii. Within the Outer [Hauraki] Gulf sub-legal S. verreauxi first increased at fished sites suggesting S. verreauxi's rise may, in part, be aided by reduced competition with J. edwardsii. The relationship between sea surface temperature (SST), El Niño Southern Oscillation (ENSO) and lobster density was explored using time-lagged analyses. J. edwardsii densities were negatively correlated with SST and best explained by SST and ENSO lagged by 2–3 years. The influence of both climate variables was stronger at sites within the semi-enclosed Hauraki Gulf compared with the more oceanographically exposed Eastern Coromandel region. Likewise, a positive SST-S. verreauxi relationship was clear within Outer Gulf but absent in the Eastern Coromandel. Collectively, these results suggest fishing is the primary driver of lobster redistributions, with warming acting as a secondary, region-specific modulator.

Session 33: Evolutionary Biology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Exploring parallelism of gene expression across ecotypes of the threespine stickleback (*Gasterosteus aculeatus*)

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Examples of phenotypic parallelism during environmental adaptation offer tantalizing clues to the repeatability and predictability of evolution outcomes. In some cases, parallel phenotypic evolution is driven by parallel changes on the molecular level. In others, divergent molecular trajectories underly a shared phenotypic response. The threespine stickleback, *Gasterosteus aculeatus*, provides an excellent opportunity to study parallel phenotypic evolution and its molecular basis. Two phenotypically distinct *G. aculeatus* ecotypes co-occur within each of three lakes in British Columbia; one is a shore-specialist (benthic) and the other is an open-water specialist (limnetic). Because each lake was colonized by the ancestral marine form independently, this benthic-limnetic divergence represents a case of parallel evolution. We examine how patterns of gene expression in both gill and liver vary among these ecotype-lake pairs. We demonstrate a high degree of overlap of genes differentially expressed between ecotypes across the three lakes, more than would be expected due to chance. This suggests a highly parallel basis of repeated phenotypic evolution at the transcriptomic level. Gene co-expression network analysis reveals that genes whose expression patterns are more parallel across ecotype-lake pairs also have greater network connectivity, suggesting that highly pleiotropic genes are common targets of repeated adaptation. Future analyses will incorporate genomic and phenotypic data to examine how parallelism scales across levels of biological organization.

Exploring the historical ecology and evolution of grunion, stickleback, tidewater goby using genomic resequencing in California

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1- UC Los Angeles 2- Pepperdine U. 3- Humboldt S.U.

Here we compare three genomic resequencing projects exploring population genetics in California fishes with varied use of coastal and stream resources while treating history, anthropogenic impacts, and management issues. Grunion, an unusual beach breeding fish, are manually harvested requiring state management, appear to be experiencing impacts of climate change, and have the most effective marine dispersal of the three species. Stickleback are revealed to have substantial dispersal along the coast and independent evolution upstream, including the evolution of federally listed unarmored forms. While tidewater gobies live in coastal lagoons alongside many coastal populations of stickleback, their strict association with lagoons makes them one of the least dispersive of our coastal “marine” fishes. We have generated genomic resequencing data on all three of these taxa and can now compare the patterns of genetic isolation and admixture associated with these distinct habitat preferences and life histories. These studies employ time series as well as spatial arrays of samples, and in one case use of museum samples. With these approaches, we are now in a position to reconstruct the evolution and historical ecology across taxa, explore the how habitat and life history effects of selection and drift, and assess the genetics of morphologic and physiological adaptation and their responses to climate change.

The historical significance of the midlife crisis morph in the southern shield limpet

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Shield limpets, *Lottia pelta* (Rathke, 1833), are currently considered a widespread North Pacific species, but my DNA sequence comparisons have instead supported a northern vs. southern pair of species with ranges overlapping in a transition zone along California’s Central Coast. *L. pelta* is best restricted to the northern shield limpet, described from Johann Eschscholtz’s 1823-26 collections mostly in Sitka, Alaska. The oldest available (but neglected) potential name for the southern shield limpet is *Patella cinis* Reeve, 1855, which I would revive as *Lottia cinis* (Reeve, 1855). However, its Monterey type locality is problematic because I have found both species near there. Reeve’s two illustrated syntype specimens are examples of what my students and I call midlife crisis (MLC) morphs for our studies in southern California. We find MLC morphs under rockweeds, together with typical rock morphs, but the top half of the MLC shell resembles kelp morph southern shield limpets found living on feather boa kelp; they have similar shells to *L. insessa* (Hinds, 1842), a species that is always found on feather boa kelp. We have proposed that shell growth changes abruptly when a kelp morph southern shield limpet leaves the feather boa kelp and migrates to live under rockweeds. The northern shield limpet is also well known to have different morphs, depending on microhabitat, but I have never found MLC morphs from localities further north, suggesting that both illustrated *L. cinis* type specimens are best regarded as southern shield limpets.

Phylogenomics sheds light on the storied evolution of the elusive order Gadiformes (cods, grenadiers, and kin)

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Scripps Institution of Oceanography

Cods, hakes, grenadiers, and their kin (order Gadiformes) comprise an ancient and biodiverse clade of predominantly-marine fishes. With more than 620 species in 17 families, these fishes exhibit remarkable morphological variability — some members possess dorsal antennae (Bregmaceros); bioluminescent organ systems (Steindachneria, many morids and macrourids); bulbous, inflated heads (Macrouroides, Squalogadus); or glassy bodies with ornate, streamer-like appendages (Eretmophorus). This diversity is mirrored in their ecology — major global fisheries are sustained by shallow-water oceanic species like cod, pollock, and haddock, while grenadiers, gargoylefishes, and whiptails represent some of the most abundant and physically massive deep

ocean vertebrates. However, our systematic knowledge of this order is significantly lacking. Gadiformes diversified through an ancient adaptive radiation, a massive flurry of speciation in which countless major lineages diverged from one another across a short time frame. Such biological events are confounding to most methods of phylogenetic analysis, and previous studies of gadiform systematics have failed to approach topological consensus. The present study is the first to incorporate whole-genome sequences — including 49 complete gadiform genomes — into a comprehensive phylogeny of the order including all 17 families and almost 300 species.

Adaptive radiations and evolutionary constraints in the marine-derived freshwater fishes of Australia–New Guinea

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1- University of California San Diego 2- University of Oklahoma

Australia and New Guinea (AUNG) rivers represent a natural evolutionary laboratory: unlike other continents, their ichthyofaunas are dominated by marine-derived lineages rather than primary freshwater ones. This unique setting enables replicated tests of why some marine-to-freshwater (m2f) colonizations give rise to striking adaptive radiations while others do not. Building on previous work in sea catfishes, we proposed an “early arrivers/late comers” hypothesis: lineages colonizing rivers earlier should have had greater ecological opportunity and thus diversified more than those arriving later. Using a densely sampled fish phylogeny, with phylogenomic and legacy markers, we identified 28 independent m2f colonizations across the region through the Cenozoic (56–2 Ma), with a pronounced peak in the Middle Miocene (16–11 Ma). Contrary to this prediction, diversification analyses reveal that younger clades often diversify faster than older ones. In some cases, transitions coincide with bursts of speciation consistent with adaptive radiation theory, but many colonizations yielded only species-poor lineages. Multivariate analyses of functional traits revealed no strong association between trait space and either colonization timing or diversification rate. Finally, comparisons against paleoenvironmental curves identified two predictors of colonization: low oxygen and sea level. Together, these results demonstrate that AUNG rivers provide great insights for testing how ecological opportunity, Earth history, and clade-specific traits interact to shape colonization outcomes.

The evolution of scotopic vision in Pacific rockfishes (genus Sebastes) occupying different depth ranges

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CSU Monterey Bay

Adaptation to low-light or lightless environments has evolved frequently across diverse clades of marine and freshwater fishes, making traits associated with these habitats particularly useful for studying convergent evolution across many levels of biological organization, from molecular to morphological. In this study, we investigated genetic mechanisms that may driving recurrent features in such taxa. We investigated positive selection in candidate genes, including the opsin gene family, in rockfishes (genus Sebastes), a diverse clade of marine fishes in which closely related species occupy different depths and light environments. We compared substitution patterns and signatures of positive selection in candidate genes across >40 rockfish species. While specific sites under selection within genes largely differ across species that are separated by large evolutionary distances, common patterns at the gene and gene family level provide compelling evidence for the prevalence of convergent evolution toward low-light environments across independent clades of rockfishes.

Employing a novel imaging machine to catalog large-bodied specimens in biological collections

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1- UC San Diego 2- Scripps Institution of Oceanography

Biological collections are facilities that store animal and plant tissue over long periods of time. They are invaluable resources for understanding biodiversity and allowing us to document, maintain, and research life on Earth. By preserving numerous specimens, collections ensure scientists can easily assess ecological and evolutionary trends for decades to come. However to make this data accessible to everyone in the modern age, large scale digitization efforts are required. Our project seeks to digitize over 3,500 large tank-stored fish specimens preserved within the Scripps Institute of Oceanography Marine Vertebrate Collection (MVC). Photographing and taking measurements of each individual fish specimen, we will create an online accessible visual library to aid in scientific research and public outreach. To complete this task, we have designed and tested a novel imaging machine that can remotely photograph large specimens. This machine has streamlined specimen cataloging, reducing a previously two person job down to one, while vastly improving image quality. With subsequent iterations, we will incorporate computer vision technology to further automate and optimize inventory processes. This technology lays the groundwork for broader digitization efforts and has the potential to standardize large-specimen imaging across institutions.

A few meters away: Large and fine-scale patterns of diversification in the rough limpet along the California's intertidal zone

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University of California Merced

Understanding how environmental gradients and habitat heterogeneity influence population divergence and speciation remains a main question in evolutionary biology. While large-scale climatic gradients (~1000 km) may promote population structure, small-scale (~0.01 km) spatial variation might also lead to segregation of specific genotypes due to differential selective pressures. The rough limpet (*Lottia scabra*) inhabits intertidal environments along the California Transition Zone (CTZ)—an area with a steep climatic gradient, where cold-water species gradually replace warm water-ones. Across the intertidal zone, vertical gradients in emersion time reflect heterogenous habitats varying in abiotic and biotic conditions that lead to differential ecological pressures. Here we ask how large-scale latitudinal gradients and small-scale intertidal gradients intersect to shape the distribution of genetic diversity in the rough limpet. We generated a chromosome-level reference genome and 10X whole-genome resequencing data for 133 individuals from 27 localities across the coast of California. Analyses revealed population genetic differentiation in agreement with the latitudinal environmental cline, with gene flow across the CTZ. We also found striking genetic differences between individuals that inhabit only a few meters away in the upper vs. lower intertidal zones. We evaluate whether small-scale allele-specific intertidal patterns mirror broader large-scale latitudinal gradients, to investigate the underlying mechanisms driving divergence across contrasting spatial scales.

Session 34: Population Biology and Ecology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Morphological variability of *Egregia menziesii* in California over two centuries characterized through historical and contemporary herbarium specimens

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1- Scripps Institution of Oceanography, UC San Diego 2- UC Los Angeles 3- San Diego Natural History Museum 4- UC Berkeley

The canopy-forming feather boa kelp, *Egregia menziesii*, exhibits remarkable morphological variability across its geographic range. Regional morphotypes of *Egregia* were once considered separate species, but they were not determined to be genetically distinct and their morphology is thought to reflect local physical or environmental conditions. While morphological variation in *Egregia* has long been observed and was previously characterized through field surveys in the early 2000s, we revisited this topic using digital morphometrics (i.e., image analysis) of

1,624 macroalgal herbarium specimens from California dating back to the 19th century. We found that *Egregia*'s morphology (in terms of rachis texture, lateral blade shape, and blade or pneumatocyst density) varies along a latitudinal gradient and is strongly linked to seawater temperature, with some region-specific morphological changes in recent decades. Further, the presence or absence of sporophylls by month in southern-region specimens provided insight into the scarcely documented reproductive phenology of *Egregia*. Herbarium collections are invaluable for studying patterns in morphology because they showcase inter- and intraspecific variability and establish a baseline for comparison through time. Integrating natural historical and contemporary data will be critical for understanding and predicting future trends in the context of warming.

Integrating autonomous aerial vehicles and machine learning in image-based studies of pinniped populations

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The study of pinnipeds has historically been constrained by challenges with accessing the environments that they occupy. Uncrewed aerial vehicles (UAVs) offer a tool to overcome many of these challenges in a cost-effective manner while providing non-invasive methods to survey pinnipeds. Additionally, UAV imagery can also provide more accurate count data than conventional boat-based or spotting scope-based surveys. The specialized sensors that UAVs can deploy, such as multispectral and thermal, can also aid in the detection of individuals pinnipeds that are spectrally like the substrate at sites that they occupy. Machine learning approaches, such as convolutional neural networks (CNN), can support UAV image analysis by providing more rapid analysis of image data relative to manual counts over the multiple spatial and temporal scales across which UAV imagery can be collected. In this talk, I will describe the integration of UAV survey and machine learning image analysis approaches in the implementation of a large-scale survey program for pinnipeds designed to improve our understanding of their ecology in Central California. The results of this work have provided new insight into spatial and temporal hotspots of pinniped abundance that would have been overlooked using traditional survey approaches. The results of this work also demonstrate the value of integrating emerging technologies into studies of marine vertebrates to improve our understanding of their ecology.

Hybridization dynamics in monkeyflowers: Fine-scaled spatial structure and the importance of environmental heterogeneity

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1- UC San Diego, University of Georgia 2- Reed College 3- University of Georgia

Hybridization between incompletely isolated lineages is increasingly seen as an important force in natural populations. Both spatial and temporal heterogeneity influence the evolutionary trajectory of populations, but the interplay between environmental variability and hybridization has received less attention. Using population-scale sequencing of the widespread monkeyflower species *Mimulus guttatus* and *Mimulus nasutus*, we examine the role of heterogeneity across space and time in shaping hybridization outcomes. We find that population substructure at small (20-50m) spatial scales, combined with phenological and mating-system divergence between hybrids and their progenitors, permits the maintenance of distinct hybrid cohorts. The degree of phenological and spatial isolation varies across populations, corresponding with variation in the persistence of distinct cohorts. The strength of isolation is also mediated by environmental factors that fluctuate across seasons, generating a dynamic population mosaic through time. Overall, our work demonstrates the critical role of environmental heterogeneity in shaping hybridization outcomes, and highlights the complexity of the speciation process.

Northern elephant seal (*Mirounga angustirostris*) weanling mass and morphometrics at Piedras Blancas

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For animals with parental care, the transition to independence is a critical life history juncture. As capital breeders, northern elephant seal (NES) mothers abruptly wean their pup after a short, 4-week nursing period. Mass at weaning is a critical predictor of weanling survival, and post-weaning survival rates to the next year are less than 50% for northern elephant seals. The objective of this study was to examine the factors affecting weanling mass and morphometrics (standard length, curvilinear length, and axillary girth) at Piedras Blancas, the largest mainland NES colony, from 2018-2025. A multiple regression model of weaning mass reveals no significant difference in average weaning mass between beaches, but does find a positive association between weaning mass and the girth/length ratio and averaged values of the Southern Oscillation Index (SOI). Specifically, using changes in SOI as a proxy for El Niño/La Niña conditions, the model's estimates are consistent with an estimated increase in average weaning mass when the SOI trends towards La Niña conditions (positive values of SOI). These findings have implications for the health of the Piedras Blancas population and for the effects of climatic variation on the transition to independence in NES.

***Vibrio pectenicida* and sea star wasting disease in the field**

Prentice, M.B.[1]; Crandall, G.[2]; Kellogg, C.T.E.[1]; Clemente-Carvalho, R.B.G.[3]; Prentice, C.[3]; Pontier, O.[3]; Froese, T.[3]; Van Maanen, D.[3]; Currie-Olsen, D.[3]; Olson, A.[3]; Bachen, K.[3]; Hessing-Lewis, M.[3]; Montieth, Z.[3]; Gehman, A.L.M.[1*]

1- University of British Columbia / Hakai Institute 2- University of Washington 3- Hakai Institute

Sea star wasting disease (SSWD) has devastated *Pycnopodia helianthoides* populations along the Northeast Pacific since 2013, leading to the listing of *P. helianthoides* as critically endangered with the IUCN and recommended for listing by NOAA and COSEWIC in the US and Canada, respectively. Signs of SSWD have been documented since 2013, only recently has a causative agent of SSWD, *Vibrio pectenicida*, been identified, opening up the ability to evaluate field outbreaks of SSWD. We evaluated the relationship between individual disease signs, population disease prevalence and the detection of *V. pectenicida* in individuals. We conducted expert subtidal diver surveys paired with CTD casts in a range of shallow subtidal habitats in the central coast of British Columbia in May and October of 2023, collecting sea star coelomic fluid, surface swabs and seawater samples at each site. Disease signs showed seasonal variance as has been noted in this system, with no SSWD signs detected in May and an outbreak of SSWD observed in October. We did not detect *V. pectenicida* in May, and it was present in October, and had higher relative abundance at sites with observed SSWD signs than at sites with no signs of disease. Further re-analysis of the leading edge of the SSWD outbreak in SE Alaska showed similar patterns, with *V. pectenicida* associated with areas having current outbreaks. These field datasets allow us to start to evaluate and confirm the relationality between signs of disease in the field and a causative agent found in the lab.

Joint estimation of environmental effects and ecosystem dynamics with EcoState and dynamic structural equation models

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1- University of Washington 2- NOAA Alaska Fisheries Science Center

Incorporating environmental variation into ecosystem models is crucial for dynamic management and climate change planning. Most ecosystem models used in marine ecology and resource management are developed using the mass-balance model Ecopath with Ecosim (EwE), which incorporates environmental drivers through the use of forcing functions whose shape is typically assumed or fitted outside the model. Dynamic structural equation models (DSEM) offer a general and flexible framework for fitting causal models to time series data. DSEM is particularly applicable to management because it can be used to translate conceptual models derived from ecological knowledge or stakeholder input into statistical models capable of disentangling the direct and indirect physical drivers of biological responses. Here, we introduce an extension to the recently developed state-space mass-balance ecosystem modeling software "EcoState" that leverages DSEM to link temporal variation in population growth, recruitment, and consumption directly to environmental covariates. EcoState with DSEM allows users to adapt existing EwE models to jointly estimate environmental effects alongside ecosystem dynamics and

conduct formal tests of competing hypotheses regarding environmental impacts on biological processes. Future dynamics can be projected while incorporating uncertainty in environmental effects. We demonstrate EcoState with DSEM by adapting an existing mass-balance model of the Eastern Bering Sea to estimate the effect of bottom temperature on dynamics of multiple groundfish stocks.

Session 35: Special Session III: Non-Academic Careers and Research Panel Q&A

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Exploring Non-Academic Careers & Research
Wallingford, P.D.[1*]; Wise, M.[2]; Truong, A.[3]

1- The Nature Conservancy 2- Irvine Ranch Water District 3- Merkel and Associates

Many students are interested in pursuing non-academic careers but may not be familiar with the types of positions available or how to transition from academic research. This session will explore diverse career opportunities in marine science beyond traditional academic positions through a series of short talks followed by a panel and Q&A session. Marine scientists in government, non-profit, and industry positions will discuss their current roles and projects, career trajectories, and the transition from academia. Speakers will then convene for a panel covering topics such as the differences between university and non-university careers and how to translate academic skills to other positions, with an opportunity for audience members to ask questions. This session will highlight opportunities for marine science careers outside of academia and provide advice for students navigating career choices during and after their degree.

Session 36: Kelp Forest Ecology IV

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Kelp carbon output: Dissolved organic carbon (DOC) release from macrocystis pyrifera in responses to seasonal temperatures and nutrients
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Kelp forests have an outstanding capacity to fix carbon into fast-growing canopies. The kelp carbon budget is often studied at the level of primary productivity, with greater knowledge gaps related to export pathways via dissolved organic carbon (DOC). Kelp DOC fuels trophic webs and may contribute to carbon sequestration. Higher macroalgal DOC production has been linked to warmer and nutrient-limited seasons, but this relationship has not been tested in temperature-controlled experiments. Here, we explore DOC release rates of giant kelp, *Macrocystis pyrifera*, in response to temperature and nutrient seasonality. Kelp blades collected from the surface canopy off La Jolla, CA, were exposed to treatments ranging from 15°C to 22°C. After 7 days, kelp DOC release and nutrient uptake were measured in a 6h-incubation. This experiment was replicated in spring, fall, and winter (2024-2025). Within seasons, higher temperatures had no significant effect on DOC release. Between seasons at 19°C, kelp showed lower DOC release and higher nitrogen uptake in the fall compared to spring. Therefore, kelp carbon output via DOC release did not increase under warm water and low nitrate, as initially expected. Our results help to inform the development of carbon credits and coastal management efforts related to carbon cycling.

Extreme marine heatwaves onset kelp forest alternative stable states in Baja California, Mexico
Bauer, J.[1*]; Lorda, J.[2]; Beas-Luna, R.[2]; Malpica-Cruz, L.[2]; Abadía-Cardoso, A.[2]; Paz-Lacavex, A.[3]; Olmos, J.[1]

1- CICESE 2- UABC 3- UC Santa Cruz

Kelp forests are experiencing extreme declines globally, yet local social-ecological factors may mediate their responses to climate perturbations. Using a combination of long-term field surveys (2016–2024) and satellite data (2004–2024), we examined the regional effects of the 2014–2016 marine heatwave regime on kelp forest ecosystems along a 600 km latitudinal gradient in Baja California, Mexico. We documented three distinct geographical subregion trajectories: (1) a remarkable resilience of giant kelp, *Macrocystis pyrifera*, at its thermal limits in the southern subregion, recovering 95% of the historical canopy area despite experiencing the highest temperatures; (2) understory-dominated state in the mid-subregion, with a 96% decrease in *M. pyrifera* canopy; and (3) a shift to an urchin barren alternative stable state in the northern subregion, characterized by a 2,485% increase in herbivore densities from 2016 to 2023 —dominated by purple sea urchin *Strongylocentrotus purpuratus* (44%)— and a 95% reduction in giant kelp canopy area compared to pre-warming baseline. The southern subregion's resilience was associated with high predators' (10.26 ± 5.63 per 60 m²) and low herbivores' (25.20 ± 8.89 per 60 m²) densities dominated by *Megastraea* spp. (83%) with *S. purpuratus* absent. In contrast, the northern subregion's shift from kelp forests to urchin barrens coincided with low predator abundances (5.05 ± 2.32 per 60 m²), potentially linked to fragmented fisheries management.

Eyes on kelp: Environmental monitoring of Puget Sound bull kelp forests to improve restoration
Inch, K.M.[1*]; Hayford, H.[1]; Allen, B.[1]; Schwager, S.[1]; Kochuten, M.[1]; McKenna, G.[2]; Peabody, B.[1]; Toft, J.[1]

1- Puget Sound Restoration Fund 2- Washington State Department of Natural Resources

Bull kelp, *Nereocystis luetkeana*, found along coastlines from Alaska to California, provides key benefits such as safe refuge for culturally significant species, carbon cycling, and coastal protection. Within Puget Sound, Washington, some sub-basins have experienced declines of up to 96%, with complete loss at other locations. Environmental conditions inevitably hold clues; for bull kelp to thrive, conditions in and adjacent to marine forests must support growth and development across life stages. The Eyes on Kelp project - which includes a network of environmental monitoring sites throughout Puget Sound - was developed to help address concerns about bull kelp decline. An array of environmental instruments at each site continuously tracks temperature, light, dissolved oxygen, salinity, pH, and water level. With these data, we can explore how environmental factors may be correlated to changes associated with bull kelp forests. We analyzed the relationship between summer sea surface temperature and bull kelp growth and reproductive metrics at our restoration outplant over three years. In summer 2024, temperatures rose above 16℃, which preceded a precipitous decline in tissue health. Ongoing monitoring will allow further investigation into possible environmental drivers of bull kelp decline and persistence, such as the influence of salinity, which may help predict site-specific fluctuations in bull kelp extent. These insights can then generate stepping stones for conservation and restoration efforts by identifying suitable conditions for bull kelp habitat.

Long-term ecological shifts on temperate reefs in Aotearoa New Zealand: Impacts of long-term warming and extreme climatic events
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University of Auckland

Kelp forest ecosystems are under increasing stress globally with changing climatic conditions exacerbating the impacts of existing anthropogenic stressors. Long-term monitoring (1999–2025) of shallow reefs in northern Aotearoa New Zealand has revealed rapid and complex changes in kelp forest ecosystems over the last decade. Long-term increases in the subtropical sea urchin Centrostephanus rodgersii has had major impacts on reef ecosystems at offshore islands, with increasing loss of deep-water kelp forests and impacts on diverse rock wall assemblages. At coastal locations, regional-scale declines in canopy-forming kelp and fucoid species have occurred in recent years, following record-breaking marine heatwaves in 2022 and extreme rainfall and storm events in 2023. Concurrently, there has been an increase in turfing and filamentous algae, sediment cover on the reef, and a suite of invasive species. While the precise causal mechanisms are complex, the observed ecosystem degradation is likely related to the cumulative stress imposed by these extreme climate events. Furthermore, these

impacts have generally been greatest in areas where sea urchins are abundant and undermine the resilience of kelp forests. These findings align with global trends of temperate reef decline under increasing anthropogenic and climate-related pressures. This research underscores the critical need for continued, long-term monitoring to understand the resilience and recovery dynamics of these ecosystems, and for targeted research to inform effective management strategies that can mitigate future im

ROV surveys within kelp forests and open-source Machine Learning (ML) algorithms to (1) process survey images and (2) extract data

Randell, Z.*; Williams, M.; Thomson, R.; Johnson, K.; McQueen, C.

Seattle Aquarium

Since 2022, the Seattle Aquarium has developed methods of using relatively low-cost remotely operated vehicles (ROVs) to conduct benthic surveys within kelp forests. This survey framework has focused upon utilizing open-source ROV firmware and analytical methods, enabling novel contributions by volunteer software developers and other experts. Our approach (detailed here on GitHub: https://github.com/Seattle-Aquarium/Coastal_Climate_Resilience (https://github.com/Seattle-Aquarium/Coastal_Climate_Resilience)) enables unconstrained vehicle run-time (8+ hours) at depths less than 50m, semi-autonomous flight operations, precise geospatial tracking, and the capture of high-resolution benthic imagery. Volunteer contributions have enabled an open-source ML framework to color-correct and process imagery at scale. Once processed, we apply a separate open-source algorithm (via CoralNet-Toolbox) to extract percent-cover and abundance data from our imagery; the classification (percent-cover) model has been trained on 25 categories of fleshy red algae, brown, and green algae, sessile invertebrates, and various substrate categories, and is performing with an accuracy of 96%, enabling deployment at scale. We envision this framework to not replace divers—our research has documented greater diver efficacy at capturing cryptic invertebrates and species under vegetation—rather, we propose this ROV methodology as a complementary method to gather additional data, particularly regarding system state, across spatial extents and depths unobtainable by traditional diver methods.

High resolution remote sensing to map kelp canopy and water quality in San Pedro Bay

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1- WSP USA 2- Port of Los Angeles 3- Port of Long Beach

The Ports of Long Beach and Los Angeles in San Pedro Bay have been conducting joint biological resource surveys since 2000 to characterize the Port Complex’s marine habitats. As part of these biological resource surveys, the Ports map kelp canopy and survey communities present on riprap embankments and the federal breakwater. Data from these surveys are used in environmental documents and biological mitigation planning to determine if Port activities are likely to have an impact on Essential Fish Habitat (EFH) and protected species under the Endangered Species Act (ESA) and Fisheries Management Plans (FMP) for groundfish and pelagic species. Beginning in 2021, the Ports conducted pilot and validation studies to use satellite imagery as a tool to measure kelp canopy and water quality parameters with promising results that warranted implementing the technology into their joint 2023 biological surveys. The creation of a library of kelp canopy images from 2018-2024, in addition to important water quality parameters such as sea surface temperature and turbidity, has created a long-term dataset that can be used to visualize which areas of the Port Complex are likely suitable for kelp recruitment and growth throughout the year and how seasonal variability affects kelp canopy. High resolution remote sensing offers a cost-effective tool for resource managers to map kelp canopy for future kelp impact and mitigation studies in addition to furthering our understanding of the dynamics and distribution of kelp canopy growing in urbanized environments.

Session 37: Conservation and Restoration VI

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Developing a comprehensive ocean report card for the U.S. west coast

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1- California Ocean Science Trust 2- Southern California Coastal Waters Research Project 3- West Coast Ocean Data Portal 4- Oregon Coastal Management Program 5- California Ocean Protection Council

To address global environmental crises like climate change, scientists need to effectively communicate vast amounts of information to people who can take action, including decision-makers and high-level resource managers. Environmental report cards are a useful way to condense vast amounts of technical information for these audiences in a way that is scientifically accurate, succinct, and meaningful. Here, we report on the process of creating a West Coast Ocean Report Card that uses a suite of indicators to evaluate the biological, physical, and human dimensions of the ocean and coast in Washington, Oregon, and California. This process has three key components: (1) metrics that simplify scientific detail into information that is meaningful to a non-scientific audience, (2) a method of scoring indicators that accommodates geographic and methodological variability, and (3) a single high-level grade for each indicator so that non-technical audiences can easily what the data show. This report card demonstrates a new approach to integrating a range of complex scientific information over a broad spatial scale to provide a simple answer to the fundamental question: “How is the ocean doing?”

Missing molluscs: Discovery of large numbers of endangered black abalone in the shallow subtidal

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1- UC Santa Barbara 2- Retired, Channel Islands National Park 3- UC Santa Cruz

Crucial broadscale, long-term monitoring efforts for endangered black abalone (*Haliotis cracherodii*) have been conducted for decades exclusively in the intertidal zone. However the species is known to also inhabit the shallow subtidal at depths up to 6 m. We adapted existing intertidal survey methods to collect comparable population data during SCUBA surveys in the shallow fringe of the subtidal zone (0 to 6 m depth). During Fall of 2024 we surveyed over 5 km of coastline at Anacapa and Santa Cruz Islands and recorded thousands of subtidal black abalone. Individuals were found predominantly between depths of 1 to 2 m but as deep as 4 m. Subtidal abalone were larger on average (mean length 120 mm) than those surveyed at neighboring intertidal sites (mean length 85 mm) and very few recruits were found. Both density and biomass of subtidal black abalone populations were similar to intertidal populations on Santa Cruz Island, suggesting that fully one half of the black abalone population may be missing from ongoing intertidal monitoring efforts in some areas. Size frequency distributions from three co-located intertidal and subtidal sites suggest offshore ontogenetic movement with a significant “pool” of large adults of relatively high reproductive potential in the subtidal. In addition to demonstrating that surveys can be conducted in the ‘no-go zone’ of the turbulent subtidal fringe, this pioneering work demonstrates the need for range-wide expansion of black abalone monitoring into the shallow subtidal.

Saving the forgotten forests: Palos Verdes kelp forest restoration with The Bay Foundation

Johnson, M.[*]

The Bay Foundation

Macrocystis pyrifera (giant kelp) canopy cover at Palos Verdes Peninsula has decreased by approximately 80% since the first large-scale survey in 1911 (Ford and Meux 2010, MBC 2019). Sedimentation, development, urban runoff, and storms slowed kelp growth. At the same time, the loss of key urchin predators and competitors allowed urchins to overrun the reef and devour the remainingkelp. Subtidal observations based upon mapping efforts conducted in 2010 identified large expanses of nearshore rocky reef that were dominated by high densities of Strongylocentrotus purpuratus (purple sea urchins) and Mesocentrotus franciscanus (red sea urchins). In total, 152 acres were described to exist in an urchin barren state. It is within this context that The Bay Foundation initiated the Palos Verdes Kelp Restoration Project through in situ culling of S. purpuratus on the Palos Verdes Peninsula.

The goal is to reduce populations of S. purpuratus to natural densities (associated with stable giant kelp communities in southern California) to catalyze recruitment and development of giant kelp and other macroalgae. Decreased S.purpuratus grazing pressure allows for the enhancement of the biogenic habitat of rocky reefs that have historically supported kelp forests. Ultimately, this increases spatial and temporal stability, as well as biomass and production associated with the rocky reef ecosystems on the Palos Verdes Peninsula. To date over 80 acres of reef has been restored, with an observed increase in red urchin gonad biomass, an increase in community diversity, and a significant inc

Splice things up: Restoring bull kelp in Oregon using suspending, submerged lines in urchin barrens
Hendrickson, C.*; Hamilton, S.; Calvanese, T.

Oregon Kelp Alliance

Oregon has lost around ⅔ of its bull kelp forests since 2014, including near total ecosystem loss in certain regions on the south coast. This loss is mainly attributed to overgrazing by purple sea urchins, transforming healthy kelp forests into persistent urchin barrens. As part of ongoing kelp restoration work, the Oregon Kelp Alliance (ORKA) tested the use of Arrays to Recover Kelp Ecosystem Vegetation (ARKEVs), a novel restoration technique from partners in northern California. ARKEVs are temporary kelp outplanting structures placed in urchin barren sites along exposed coasts, allowing kelp to grow out of reach of urchins. In Nellies Cove, Port Orford, wild kelp that washed ashore was spliced into ARKEVs. Some ARKEVs were very successful, with survival rates up to 85%, reaching the surface in 38 days, and producing sori by day 50, although success varied widely. Kelps outplanted earlier showed significantly higher growth rates than those set out later, highlighting the importance of early season implementation. Kelp grown in this project provided habitat in an urchin barren and coincided with a large recruitment of juvenile fish, while ARKEVs deployed without kelp showed significantly fewer fish. These benefits to fish recruitment support this important ecosystem as well as the local fishing fleet and community that depend on it. ORKA intends to leverage the success of this project to expand deployment next year and will adapt ARKEV use to local conditions and community objectives, such as eliminating plastics, for kelp forest ecosystem restoration on the Oregon coast.

Enhancing pinto abalone (*Haliotis kamtschatkana*) survivorship with novel outplanting techniques
Garden, L.[1]; Sole, A.H.[2]; Jones, K.[3]; Lueck, P.[4]; Bouma, J.[5]; Bates, E.[5]; Schwarck, N.T.[6]; Smith, D.[6*]

1- Catawba College 2- Cornell University 3- Belhaven University 4- Minnesota State University 5- Puget Sound Restoration Fund 6- Western Washington University

The pinto abalone (*Haliotis kamtschatkana*) is the only abalone native to and present along Washington's coast. Populations have severely declined in the last fifty years due to overharvest and remain critically low despite conservation aquaculture and outplanting of hatchery-raised juveniles. To improve outplanting success, we examined the influence of density on dispersal rate from tubes by outplanting abalone in three densities and recording the number of abalone remaining in each tube for a week afterward. We found that density of abalone in an outplant tube does not impact the rate at which abalone will disperse from the tube into the surrounding habitat. We also tested the effectiveness of clear and opaque tubes on abalone dispersal rates and evaluated the predatory behavior of *Amphissa columbiana* toward healthy and injured abalone. In field trials, clear tubes resulted in significantly faster dispersal rates than opaque tubes ($p = 0.032$), suggesting that increased light exposure may encourage abalone to leave the tubes more quickly and integrate into the natural habitat, potentially improving survival. Laboratory choice experiments showed that *A. columbiana* did not actively prey on healthy abalone ($p = 0.802$) but significantly preferred injured individuals ($p = 0.0278$). This highlights the importance of minimizing injury during handling and transport. These findings suggest that thoughtful handling protocols and the use of clear tubes for outplanting may enhance the effectiveness of current abalone restoration strategies.

Molecular star gazing: Development and validation of an environmental DNA assay for the sunflower star (*Pycnopodia helianthoides*)

Gold, Z.[1*]; Hodin, J.[2]; Kidd, A.[3]; Lemay, M.A.[4]; Weinrich, J.[5]; Colleen Kellogg, C.T.E.[4]; Robinson, K.M.[4]; Carvalho, R.C.[4]; Schiebelhut, L.M.[6]; McAllister, S.[5]

1- NOAA Pacific Marine Environmental Laboratory 2- Friday Harbor Labs, University of Washington 3- Sunflower Star Laboratory 4- Hakai Institute 5- University of Washington Cooperative Institute for Climate, Ocean, & Ecosystem Studies 6- UC Merced

The sunflower sea star (*Pycnopodia helianthoides*) has suffered a catastrophic decline across its range due since 2013 to the devastating *Vibrio pectenicida* FHCF-3 driven Sea Star Wasting Disease (SSWD). The functional extinction of this apex predator across significant parts of its range has created a need to identify the remaining intact populations. Yet, visual methods for monitoring this species are prohibitively time- and labor-intensive across the >12,000 km of the U.S. West Coast, hindering the scale of ongoing monitoring and recovery efforts. In contrast, environmental DNA (eDNA) approaches provide a simple, cost-effective, and non-destructive method for monitoring marine species, consistently outperforming visual monitoring efforts in sensitivity, speed, and cost. Here we designed, developed, and validated a *P. helianthoides* specific eDNA quantitative PCR (qPCR) and digital droplet (ddPCR) assay to identify refugia. To achieve this, we generated the most comprehensive sea star mitogenome reference database to date (n=26). We then used *unikseq* to identify the unique nad5 gene region and Geneious to design a highly specific Taqman assay. We validated the performance of this assay through lab, mesocosms, and field testing demonstrating a highly specific and sensitive assay. The development of this eDNA assay helps provide a rapid and scalable tool for monitoring this apex predatory species, enhancing management and recovery efforts to identify remnant populations and determine impact response and recovery following transplantation efforts.

Session 38: Community Ecology II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Unique thermal responses of eelgrass, a pathogen, and an herbivorous disease vector can affect eelgrass system productivity and disease dynamics

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1- UC Davis 2- Duke University, UC Davis 3- Northeastern University Marine Science Center, UC Davis

Biological rates, like growth, tend to have unimodal (hump-shaped) responses to temperature, and these relationships can vary among species and populations. Full thermal performance relationships are rarely characterized for interacting species (like consumer-resource pairs), making it challenging to predict how their interactions, and subsequently, how communities, will shift with climate change. Using laboratory experiments, we investigated how the thermal responses of eelgrass (Zostera marina), an isopod grazer (Pentidotea resecata), which acts as an indirect vector of eelgrass wasting disease, and the microbial pathogen that causes this disease (Labyrinthula zosterae), interact to affect eelgrass productivity and wasting disease dynamics. In the absence of grazers, eelgrass growth responded unimodally to temperature, with growth declining more rapidly at higher-than-optimal temperatures in plants that were exposed to an infected conspecific (vs. plants with a healthy conspecific). With grazers, the unimodal pattern disappeared. Instead, growth was depressed but increased monotonically with temperature. Isopod thermal response curves suggest that this pattern was driven by elevated grazing at intermediate temperatures, and a decline in grazing and reduced isopod survival at the highest temperatures. Warming accelerated the time to disease onset, potentially reflecting the pathogen's higher thermal limit compared to the eelgrass. Thus, the thermal performance of all three of these interacting taxa informs predictions of eelgrass productivity in a changing climate.

Eelgrass microbiome dynamics under field and lab heat stress combined with different disease strains
Maher, R.L.[1*]; Ayala, A.[2]; Crandall, G.A.[3]; Harvell, C.D.[4]

1- Friday Harbor Laboratories 2- University of North Georgia 3- University of Washington 4- Cornell University

The interaction between host microbiomes, pathogen diversity, and environmental stress is a critical but understudied mechanism shaping disease outcomes in marine foundation species. Eelgrass (*Zostera marina*) suffering from wasting disease, caused by the protist *Labyrinthula zosterae* (Lz), offers a powerful system with which to probe this interaction. We conducted laboratory experiments to test: (1) whether thermal stress (19°C vs. 11°C) compromises the eelgrass microbiome and exacerbates disease outcomes; (2) whether these outcomes differ between two Lz isolates; and (3) whether lab-derived microbiome signatures of heat stress correspond with those observed in intertidal eelgrass experiencing a short temperature anomaly at Fourth of July Beach, San Juan Island, WA. In the lab, heat stress significantly heightened wasting disease severity across both pathogen isolates, with no difference in virulence between them. Heat stress also exacerbated microbiome dysbiosis: diversity and variability declined, community composition shifted, and numerous microbial taxa changed in abundance. In contrast, heat stress in the field increased microbiome diversity and variability while inducing extensive tissue damage and reducing growth. Overall, we show that warming accelerates wasting disease progression in eelgrass by some combination of microbiome disruption, enhanced pathogen virulence, or compromised host defenses. Integrating the microbiome into eelgrass disease ecology promises deeper insights for forecasting disease outbreaks and bolstering eelgrass resilience.

Field ocean acidification and warming experiment increases community evenness by reducing abundances of dominant species
Sorte, C.J.B.[1*]; Miller, L.P.[2]; Rangel, R.E.[3]; Kroeker, K.[3]; Bracken, M.E.S.[1]

1- University of California, Irvine 2- San Diego State University 3- University of California, Santa Cruz

Ecosystems are simultaneously experiencing changes in multiple environmental factors, including increased CO2 levels, decreased pH, and warming. These changes can influence species both directly and indirectly, through alterations in species interactions. We conducted a factorial manipulation of CO2 (reducing pH) and temperature in twenty tide pools over a full growing season on the coast of Alaska, USA. Exposure to climate manipulations reduced abundance of dominant species – particularly the most abundant mobile herbivores – via both direct effects and impacts on basal species, leading to surprising increases in community evenness. The environmental factor most responsible for population impacts differed by species, and there was indication of greater community responses when exposed to changes in single rather than multiple environmental factors. Total species richness did not change between experimental treatments, illustrating that some aspects of biodiversity may be resistant to changes at the level of our climate manipulations. However, we observed substantial (80-100%) declines of multiple shellfish species in the tide pools highest on the shore – and therefore experiencing the most extreme conditions – when these pools were also exposed to climate manipulations and a regional heat wave. Our findings highlight the importance of studies conducted in natural, dynamic ecosystems to account for environmental variation, community interactions, and behavioral responses of mobile species.

Ecological recovery following the hurricane-driven reopening of Midnight Pass in Sarasota Bay, Florida
Bedgood, S.A.[1*]; Lancaster, E.R.[2]; Maloy, C.[1]; Moscoso, J.A.[1]; Levell, S.T.[1]

1- New College of Florida 2- Eckerd College

Midnight Pass, a former tidal inlet linking the Gulf of Mexico and Little Sarasota Bay, was closed in 1983 at the request of a waterfront homeowner, altering bay hydrology and limiting nutrient exchange with the Gulf. This change reduced water flow but also allowed for the growth of fish nursery habitats and seagrass beds. In 2024, Hurricanes Helene and Milton suddenly re-opened the pass, dramatically reshaping hydrodynamic conditions and smothering adjacent seagrass beds under storm-deposited sediments. Since the reopening, we have conducted monthly surveys at semi-permanent transects to monitor the recovery of seagrass and associated communities.

Over the past year, we observed moderate recovery of *Halodule wrightii* (shoal grass) and notable shifts in fish and invertebrate assemblages. Recovery trajectories vary with distance from the reopened pass and substrate composition, suggesting strong impacts of tidal currents on the recolonization processes. Future work will integrate microbial community profiling from sediment cores with environmental DNA (eDNA) analysis from filtered water samples to evaluate changes in biodiversity across the area. Our findings contribute to understanding the ecological resilience of estuarine systems following sudden hydrological restoration events and inform management strategies for similar inlet systems experiencing both anthropogenic and storm-driven changes.

Transitions in macroalgae assemblages during kelp forest recovery from sea urchin barrens

Grant, S.N.[1*]; Smith, J.G.[2]

1- Monterey Bay Aquarium 2- UC Santa Cruz, Monterey Bay Aquarium

Sequences of disturbances can restructure kelp forest communities through compounding stressors and cascading effects. Over a decade after widespread sea urchin outbreaks along the Monterey Peninsula, some reefs persist as barrens or forests, while others show signs of incipient recovery. This mosaic of persistent barrens, persistent forests, and incipient forests offers a unique opportunity to evaluate transition and recovery dynamics of marine macroalgae. We identified patch types a priori using hierarchical spatial clustering, then conducted extensive SCUBA surveys to characterize the invertebrate and macroalgae assemblages at each patch. Surveys were conducted in 2024–2025 across 7 replicate blocks and two depth zones (5–12 m, 12–20 m), each containing a unique persistent forest, barren, and incipient forest (42 sites total). Multivariate linear discriminant analysis was used to classify patch type and detect transitions from barren to incipient forest, or from incipient to persistent forest. Results show that incipient forests were characterized by understory species, particularly *Pterygophora californica*, while persistent forests were dominated by *Macrocystis pyrifera*. Reef structural complexity and local urchin behavior strongly mediated these trajectories, underscoring the combined influence of abiotic and biotic conditions on recovery. These insights into the predominant macroalgae species in transitioning patches enhance our understanding of the mechanisms underlying kelp forest recovery.

Sea otter patch utilization and foraging at kelp forest-urchin barren margins: Implications for ecosystem persistence and recovery

Smith, J.G.[1*]; Konrad, L.[2]

1- Monterey Bay Aquarium / University of California Santa Cruz 2- Monterey Bay Aquarium

The continued lack of large-scale kelp forest recovery following widespread loss in central and northern California has created great interest in understanding natural mechanisms of ecosystem recovery and persistence. In recent years, small-scale incipient forests (areas with kelp that were previously sea urchin barrens) have been documented along the central coast region in Monterey and Carmel Bay. These incipient forests, and areas that have persisted as remnant forests or sea urchin barrens, presented a unique opportunity to assess the foraging behavior of sea otters as a mechanism that may reinforce kelp forest recovery through predation on sea urchins. To assess recovery, we conducted two years (2024 and 2025) of subtidal monitoring surveys at incipient forests, persistent forests, and persistent barrens, paired with shore-based observations of sea otter patch occupancy, to comparatively evaluate patch utilization and rates of kelp forest recovery. To evaluate persistence, we then conducted separate 80-meter long transects, paired with sea urchin dissections and sea otter foraging observations at forest-barren ‘margins.’ Our findings indicate that sea urchin behavior, herbivore density (sea urchins and gastropod snails), reef rugosity, and wave exposure are important predictors of kelp forest recovery, and that sea otters can both contribute to patch persistence and reinforce rates of kelp forest recovery. Together, these findings advance understanding of the coupled processes that shape kelp forest recovery and persistence across heterogeneous habitats.

Session 39: Coral Reef Ecology III

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Gene expression drives coral resilience to thermal stress
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1- CSU Northridge 2- Columbia River Inter-Tribal Fish Commission 3- California Academy of Sciences

Coral bleaching can be driven by high seawater temperatures and is becoming a more frequent event across the globe. There was a coral bleaching event in Kane'ohe Bay, Oahu, Hawai'i, in 2014 and 2015. During these bleaching events paired *Montipora capitata* colonies (one that bleached adjacent to one that didn't) were tagged and monitored for the extent of bleaching and their recovery. Samples were collected at multiple time points, frozen in liquid nitrogen, and then analyzed using RNAseq to determine if there were difference in gene expression between those corals that bleached or didn't. Gene ontology analysis show that genes that drive multiple cellular processes (metabolic pathways, DNA/RNA processing, cell signaling, ubiquitin, Lysosome, and vitamin regulation) had differential expression. These results suggest that variation in coral physiology among individuals within a species can determine their susceptibility to thermal stress.

Coral to coral phase shift and reversal on a micronesian atoll
Paddack, M.J.[1*]; Gonzales, E.F.[2]; Bernardi, G.[3]; Rumal, J.[2]; Crane, N.L.[4]

1- One People One Reef, Santa Barbara City College 2- One People One Reef 3- One People One Reef, UCSC 4- One People One Reef, Society for Conservation Biology, Smith Fellows Program

Many coral reefs have experienced phase shifts, changing from coral-dominated to macroalgal-dominated states, driven either by top-down (e.g., declines in reef herbivores) or bottom-up (e.g., increased nutrients) forces. These alternate states have proved to be persistent, with long-term declines in ecosystem function. At the request of local communities, we documented a coral-to-coral phase shift, with monocultures of *Montipora* cf capitata overtaking some reefs of Ulithi Atoll. This shift is of concern to the indigenous communities of the atoll due to its impact upon their subsistence fisheries. Community-led marine management has since revived traditional practices and integrated new scientific knowledge. In 2015, Typhoon Maysak hit Ulithi Atoll directly, causing severe damage above and below water, scouring the *Montipora* fields. In tracking reef recovery, we found two managed reefs in the northern atoll that have undergone a phase shift reversal, with return of both coral and fish diversity. The resilience of these reefs provides both hope and insight into the socio-ecological factors that can support recovery of ecosystems and ecosystem function.

Coral reef restoration guidelines and case studies in Taiwan
Fan, T.Y.[*]

National Museum of Marine Biology and Aquarium

Coral reefs are critical marine ecosystems, yet they are rapidly declining globally including in Taiwan due to anthropogenic pressures and the escalating impacts of climate change. Urgent actions are required, including carbon reduction, localized management, and active restoration efforts. International coral reef restoration guidelines have provided a foundation of theories, principles, methodologies, case studies, and success criteria, many of which have been adopted and adapted in Taiwan. Monitoring data indicate that coral reefs in southern Taiwan, particularly in Pingtung, are undergoing the most severe degradation. This is especially evident in areas impacted by overtourism. The combined effects of human disturbance, intensified marine heatwaves, and typhoons have significantly accelerated coral loss, underscoring the need for proactive restoration strategies. During 2021 to 2025, survival and growth assessments of in situ coral nurseries reveal that sheltered artificial reef sites, such as those located in power plant intakes or within seawalls, outperform both exposed artificial reefs and natural reef areas. These findings support the prioritization of artificial reefs as nursery sites, offering ecological

benefits while serving as cost-effective, nature-based coastal protection solutions. Additionally, an ex situ coral nursery has established a complete life cycle cultivation system for the brooding coral Pocillopora acuta, facilitating larval enhancement restoration techniques.

Resilient coral communities on degraded Caribbean reefs

Edmunds, P.J.*

California State University Northridge

After decades of coral death, many tropical coral communities consist of populations at low abundances, ensuring that future coral reefs will differ from those of the recent past. The large spatial scale of this phenomenon erodes incentive to study the relict communities, yet their analyses reveal the biological resource upon which reef recovery will rely. Here, 32 yrs of annual surveys (1992–2023) of benthic communities at six sites on the fringing reefs (7–9 m depth) of St. John, US Virgin Islands, are used to consider the potential future trajectories of change for low abundance coral communities. On these reefs, the mean cover of macroalgae and CTB (crustose coralline algae, turf, and bare space, combined) increased at 2.8% decade -1 and 4.0% decade -1 , respectively, together covering 81% of the reefs by 2023, while coral cover remained at 2–4%. The sites differed in coral cover averaged among years (range 1–7%), and in heterogeneity among photoquadrats for coral generic richness. Coral generic richness declined in the third decade of the study in favor of weedy corals, but the reefs exhibited high ecological resilience while spatially dominated by macroalgae. With ≤ 4% cover of live coral these communities are tropical reefs populated by living corals, and while they are no longer coral reefs, they retain ecological importance by supporting low abundance populations of corals that so far have avoided extirpation.

Amino acid isotope analysis identifies symbiont-support of coral nutrition across an environmental gradient

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Reef-building corals along with their endosymbiont algae (Symbiodiniaceae) support coral reef ecosystems by providing habitat and nutrition for diverse aquatic organisms. Stable isotope analyses provide a powerful tool for investigating ecological and biogeochemical processes in coral reefs, including nutrient cycling, trophic interactions, and environmental influences on reef organisms. Here, we assess the nutritional plasticity in two reef-building corals, *Montipora capitata* and *Porites compressa*, in Kāneʻohe Bay, Oʻahu across a depth gradient (from <1 to 12m), which represents a 90% reduction in photosynthetic light availability for their endosymbiont algae. Coral host and symbiont tissues were separated and analyzed for bulk tissue carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) and amino acid compound-specific carbon isotope composition ($\delta^{13}C_{AA}$). We compared isotope niche overlap between hosts and symbionts in both species and found distinct patterns in resource use among these mixotrophic corals. Essential amino acid $\delta^{13}C$ fingerprints revealed high autotrophic reliance despite extreme light attenuation. These findings offer insight into the biology and biogeochemistry of reef-building corals and how trophic plasticity shapes their nutritional strategies across environmental gradients.

Drone thermal imaging and benthic time-series analysis show dynamic spatial and temporal delivery of submarine groundwater discharge on a shallow coral reef

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Submarine groundwater discharge (SGD) is spatially heterogeneous and temporally dynamic, introducing nutrient-rich, low-salinity water into coastal ecosystems and significantly altering reef biogeochemistry. At Black Point, Oʻahu, we used a two-pronged approach, drone-based thermal infrared (TIR) imagery and benthic salinity time series, to resolve fine-scale patterns of SGD delivery, residence time, and offshore transport across a shallow coral reef. High-resolution surface thermal imagery revealed persistent and spatially extensive SGD plumes that

remained buoyant near the surface, particularly in regions of reduced circulation. Sequential orthomosaics showed pooling of SGD in specific areas of the reef and gradual offshore dispersal. Benthic salinity data complemented these observations by capturing the temporal dynamics of groundwater transport across the reef, with cross-correlation analyses revealing a sequence of seep discharge, mid-reef accumulation, and delayed offshore mixing. These dynamics were strongly influenced by reef geomorphology and local hydrodynamics, emphasizing the need to consider both spatial structure and temporal variability when assessing the ecological impacts of SGD. Our findings demonstrate the value of integrating sUAS-TIR mapping with in situ time-series analysis to (1) identify areas of potential ecological sensitivity and point-sources of land-based pollution, and (2) better characterize the mechanisms driving groundwater transport in coral reef environments.

Session 40: Physiological Ecology III

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Dueling mussels: Analyzing the osmotic tolerance of competitive mussel congeners
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The invasive mussel *Mytilus galloprovincialis* is known as a limited hyposaline tolerant species while its competitive congener, *M. trossulus*, is regarded as more osmotically tolerant. However, there is little known regarding the mechanisms that confer a greater osmotic tolerance in one species over the other. Thus, we sought to determine the osmotic tolerance of the two competitive mussel species and the physiological mechanisms conferring hyposalinity tolerance. We collected *M. galloprovincialis* mussels from Marina del Rey Harbor (MDR), CA and *M. trossulus* mussels Coos Bay, OR, and acclimated them in the lab to control conditions for two-weeks. Following acclimation, mussels were exposed to salinity conditions ranging from 5-40 ppt for one week and then physiological measurements obtained including: metabolic rate (MR), clearance rate (CR), hemolymph osmolarity, HSP70 protein abundance, and antioxidant activity. We found that MR was reduced by 95% under hyposaline conditions in both species compared to the control. CR steadily decreased with hyposalinity and was reduced by 50% under 5ppt compared to the control. Mussels remained nearly isosmotic above ~500 mOsm exposure but became hyperosmotic regulators below 500 mOsm. We found HSP70 protein abundance was greatest at mid-salinities and greater antioxidant activity was found in *M. trossulus* at low salinities compared to *M. galloprovincialis*.

Seasonal thermal thresholds of California kelp: Part A - Winter
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Kelp forests worldwide are facing significant stress from climate change, with warming oceans and marine heatwaves altering their distribution, abundance, physiology, and ecological function. While many studies focus on acute summer heat events, kelp also experience substantial temperature variation throughout the year, influencing their physiology and capacity to tolerate warming. Understanding species-specific thermal limits in both mortality and performance decline is essential for predicting future community structure and ecosystem resilience. We examined the thermal performance of eight ecologically and morphologically distinct California kelp species, exposing macroscopic life stages to 13–25°C for two weeks. In Laminaria, Agarum, Pelagophycus, Nereocystis, Pterygophora, and Macrocystis, physiological function was maintained at 13–19°C, but thresholds emerged: above ~22°C, growth rates became negative for most species and photosynthetic efficiency declined rapidly. In contrast, Eisenia and Egregia sustained relatively high photochemical efficiency and photosynthetic rates even at 25°C, showing only modest growth declines, though both experienced reduced carbon balance as respiration increased. These results identify upper thermal limits for cooler seasonal conditions and highlight variation in resilience. They

suggest that while some kelps may tolerate short-term warming, prolonged exposure beyond 22°C could undermine kelp forests, whereas Egregia and Eisenia emerge as climate-resilient species likely to persist in warmer oceans and serve as candidates for restoration

Hypoxia induces neuroplasticity, vascular adaptation, and transcriptomic and proteomic signatures in the speckled sanddab brain

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The brain is the main regulator of the stress response, coordinating behavioral and physiological responses that are essential for survival and adaptation. Hypoxia, or reduced oxygen availability, is one such stressor and is increasingly prevalent in coastal ecosystems. In the Elkhorn Slough, hypoxia (<2 mg O_2/L) has been shown to disrupt fish growth, survival, and reproduction, yet the cellular and molecular mechanisms of brain adaptation remain poorly understood. Here, we examined brain plasticity in the speckled sanddab (Citharichthys stigmaeus), a flatfish that regularly encounters hypoxia in Elkhorn Slough. Histological, transcriptomic, and proteomic approaches were used to characterize neurogenic, vascular, and molecular responses in brains of fish exposed to 7 days of hypoxia. We observed increased neural cell proliferation, measured by 5-ethynyl-2′-deoxyuridine $(EdU)^+$ cells in the hypothalamus and optic tectum, alongside reduced survival of 5-bromo-2′-deoxyuridine (BrdU)+ cells. Vascular analyses using glucose transporter 1 (GLUT1) revealed increased vessel area and count, indicating remodeling of brain blood vessels. Using RNA-sequencing, we identified differentially expressed genes implicated in stress signaling, metabolism, immune function, and neuronal plasticity, while quantitative proteomics revealed complementary protein changes in overlapping pathways. These results provide an initial characterization of brain adaptation to hypoxia in an estuarine fish and point to potential mechanisms of both resilience and vulnerability in a changing coastal environment.

In situ climate manipulations alter intertidal seaweed photophysiology

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Heat waves are increasing in intensity and frequency, and predicting the impacts of these extreme events requires understanding how species respond to climate stressors under field conditions. We developed a method for creating plot-scale aerial heat-wave conditions and evaluated impacts on rocky shore communities in Sitka, Alaska. We deployed climate manipulations (heated chambers, unheated chambers, and unmanipulated controls; n = 7 each) in the *Fucus distichus* rockweed zone for ~2.5 hours during low tides. Warming treatments resulted in a 95th percentile temperature of 32.6 ± 2.3 ºC, > 12 ºC higher than control temperatures and on par with record high temperatures at our study location. 95th percentile temperatures in heated treatments were 8.7 ºC lower under the algal canopy than above the canopy. Heat-wave manipulations resulted in photophysiological stress on rockweeds, and that stress was ameliorated by the canopy. *Fucus* individuals below the canopy always had higher effective photochemical quantum yield (*Yii*) values (i.e., experienced lower stress) than those atop the canopy. *Yii* values of exposed individuals in heated treatments were reduced by half relative to those in unheated treatments. Further, there were no differences in *Yii* between the heated and control treatments for individuals sampled below the canopy. Our work highlights the practicality of conducting in situ intertidal climate manipulations, the rapid effects of those manipulations on seaweed physiology, and the role of rockweeds in ameliorating climate stressors.

Conflicted outcomes: Placentation shapes how postzygotic isolation manifests

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New College of Florida

The Viviparity-Driven Conflict Hypothesis predicts that parent-offspring conflict, intensified by placentation, should alter how postzygotic isolation manifests. I tested this by comparing reproductive incompatibility in two poeciliid fish species from Pacific-slope drainages of western and central Mexico, *Poeciliopsis prolifica* (placental) and *P. infans* (non-placental), using interpopulation crosses between genetically diverged populations within each species. I measured offspring size and F1 fertility (offspring production rate) across reciprocal intra- and interpopulation crosses. I found evidence for incompatibility in both species, but it manifested differently in each species. In *P. prolifica*, interpopulation crosses produced smaller offspring, reflecting reduced maternal investment. In *P. infans*, incompatibility was expressed instead as reduced fertility and smaller litters. In both species, only one maternal lineage reflected incompatibility. These contrasting outcomes suggest reproductive mode influences the trait through which isolation is expressed, rather than its overall magnitude. These findings support the idea that reproductive conflict plays a key role in shaping postzygotic barriers. In placental species, incompatibility may manifest through disrupted provisioning, while in non-placental species, it appears through fertility decline. This work highlights the importance of considering reproductive mode when interpreting the evolution of reproductive isolation and adds evidence for asymmetric incompatibilities within species.

Patterns and thermoregulatory impacts of catastrophic molt in male northern elephant seals
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Many animals undergo molt (shedding of skin, hair, feathers, or shell) to facilitate growth and development. This process is often passive and in small amounts. However, northern elephant seals (*Mirounga angustirostris*, NES) exhibit an unusual physiological phenomenon known as a “catastrophic molt,” which involves the shedding of both hair and cornified epidermis over a short period of time. Although NES are well studied, there is surprisingly little information about their annual molt. In this project, we documented the molt pattern and surface temperatures of subadult and adult male NES during the catastrophic molt. To do this, we performed visual observations and collected infrared thermal images of molting male NES at the Piedras Blancas rookery across two molting seasons. We created a molt code to describe the predictable pattern of male molt we observed. Seals consistently began molt on the head and flippers, followed by their chest shield and dorsum, and completed with the ventrum. We also found that freshly molted body regions were associated with areas of increased surface temperature, suggesting that these seals may increase blood flow to the skin to facilitate the molting process. This is the first study to document the pattern and thermal consequences of the catastrophic molt in male NES. Future work will compare these results to the molt in other NES age classes.

Session 41: Aquaculture II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

Differential diet impacts on red abalone growth and grazing rates under ocean acidification
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Accelerated ocean acidification is threatening food security and conservation efforts across the globe and requires innovative strategies to build resilience in marine populations. Aquaculture plays a vital role in global seafood production and security but is also increasingly vulnerable to acidification. The red abalone (*Haliotis rufescens*) is a culturally and economically iconic California species that solely relies on aquaculture for production of individuals since widespread population collapses in 2018. Abalone aquaculture has traditionally relied on a diet of giant kelp, with alternative diets of various seaweed species gaining interest due to their potential to enhance growth. However, whether varying diets can improve resilience in populations to projected future conditions is unclear. We exposed red abalone to two different pH treatments; a low, projected pH of 7.65 and an ambient treatment of 7.90. Abalone within each treatment were given three diet treatments: Dulse (*Devalerea mollis*) only, Ogo (*Gracilaria*

pacifica) only, and a mixed treatment of both seaweeds. The abalone in reduced pH had lower growth rates overall, but the dulse diet treatment had higher growth rates compared to other diet treatments. Interestingly, abalone grazing rates were higher for ogo and mixed diets with less dulse being consumed overall. Understanding how diet can build resilience is valuable for aiding practitioners and restoration efforts under future environmental change.

With a grain of salt: The effects of salinity on the red seaweed *Asparagopsis taxiformis*
Ben-Zvi, O.*; Elliot, C.; Zou, R.; Round, T.; Contractor, K.; Smith, J.E.

Scripps Institution of Oceanography, UC San Diego

Asparagopsis taxiformis, a red seaweed, is of great interest for its potential to significantly reduce methane emissions in the cattle industry. It is cultivated across diverse facilities and scales, with the goal of enhancing both growth rates and the production of halogenated compounds such as bromoform, a key metabolite underlying its methane-mitigation capacity. Salinity fluctuations are common in both natural environments and aquaculture systems and may induce stress responses, including, but not limited to, the accumulation of reactive oxygen species such as hydrogen peroxide (H_2O_2), a known precursor for bromoform synthesis. In this study, we examined the effects of salinity on *A. taxiformis* by exposing the algae to five salinity treatments: 30 ppt, 32 ppt (ambient seawater salinity), 38 ppt, and 42 ppt for six weeks and monitoring its relative growth rate, bromoform concentration, contamination, and H_2O_2 production. We found that higher salinity resulted in reduced growth and higher contamination. Moreover, any deviation from ambient seawater salinity was followed by a decrease in bromoform concentration. These findings provide new insights into the stress physiology of *A. taxiformis* and emphasize the negative impacts of altered salinity on bromoform productivity, informing strategies for the optimization of large-scale cultivation.

Closing the life cycle of the native California clam, *Tivela stultorum*, for commercial aquaculture production.
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1- Concordia University Irvine 2- Holdfast Aquaculture 3- Get Inspired, Inc.

Pismo clams, *Tivela stultorum*, represent a potential native California aquaculture species that can help meet some of the growing demand for seafood and boost the California aquaculture industry. In 2022, the presenting team successfully spawned and reared the Pismo clam through juvenile stages, setting the stage for further development of aquaculture protocols. Here we will report on recent and ongoing trials completed as part of a California Sea Grant-funded project aimed to develop a commercial aquaculture framework for this species. Topics will include successes, challenges, and future plans for commercial-scale hatchery production, *ex situ* broodstock conditioning, larval rearing and settlement protocols, and strategic planning for out-planting in a commercial aquaculture setting.

Thermal sensitivity of Gracilaria sp.: Effects on growth, physiology, agar yield, and shelf-life
Ortiz, K.*; Smith, J.E.

Scripps Institution of Oceanography, University of California San Diego

Gracilaria species, or “ogo,” are farmed globally for agar production, aquaculture feed, and culinary markets, yet the cultivation conditions to optimize production of Gracilaria in California remains underexplored. Seaweed aquaculture in CA is still underdeveloped, and the contrasting thermal regimes across the state highlight the need to evaluate species performance under regional conditions. In particular, the warmer waters of Southern CA present both opportunities and challenges for developing Graciliaria as a candidate for land-based cultivation. To address this, we ran a large-scale thermal performance experiment in the lab at Scripps Institution of Oceanography. Replicate samples of Gracilaria were exposed to seven temperature treatments (12–30°C) for four

weeks in a static, closed-loop culture system. Growth was monitored weekly by recording wet weight, while photosynthetic efficiency (Fv/Fm) was measured at three-day intervals using PAM fluorometry. Endpoint tissues were analyzed for nutritional composition and agar yield using established extraction and gel strength protocols. In parallel, shelf-life stability is being assessed with biomass harvested from outdoor flow-through systems, focusing on respiration rates and storage conditions to evaluate and ideally extend post-harvest quality and marketability. Temperature and complementary shelf-life trials provide a multidimensional perspective on the performance of Gracilaria, linking physiological thresholds with applied considerations for aquaculture resilience and farm-to-table applications on a warming CA coast.

Poster Sessions

Poster Session I

* indicates presenting author, † indicates eligibility for Best Student Paper Award

1 - Effect of Temperature and Food Availability on the Reproductive Output of the Acorn Barnacle: *Chthamalus fissus*

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Climate change is predicted to intensify ocean warming and the reduction in phytoplankton abundance, potentially disrupting reproductive processes in filter-feeding intertidal invertebrates. This study investigated the combined effects of water temperature increases and food availability on the reproductive output on *Chthamalus fissus*, a dominant intertidal barnacle species found along the Southern California coastline. Using a controlled laboratory experiment, barnacles collected from the nearshore rocky intertidal habitat in La Jolla, California, were exposed to two temperature regimes (ambient water temperature ~ 18°C and elevated water temperature ~ 20-21°C) and two food concentration treatments (low and high phytoplankton and rotifer densities). Each week, temperature and salinity were monitored, tanks were cleaned, and the number of barnacle nauplii produced (barnacle reproductive output) was measured for each experimental treatment. Temperature had a significant effect on reproductive output ($p=0.0046$), with warm-water treatments producing more nauplii than cold-water treatments, regardless of food concentration. Food availability did not significantly affect reproductive output ($p=0.3372$), and no significant interaction between temperature and food was detected. These results suggest that elevated temperatures may enhance short-term reproduction in *C. fissus*, but the long-term effects under reduced food conditions remain uncertain.

2 - Optimizing Fisheries Regulations for a Proposed Kailua Marine Managed Area Under a Changing Climate

† Pettit, A.[1*]; Innes-Gold, A.[1]; Morris, T.[2]; Madin, E.[1]

1- UH Mānoa 2- Manu ʻIwa O Ka Malanai

Nearshore coral reef fisheries are vital to Hawaiʻi, providing an essential food source and supporting community well-being. However, these fisheries are increasingly threatened by overfishing and climate change, with Oʻahu experiencing the steepest declines. In response, Manu ʻIwa O Ka Malanai (MIOKM) has proposed a Marine Managed Area (MMA) in Kailua. Yet the effectiveness of proposed regulations in rebuilding depleted fish stocks remains uncertain, particularly under projected ocean warming. This project combines ecological surveys, fisheries monitoring, and population modeling to evaluate management strategies for the proposed MMA. We are conducting fish and benthic surveys in addition to fishing effort surveys across Kailua, Kaʻōhao, and Waimānalo to measure changes in reef health and fishing activity. This data will parameterize a spatially explicit, climate-informed population model that simulates fish biomass, harvest, and spillover under varying management strategies (e.g.,

gear restrictions, bag limits) and future climate scenarios. Our findings will identify strategies that best enhance food security in the region by promoting fish biomass recovery and sustainable harvest, while also supporting reef resilience. An interactive web application will make model outcomes accessible to fishers, managers, and community members. Ultimately, this project aims to provide a scalable framework to inform adaptive, climate-resilient management of nearshore fisheries across Hawai‘i.

3 - Phenotypic effects of diatom density of Phyllaplysia taylori

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1- Friday Harbor Laboratories 2- Chapman University

Zostera marina is an essential marine habitat, providing food for grazers and holding cultural significance among indigenous tribes. Phyllaplysia taylori, a sea hare endemic to the west coast, spends its entire life cycle on the leaves of Z. marina and fulfills a vital role in maintaining the health of eelgrass meadows. By grazing on epiphytes growing on the leaves of Z. marina, they improve the plant’s ability to capture sunlight and bolster the resiliency of eelgrass ecosystems. As climate change progresses, rising temperatures and eutrophication may lead to increased diatom growth. Preliminary observation of P. taylori in diatom-dense conditions revealed an atypically massive and wide phenotype. Increased body size could lower the fitness of P. taylori by inhibiting their attachment to Z. marina leaves. In this study, we explored the phenotypic effects of a diatom-dense diet on the persistence of physical characteristics including mass, foot area, and width. 60 individuals were divided into three groups (n=20) a diatom dense test group, a control group in a simulated meadow condition composed of transplanted Z. marina ramets, and an outgroup, moved from the test condition to the control condition after three weeks. After 6 weeks, individuals in the test group were on average 60.15% more massive than the control group, while the outgroup individuals were 70.48% more massive. The foot area of the test group averaged 32.52% greater than the control group, while the outgroup averaged 37.76% higher. Width differences between groups were not statistically significant.

4 - Characterizing coral physiological responses to nutrient imbalance using ^{13}C stable isotope incubations

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1- UC San Diego, Scripps Inst. of Oceanography 2- University of Hawai‘i at Mānoa

Eutrophication of coastal waters is a major driver of coral decline, yet the mechanisms linking altered nutrient regimes to reduced resilience remain poorly resolved. Unfavorable nutrient ratios can increase bleaching susceptibility; nitrogen enrichment weakens host control over symbionts, leading to elevated densities. This proliferation increases phosphorus demand, and when phosphorus is limiting, imbalance develops. Under such conditions, symbionts remodel thylakoid membranes by substituting phospholipids with sulpholipids, a process that compromises photosynthetic efficiency and may reduce tolerance to thermal and light stress. To test this mechanism, *Pocillopora* spp. and *Montipora grisea* fragments from Moorea, French Polynesia were incubated for 20 days under three nutrient regimes: nitrate enrichment (6 µmol L^{-1} NO_3^-), combined nitrate and phosphate enrichment (6 µmol L^{-1} NO_3^- + 2.5 µmol L^{-1} PO_4^{3-}), and unenriched controls. Following enrichment, photosynthesis was quantified in direct carbon units using stable isotope (^{13}C) incubations. Fragments were exposed for 6 h in aquaria amended with ~15 atom% ^{13}C bicarbonate, after which tissue was analyzed for symbiont density, chlorophyll *a*, and isotopic composition. We hypothesize that nitrate enrichment alone will increase symbiont density but reduce carbon uptake due to phosphorus limitation, whereas combined enrichment will enhance both symbiont density and carbon uptake.

5 - Impacts of Trampling on Sea Anemones (Anthopleura elegantissima & A. sola) in Southern California Rocky Intertidal Zones

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California State Polytechnic University, Pomona

In highly urbanized areas, many people visit rocky intertidal habitats for recreational and educational purposes. Visitor activities, such as collecting and trampling, can harm intertidal organisms and alter normal ecosystem functioning. Foot traffic, in particular, has been shown to dislodge or crush intertidal species, including ecologically important rockweeds and mussels, resulting in reduced cover, biomass, size, and reproductive capacity. Ignored in these studies, however, are the impacts of trampling on sea anemones, despite their ecological importance. To experimentally examine the effects of trampling on two sea anemone species, *Anthopleura elegantissima* and *A. sola*, we established fixed plots in a randomized block design in Palos Verdes, southern CA. Three plots within each block (n=5) for each species were assigned a trampling treatment consisting of walking on fixed plots evenly once per month for 12 months (starting Dec 2024): *A. elegantissima* treatments consisted of 0 (control), 36, and 72 steps in small plots ($0.09m^2$) while *A. sola* treatments were 0, 150, and 300 steps in larger plots ($0.35m^2$). Before trampling, percent cover and the number of anemones present were assessed, with impacts determined over time and compared between species. Thus far, both anemones appear to be unimpacted by trampling, likely avoiding damage by expelling water when crushed. Results will expand our knowledge about visitor impacts and inform management decisions as urbanization and visitation continue to increase.

6 - The Effect of Nutrient Concentration and Phytoplankton Species on Marine Snow Formed with Microplastics

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University of San Diego

The sequestration of carbon in the ocean relies on marine snow, which forms from phytoplankton in the surface ocean and sinks, storing carbon in the deep sea. The anthropogenic input of microplastics – tiny particles that are less than 5mm in size, which can remain in the ocean for long periods of time – has been increasing in recent decades, with known detrimental ecosystem effects. Although microplastics typically float, they can be incorporated into marine snow, providing a mechanism to transfer this contaminant to the benthos. The objective of this study was to determine the effects of nutrient concentration on marine snow formed with microplastics from two different species of phytoplankton. After phytoplankton was grown for two weeks in two different concentrations of nitrate, cultures were added to cylindrical tanks and rotated for 4 days to form aggregates. Aggregates were photographed to measure aggregate size and shape. Then, aggregates were observed in a settling tank and imaged to quantify settling velocity. Finally, the number of microplastics in aggregates relative to the total microplastics added was counted to determine the extent to which the microplastics were incorporated into the marine snow. Here, we will present results demonstrating differences between these aggregate properties based on nutrient concentration and phytoplankton species. Since nutrient concentrations will likely be altered by global climate change, differences in aggregate properties could affect the amount of carbon and microplastics transported to the deep ocean.

7 - Novel Sequencing of Rhodopsin in Deep-Dwelling Rockfishes

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Rockfishes, Sebastes spp., are an unusually speciose clade of fish. They are mostly found along the North Pacific Coast and include over 100 species. Occupying a wide variety of depth ranges, rockfishes are highly diverse in both their morphology and ecological niches. We hypothesize that a primary driver of this diversification is adaptation to different depths. For visual predators, sufficient ambient illumination is critical for locating prey. As depth increases, illumination decreases and the spectrum of underwater light becomes increasingly narrowed. Rhodopsin, Rh1, is a depth-associated gene that is responsible for vision and color perception in low light environments. We propose that Rh1 can be demonstrated to show convergent evolution and signatures of selection if compared across many rockfish species across varying depths. This could indicate an environmental pressure for diversification. Our past work has shown a greater level of Rh1 selection in deep water habitats. We seek to provide a better representation of deep water rockfish through our selection of species of interest. We

extracted, amplified, sequenced, and edited the Rh1 genes from multiple rockfish species for whom the gene has never been sequenced. We uploaded these novel sequences to the National Center for Biological Information (NCBI) to make these sequences available to the public. These sequences were tested for selection against those of other species. This project seeks to gain a stronger understanding of Rh1 selection in narrow, low light environments among rockfishes.

8 - Influence of gear type selectivity on diet composition of nearshore rockfish

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Cal Poly San Luis Obispo

Understanding the status of nearshore fish stocks require information about species abundance, catch data, and ecological interactions. These components, along with life history information from fisheries research projects, feed into stock assessment models and strengthen our understanding of nearshore fish stocks. The California Collaborative Fisheries Research Program (CCFRP) is one such program that conducts research to evaluate marine protected areas and the status of nearshore fish populations. This study investigates how the dietary preferences of Blue rockfish (*Sebastes mystinus*) and Olive rockfish (*Sebastes serranoides*) influence the gear types they are likely to be caught with. Specifically, we ask whether different gear types (unbaited and baited shrimp fly and lingcod bar) correspond to variation in gut contents and whether these differences vary temporally. Over the course of two summers, CCFRP conducted hook-and-line surveys at Point Buchon and Piedras Blancas. For each captured fish, species, length, weight, and gear type were recorded, and stomachs were preserved for laboratory analysis. Gut fullness and contents were analyzed by prey occurrence and diversity. Our preliminary findings indicate a variance of preypreferences across gear type and years. These differences may reflect the different foraging habits between Blue and Olive rockfish. Results will inform future ecological studies by highlighting the importance of gear choice in trophic research and may have implications for fisheries monitoring and ecosystem-based management strategies.

9 - Plant Growth and Local Adaptation Response to Nitrogen Pollution in the Los Angeles Basin

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As the environmental threats of the climate crisis escalate, it is essential to understand the ecological and evolutionary implications of human activities. Populations facing disturbances may respond by migrating, adapting, acclimating, or simply dying. For sessile plants, migration is not an immediate option. Instead, phenotypic plasticity and local adaptation are primary strategies that allow them to cope with varying environmental conditions. While these strategies have been well-studied in annual plants, less is known about the responses of perennial plants. This gap is especially important in communities where increasing droughts, wildfires, and air pollution exacerbate the effects of climate change. This study will analyze plant morphological and physiological traits in response to changes in soil nitrogen, simulating pollution-related nitrogen deposition in the Los Angeles Basin, which is naturally nutrient-poor. We will conduct a greenhouse experiment comparing Chaparral native perennial *Eriogonum fasciculatum* from wild seeds collected from both high- and low-nitrogen deposition areas and grow them under home and away nitrogen soil conditions. To evaluate plant responses, we will measure growth rate, specific leaf area, biomass allocation, and reproductive output. We anticipate that our findings will contribute to understanding anthropogenic impacts on the ecology and evolution of native perennial plants, as well as to local conservation initiatives in Southern California.

10 - Using Photographs to Determine the Rate of Scar Healing in Goose-beaked Whales

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Duke University

The goose-beaked whale (*Ziphius cavirostris*) is a deep-diving species of odontocete found in temperate, tropical, and subtropical waters, and very little is known about their life history. Male goose-beaked whales use their teeth in aggressive interactions with male conspecifics to demonstrate dominance, resulting in wounds and scarring. In addition to wounds caused by conspecifics, visually distinct artificial wounds are found on some animals caused by implantable tags. Using a collection of photographs taken off Cape Hatteras spanning 17 years, this study characterized natural and artificial wounds on goose-beaked whales and calculated the healing time of both natural and artificial wounds. The shortest observed healing time of natural wounds in goose-beaked whales was 35 days, and the shortest observed healing time of artificial wounds in goose-beaked whales was 331 days. Seasonality of natural wound acquisition was also investigated and suggests that there are more wounds per field hour in the month of August, which may suggest seasonality of reproduction. This study is useful in understanding the impacts of artificial tags and the healing time of natural wounds in goose-beaked whales and could contribute to future work estimating age and examining male-male competition.

11 - Between a rock and a hard place: Mussel bed depths along the Oregon Coast from 2015 - 2025

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Oregon State University

Mussels are important sources of food, habitat, and protection from the waves for many organisms residing in the rocky intertidal zone. Along the Oregon Coast, California Mussels (*Mytilus californianus*) act as ecosystem engineers, creating habitat for many invertebrates within their mussel beds and enhancing biodiversity. While these mussels frequently endure intense wave action, large waves can sometimes dislodge them from the rocks. As climate change intensifies the wave climate of the Pacific Northwest, increased wave heights may lead to disturbances in the mussel bed. At the same time, rising sea surface temperatures may cause an opposing effect on mussel beds as mussels have been shown to experience increased growth rates during warm water events. To investigate mussel bed responses to various climate change-related impacts, we monitored the depth of the same mussel beds at 5 sites along the Oregon Coast from 2015 to 2025. We found that mussel bed depth has steadily increased at Boiler Bay, but has been more variable at other sites. Mussel bed depth at Fogarty Creek, Yachats Beach, and Strawberry Hill underwent periods of expansion and decline over the past decade. Investigating climate impacts on ecosystem engineers is especially important to predicting and understanding potential impacts to the species they support, and the biodiversity of the ecosystem as a whole.

12 - Can hyperspectral and microstructural analyses discriminate between two cryptic species of rockfishes?

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Rockfishes (genus Sebastes) are nearshore, temperate fishes of the North Eastern Pacific Ocean that exhibit remarkable evolutionary diversification. Rockfishes have become an exemplary study group due to their high morphological, ecological, and genetic diversity. The rockfish genus also has several cryptic species complexes, where documenting accurate data for each of these species has proved difficult due to their almost identical morphologies. For example, the vermillion-sunset rockfish complex comprises two sister species, vermillion rockfish (S. miniatus) and sunset rockfish (S. crocotulus). Although genetically distinct, both species are grouped together and commonly sold as a singular species throughout California fish markets and grocery stores. Like other rockfishes, the vermillion-sunset complex is an economically valuable species in both commercial and recreational fishing (Hyde et al., 2008; Keller et al., 2022). Can hyperspectral and microstructural analyses discriminate between coloration and patterning of S. miniatus and S. crocotulus? We measured the spectral reflectance of these two species using an imaging hyperspectrophotometer. We also examined the skin microstructure composition in search of micro differences between patches of the specimens. Hyperspectral data

is a tool that has been used to discriminate among different fish species, as successfully demonstrated in a study with piranhas and pacus conducted by Kolmann et al.(2021). Our results may aid in conducting more precise biodiversity and stock assessments, and lead to better fisheries management.

13 - The Effects of Zinc and Copper Exposure on Rhodolith Health and Calcification

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Coastal ecosystems are increasingly impacted by heavy metal contamination from maritime activity. Zinc, released from sacrificial anodes, and copper, leached from antifouling paints, accumulate in seawater and sediments in boating-intensive regions such as Catalina Island. These pollutants disrupt biogeochemical cycles and threaten foundation species. Rhodoliths, free-living calcareous red algae, provide essential habitat and enhance biodiversity, yet are particularly vulnerable because they rely on $CaCO_3$ deposition. This study examines the effects of zinc and copper on rhodolith calcification and visible health under controlled conditions at the San Diego State University Coastal and Marine Institute Laboratory. A factorial design will test zinc supplied as $ZnSO_4 \cdot 7H_2O$ (50, 200, 400 ppb), copper supplied as $CuSO_4 \cdot 5H_2O$ (50, 200, 400 ppb), and combined treatments during 21-day incubations. Calcification rates will be quantified using total alkalinity titrations, and benthic incubation chambers will measure net community metabolism, quantifying net photosynthesis and respiration. We hypothesize that elevated zinc and copper concentrations will reduce calcification and impair metabolic performance, with combined exposures producing synergistic negative effects. Results will provide new insight into rhodolith vulnerability to maritime-derived pollution and inform conservation strategies in coastal regions facing chronic heavy metal contamination.

14 - New swimming spaghetti worms (Terebellidae, Annelida) from the eastern Pacific Ocean

† Barnes, X.Q.M.*; Rouse, G.W.

UC San Diego - Scripps Institute

In 1971, Edward Bland, the pilot of the deep-sea submersible Alvin, noticed remarkable ‘powder puff-like’ animals on the seafloor between 597 - 635m depth off The Bahamas. On trying to collect them, they would swim away, and after an initial lack of success, two specimens were captured and brought to the surface. These specimens would become representatives of a new species of Terebellidae, a group not known for swimming. It was described as *Biremis blandi* in 1973 and was occasionally witnessed by other deep-sea vehicles over the decades. *Biremis* is part of the tribe Polycirrini within Terebellidae, a group characterized by the lack of any form of gills. There are currently 6 genera of Polycirrini, with most of the 122 accepted species belonging to *Polycirrus*. Here we describe two new species of *Biremis* from the Pacific Ocean, one from off Mexico and the other off Costa Rica, using morphology and DNA data. Unlike their other terebellid relatives, these animals were found lying on the seafloor with no tubes and were also capable of swimming. We obtained a specimen of *Biremis blandi* for DNA sequencing, allowing us to provide the first mitochondrial genomes for Polycirrini. Surprisingly, the results show that the two Pacific species do not group together, but that the Costa Rica species is most closely related to *Biremis blandi*. Also, the genus *Biremis* appears nested inside *Polycirrus*, making the latter paraphyletic. Further sampling of *Polycirrus* for DNA analysis will be required to resolve this taxonomic issue.

15 - Alphabet coding for efficient bioacoustic analysis of humpback whale songs along the California coast

† Ng, I.Q.*; Schroth, M.; Liwanag, H.

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Long-term acoustic monitoring of migratory cetaceans can provide information about the ocean’s marine soundscape that is key to conservation efforts. Our project aims to establish a long-term bioacoustic monitoring station off the coast of central California, helping to close the gap in our understanding of cetacean presence along

the Pacific coastline. Humpback whale vocalizations can give an insight into their behavior, social structures, and responses to environmental changes. The goal of our project this past summer was to develop a methodology for simplifying the analysis of complex bioacoustic recordings of humpback whale songs. We used data recorded from our hydrophone, which was periodically deployed between 2022 and 2023 at the base of the Cal Poly pier in Avila Beach. To create a consistent way of organizing humpback songs for analysis, we assigned each whale vocalization/call unit in a song to a specific letter of the alphabet, creating an alphabet-based coding system that enables more efficient summaries of humpback whale songs. This method simplifies complex vocalizations into a structured format, allowing for rapid analysis and comparison across different recordings. In the future, this approach could enhance our ability to implement artificial intelligence to help annotate sound files and spectrograms to reduce processing time while maintaining accuracy in larger datasets. This increases our ability to monitor marine mammal populations and understand regional differences along the coast, supporting more targeted conservation efforts.

16 - Mapping Barriers to Salmon Migration in a Washington State Watershed

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Understanding the extent and impact of stream barriers is essential for effective salmonid conservation. In WRIA 18, we evaluated natural and anthropogenic constraints to stream connectivity for Chinook, Coho, and Pink salmon. Our analysis revealed that natural point barriers and high-gradient stream segments exclude Coho and Chinook from 662.8 km of stream and Pink salmon from 1,203.3 km. After accounting for these natural limitations, 2,093.1 km (55.8%) of stream remain accessible to Coho and Chinook, and 1,552.6 km (41.4%) to Pink salmon. Additional assessment identified 911.1 km of stream impaired by anthropogenic structures, including fully or mostly inaccessible segments. Fifteen barriers were prioritized for restoration, based on species-specific access potential. These findings highlight the necessity of integrating physical habitat accessibility with species-specific ecological requirements. While improving connectivity remains a foundational conservation strategy, long-term recovery will require Adaptive Management and complementary interventions, such as habitat restoration, water quality improvement, and continuous monitoring to support sustainable salmonid populations.

17 - Investigating differential gene expression in heat-stressed Galápagos corals

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1- Moss Landing Marine Labs, CSU Monterey Bay 2- CSU Monterey Bay 3- Universidad San Francisco de Quito

Thermal plasticity is the ability for an individual to adapt its physiology in response to atypical temperature conditions. Plasticity is in part determined by an organism's cellular stress response (CSR), a molecular response to damaged macromolecules. In a 1.5°C warming scenario, coral reefs are predicted to decline 70 - 90% by 2100 (IPCC). The massive coral *Pavona clavus* is a functionally important reef-building coral prevalent across the Galápagos Islands and subject to a history of thermal stress events, yet no studies have investigated its molecular response to temperature stress. Here, we aim to (1) compare differential gene expression (DGE) in *P. clavus* across tiered heat stress assays, and (2) functionally annotate genes to uncover CSR pathways, and (3) predict the upper thermal limit of *P. clavus*. Using the Coral Bleaching Automated Stress System (CBASS) we exposed *P. clavus* colonies from Darwin Island to tiered heat stress (32.5°C, 34.0°C and 35.5°C) and measured bleaching and transcriptomic responses via RNA-Seq. Bleaching response became more severe and differentially expressed genes more abundant at higher assay temperatures. Compared to the control (26°C), upregulated genes were generally associated with heat shock response pathways, whereas downregulated genes were associated with cellular metabolic processes. A thermal limit for *P. clavus* is suggested to occur at 35.5°C. This research can help identify molecular pathways in resilient corals and aid in management as we brace for continued climate-driven stress on reefs.

18 - Mapping submarine groundwater discharge delivery on coral reefs using drone thermal infrared imagery

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1- Pepperdine University 2- SIO, UC San Diego

Submarine groundwater discharge (SGD) can be a significant source of land-derived nutrients, introducing freshwater enriched with dissolved inorganic compounds into coastal ecosystems. Over the past century, on-site sewage disposal systems and rapid urbanization around Maunalua Bay (O‘ahu, HI) have increased nutrient loading via SGD, reducing coral cover and favoring nutrient-tolerant algae. This study integrates drone-based thermal infrared imagery (TIR) with benthic salinity monitoring to capture both spatial distribution and temporal dynamics of groundwater transport across the reef. Because SGD is colder than the ambient coastal water and floats on top of the water column due to its low salinity, we were able to create orthomosaic maps of the plume by stitching together ~300 thermal images (taken by the drone at night) with 85% overlap to sidelap ratio. The thermal imagery was then validated through surface water sampling for inorganic nutrients and YSI measurements (salinity, temperature, pH, ORP, TDS, etc.). By combining high-resolution drone mapping with in situ time-series data, this research provides a framework for sources of land-based nutrient inputs. These maps will aid in forming a more complete model of phytoplankton and macroalgae productivity and provide critical insights into how SGD alters water chemistry and ecosystem dynamics.

19 - Changes in Environmental Memory and Navigational Paths of Pagurus samuelis When Exposed to Sudden Increased Temperatures

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Rising temperatures alter the physiology and behavior of many species, especially during heat waves. Memory is a physiological trait that may be impacted by heat stress. I hypothesized that heat shock will impair memory in an intertidal zone hermit crab *Pagurus samuelis*. To test that hypothesis, I trained adult crabs (n=6) to find a piece of shrimp in an oyster shell during a 4-week-long experiment. Training lasted one week, following which time the crabs’ ability to locate the oyster shell was tested for an additional week in the absence of shrimp. A second one-week retraining period then began, during which time shrimp was present in the oyster shell, and then at the start of the second week, each crab received a 1h 30°C heat shock prior to the second week in which shrimp was not present in the oyster shell. All trials and husbandry of hermit crabs was at 14-16°C. Each hermit crab had a different behavior pattern, but in 4 out of 6 individuals, there was a strong reduction in time required to find the food during the initial week (suggesting memory), and in 3 out of those 4 specimens, there was evidence that the memory of shrimp in the oyster shell was lost within the second week. Following subsequent retraining and heat shock, results were mixed, and the impact of heat shock was not clear. Further trials with additional specimens are ongoing. Understanding whether heat shock impacts memory in hermit crabs is important for a general understanding of response to heat waves, as well as specific ecosystem functions of hermit crabs that may require site fidelity.

20 - Fatty acids reveal trophic relationships of invasive green crabs in the Coos Bay estuary

† Diehl, E.J.[1*]; Galloway, A.W.E.[1]; Schooler, S.[2]

1- University of Oregon 2- South Slough National Estuarine Research Reserve

A consistent increase in abundance of 5-spine green crab (*Carcinus maenas*) has been observed in the Coos estuary, Oregon, where the South Slough National Estuarine Research Reserve (SSNERR) has been monitoring the invasion since 2002. The effects of the growing population of green crab on estuary ecosystem function and significant local fishery species are still unknown. Green crabs are known to have a variable and omnivorous diet, with other shellfish species as the most common prey items. However, it is difficult to make direct feeding observations, and stomach content analysis is biased against soft bodied organisms. To investigate diet and

trophic relationships, we collected ~70 green crabs from ten SSNERR monitoring sites around the Coos estuary and dissected muscle tissue samples from their claws for fatty acids analysis. Fatty acids are commonly used as trophic biomarkers to infer ecological connections between species. The crabs collected in the field will be compared to crabs held in lab for eight weeks where they received a single species diet. Based on previous studies with other crab species, we expect to see overlap in the fatty acid profiles between field and lab crabs, indicating that wild crabs consume the same diets as those simulated in the lab. We will test for differences in fatty acid profiles between upper and lower estuary green crabs. This information will help characterize green crab trophic ecology and their impact on the Coos estuary, aiding in management of important local commercial and recreational fisheries.

21 - Predicting the distribution of cold water corals in the Northeast Atlantic Ocean

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1- CSU Monterey Bay 2- National Centers For Coastal Ocean Science

Cold-water corals (Phylum Cnidaria) are ecologically important foundation species that provide complex habitats and communities to surrounding species. These deep-water species grow slowly, with some living over 1000 years. Unfortunately, communities face disturbances, such as trawling or a rise in temperatures, which affect the coral's growth. We developed spatial models of four coral species (*Primnoa, Paragorgia, Desmophyllum pertusum, Bathypathes*) to determine their potential distributions and habitat associations in submarine canyons off the northeast United States. Three spatial models were used for the study–MaxEnt, Random Forest, and GAMs. All models used multiple environmental variables as inputs, as well as presence and absence data (excluding MaxEnt), to accurately predict the distribution of all species. Each model type was tuned and optimized for each species to produce a model with the best ability to predict on test data, based on AUC, Kappa statistic, and point-biserial correlation coefficient. Depth (Importance = 41.2%) and slope (Importance = 32.8%) were the most important factors in MaxEnt models for *Primnoa* and *Paragorgia*. Total alkalinity (Importance = 9.8%) and slope (Importance = 11%) were important factors for *Primnoa* and *D. pertusum* based on Random Forest. Based on these distributions, we predict that these species are likely to be found in submarine canyons, which are important habitats supporting deep-water corals; these models identify potential targets for deep-sea conservation.

22 - Using UASs to Assess Size-Dependent Juvenile White Shark (Carcharodon carcharias) Responses to Environmental Stimuli in the Monterey Bay

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1- CSU Monterey Bay 2- Moss Landing Marine Labs, CSU Monterey Bay 3- CSU Monterey Bay, Moss Landing Marine Labs

Since the 2014-2016 Pacific marine heatwave, many marine species have shifted their ranges poleward, including the juvenile white shark (JWS). This shift in suitable thermal habitat has allowed juvenile white sharks to seasonally inhabit Monterey Bay, which now lies within their thermal habitat selection curve. Among juveniles, thermal habitat patchiness has been shown to be a key predictor of spatial distribution along their cold-edge range limit. However, at larger sizes, adult white shark habitat selection is much less temperature dependent, and they are able to inhabit much colder water, presumably owing to their larger size and thermal mass. To investigate the size dependency of JWS thermal responses, we used a small uncrewed aerial system (sUAS) to count and estimate the size of coastally-aggregating JWSs, and paired these measurements with satellite remote-sensed environmental data. We found size-dependent responses, with smaller sharks responding more strongly to surface temperature and local warm anomalies. This work highlights the size demographic that may be most aggregated by patchy thermal habitat, potentially creating increased or novel top-down pressure along the cold-edge of their poleward shifting habitat.

23 - *Watersipora spp.* as a non-native host for intertidal invertebrates diversity

† Gonzalez-Rojas, A.[*]; Araujo-Leyva, O.R.; Lorda, J.; Beas-Luna, R.

Universidad Autónoma de Baja California

Watersipora arcuata and *Watersipora subtorquata* are globally distributed habitat-engineering invasive bryozoans whose colonies can function as refuges for different species of small marine invertebrates. This study compares the composition of epibiotic invertebrate communities associated with *Watersipora spp.* and the natural substrates from the west coast of Baja California to determine whether invasive habitats alter the biological community. We collected two 12.6 cm^2 cores, one from *Watersipora spp.* colonies and one in the adjacent substrate in ten different sites of Baja California. The results show an average of 87 epibionts per core inhabited *Watersipora spp.* and 113 inhabited other substrates. The site with the highest abundance was El Mosquito beach (240 epibionts per core) and the lowest was Molino Viejo pier (36). The composition of the epifauna community differed among the sites ($p < 0.05$) and between the invasive colonies of *Watersipora spp.* and natural substrates ($p < 0.05$); the invertebrate assemblage of these communities differed by 63.51%, these differences were mainly due to barnacles and sea snails. The groups that were largely unaffected by the presence of *Watersipora spp.* were polychaetes, nematodes, bivalves, tanaidaceans and amphipods. These results suggest that the habitat alterations caused by *Watersipora spp.* colonies are able to modify the structure of the epibiontic invertebrate community in the rocky intertidal, leading to lower abundances of sea snails and barnacles.

24 - Documenting Marine Biodiversity Along the Pacific Coast Using eDNA

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California State University San Bernardino

Environmental DNA (eDNA) provides a non-invasive approach to studying biodiversity by detecting genetic material shed by organisms into their environment (e.g., soil, snow, water). This project focuses on marine biodiversity through the analysis of tissue samples from 11 species collected along the Pacific Coast, with an emphasis on two fish families: Pholidae and Stichaeidae. Samples were obtained from Friday Harbor Laboratories in Washington. DNA was extracted from muscle tissue, quantified, and amplified using primers targeting a fragment of the 12S rRNA gene. Gel electrophoresis was used to confirm successful amplification, and the samples were subsequently sequenced using the Sanger method. The resulting sequences will be deposited in public databases to support future research in marine conservation and species identification. By analyzing 12S gene fragment sequences, we aim to identify fixed mutations across taxa. Future work will expand to eDNA samples from intertidal and subtidal habitats to evaluate whether our markers reliably match the species examined here. This approach provides a foundation for documenting fish biodiversity using eDNA-based methods.

25 - Predictive habitat suitability modeling for Nereocystis luetkeana in San Juan County, Washington

† Bews, E.R.*

University of Washington

Bull kelp (*Nereocystis luetkeana*) is an important foundational species in the Salish Sea, where it provides structurally complex habitat and supports biodiversity. Declines in populations throughout Washington State have raised concerns about how changing environmental conditions impact the distribution of habitat suitable for the growth and persistence of *Nereocystis*. To explore the drivers of change in these systems, a habitat suitability model is being developed for *Nereocystis* in San Juan County, WA that integrates hydrodynamic and water quality outputs from the Salish Sea Model with bathymetry, substrate classification, and historic kelp bed distributions. Presence-absence data were collected during field surveys in summer 2025 to validate model predictions and explore temporal stability at persistent, patchy, and former kelp beds. Suitability will be assessed under present conditions and projected scenarios to identify areas of potential habitat change. Results will link oceanographic processes with realized distributions of bull kelp and provide a framework for identifying priority sites for conservation and restoration. This work advances understanding kelp habitat dynamics and supports regional management and stewardship efforts led by the Samish Indian Nation and other entities in Washington State.

26 - Leaf it to the sea hares: How eelgrass shapes growth regulation in Phyllaplysia taylori

† Dudley, E.[1*]; Applebaum, S.[2]; Tanner, R.L.[1]

1- Chapman University 2- University of Southern California

Eelgrass (*Zostera marina*) meadows are ecologically important for carbon sequestration, nursery habitats for fisheries, and wave attenuation. There is substantial leaf size variability across *Z. marina's* range, with Southern California leaves at ~2 mm in width and more Northern phenotypes reaching up to 11 mm. Invertebrate epiphytic grazers are known for their ability to clean *Z. marina* leaves, allowing for efficient photosynthesis and supporting healthy meadows. Notably, the eelgrass sea hare (*Phyllaplysia taylori*) is the most efficient epiphytic grazer with an adult body size mirroring the leaf size variability, presumably maximizing use of the seagrass habitat. How the body size of *P. taylori* is adjusting plasticly to *Z. marina* leaf size is unknown. Additionally, there is a lack of research on the mechanisms behind invertebrate growth. *P. taylori* from Southern California (Cabrillo Beach, CA) and Northern (San Juan Islands, WA) populations living on thin and thick leaves, respectively, were analyzed to determine how substrate limitation impacted the regulation and growth to their corresponding body size. Real-time PCR assays for the expression of genes with roles as regulatory signals for growth, structures responsible for protein biosynthesis, and active in protein turnover were conducted. This study informs evolutionary questions about how species interactions can drive individual trait adaptation, potentially facilitating specialization or speciation at range ends.

27 - Description of a new, leaf-shaped carnivorous sponge (Porifera: Cladorhizidae) from Northeastern Pacific Ocean

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1- Moss Landing Marine Labs 2- MBARI

Carnivorous sponges (Porifera: Cladorhizidae) belong to a family that have developed a unique feeding style, highly adapted to the food-poor deep sea. In this study, we describe a recently discovered species of carnivorous sponge with a remarkable morphology which ranges from Southern California to British Columbia. The holotype was collected north of the San Francisco Bay, California, with two paratypes collected from Squally Channel, British Columbia and one paratype collected from Monterey Bay, California, all by remotely operated vehicle from depths ranging from 320 to 620m. The holotype is a 10cm long, 4cm wide, 1-2mm thick, leaf-like sponge with two oval lobes attached midway through. The sponge spicule suite is composed of two size classes of styles, one size class of forceps, and a single size of abundant palmate anisochelae. Based on the forceps and palmate anisochelae, the most likely genus for this sponge is *Lycopodina* (Lundbeck, 1905). Video observations from remotely operated vehicles (ROVs) are used to enhance the known geographic and depth ranges for this species. Based on video observations, we have found that the morphology can vary, from a single lobe, to multiple lobes radiating from a central stalk. Video observations also extend the geographic range further south, to the Gulf of California and known depth of 346 – 3256 m. Describing this species will add to our understanding of the biodiversity of carnivorous sponges, and contribute to the baseline understanding needed to describe the role carnivorous sponges play in the deep sea.

28 - Dietary consequences of invasive *Sargassum* on *Pugettia gracilis*

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1- University of California, San Diego 2- Everett Community College

Along the west coast of North America, kelp forests significantly drive marine productivity and sustain biodiversity. In the Salish Sea, bull kelp (*Nereocystis luetkeana*) provide nursery grounds for various fish and invertebrates. However, these forests are increasingly threatened by abiotic and biotic forces. Climate change and invasive seaweeds such as *Sargassum muticum* endanger bull kelp, compromising the habitat and food that marine herbivores rely on. *Pugettia gracilis*, the graceful kelp crab, depends on bull kelp beds for a nutrient-rich food source, shelter, and reproduction. Yet, with the spread of *Sargassum*, herbivores like *P. gracilis* are forced to expand their diets to include non-native macroalgae, and the ecophysiological impacts of this shift remain unclear.

In this study, we quantified the consequences of an invasive *Sargassum* diet on *P. gracilis*' molting rate, fecal mass, and body mass. Laboratory feeding experiments with 28 juvenile *P. gracilis* revealed that diet alone did not significantly affect our three metrics, but crab size did. Interestingly, crabs fed *Sargassum* changed carapace color from dark brown to orange. Our results suggest that *Sargassum* may become part of a more generalist diet in *P. gracilis* if bull kelp beds disappear. Though *Sargassum* may not directly limit crab development, it could influence traits such as carapace color on a short-term scale, potentially serving as a bioindicator of diet in kelp crabs under changing ocean conditions.

29 - Using Cooperative Fisheries Research to Co-design an Observatory for Early Warning of Harmful Algal Blooms off the Oregon Coast

† Wood, T.J.*; George, K.; Kent, A.; Cramer, L.A.; Kavanaugh, M.T.

Oregon State University

Rapidly shifting ocean conditions in the Northeast Pacific have the potential to reduce food quality and increase the frequency and severity of harmful algal blooms (HABs). Recent widespread blooms of the toxigenic diatom Pseudo-nitzschia have disrupted commercially and culturally important fisheries in the Northern California Current. To improve early detection of blooms offshore, before toxins accumulate in food webs, we established a cooperative monitoring program with local fishing communities. Fishers collect water samples and environmental data during fishing operations and transit along the Oregon coast. Water samples are analyzed for Pseudo-nitzschia abundance and phytoplankton community composition using imaging flow cytometry. The concentration of domoic acid (produced by Pseudo-nitzschia) in each sample is measured using Enzyme-Linked Immunosorbent Assay (ELISA testing). Data are disseminated to fisherman within days of collection and ingested into regional HAB forecast models for resource managers. This collaboration allows scientists to gain access to offshore observations when access to sea is limited, while fishers emphasize the value of improved HAB forecasts and predictive capacity for their operations. Together, these efforts demonstrate how cooperative research expands the reach of traditional observing systems, strengthens early warning, and increases resilience of coastal communities facing intensifying HAB threats.

30 - Thermal tolerance differences in Lottia digitalis and austrodigitalis cryptic species complex

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University of California, Davis

The occurrence of cryptic species in marine organisms with pelagic larval dispersal is a scientific puzzle. When two cryptic species occupy the same habitat and have no apparent barriers to reproduction, what maintains the species boundary? As genetic analyses have become more prevalent, we are identifying more and more morphologically indistinguishable species pairs that live in sympatry. However, the ecological differences between these species pairs often remain a mystery. Ribbed limpets are a pair of cryptic species (*Lottia digitalis* and *Lottia austrodigitalis*) where the southern species (*L. austrodigitalis*) has been expanding its range north at the expense of the northern species. One hypothesis is that this range expansion has been facilitated by warming temperatures and differences in thermal tolerance between the two species. Additionally, one study found fixed amino acid substitution between the two species in an enzyme relevant to thermal adaptation in many invertebrates. However, there has no comparison of organismal thermal tolerance between the species. We compared thermal tolerances of *L. austrodigitalis* and *L. digitalis* by measuring cardiac performance during a thermal ramp. Limpets were sampled from both within and outside of their zone of sympatry, comparing both break point and flat line temperatures. Our results will shed light on ecological factors that maintain species barriers and how abiotic limits shape species distributions.

31 - Seascape Genomics: Exploring the Evolutionary Responses of Oregon Rockfishes to Climate-Induced Ocean Changes

† Gordon, L.*; Grorud-Colvert, K.; Barreto, F.

Oregon State University

As anthropogenic climate change accelerates, our seas are rapidly warming, destabilizing marine ecosystems. In the Pacific Northwest, rockfishes (Sebastes spp.) are both ecologically and economically important species. Changes in environmental variables, such as sea surface temperature (SST) have been shown to decrease juvenile rockfish survival. Therefore, it is important to quantify how environmental pressures shape the genetic composition of new rockfish cohorts. Seascape Genomics provides a new approach for exploring how environmental features shape the genomes of marine species. By integrating fine-scale oceanographic data with high-thoroughput DNA sequencing, such as low-coverage whole genome sequencing (lcWGS), seascape genomics permits detection of chromosomal regions that may contain genes under selection. Since 2011, the Grorud-Colvert lab at Oregon State University (OSU) has been collecting settling juvenile rockfish from coastal surface waters. This collection have never been analyed genomically, and provides a unique opportunity for quantifying genomic change in rockfishes in Oregon. I aim to explore the following questions: 1) Which environmental variables influence rockfish genetic composition, and 2) how is the genomic composition of rockfish cohorts changing from year to year? I hypothesize that allele frequencies of target species shift significantly over time, corresponding to changes in SST, Oxygen-18, and planktonic biomass due to differential juvenile survival in a population.

32 - The influence of seaweed functional groups and traits on associated meiofaunal community structure in the rocky intertidal zone

† Morris, J.H.*; Smith, J.R.

Cal Poly Pomona

Seaweeds play important roles in structure and functioning of coastal marine ecosystems by shaping food webs and providing habitat. Seaweeds are categorized into functional groups based on morphology indicating their ecological role. Such traits influence photosynthetic rate, susceptibility to herbivory, and nutrient uptake. Form and function also impact their ability to provide habitat, driving the composition of associated fauna. However, it is uncertain whether functional traits of seaweeds are consistent within established functional groups, and if specific invertebrate assemblages are associated with certain functional groups or traits. This can impact meiofauna, which are under-sampled in marine ecological studies. I aim to investigate the relationship between meiofaunal community structure and seaweed functional groups, and whether those relationships are driven by groups or the inconsistent functional traits within groups. Samples were collected from intertidal communities in Palos Verdes, CA from a suite of seaweeds representing six functional groups and across functional groups that vary in specific traits that are essential to meiofauna. All invertebrates were counted and identified to the lowest possible taxon. Using multivariate community analyses and principal component analysis, I explored putative patterns between seaweed groups and traits with their associated meiofaunal communities. This research documents meiofaunal assemblages in rocky intertidal seaweeds and advances our understanding of whether meiofauna are associated with seaweed form and/or traits.

33 - Temporal Patterns in Fish Diversity Vary Across Multiple Spatial Scales Within Southern California Estuaries

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San Diego State University

Estuaries represent morphologically diverse ecosystems that contain various habitat types. These environments are also hydrologically dynamic, with seasonal changes in salinity and temperature leading to abiotic variability across space and time. In response to this dynamic environment, the composition of estuarine fish communities shift seasonally. Even with our current knowledge of estuarine systems, we lack information concerning the specific patterns of habitat use by fish communities and how this interacts with seasonal changes. In order to test this, we surveyed fish communities monthly for one year using Baited Remote Underwater Video Stations (BRUVS) at two

estuaries in San Diego (San Dieguito and Los Penasquitos Lagoon). Estuary patterns within San Dieguito and Los Penasquitos Lagoon were explored at two habitat types (main channel and tidal creek) and two proximities to the ocean (near and far). As confirmed by previous studies, species richness of estuarine fish increased from spring to summer months. This study showed that the strength of this effect varied across all spatial scales. San Dieguito Lagoon displayed stronger seasonality than Los Penasquitos Lagoon, despite only being separated by ~5 km. Within San Dieguito, seasonality was stronger at sites closer to the estuary mouth and at main channel sites. The within estuary patterns were weaker, and sometimes opposite, at Los Penasquitos. These findings indicate that the observed patterns may vary with context, emphasizing the need to understand how critical drivers interact with spatial scale.

34 - Impacts of Urbanization and Seasonality on Aquatic Nitrogen Sources Using Nitrogen Isotopes of Algae in Monterey County

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Santa Catalina School

Variation in human land use and sewage infrastructure can affect the types and concentration of pollutants entering aquatic ecosystems. Increased sewage levels within these ecosystems may result in abnormally high nitrogen levels, leading to eutrophication, and pathogens and toxins that may threaten organism and ecosystem health. Sewage may enter rivers and coastal areas via groundwater, especially when sewage treatment is limited or sewage lines are damaged. The Carmel and Big Sur Rivers are important habitats for endangered steelhead and Pacific lamprey. While previous monitoring has shown low total nitrogen at many sites, many homes in both watersheds do not have wastewater treatment and there is evidence that some sewage lines for Carmel Area Wastewater District (CAWD) may be damaged. Algal tissue with elevated $\delta^{15}N$ levels was used as an indicator for sewage entering both rivers. We expected evidence of sewage input into both rivers especially in lower reaches. Compared to samples from upper reaches with no development (1.55 ‰), sites with higher urbanization levels show sewage inputs on both rivers (n=8; 7.75-11.00 ‰). There was no statistically significant difference between fall and spring sample site duplicates. Preliminary analysis shows that the relationship between $\delta^{15}N$ levels and site distance from golf courses, site distance down river, and housing density in a 500m radius are not significant. While overall nitrogen levels may be low, chronic inputs of low amounts of sewage may have consequences for endangered species and coastal areas near these river outlets.

35 - Lignin Content in Salt-Exposed Loblolly Pines (Pinus taeda) as an Explanation of Reduced Wood Density Using the Acetyl Bromide Method

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Coastal forests in the southeastern and mid-Atlantic regions of the United States experience salinization and hydrologic alterations, leading to inland marsh migration and expanding ghost forests. Despite widespread tree mortality due to salinity intrusion, the processes driving tree decline and death in these systems are not fully known. Recent studies have indicated that salt exposure is associated with reduced wood density in loblolly pine *(P. taeda)*, but the cause of this has not yet been found. We hypothesize that reduced lignin content, a compound that provides protection and rigidity, could be the source of wood density differences. To test this hypothesis, we compared lignin content from trees in the high-elevation forest (>1m, with minimal salt exposure) and low-elevation forest (<0.7m, with high salt exposure) at three locations on the Delmarva Peninsula. We hypothesized that salt-exposed trees at Milford Neck, DE, Monie Bay, MD, and Brownsville Forest, VA have lower lignin content than their less-exposed upland counterparts due to reduced photosynthetic rates associated with salt stress, explaining the lower wood density found in these trees. Samples were collected by coring trees with an increment borer, and a modified acetyl bromide method was used to determine wood lignin content. Samples were restricted to trees with

known wood density and cell morphology. Results from Monie Bay suggest lower lignin content in salt-exposed forest when compared to trees with lower salt exposure. Results from the Delaware and Virginia locations are pending.

36 - Comparing the performance of statistical vs mechanistic models of range dynamics of shortbelly rockfish in California.

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University of California, Santa Cruz

The commercial groundfish fishery contributes over $158 million annually to the U.S. economy (NOAA, 2023). Pacific rockfish (*Sebastes spp.*) are central to this fishery, valued for market importance, distribution, and ecological roles in commercial and recreational sectors. Shortbelly rockfish (*Sebastes jordani*) are a key forage species and frequent bycatch in trawl fisheries, making monitoring essential to prevent ecosystem impacts. Species projections guiding fishery management are often based on Species Distribution Models (SDMs), but these models struggle to capture processes driving distributions, especially under climate change. Our project compares the forecasting accuracy of SDMs with Dynamic Range Models (DRMs) for shortbelly rockfish. DRMs are mechanistic models that use spatial population dynamics to estimate abundance across space and time, making them well-suited for species experiencing environmental variability, high mortality, and fluctuating recruitment. We fit DRMs and SDMs to historical rockfish observations in California and evaluate model performance at out-of-sample forecasting. Results will identify the most effective approach for long-term management. By explicitly linking demographic processes to climate, DRMs show promise for improving predictions of species responses to change.

37 - Effects of Dietary Composition on Physiology and Growth in Two Species of Endangered Abalone

† Wang, E.*

UC Berkeley

Red abalone (Haliotis rufescens) and White abalone (Haliotis sorenseni), locally prized for economic and cultural significance along the coast of California, have both faced drastic population declines in recent decades. Red abalone were recreationally fished until 2017, when the population collapsed following an ecosystem-level decline of kelp forests. White abalone faced decline as a result of overfishing and were listed as ‘Critically Endangered’ in 2001. Both species show few signs of natural reproduction and no evidence of natural recruitment. Aquaculture and captive breeding programs for these species require a food source, which is costly, and historically have included finite resources like wild-harvested kelp, red seaweed, and fishmeal. As a result, there is a need for the development of low-cost but high-value food sources that are available year-round. This project tested pelleted food made with grape byproducts from wine production and insect protein as a more sustainable alternative to conventional feeds. Using both Red and White abalone, this project measured feeding rates, growth rates, and physiological metrics, including metabolic demands, in response to food composition. Results indicate significant effects of food composition and among species on size-specific rates of food consumption, energetic efficiency, growth rates, and metabolism, for a given body size. Results highlight the value of understanding food quality, body size, and species-specific differences in optimizing aquaculture feed for abalone cultivation and captive breeding programs.

38 - Methods comparison using satellite and drone imagery to determine change over time of mangrove cover in Baja California

† Baek, Y.*; Wachira, D.*

Santa Catalina School

Mangrove forests play an important role as faunal nurseries and buffers for coastal communities. Worldwide, estimates of mangrove loss are 20% from 1985 to 2020 Assessing their persistence is a crucial aspect of coastal monitoring efforts. To support conservation in Baja California Sur, we evaluated canopy change over time at six sites from 2018 to 2025 using remote sensing techniques. To map mangrove canopy surface area, we used Sentinel-2 satellite imagery (10m resolution) to calculate the Mangrove Vegetation Index (MVI) and Normalized Difference Vegetation Index (NDVI) in ArcGIS. Both indices quantify vegetation cover, but MVI specializes in the moisture of mangroves. To assess accuracy, we compared MVI and NDVI to high-resolution drone data from a subset of sites collected in 2018 and 2019. Both MVI and NDVI estimated greater surface area than drone results at all 3 sites. However, MVI values were marginally closer to the drone data than NDVI (mean differences of 3.4-36.8% for MVI versus 4.8-81.1% for NDVI). Canopy cover estimates of MVI versus NDVI differed by up to 32.6% (depending on year and site). Using MVI, canopy cover estimates from 2018 to 2025 increased at 5 of 6 sites, decreased at 1 site, and showed no change at 1 site. Further study is needed to identify why one site showed a slight decrease. Future work will also include expanding the spatial and temporal scale of this study, as well as including 2025 drone coverage at 5 sites to continue ground-truthing satellite imagery analysis.

39 - New myzostomids (Annelida) associated with black corals

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Myzostomida is a clade of annelid worms first discovered in the 1820's. Adult myzostomids live as obligate symbiotes, mainly on echinoderms, with a majority being found on crinoids. There are currently 194 myzostome species placed in 15 genera. Myzostomes can live roaming over their hosts and stealing food from their ambulacral grooves, or more cryptically in galls or cysts where they can place their proboscis into the groove for food. Others live in the mouth of their host, or as parasites internally in the coelom or gonad. In 1977 myzostomids were found associated with a sea whip, though this was never formally published. In 2017 another black-coral symbiont was discovered off Madagascar and formally named *Eeenymeenymyzostoma nigrocorallium*. Here three additional species of antipatharian-associated *Eeenymeenymyzostoma* are described and their DNA analysed, including the one originally found off Puerto Rico. The other two new species are from Costa Rica and Indonesia. As part of this study, the mitogenomes of several myzostomid genera will also be analyzed.

40 - Sea Urchin Morphometrics Reflect Kelp Patch Dynamics in a Recovering Forest

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1- Pitzer College 2- The Nature Conservancy

Ecosystem state shifts can cause drastic changes in primary producer dynamics and availability, thereby impacting herbivore morphological conditions. Within kelp forest states, herbivorous sea urchins have been found to exhibit higher gonadal indices and larger test diameters than those found in areas devoid of kelp (i.e. barren states). Although urchin morphology has been tested in kelp forest and barren conditions, the fine-scale dynamics between urchin morphometric conditions and distance from kelp patches and their margins are unknown, especially in a restoration context. This study measured bull kelp patch dynamics in relation to purple urchin harvest locations at an active restoration site on the northern California coast to articulate the relationships between urchin morphometric conditions and proximity to kelp. Kelp canopy cover data was collected at a 3 cm resolution scale to accurately calculate distances between harvest locations and the nearest kelp patch. To determine the size and gonadal indices of urchins harvested from known locations in the restoration area, morphological data collection included wet weight, test diameter, and gonad wet weight. Preliminary results indicate a negative relationship between urchin gonadal indices and distance from kelp, suggesting that proximity to kelp impacts urchin morphological condition within a restoration area. These empirical findings advance our ecological understanding of how primary producer dynamics influence herbivore morphological traits in these systems.

41 - Comparing a novel instance segmentation model with traditional techniques for quantifying sponge percent cover inside reef balls

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Anthropogenic urbanization has drastically reduced the structural integrity of our shorelines, increasing the rate of coastal erosion in the face of rising sea levels. The San Diego Bay Native Oyster Living Shorelines Project deployed 360 concrete reef balls arranged into 6 along-shore arrays aimed at reducing shoreline erosion while simultaneously restoring native Olympia oyster (Ostrea lurida) populations and promoting biodiversity. From personal observation, sponge populations grew expansively in the first two years since reef ball deployment. Thus, we sought to quantify sponge growth while exploring alternatives to labor-intensive, human-conducted surveys, through the use of novel instance segmentation. We compared traditional techniques of measuring coverage with machine learning in terms of accuracy in sponge identification and quantification. We also characterized trends in sponge cover over the years and across tidal elevations. Four percent cover techniques were compared to one control method using photo plots and human-conducted surveys from 2024; we found that machine learning adjusted for lighting/saturation was the most accurate, only differing by 0.62% from the control. Using this technique, we determined that average sponge cover increased 6.3 times from 2023 to 2024 at tidal elevations below 0.6m MLLW. Additionally, a once positive correlation observed between live O. lurida and marine sponge point contact coverage turned negative in 2025, begging the question of whether or not sponges are outcompeting native oysters, which will be addressed in future work.

42 - Invertebrate biodiversity in kelp forests revealed by autonomous reef monitoring structures

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Seattle University

Autonomous Reef Monitoring Structures (ARMS) are standardized tools used to assess the biodiversity of marine ecosystems. ARMS provide an ideal habitat for both sessile and motile species, allowing for a comprehensive sampling of marine invertebrates. This study examines invertebrate biodiversity from two sets of ARMS deployed in kelp forests in the Puget Sound, one in *Saccharina* kelp forests within the Maury Island Aquatic Reserve (MIAR) and one in *Nereocystis* kelp forests within the Cypress Island Marine Reserve (CIAR). Between the two sites, the MIAR ARMS exhibited a higher invertebrate richness. Species composition was markedly different between the two sites, with MIAR samples dominated by annelids and molluscs, and CIAR samples dominated by crustaceans. These findings highlight variations in invertebrate assemblages between these two regions and kelp forest types and the utility of ARMS as a tool to quantify biodiversity in subtidal habitats.

43 - Characterizing the microbial and metabolomic role of calcifiers common to coral reef recovery

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While our understanding of the processes driving coral reef decline grows, there remains a lack of understanding in the mechanisms involved with coral reef recovery. Calcifying organisms and their microbial constituents provide a foundation for coral reef ecosystems by creating structural habitat and recycling essential nutrients, respectively. During coral decline, microbial functions may be lost, impacting the highly coupled exchange of organic carbon and nutrient transformation. This study aims to better understand the roles that surviving calcifying organisms have on a reef's benthic microbial and metabolomic communities, two factors important to the coupled nutrient cycling. Influences on microbial and metabolite community composition were assessed for three calcifying organisms observed on the forereefs of Moorea, French Polynesia: *Millipora platyphylla, Porites lobata,* and crustose coralline algae. The loss of reef building corals in Moorea was caused by a severe marine heatwave in 2019, followed by an outbreak of *crown-of-thorns starfish.* Influences on the microbial and metabolomic community are measured through three mechanisms: 1) microbial density regulation via organismal grazing pressure, 2) classification of the

unique microbial community, and 3) classification of the unique metabolite pool exuded by each organism. This research leverages molecular techniques to better understand the highly coupled process between the benthic microbial community and stabilizing biochemical feedbacks fundamental to reef survival and recovery.

44 - Exploring Interannual Variations in Adult Alewife (Alosa pseudoharengus) Energy Condition as a Proxy for Changing Environmental and Feeding Conditions in the Gulf of Maine

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As ocean temperatures rise due to climate change, the Gulf of Maine has experienced particularly rapid warming, averaging an increase of 0.4℃ per decade over the past 30 years. This shift has altered marine ecosystems and reduced the availability of high-energy prey such as *Calanus finmarchicus*, a key food source for pelagic forage fish like alewife (*Alosa pseudoharengus*). Because alewives spend most of their adult lives feeding in the Gulf of Maine before returning to freshwater to spawn, their energy condition may reflect broader environmental and ecological changes. This study uses specimens collected through the Casco Bay Aquatic Systems Survey to explore interannual and ontogenetic variation in alewife energy condition from 2014 to 2025. Thawed alewives were dissected to collect internal organs. Metrics such as dry weight percentage, Fulton's condition factor, and somatic indices (liver and gonad) will be assessed as proxies for energy density and feeding success. These condition metrics will be compared across years and related to Gulf of Maine sea surface temperature anomalies and food. abundance where available. We hypothesize that larger individuals will exhibit higher energy condition and that fish from earlier, cooler years will have higher energy reserves than those from more recent, warmer years. Results from this study will contribute to our understanding of how climate-driven changes in marine food webs influence forage fish condition and may support the use of alewife as a sentinel species for monitoring ecosystem change in the Gulf of Maine.

45 - Evaluating the Efficacy of Passive eDNA Sampling for Biodiversity Monitoring in Yucatán Cenotes

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Cenotes of the Yucatán Peninsula represent ecologically and culturally significant ecosystems that are increasingly threatened by pollution, anthropogenic stressors, and climate change. Effective monitoring of their biodiversity is essential but often limited by the logistical and ecological challenges of traditional methods such as visual census surveys or net capture. Environmental DNA (eDNA) has emerged as a powerful, non-invasive tool for biodiversity monitoring, yet most applications involving aquatic ecosystems rely on active water filtration, which can be time-intensive and difficult to scale. In this study, we evaluate the efficacy of passive eDNA (PEDS) samplers, deployed both as fixed-point stations and mobile diver-attached samplers to assess fish biodiversity across cenotes from three regions in Yucatán (Riviera Maya, Eastern Yucatán, and Western Yucatán). We integrate passive eDNA sampling approaches with active eDNA water sampling to compare detection rates and how cenote architecture and hydrology may influence DNA signals. By testing multiple adsorbent materials (cotton and multi ester cellulose) across cenotes, this research examines both the reliability and practicality of passive eDNA as a community-based biomonitoring tool. Beyond biodiversity assessments, sequence data generated from eDNA will provide a foundation for phylogeographic studies of cenote fishes, allowing us to explore genetic structure and connectivity across this fragmented karst landscape. Our findings will advance non-invasive methods for monitoring fragile karst aquifers while building

46 - Investigating Leatherback Sea Turtle Foraging Strategies and Preferences for Scyphozoan Jellyfish in Coastal Ecosystems

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The Western Pacific stock of leatherback sea turtles (*Dermochelys coriacea*) is a distinct population of an endangered species that migrates thousands of miles to forage in central California waters, where jellyfish are a primary food source. Jellyfish vary in energy density, which may shape leatherback foraging habits. This study measures the caloric density (kJ/g) of four common prey species: *Chrysaora fuscescens*, *Chrysaora colorata*, *Phacellophora camtschatica*, and *Aurelia labiata*, to test if differences influence foraging. We hypothesize that values vary among species and body regions, with robust species such as *C. fuscescens* and *C. colorata* containing higher energy than gelatinous species like *P. camtschatica* and *A. labiata*. Jellyfish were collected from Monterey Bay and the Gulf of the Farallones and analyzed using a Parr 6100 bomb calorimeter. For two species, specimens were divided into five regions (bell, oral arms, manubrium, stomach, gonads), while *P. camtschatica* and *C. fuscescens* were analyzed whole. Preliminary results show *C. fuscescens* and *C. colorata* have higher caloric density, especially in gonadal and stomach tissues, while *A. labiata* and *P. camtschatica* are uniformly low. Replication includes five individuals per species. Data will be analyzed using ANOVA with post hoc tests to compare species and regions. This research highlights how prey quality may shape leatherback foraging and informs predictions about effects of shifting jellyfish populations.

47 - Improving cell culture conditions for proliferation of *Botryllus schlosseri* epithelial cells

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Despite decades of research, the development of methods to reliably generate cell culture systems for marine invertebrates has been challenging. There are currently only a few marine invertebrate cell lines available compared to the thousands that exist for vertebrates. *Botryllus schlosseri* is a colonial tunicate species found globally and is a close relative to vertebrates. We sought to improve medium formulation to support the proliferation and longevity of *B. schlosseri* epithelial cells *in vitro*. Previous attempts have yielded low cell growth of only ~30 cells per seeded tissue and senescence within a few days. For this study, wild colonies of *B. schlosseri* were collected from local marinas followed by microdissection of zooids and buds for primary explants. We tested various ratios of complete medium to seawater while controlling for total osmolality. We found that 75% medium with 25% seawater (75/25) and 50% medium with 50% seawater (50/50) yielded the most consistent growth and highest number of cells within a 5 day period. We ultimately selected the 50/50 medium formulation and harvested cells at 1, 3, and 5 days for bulk RNA sequencing and proteomics. Future work will characterize the molecular phenotype of *B. schlosseri* epithelial cells *in vitro* and use this information to further optimize their proliferative capacity. Funding provided by NSF MCB-2127517.

48 - Metabolic Responses to Unpredictable Heat Extremes Across the Range of an Estuarine Sea Slug

† Leem, J.M.[1*]; Aghajani, E.[2*]; Tanner, R.L.[2]; Wyllie-Echeverria, S.[3]

1- Whitman College 2- Chapman University 3- University of Washington

Phyllaplysia taylori, a grazing sea hare found in *Zostera marina* (eelgrass) meadows along the Pacific coast of North America, promotes seagrass health by consuming epiphytic algae that hinder photosynthesis. These eelgrass beds provide valuable ecosystem services including carbon storage, shoreline protection, and nursery habitat for marine species. However, rising ocean temperatures pose a threat to the grazer-seagrass dynamic. To explore the thermal sensitivity of *P. taylori* (and their reproduction, see Aghajani et al. poster), individuals collected from Friday Harbor, WA and Cabrillo Beach, CA were subject to a 3-week experimental acclimation to five thermal regimes representing differing frequencies and durations of heat extremes. We generated metabolic performance curves of oxygen consumption at three temperatures representative of average coastal conditions (13°C Friday Harbor/15°C Cabrillo Beach), a heat extreme (25°C/27°C), and an intermediate temperature (19°C/21°C). In both populations, metabolic rate increased with temperature, suggesting higher energetic demand under warming. *P. taylori* from Friday Harbor exhibited consistently higher respiration rates at all treatment levels compared to

Cabrillo. These results indicate that northern *P. taylori* may respond more metabolically to warming conditions, which could influence their grazing behavior and, in turn, the health of eelgrass ecosystems. This work highlights the need to better understand regional physiological variation as stochastic climate stressors intensify.

49 - Effects of Fine-Scale Nitrate Stress on Early-Sporophyte Blade Morphology and Recruitment of *Macrocystis pyrifera*

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Macrocystis pyrifera (M. pyrifera) is an important species of brown macroalgae that form productive kelp forest ecosystems along a range of coastlines with cool, nutrient-rich waters. Studies evaluating the response of kelp forest canopies to marine heat waves in Southern California have shown adult sporophyte *M. pyrifera* can withstand extended heat stress, yet the effect of nutrient variation on recruitment and physiology of early sporophyte *M. pyrifera* is poorly understood. Nutrient availability (nitrate) in California is largely mediated by upwelling and is associated with low temperatures, but this is decoupled in British Columbia. To understand the potential effects of variable nutrients on juvenile sporophyte recruitment and physiology in a decoupled nutrient-temperature regime, we performed a fine-scale manipulation of nitrates (1-12 uM) under favorable temperature (12 C) available to post-zygote *M. pyrifera* and recorded changes in population density and blade morphology. Initial results show insignificant variation of *M. pyrifera* population density between treatment groups, indicating that recruitment of sporophytes may withstand mid-to-low nutrient variation under favorable temperatures. Pilot study results also showed changes in blade morphology associated with variable nitrates. We will present an analysis of *M. pyrifera* dimensions among 1-12 uM NO_3^- conditions alongside survivorship statistics to illustrate potential impacts of nitrate stress on immature sporophyte *M. pyrifera* morphology.

50 - Influences of brittle star beds on mesophotic rocky reef fish communities

Kolda, J.F.*; Carlson, P.M.; Jainese, C.J.; Caselle, J.E.

UC Santa Barbara

Marine protected areas (MPAs) are designated regions of the ocean designed to protect marine habitats from extractive human activities, namely fishing. Monitoring MPAs is essential for evaluating their effectiveness and a critical component of effective adaptive management. Mesophotic (30–100 m) rocky reef fishes are valuable recreational and commercial resources; however, they are largely understudied due to depth restrictions of common sampling methods. Baited remote underwater video (BRUV) surveys conducted at two sites in California's statewide MPA network and their paired reference areas have proven effective for monitoring mesophotic reefs. Prior work has shown MPA status, depth, and habitat to be strong predictors of abundance and biomass for targeted fish species. Here, we highlight the presence of ophiuroid beds as an additional predictor of fish abundance and biomass. Assessing benthic composition in existing video surveys, we found that demersal fish biomass was lower in surveys where brittle star beds were present. By incorporating brittle star bed presence into BRUV analyses, we demonstrate that benthic composition, particularly dense ophiuroid aggregations, can influence demersal fish biomass. Accounting for this factor can enhance the utility of BRUV surveys as a tool for MPA monitoring by directly linking environmental observations with fish abundance and biomass data.

51 - Effects of Sediment Grain Size and Shell Length on the Burial Rates of Pismo Clams (Tivela stultorum) in the Monterey Bay

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CSU Monterey Bay

This Pismo clam (*Tivela stultorum*) was once a prominent fishery species along the California coast, from Monterey, California to Baja California, Mexico. However, overexploitation of the species led to a large population collapse during the 1990s. Although numerous laws and regulations have been implemented to help the recovery

of this species, much of the enforcement is self-regulated, and illegal harvesting has increased in recent years. In addition, due to their slow recovery and growth in the Monterey Bay, there is a substantial knowledge gap regarding the basic biology of Pismo clams, especially regarding the time it takes a clam to fully bury into the sand, also known as their burial rate. Since Pismo clams inhabit the sandy intertidal and subtidal, their ability to bury themselves efficiently into the sand is critical for their survival, protecting them from wave action, desiccation, and predation from animals such as shorebirds and the southern sea otter. In this project, we aimed to explore the relationship between sediment size and burial rate behavior across clams of different sizes. Pismo clams of various sizes were collected from Manresa State Beach and placed into tanks in order to test burial rate under different sediment habitat conditions. Burial rate of younger, smaller clams were faster to bury in coarse sediment conditions compared to larger clams. These results will provide insight into the optimal geological habitat conditions that could assist in the reestablishment and recovery for local Pismo clam populations in the Monterey Bay.

52 - The striped shore crab in estuaries is loaded with diverse parasites, most of which transmit to bird, fish, & shark/ray predators

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The striped shore crab, Pachygrapsus crassipes, is one of the most common animals in California estuaries, functioning as an ecosystem engineer and a key player in the food web. However, the crab's parasitism remains poorly understood. This is unfortunate because parasites can substantially impact their hosts, with ripple effects in the food web, making it critical to understand the crab's parasitism to understand its ecological role. Therefore, at three California/Baja California estuaries, we quantified parasite load and diversity in 559 individual crabs. Sixteen parasite species were detected, spanning various taxa and functional groups: trophically transmitted parasites, parasitic castrators, typical parasites, and pathogens. The parasite assemblages were dominated by trophically transmitted parasites that use crab predators (teleosts, elasmobranchs, or birds) as final hosts; most of these parasites were trematodes that transmit to birds and which infected 96% of crabs with 1-4600 individuals/host. Although parasitic castrators were rare (infecting 2% of crabs), their large body size led them to dominate parasite biomass and energy flux in infected hosts. Parasite abundance, biomass, energy flux, and diversity strongly increased with crab size, but then decreased in largest crabs, possibly reflecting increased predation on highly infected crabs given behavior manipulation by trophically transmitted parasites. This diverse, variable yet omnipresent parasite community indicates diverse and important effects on P. crassipes performance and its role in estuarine food webs.

53 - Increasing the Range and Accuracy of a Remote Shark Tag Relay Station

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Many types of biologging tags used on marine fishes and sharks collect large amounts of data and are designed to pop off after a certain amount of time. In order to locate and recover these tags with the data in memory, the tags are fitted with a radio beacon. The Ocean Predator Ecology currently uses a radio beacon relay station fitted with an omnidirectional antenna to detect local radio signals from shark tags that have surfaced and are ready to be retrieved. The station then sends a text message and updates a cloud database with the time the signal was received and the approximate location. The current process to find the exact location of the tag is very time intensive, involving multiple people manually scanning with directional antennas across the water to triangulate the location of the tag. By adding a directional antenna at the relay station that can be remotely-controlled, researchers can get a much better approximation of the location of the tag, reducing time in the field needed to find and retrieve the tag and its stored data. Because the current remote antenna is omnidirectional, both the range and precision

for locating released tags are limited. Including a remotely-controlled directional antenna will increase the range for detecting signals from surfaced tags, and allow for tracking of tags that may have been carried further away by ocean currents, and overall reduce the amount of field hours required to retrieve a tag.

54 - Microbial Biofilms Promote Settlement for the Invasive Bryozoan, *Watersipora sp.*

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Biofouling, the attachment and growth of organisms onto submerged surfaces, poses problems for ocean-based industries. Encrusting bryozoans in the genus *Watersipora* significantly affect community structure when present. The use of *Watersipora* for testing antifouling coatings requires understanding their optimal settlement conditions. An important consideration for bryozoan settlement are microbial biofilms (MBs) and, to our knowledge, no studies have definitively shown how long biofilms must be developed for quick settlement of *Watersipora* larvae. Therefore, we examined whether the duration of acetate exposure affects settlement time of *Watersipora* larvae. We exposed acetate sheets for 0, 3, 6, 12 or 24 days (d) to unfiltered flowing seawater. We exposed larvae to these substrates and observed the amount of settlement over time (n=4). We hypothesized larvae would settle fastest on acetate exposed for 24 d, and settlement would correlate to the MB development time. We observed significantly faster and higher average settlement of larvae on acetate exposed for 24 d and 12 d than other treatments ($p<0.05$). The 6 d exposed acetate surfaces had the next highest larval settlement times, significantly higher than settlement on acetate exposed for 0 or 3 d, which were not significantly different from one another ($p>0.05$). These data show we can limit our preexposure of test substrates to 12 d for future experiments testing antifouling coatings. Biofilms were sampled, frozen at -80°C and will be used to determine the microbial community structure.

55 - Evaluating Plant Growth and Success of a Miyawaki Microforest within an Urban Mediterranean environment

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Forests provide critical ecosystem services, including erosion control, air filtering, and thermal regulation. Urban areas are often most in need of these services, but suffer from space constraints. Microforests, small and dense forests packed with diverse native plants, can be an effective solution for maximizing ecosystem services in cities. However, more research is needed to understand the factors that impact the success of microforests in Mediterranean climates, where they remain understudied. We monitored a microforest in Los Angeles created with the Miyawaki method, which utilizes a high density of randomly distributed plant species with different growth strategies. We leveraged repeated community observations, field measurements, and drone monitoring to evaluate the success of individual plants in the microforest based on their height, coverage, health, and growth rate. We then assessed how plant success varied with location (i.e., edge effect), plant neighbors (i.e., average height and coverage within a 1m buffer of each plant), and species density. The microforest showed a high success rate, with a ~99% survival rate within the first 18 months. Our preliminary analyses suggest that proximity to the edge of the microforest does not significantly impact plant survival. Additionally, our analysis indicates that plant neighboring coverage impacts success for certain species, with significant correlations between the height of herbaceous perennials, shrubs, and vegetation cover within 1-m buffers. Most significantly, we noticed a large difference in plant success betw

56 - Lasting effects of bleaching: How prior thermal stress shapes coral physiology and resilience

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Understanding how organisms respond to repeated environmental stressors is central to predicting resilience in the face of climate change. In reef-building corals, exposure to acute thermal stress can lead to bleaching; however, not all individuals respond in the same way. Increasing evidence suggests that prior exposure to stress can influence coral responses to subsequent events, either by enhancing resilience through acclimatization or by compounding damage if recovery is incomplete. In this study, we investigate how prior bleaching history influences coral growth, physiological stress responses, and gene regulation during a simulated heatwave following a natural thermal stress event. Corals were grown in a common garden environment and monitored through a natural bleaching event then subjected to a controlled heat stress experiment a year later. Corals that bleached and recovered were labeled as “resilient” while corals that did not bleach were considered “resistant”. Preliminary results suggest that prior bleaching has lingering effects reflected in both physiological stress responses and long-term growth and energy reserves. Notably, resilient corals grew less and were still producing significantly increased antioxidant levels even under control conditions compared to resistant corals. By exploring coral recovery and re-exposure dynamics, this study highlights the potential for stress memory and lingering physiological effects of past bleaching to influence resilience in an era of increasingly frequent marine heatwaves.

57 - Community-led projects address impact of marine debris in coastal Alaska

Taradash, A.C.*; Eckert, G.L.; Cain, M.R.

Alaska Sea Grant

Marine debris is a perennial issue facing many North American coastal communities and habitats. Alaska faces unique marine debris issues due to its vast and remote coastline. The many rural, isolated communities along Alaska’s coast often struggle to address local marine debris due to the high cost and difficulty of waste management logistics. To help address the challenges of local marine debris cleanup in Alaska, Alaska Sea Grant is supporting twelve community-led marine debris projects around the state that include debris collection, monitoring, analysis, transport, reuse, recycling and disposal. Two projects that started last year have removed over 10,000 and 5,500 pounds of debris around Baranof Island and in Prince William Sound, respectively. All projects center community involvement and education—key goals identified in the Alaska Marine Debris Action Plan—by engaging commercial fishers, students, and other community members in the cleanup process and informing them on marine debris and its impacts. Through continued project funding, Alaska Sea Grant aims to support communities in solving critical waste issues while increasing local awareness and knowledge of marine debris.

58 - Mapping Environmental Equity: A GIS-Based Assessment of Green Spaces, Nature, and Urban Temperatures in San Diego County

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Urban green spaces provide critical ecosystem services critical to physical and psychological well-being. Access to these benefits is often unevenly distributed across urban populations, reflecting histories of racial and socioeconomic inequity. Previous studies have found that low-income households, elderly residents, and racial minorities frequently have limited access to green areas, despite being more dependent on these spaces for thermal comfort, recreation, and well-being. This study examines the spatial equity in access to urban greenspaces and their cooling services across San Diego County. We use InVEST’s Urban Nature Access and Urban Cooling models to estimate nature access and cooling capacity within each census block using geospatial data. We then calculate for each census block the available green space area per resident as well as the proportion of each census block that is within a walking distance of a green space. Finally, we perform multiple linear regressions to assess the relationship between access to green space, cooling capacity, age, and race. We find that areas with higher proportions of racial and ethnic minority residents often experience lower per capita access to public and private green space and thus reduced cooling benefits. Historical land use patterns and legacy effects—including

redlining—possibly contribute to these spatial disparities. Total green area did not significantly correlate with temperature, however, it was significantly correlated with cooling capacity. These findings underscore the need for equity- and community-centered plan

59 - Competition between two globally invasive bryozoans

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Cheilostome bryozoans in two genera (*Watersipora* and *Schizoporella*) comprise several of the most important globally invasive marine species, but their interactions have rarely been explored in California coastal waters. *Schizoporella* colonies present in Humboldt Bay are here putatively identified as *Schizoporella japonica*, a species native to East Asia that has gained traction as a relatively cosmopolitan invader, especially in Europe and North America. Given that the two genera occupy a similar niche and habitat in marine fouling communities, there is likely some degree of competition between them. To explore this, 20 panels with 30 transplanted colony fragments (10 pairings of both genera plus 5 replicate lone colonies from each genus) were placed under the docks at the Eureka marina in Humboldt Bay, CA. Panels were cleaned weekly to remove unwanted settlement from other animals such as tunicates and photographed. Results from 5 weeks of growth show multiple zooidal budding directions, including frontal budding in *S. japonica*, often along the broken edge of cut and pasted fragments despite having part of the original growing edge which remained intact. In general, *S. japonica* recovered from cutting and pasting significantly faster than *Watersipora* colonies by budding in multiple directions from cut edges. Nevertheless, early results suggest the slower growing *Watersipora* overgrows *S. japonica* for unknown reasons, reflecting its dominance on docks in Humboldt Bay.

60 - Phylogenetic analysis of Caribbean and Pacific Hydrolithon species

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Cal State University Northridge

Crustose coralline algae species are critical primary producers in coral reef ecosystems, however their diversity is still poorly understood. The genus *Hydrolithon*, which plays a crucial role in facilitating coral recruitment, is no exception. Interestingly, *Hydrolithon* species from the Caribbean have been synonymized with species from the Pacific, emphasizing the gaps of knowledge surrounding the understanding of *Hydrolithon* genetic diversity. To clarify the genetic relationships within the *Hydrolithon* genus. Samples were collected from coral reefs in the Caribbean and Moorea (French Polynesia). DNA from each sample was extracted, amplified for the psbA gene region (1000 bp of the chloroplast genome), and sequenced on a sanger sequencer. The resulting sequences were aligned and a Maximum Likelihood phylogenetic tree was created with RAxML. The phylogeny shows three distinct clades, with two coming from the specimens from Moorea and another clade that contained both Caribbean and Pacific individuals. These results suggest multiple species in the *Hydrolithon* genus, and more research will be conducted to the species diversity of this genus to inform conservation strategies that better protect these critical coral reef community members.

61 - Quantifying the effect of benthic cyanobacteria mats on coral reefs in the Caribbean and South Pacific

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Historic records from coral reefs in the Caribbean and South Pacific suggest benthic cyanobacterial mats (CBM) are increasing in abundance. In 2025, surveys of reefs (<10 m depth) in Moorea, French Polynesia, and St. John, US Virgin Islands, showed CBMs covered 3.1% and 7.1% of reef surfaces, respectively, and while coverage has not increased since 2006 in Moorea, they increased 0.1%/y at one site in St. John from 1996 to 2023. In both locations, CBMs occurred as mats 0.01–7 m in diameter that grew over coral colonies within their bounds. In 2025, only 6% and 5% of coral colonies in the back reef (Moorea) or on fringing reefs (St. John) were overgrown by

CBMs, but overgrown corals were impacted. In Moorea, manipulative experiments showed massive Porites spp. corals from the back reef covered by Oscillatoria-dominated CBMs became pale within 7 days, and in aquaria, the same CBMs reduced photosynthetic efficiency (Fv/Fm) of algal symbionts in corals within 10 days; these results show CBMs can negatively affect corals. In St. John, coral color analyses demonstrated colonies beneath CBMs were paler than colonies on the open reef, with this effect differing among coral species and being strongest for Siderastrea. Geo-location of mats over 0.03 km2 of St. John reefs demonstrated CBMs were significantly clustered and most common at the downstream site; these results suggest CBMs might locally proliferate through flow-mediated dispersal. Together these results suggest CBMs are an emerging threat to tropical scleractinians on shallow coral reefs, particularly in the Caribbean.

62 - Predation on Juvenile Sea Urchins as a Potential Mechanism for Kelp Forest Ecosystem Persistence

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1- California State University Monterey Bay 2- Moss Landing Marine Labs

Central California subtidal kelp forests provide essential habitat for marine organisms and ecosystem services for coastal populations. Large-scale disturbances combined with overgrazing by *Strongylocentrotus purpuratus*, the purple sea urchin, can cause kelp forests to shift to an alternative stable state known as an urchin barren. The mechanisms that cause the shift have been well studied, yet mechanisms that lead to the concurrent urchin population boom are less understood. To investigate predation on juvenile sea urchins as a potential mechanism to regulate urchin populations, this preliminary work aimed to answer three questions: what predators eat juvenile urchins, how are juveniles distributed, and how does mortality differ between habitats. Underwater visual surveys quantified the abundance of juvenile urchins (< 2cm) and putative predators in kelp forest and barren habitats, which indicated increased densities of juveniles near adult conspecifics and in plots with elevated cover of articulated coralline algae. Controlled laboratory studies determined which predator species were capable of consuming juvenile urchins, revealing one predator, the bat star (*Patiria miniata*). An in situ experiment quantified mortality of juveniles in multiple habitats, which showed no differences in mortality between habitats but followed a pattern or refuge-related survivorship. This preliminary study begins to lay the foundation for how top-down control can impact the juvenile stage of an important grazer.

63 - The ecological role of *Pterygophora californica* during unprecedented kelp forest loss in northern California

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In northern California, the loss of keystone predators, combined with unprecedented ocean warming has led to the collapse of > 90% of bull kelp (*Nereocystis luetkeana*) forests and the expansion of urchin barrens. However, woody kelp (*Pterygophora californica*, a long-lived understory kelp, can persist in transition zones and provide structural complexity, primary productivity, and habitat stability in the absence of bull kelp. To determine woody kelp's role as an alternate foundation (AF) species, I conducted surveys in barrens, bull kelp forests, and woody kelp zones and quantified the biodiversity and community structure in each. Then to understand why woody kelp persists in transition zones, I conducted a four choice feeding experiment between bull kelp and woody kelp blades and stipes to determine how resistant each species is to grazing by the purple urchin (*Strongylocentrotus purpuratus*). The objectives of this study were to determine if (1) woody kelp can serve as an AF species, supporting more biodiversity than barrens; (2) the community assemblage will differ between each zone; (3) the succession of kelp forests to urchin barren is driven by palatability, and woody kelp is less palatable than bull kelp. Preliminary results suggest woody kelp zones have more diverse assemblages than barrens and greater resistance to urchin grazing. Current restoration in northern California only focuses on the canopy forming kelp bull kelp, but future restoration should include other more resilient foundation species like woody kelp.

64 - Physical-Ecological Dynamics Shaping Coral Community Structure in the Back Reef of Moorea's Lagoon

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Understanding small-scale, high-frequency ocean temperature variability and its physical drivers is important for coral reef conservation and restoration because this variability influences corals' response and exposure to heat stress. As thermal stress events increase in intensity and frequency, these dynamics will establish the benthic communities of future reefs. Here we present an analysis of temperature data continuously collected at back reef sites 1 km apart surrounding the island of Moorea, French Polynesia since August 2021 by investigators at the Moorea Coral Reef Long Term Ecological Research site. These data exhibit within-island variability (~1°C difference in daily temperature range, DTR) but minimal difference in mean temperature, presenting an opportunity to assess how fine-scale thermal dynamics influence coral community structure within a single habitat type. To explore potential drivers of thermal variation, current velocity in the back reef was measured via surfzone drifters. Percent benthic cover, coral genus diversity, and colony size were estimated through benthic surveys in the austral winters of 2024 and 2025. Sites with higher DTR exhibit stronger diurnal and semidiurnal temperature signals, likely influenced by differences in water residence time and flow variation across shallow reef flats. Moorea's back reef exhibits heterogeneity in both coral community structure and physical dynamics, illustrating the importance of identifying local drivers of DTR and investigating how thermal variation impacts coral community variation at a kilometer scale.

65 - Assessing late-summer growth rates of Hedophyllum nigripes across Macrocystis pyrifera and Nereocystis leutkeana forest types in Sitka, Alaska.

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UC Santa Cruz

Along the west coast of North America, kelp forests are mainly characterized by two dominant canopy-forming species, Giant Kelp *Macrocystis pyrifera* and Bull Kelp *Nereocystis leutkeana*. Seasonal variations in life cycles and canopy biomass of *M. pyrifera* and *N. leutkeana* can induce fluctuations in light availability, consequently driving temporal changes in understory algal biomass and productivity. While seasonal growth rates of understory algae have been documented in *M. pyrifera* forests, there is limited understanding of how these rates compare to *N. leutkeana* forests. This study aims to quantify the specific growth rate of understory alga *Hedophyllum nigripes* during late summer in Sitka, Alaska, and to compare growth dynamics across three kelp forest types: *M. pyrifera*, *N. leutkeana*, and mixed forests. Biomass, specific growth rate, light availability, temperature, and community composition were recorded across nine sites in Sitka Sound. We hypothesize that biomass and specific growth rates of *H. nigripes* will be highest in *N. leutkeana* forests and lowest within *M. pyrifera* forests due to differences in light availability. Understanding the growth dynamics of *H. nigripes* , an important algal species for many benthic grazers, can have implications on food availability. Furthermore, assessing variation in *H. nigripes* growth rates between two foundation species is crucial to understanding differences in ecosystem productivity and the biophysical mechanisms driving community composition.

66 - Testing Physiological and Biocultural Effects of Ocean Warming and Food Quality for Climate-resilient Sea Urchin (*ƛ̓*u*c̓*up) Harvest

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1- Simon Fraser University 2- Ka:yu:'k't'h'/ Che:k'tles7et'h' First Nations

Sea urchin population dynamics and spatial distribution are directly and indirectly affected by predation and ocean warming. On the west coast of Vancouver Island, sea urchin (ƛuc̓up, *Strongylocentrotus spp.*) harvest is important for the food security and cultural continuity of Ka;'yu;'k't'h' Che:k'tles7et'h' First Nations (KCFN). However, since the reintroduction of sea otters–a key predator of urchins–within KCFN territory approximately 50 years ago, urchins have been largely absent and unharvestable. In response, KCFN seeks to undertake urchin transplant efforts that, in addition to bringing back harvesting for the Nations, incorporates climate mitigation strategies to restore balanced mosaics of urchin- and kelp-dominated reef habitats. In collaboration with KCFN, we seek to explore how ocean warming and urchin food quality (turf algaes vs. kelps) affects urchin ecophysiology and value for people through a factorial mesocosm experiment. We will test how ocean warming and food quality affects physiological indicators of thermal stress, gonad development, and gonad nutritional quality. Through community tasting events, we will also test effects on biocultural indicators of urchin quality and KCFN Member's confidence in consumption. By integrating biological indicators of urchin health and development with socio-ecological indicators of urchin quality, we aim to support the return of resilient, harvestable urchin populations to KCFN territory while identifying strategies to sustain or improve palatability and nutritional quality.

67 - Diving into Temporal Variability in the Kelp Forest Community at Hopkins Marine Station

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1- Moss Landing Marine Labs 2- NOAA MBNMS 3- CSU Monterey Bay

Ecosystem-based monitoring is essential for characterizing community structure and population assessments. Visual surveys are the backbone of kelp forest monitoring; they provide quantitative, long-term data on fish, invertebrates, and algal assemblages. Due to the dynamic nature of subtidal ecosystems, there are limited windows when monitoring can occur based on field conditions. Typically, assessments are annual because surveys are intensive and require extensive diver training and taxonomic expertise. The objective of this research is to determine the intrannual variation of community structure in central California giant kelp forests. Monthly scuba-based visual surveys were performed across eight months at protected kelp forests at Stanford's Hopkins Marine Station (HMS), in Pacific Grove, California. Visual surveys followed the established Partnership of Interdisciplinary Studies of Coastal Oceans (PISCO) protocols. Six 30 m transects were performed along the permanent cable at HMS to quantify invertebrates, algae, and fish.These monthly surveys captured temporal trends in kelp forest community composition. However, visual surveys are limited by diver bottom time, taxonomic ID expertise, and identifying cryptic or rare taxa in low visibility conditions. Future work will compare, contrast, and combine environmental DNA (eDNA) metabarcoding data, extracted from water sampled along the same transects, to assess if molecular approaches complement visual surveys, with the goal to enhance long-term kelp forest monitoring strategies.

68 - How do riverine construction events affect overall parasite abundance?

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1- University of Washington 2- Neumann University 3- New Mexico State University 4- University of California Santa Barbara 5- University of New Mexico 6- Hasselt University

Urbanization brings many environmental changes, particularly to major river systems. In the Rio Grande, these changes include channelization via dams, levees, and irrigation ditches. Damming efforts alter flow rate, sediment deposition, and downstream riparian habitats, directly affecting wildlife and altering local parasite abundances above and below dams, with benefits to some taxa and detriments to others. However, levee construction events, which reduce floodplain habitats, channelize rivers, and alter sediment deposition, remain understudied with respect to their impacts on parasitic communities. We hypothesized that levee construction would negatively affect parasitic abundances found within and downstream of levee systems. Our team performed parasitological dissections of 931 fluid-preserved fish collected along the Albuquerque Middle Rio Grande (MRG) between 1938-2010. We then identified MRG levees from the National Levee database, and using collection information on when

and where fish samples were collected, classified each fish by collection location relative to a levee (above, within, below) and collection period relative to construction (before, during, after). Our analysis found that, irrespective of timing or location relative to a levee, there was no significant effect of levees on parasite abundance within fish along the MRG. In this system, levees alone appear to have no detectable impact on parasite populations compared to what we would expect to see with other river modifications, such as dams.

69 - Interactive Effects of Ocean Acidification and Light Limitation on Eelgrass (*Zostera marina*) Physiology

† Miller, R.L.[*]; Hovel, K.A.

San Diego State University

Anthropogenic stressors are ubiquitous in marine ecosystems and may disproportionately affect communities when they impact habitat-forming foundation species. Eelgrass (*Zostera marina*) is a widespread coastal foundation species that enhances biodiversity, stabilizes shorelines, provides refugia, and sequesters carbon; however, it is threatened by multiple stressors, including reductions in light levels due to factors such as sedimentation and algal proliferation. Increasing atmospheric CO_2 is also driving ocean acidification (OA), which alters seawater chemistry and may affect eelgrass physiology. We conducted a mesocosm experiment to examine the interactive effects of light limitation and OA on eelgrass physiology, growth, and survival. Our experiment used an Arduino-based pH monitoring and control system to expose transplanted eelgrass shoots from San Diego Bay, California, to fully crossed combinations of sunlight (ambient and 50% reduction) and pH (ambient and 0.3 units below ambient). We measured leaf extension, quantified shoot survival, and collected above- and below-ground tissues to quantify leaf and rhizome carbon, nitrogen, non-structural carbohydrate (NSC), phenol, and fiber content. Reduced light decreased growth and above- and below-ground biomass, while OA increased growth and below-ground biomass only in ambient light. Understanding how these simultaneous changes influence eelgrass at the physiological level is essential for predicting the future persistence of this foundation species and the ecosystem functions it supports.

70 - Return Of The Kelp: a how-to guide for constructing the Array to Recover Kelp Ecosystem Vegetation (ARKEV)

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Bull kelp (*Nereocystis luetkeana*) is a foundation species in temperate nearshore marine environments that provides food, habitat, and ecological structure for a diverse community. On California's North Coast, 96% of bull kelp forests have disappeared due to multiple stressor events, which have culminated in an ecosystem imbalance and a phase shift from kelp forests to sea urchin barrens. This shift has resulted in devastating ecological and economic impacts. After years of testing various kelp enhancement techniques (e.g., green gravel, spore bags, seeded lines), our team experienced limitations in scalability and maximizing restoration outcomes. In response, we developed the Array to Recover Kelp Ecosystem Vegetation (ARKEV)- a highly scalable, cost-effective, and open-coast appropriate restoration tool designed to enhance spore availability, provide habitat, and facilitate detrital cycling to suppress sea urchin foraging behavior. We describe the results of ARKEV performance at two locations in Mendocino County, along with resources developed (i.e., blueprints and a how-to guide) for constructing ARKEVs to accelerate the pace and scale of learning and kelp recovery efforts.

71 - Behavioral and Physiological Response of the Mediterranean Mussel (*Mytilus galloprovincialis*) to Acute Hypoxia and Food Supply

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Low-inflow estuaries in Southern California are characterized by frequent inlet restrictions or closures in which water circulation is drastically reduced. This leads to vertical stratification in the water column, with deeper water layers often experiencing hypoxic events. The mussel *Mytilus galloprovincialis* is ubiquitous amongst Southern California estuaries, providing habitat structure and heterogeneity in areas with available hard substrate. While aerially exposed mussels are known to close their valves during emersion events, subtidal mussels may opt to continue to gape and filter feed if ample food is present, despite risk of hypoxia. To investigate this potential trade-off, we conducted a laboratory experiment simulating an acute hypoxic event (<2 mg/L DO for 3 hours), with and without a constant supply of microalgae. We compared valve gape, heart rate, and filtration patterns under both conditions. The results from this experiment provide insight into the behavioral and physiological strategies mussels make to survive in dynamic estuarine environments.

72 - Greening the grey: Evaluating the ability of novel coastal armouring installations to buffer abiotic stressors

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San Diego State University

Urbanization has led to habitat disruption in intertidal areas, and currently in San Diego Bay much of the harbor shoreline is equipped with rock riprap. However, in order to provide more environmentally-friendly options, the Port of San Diego has installed two preliminary sets of concrete coastal armouring units that can serve as artificial tide pools meant to provide organismal refuge as well prevent coastal erosion. In this project, we looked at how the rates of photosynthesis and respiration in these pools changes the abiotic environment. We collected temperature, dissolved oxygen, and salinity measurements from both 5 and 30 cm depths in high- and mid-shore pools. To measure how dissolved oxygen changes as a result of respiration, we measured water quality parameters before and after covering six randomly-selected tidepools with a black tarp in order to stop photosynthesis. To compare if these units were providing more thermal relief than the nearby riprap, temperature loggers were installed using marine epoxy in exposed, sheltered, and pool microhabitats among the riprap and the concrete units. Our current data shows that there is a positive correlation between dissolved oxygen and respiration, as well as photosynthesis having a strong effect on the availability of oxygen in the pools. Further research is being conducted to provide additional data on how the abiotic factors may shift over the seasons in order to investigate the effectiveness for future installations.

73 - Effect of temperature on strobilation rate of Pacific sea nettles (Chrysaora fuscescens)

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Sea nettle populations have greatly fluctuated over the past two decades; creating worldwide ecosystem shifts. Like many scyphozoan species, *Chrysaora fuscescens* has a biphasic life cycle with both an asexual polyp phase and a sexual medusa phase. When conditions are optimal, reproductive polyps (scyphistomae) initiate strobilation and produce ephyra. Our study aims to evaluate a link between water temperature and *C. fuscescens* blooms by assessing strobilation rates of three thermally regulated treatments: cold (10℃), ambient (14℃), and warm (18℃). Each treatment will contain three replicate flow-through containers each with 10 mature *C. fuscescens* polyps that will be fed Artemia nauplii ad libitum. Each day, the quantity and condition of scyphistomae will be monitored and recorded for approximately two months. Climate change is introducing additional variation to temperatures and upwelling patterns in Monterey Bay, therefore I hypothesize that colder temperatures will initiate strobilation more rapidly. I will run a repeated measures ANOVA to assess which treatment yielded the maximum scyphistomae. Understanding the biological repercussions of these changes is important in maintaining stability in our oceans and our economy. *C. fuscescens* are a major food source for endangered leatherback sea turtles and population

disequilibrium can lead to a decline of aquaculture, alteration of nutrient cycles, and a reduction in marine productivity. Future work on analyzing species specific physiological drivers of scyphozoan blooms should be conducted.

74 - Environmental effects on coastal housing via remote sensing

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Living along the coast has grown increasingly popular over the years, offering desirable amenities such as cooler temperatures, recreational opportunities, and scenic views. However, climate change has intensified extreme weather events worldwide, while also accelerating coastal erosion and rising sea levels. These changes increase the risks associated with coastal living, directly impacting housing markets in these areas. In order to salvage the housing in the coastal regions, environmental and economic variables need to be tested to determine which factors have significant impacts. By integrating spectral imagery from NASA's ECOSTRESS and EMIT satellites with annual housing price index data from the Federal Housing Finance Agency, we can examine how environmental variables influence coastal communities. Using a hedonic modeling approach, this project compares land and water quality indicators including land surface temperature, vegetation index, chlorophyll index, and turbidity. With the satellite-derived imagery data and housing price trends to identify patterns linking environmental characteristics to shifts in coastal property values.

75 - The influence of ocean acidification on red abalone (Haliotis rufescens) shell growth and thickness in an integrated multi-trophic aquaculture system

† Cotlear, R.P.[1*]; Osgood, G.[2]; Ebner, C.[2]; Kolander, N.[2]; Hamilton, S.L.[2]; Gardner, L.[3]; Graham, M.[2]; deVries, M.S.[4]

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Increased CO2 emissions have intensified ocean acidification (OA), which is a particular threat to marine organisms, especially those that build calcified structures like mollusks. Abalone are commercially important for both their meat and shells, but they are also particularly sensitive to OA. The development of integrated multi-trophic aquaculture (IMTA) systems may help to alleviate the impacts of this climate stressor. IMTA systems are a method of co-culturing two organisms of different trophic levels, allowing both to benefit from each other. In this system, red abalone (*Haliotis rufescens*) were co-cultured along with the red seaweed dulse (*Devaleraea mollis*). The abalone consume dulse for nourishment, while the dulse benefits from the abalone's ammonia and waste. We tested the potential buffering capacity of dulse on juvenile abalone, using three pH treatments: ambient pH (~8.00), a 100 year pH prediction (pH = 7.5), and a 300 year prediction (pH = 7.2) for Monterey Bay, CA. We found that the dulse did buffer the pH 7.5 and pH 7.2 treatments, slightly raising the pH to 7.56±.08 and 7.28 ±.07, respectively. In both the pH 7.5 and pH 7.2 treatments, abalone shells grew at a slower rate and were thinner than the ambient treatment, despite pH buffering. Yet, abalone shells in the 7.5 pH treatment were still significantly bigger and thicker than those in the 7.2 pH treatment. This study illustrates the future challenges that dramatic OA conditions could cause for cultured shellfish and the utility of co-culturing seaweed to mitigate negative responses to OA.

76 - *Macrocystis pyrifera* zoospores: Exploring effects of thermal patterns across seasonal changes in Santa Barbara

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Marine heatwaves (MHWs) pose a major threat to healthy kelp forest ecosystems globally and are a dominant environmental force along the Santa Barbara coast. Temperature is a key factor in kelp survival and reproduction; however, there are significant knowledge gaps about how elevated temperatures impact the microscopic life

stages of giant kelp, *Macrocystis pyrifera*. We investigated how temperature influences the germination success of early-stage giant kelp to assess potential resilience to thermal anomalies typical of MHWs in the Santa Barbara Channel. Zoospores from sporophylls were collected monthly in the field, and germination success was measured 24 hrs post-release. Using an aluminum thermal table with a temperature gradient from 14–26°C, we assessed how temperature affects zoospore germination and early gametophyte development. Preliminary results show that zoospores from summer-acclimatized sporophylls germinated successfully between 14°C and 22°C. While germination occurred at 22°C, gametophyte development was slower and exhibited abnormal morphology. These findings suggest that early life stages of *M. pyrifera* are thermally sensitive and that this sensitivity may vary by season, indicating potential legacy effects of past thermal stress on adult sporophylls. These results are especially relevant to local kelp forests, which have recently endured extreme MHWs. Ongoing data collection will further explore these legacy effects and inform restoration strategies.

77 - Investigating the Effect of Temperature on the Foraging Rate of a Temperate Grazer, *Centrostephanus coronatus*

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Climate change is expected to increase global ocean temperatures and shift ecosystem dynamics, such as food webs. Increases in body temperature often lead to increases in consumption rates for ectotherms and can disrupt food webs and community structure. For habitat-forming species like kelps, increases in urchin grazing have led to the prevalence of urchin barrens and a decrease in local biodiversity. This study tests the hypothesis that elevated temperatures influence the feeding rate of *Centrostephanus coronatus*, a diadematid sea urchin often referred to as the crowned sea urchin. This omnivorous forager is a notorious temperate grazer of subtidal regions, commonly foraging on macroalgae and various sessile invertebrates. Ten urchins were collected from Cherry Cove, Santa Catalina Island and were later manipulated via aquaria to assess how warmer temperatures influence the consumption of giant kelp, *Macrocystis pyrifera*. Feeding rates were measured over 48 hours at 21.2℃, and results were analyzed to determine the relationship between temperature and feeding behavior. Statistical findings indicate no significant increase in foraging rate at higher temperatures. These results suggest the need for further research into the behavioral and ecological consequences of warming oceans on kelp consuming echinoderms.

78 - What the Heck is a WEC? Case Study on the Creation and Evaluation of a Marine Renewable Energy Exhibit at a Public Science Center

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1- Oregon State University 2- Oregon Sea Grant

Marine renewable energy is a complex, and sometimes controversial topic that requires a nuanced approach when communicating its intricacies to public audiences. However, as a burgeoning renewable energy option it is imperative that the public be educated about it to support informed decision-making on a personal and community level. Engaging exhibits at public science centers can serve as effective conduits in connecting the public to highly technical topics, including the case study presented here. A marine renewable energy exhibit was installed in the Hatfield Marine Science Visitor Center in Newport, Oregon to provide information to the community and address uncertainties regarding marine renewable energy. The exhibit features static text displays and both tactile and audio-visual elements to help educate visitors on marine renewable energy locally and globally. The case study is organized into three parts. The first examines the collaborative public engagement processes between community, academic, and renewable energy stakeholders. The second part of the study is an evaluation of how effective the exhibit is in addressing knowledge gaps of the public using qualitative and quantitative data analysis. The final part of the study is a distillation of best practices on using informal education to help communicate renewable energy topics to public science center visitors. The study demonstrates the value of public science center exhibits in advancing community understanding of renewable energy and provide insight on collaborative exhibit design frameworks.

79 - Effect of Anthropogenic Noise on Copepod Behavior and Feeding

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Anthropogenic sound in the ocean has adverse effects on biological life, including the ability of human-made sounds to alter community structure and compromise essential ecosystem functions. Noise pollution has been found to affect a wide range of ocean organisms including primary producers, invertebrates, and marine mammals, however, there is little research on how noise impacts the behavior of zooplankton. The objective of this study was to assess the effect of duration and volume of noise on copepod feeding and behavior. In this study, starved copepods of the species *Calanus pacificus* were placed in a 60 cm tall rectangular tank with an underwater bluetooth speaker on the bottom. Copepods were observed for 15 minutes, feeding on phytoplankton that was evenly mixed into the tank at a concentration of 5,000 cells/mL. Copepods were exposed to a sustained sound of a constant frequency and pitch. In one experiment, copepods were exposed to this sound for different durations (0 minutes, 5 minutes, and the full 15 minutes), and in another experiment the sound was played at different volumes. The copepods were imaged using two cameras to track 3D copepod movement and quantify their behavior. After each treatment, gut content analysis was performed using a fluorometer to assess copepod feeding during the 15 minutes. Here, we will present results comparing copepod feeding and behavioral properties – including velocity, jump frequency, and turning rate – in relation to duration and volume of sound.

80 - Measuring the physical and chemical defenses of brown algae Silvetia compressa in response to enriched nutrients and herbivory stressors across wet and dry seasons

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Silvetia compressa is a species of brown algae found within rocky intertidal ecosystems along the North American Pacific Coast. This alga forms canopies that are home to many organisms, fostering biodiversity within coastal ecosystems. Changing climates and anthropogenic stressors have created intensified pressure on *Silvetia* canopies, especially during the winter when increased rainfall accelerates pollutant transport. One common pollutant to intertidal ecosystems is nutrient enrichment, which generally causes herbivores to increase their consumption of algae. In response, *Silvetia* utilizes physical and chemical defenses. This study investigates the impact of anthropogenic stressors on *Silvetia* by analyzing its physical and chemical responses to ambient and enriched nutrients, as well as indirect and direct herbivory stress. Samples were collected from Bluff Cove in Palos Verdes, California (33°47’38” N, 118° 24’25” W) twice: once shortly following rainfall and another following an extended dry period. After *Silvetia* was exposed to nutrient and herbivory stressors, physical toughness and biomass were measured. Nutrient enrichment did not significantly affect biomass but increased blade toughness. Under herbivory stress, algae collected during dry season lost more biomass yet developed stronger toughness than wet-season algae, while indirect herbivory stress reduced toughness at both nutrient levels. Overall, *Silvetia*’s responses are seasonally dependent, with physical defenses central to stress tolerance and resilience in intertida

81 - Effects of habitat distribution on ecological change at different spatial scales in a coral reef ecosystem

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A major concern for coral reefs is the potential for abrupt shifts in ecosystem state, including persistent increases in macroalgal cover. While the mechanisms that drive these shifts have been demonstrated experimentally at small scales, how local feedbacks drive change at larger scales remains poorly understood. Recent theory predicts that ecological state change can appear gradual at large spatial scales, even as individual patches switch states abruptly. Theory also emphasizes the importance of the spatial distribution of habitat, defined here as hard substrate able to serve as attachment space for corals, macroalage or other sessile organisms. The size and clustering of habitat patches is expected to influence both the distribution of macroalgal dominance across the

landscape and the trajectory of change over time. Here we test these predictions using spatially explicit surveys from 19 lagoon sites around the island of Moorea. In 2023 and 2024, we surveyed the benthic community over a 300 m by 100 m area at each site, enabling analysis of community structure and temporal change across a range of spatial scales. We observed wide variation in the spatial structure of lagoon habitats, ranging from nearly continuous stretches of reef to sandy regions dotted with emergent reef structure. Within sites, this variation was associated with differences in benthic community including macroalgal abundance. Year-to-year changes in community state were relatively modest, but trajectories were sensitive to habitat distribution and to the spatial scale at which change was assessed.

82 - Fish Habitat Value of Artificial Structures in the Largest Port Complex in US

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1- WSP 2- Port of Los Angeles 3- Port of Long Beach

The Ports of Los Angeles and Long Beach in San Pedro Bay contain diverse biological communities that coexist with commercial and industrial operations in the nation's busiest seaport complex. The Ports have been conducting joint biological resource surveys since 2000 to characterize the Port Complex's marine habitats and are used to meet requirements for Essential Fish Habitat (EFH) consultations under the Magnuson-Stevens Fisheries Conservation Act (MSA). This data helps determine if Port activities are likely to have an impact on EFH or protected species under the Endangered Species Act (ESA) and Fisheries Management Plans (FMP) for groundfish and coastal pelagic species. The 2000, 2008, and 2013 surveys identified 23 FMP species in soft bottom and pelagic habitats including rockfish, anchovy and smelt. The 2018 and 2023 surveys incorporated new visual diver survey methods to characterize fish, invertebrates and algae communities on riprap embankments, the federal breakwater, and pilings. The dive surveys have found over 40 species of fish using these habitats, including over a dozen reef-associated fish catalogued for the first time in the Port Complex and 8 FMP species. In 2023, 3 of the 16 FMP fish species across all surveys were only found during riprap and piling dive surveys. The novel application of rocky reef monitoring methods on artificial structures allows for more rigorous comparison of the communities observed to nearby natural reefs, offshore oil and gas infrastructure, and existing coastal rocky reef mitigation projects to guide future EFH recommendations.

83 - A case for multi-gear assessments: Detection probabilities of nearshore fish with eDNA and seine nets vary by functional traits

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Ecological studies often aim to understand species distributions and their role in ecosystems, yet the methods used to sample inherently affect which species are detected (i.e., gear selectivity). Further, species functional traits influence both their distribution and their potential to be detected by different sampling methods. Here, we investigated functional species traits to understand what traits are being selected for by gear types. We sampled three nearshore habitats in southeast Alaska by beach seines, which have historically been used to sample in this region, and environmental DNA (eDNA), an increasingly common method for aquatic sampling. eDNA showed more association with species with obligatory schooling and presence of scales, whereas beach seines were more associated with solitary species. To disentangle interactions between gear types, multiple traits, and habitats, we used occupancy modeling to estimate detection by gear type and the influence of individual traits on detection. For eDNA, detection probability for species with deciduous scales was nearly 30 times greater compared to a species with non-deciduous scales and detection probability for species with plates was lower than for a species with non-deciduous scales. These results highlight how functional traits influence detection by gear type and that the ability to accurately characterize species distributions requires accurately sampling species across a spectrum of traits.

84 - Combining field surveys with local ecological knowledge to pinpoint the southern limit of *Macrocystis pyrifera* in the northeastern Pacific

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What is the current southernmost distribution limit of the Giant kelp, *Macrocystis pyrifera* , in the Northern Hemisphere? Based on recent extreme oceanographic events, the answer to this question remains poorly documented. During July 2025, we conducted coastal surveys along Baja California's Pacific coast and interviewed local fishers to document current and historical kelp distributions. We classified observations as mature attached individuals (<100m distribution), patches (100m–1km continuous coverage), or forests (>2km continuous coverage). We found that the southernmost mature attached individuals were located at Isla Asunción, patches were found at Puerto Escondido, and full forests were present at Punta Eugenia. Local ecological knowledge revealed significant range contractions following major warming events: kelp forests disappeared from Bahía Asunción during the 1994–96 El Niño but recovered within one year. In contrast, the 2014–16 marine heatwave and El Niño caused local extinctions with no subsequent forest recovery. These integrated field and community-based data provide critical baseline information for understanding kelp forest resilience and inform conservation strategies in the face of accelerating climate change.Keywords: Distribution limits, marine heatwaves, range boundaries, kelp forests, climate change, marine conservation.

85 - Wetland restoration outcomes after 10-years of re-established tidal flow in the San Pablo Bay National Wildlife Refuge

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Ducks Unlimited

The Cullinan Ranch Restoration Project aims to restore 1,500 acres of historic tidal wetlands in the San Pablo Bay National Wildlife Refuge that will benefit endangered species including *Reithrodontomys raviventris halicoetes* (salt marsh harvest mouse) and *Rallus obsoletus* (Ridgway's rail). In January 2015, approximately 1,200 acres of the project site were restored to tidal flow through levee breaching at three different locations along Dutchman Slough, an inlet of the Napa River. To document tidal channel evolution, Ducks Unlimited (DU) installed erosion pins at each side of the three breach mouths and measured breach widths (ft) annually in 2015, 2017, 2019, and 2025. Since restoring tidal flow in 2015, all three breaches have continued to widen across the measurement years. To understand sedimentation patterns, DU installed four sediment-plates within the site and measured sediment accretion (cm) annually in 2017, 2019, and 2025. From 2019 to 2025, sediment accreted significantly at all four plates. The depositional patterns and continued reshaping of the breach mouths through natural erosion indicate the site is still evolving in response to restored tidal flow. Continued sediment accumulation could make the site suitable for colonization by low- to high-marsh plant species including *Spartina foliosa* (California cordgrass), a preferred habitat of *R. obsoletus*, and *Salicornia pacifica* (pickleweed), an important habitat for *R. r. halicoetes*.

86 - Shifts in Geophysical Drivers of Pismo Clam (Tivela stultorum) Population Distributions Across Monterey Bay

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Physical factors play a fundamental role in shaping the abundance and distribution of populations. For example, sediment composition and beach morphology primarily support the persistence of infaunal species at mid-range locations. However, at the edges of their range, other environmental factors may become more influential in shaping their presence. The Pismo clam (*Tivela stultorum*) was once a valuable commercial resource along the

California coast but experienced considerable population declines due to overexploitation in the early 20th century. Although less abundant at the northern edge of their range compared to southern populations, several groups continue to persist along the beaches of Monterey Bay. Despite this, no long-term monitoring programs have been established in the region. This project aimed to examine how the distribution, abundance, and age structure of Pismo clam populations are influenced by sedimentary and fluid habitat conditions within Monterey Bay. Over a two-year period, perpendicular transects were conducted across the bay from Santa Cruz, CA, to Monterey, CA. Beach profiles and sediment composition were critical factors in determining where Pismo clams were most abundant. Yet, using the CDIP MOP model, differences in wave energy across the bay emerged as a driving force for clam persistence. By identifying the physical factors that most significantly affect Pismo clam population dynamics, this study contributes to a better understanding of the habitat conditions necessary for the successful rehabilitation of populations in Monterey Bay.

87 - Demography, phenology, and ecology of the recently introduced kelp, Undaria pinnatifida, in Dana Point Harbor

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Biological invasions are a threat to coastal marine ecosystems worldwide. The annual kelp, *Undaria pinnatifida* (Phaeophyceae, Laminariales) also known as wakame, is a global invader native to NE Asia. Despite being present in CA harbors since 2000, it was seen for the first time in Dana Point Harbor (DPH) in 2023. Given that *Undaria* is a new invader in DPH, it is important to understand its ecology to assess management options and potential impacts on the local community. To examine the demography and phenology of *Undaria*, we conducted biweekly surveys, recording length, life stage, and reproductivity on docks where populations were observed in the previous year. To determine the distribution in the harbor, we performed a rapid abundance assessment during its approximate peak abundance. The role of *Undaria* as a habitat former and contributor to the food web were also explored. Despite being putatively uncommon in the previous year, *Undaria* has been prevalent in DPH, though limited to certain locations. Abundant recruitment was initially observed in fall with individuals growing rapidly and becoming robustly reproductive. Peaks in abundance were found in spring, but now declining starting in early summer. Juveniles have also been present consistently since fall, including recent surveys, suggesting that the population in DPH may have shifted from a typical annual cycle to having multiple cohorts over the year, as has been seen in other invaded areas. Patterns observed thus far suggest management of *Undaria* in DPH may be challenging.

88 - Mechanisms of kelp Dissolved Organic Carbon (DOC) release: the role of temperature, nutrient stoichiometry, and photosynthesis in Macrocystis pyrifera

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Dissolved organic carbon (DOC) release by macroalgae plays a key role in coastal carbon cycling, yet the mechanisms driving DOC secretion in giant kelp (*Macrocystis pyrifera*) remain unresolved. Two long-standing hypotheses: the “photosynthate diffusion” model, which links DOC release to carbon fixation rate, and the “stoichiometric overflow” model, which attributes DOC release to nutrient-driven adjustments in intracellular C:N ratio, have yielded mixed results in past studies. Recent evidence suggests nitrogen availability is a dominant factor, with DOC production negatively correlated with nitrate uptake. Our study investigates whether blade C:N ratio modulates the relationship between temperature, DOC release, and net photosynthesis. Sixteen blades from four *M. pyrifera* individuals were collected subtidally during the winter of 2025 and analyzed for baseline intracellular C:N ratio via stable isotope analysis. Remaining blades were incubated for 5 days at 15 °C and 17 °C, followed by repeat C:N, net photosynthesis, and DOC measurements. We hypothesize that warmer temperature

treatments will result in higher C:N ratios, increased net photosynthesis, and higher DOC release. Results from this study will help clarify the relative roles of temperature, nutrient stoichiometry, and carbon fixation in regulating DOC production, providing new insight into kelp contributions to carbon cycling under changing ocean conditions.

89 - Successional Dynamics, Not Spatial Clustering, Shape Pitcher Plant Microbial Diversity

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The relationship between biodiversity and ecosystem function is central to ecology, yet the role of space in BEF relationships remains unclear. In metacommunities, space can increase or decrease local diversity with potential consequences for function. We hypothesize that dispersal limitation can lead to functional clustering driven by spatial variation in diversity. Here, we assessed the role of metacommunity-scale controls on biodiversity-ecosystem function relationships within Darlingtonia californica leaf fluid. The discrete boundaries of each leaf and their role in insect degradation make this an ideal system for studying how spatial distribution shapes diversity and function. We surveyed leaf traits, environmental variables, microbial biodiversity, and ecosystem function of 50 pitcher leaves in a bog near Gasquet, CA. Function was assessed via metabolic activity (EcoPlate) and protein concentrations (Bradford assay). Diversity was measured with 16S rRNA amplicon sequencing. Results showed both ecosystem function and composition were evenly distributed in space and unrelated to environmental variables. Instead, leaf age was the strongest predictor of diversity, with richness increasing over time. Function remained remarkably consistent across both spatial and successional gradients, suggesting functional redundancy across microbial taxa. These findings indicate that at metacommunity scales, functional redundancy may uncouple biodiversity–ecosystem function relationships, resulting in widespread ecosystem functioning and species richness across spatial gradients.

90 - Urchins Rock? How do benthic substrate type and relief affect purple urchin feeding behaviors and density?

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The recent increase in purple sea urchin (*Stronglyocentrotus pupuratus*) populations on the North American West Coast is in part due to the disappearance of their major predators, one of which is the sunflower seastar (*Pycnopodia helianthoides*). As purple sea urchin populations are increasing in many parts of the coast, it is vital to understand how urchin behaviors affect bull kelp (*Nereocystis luetkeana*) forests. Purple sea urchins are generally found on contiguous rocky substrate, particularly bedrock, large boulders, or stable cobble. We performed a field experiment in Port Orford, OR, where we introduced 12 cages to the seafloor for 6 weeks, 6 of which contained sunflower seastars. The main study is testing whether sunflower stars affect the density and kelp consumption of purple and red sea urchins. In the present study, we investigated how urchin abundance correlated with substrate type and relief, focusing on the areas around control cages, without sunflower stars. Preliminary findings indicate that urchins congregate in higher numbers in different substrates, and their abundance remained relatively consistent through the project duration. We will summarize how small scale elements of substrate type and relief affect urchin densities within our repeated surveys within the $0.25m^2$ study quadrats. Understanding how substrate characteristics influence urchin abundance provides essential context for predicting their impacts on kelp forest resilience.

91 - Assessing White Shark Body Condition: An AI Framework for Optimizing 2D Morphometric Analysis with Reinforcement Learning and 3D Keypoint Potential

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Accurate biometric assessments of marine taxa from underwater video is a non-invasive approach with great promise given recent **AI advances**, but remains challenged by low-visibility environments and limited labeled data. This study assessing white shark body condition presents a novel, semi-supervised machine learning framework to enhance **YOLO-based** real-time object detection models for 2D keypoint detection(nose, tail, dorsal front, pectoral base, dorsal back) in monocular underwater videos. The framework employs **iterative pseudo-labeling** with teacher-student distillation, generating filtered pseudo-labels (confidence, length-to-width ratio, dorsal-to-tail/dorsal-to-nose ratio, and orientation angle for perpendicular silhouettes) and minimal human grading to correct errors. **Reinforcement learning** optimizes training hyperparameters to minimize keypoint mean absolute error (MAE). Deployed on **AWS** (Amazon cloud), this pipeline uses Google Drive for storage, SageMaker for GPU-accelerated training, Ground Truth for human-in-the-loop labeling, and Step Functions for automation, designed to achieve convergence in 5–10 iterations with MAE <5 pixels against a benchmark validation. The method enables metrics akin to body mass index (BMI) for body condition assessment and supports future **3D keypoint labeling** via extensible formats for volumetric biometrics. Our framework advances white shark health monitoring, with applicability to other marine taxa and broader conservation effort

92 - Species and size diversity across anthropogenic and natural habitats in Yaquina Bay

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Estuarine ecosystems contain a mosaic of natural and anthropogenic habitats, each shaping species composition and diversity. In Yaquina Bay, Oregon, we compared species abundance and size distribution between an eelgrass (*Zostera marina*) bed and the nearby Elakha Dock (anthropogenic site) in the summer of 2025. Modified box minnow traps were deployed at both sites for 24-hour intervals across sampling days (n = 250 specimens). Eelgrass supported higher overall specimen counts and significantly larger juvenile Dungeness crab carapace widths (mean 19.62 ± 0.82 mm) compared to the dock (14.70 ± 1.60 mm, p=0.0053). Fish lengths did not differ significantly by site overall (p=0.154), though Saddleback Gunnel and Black Rockfish were significantly longer in eelgrass than dock habitats. These findings highlight eelgrass as a critical nursery habitat, but also demonstrate that docks support diverse estuarine species, reflecting utilization of anthropogenic structures as habitat. Because this study was conducted in a short period in the summer, longer-term monitoring is needed to understand seasonal fluctuations and patterns in community composition. Even though the two sites were close (130 m apart), the habitats were unique enough to make a substantial difference in species abundance and size. Given ongoing dredging and dock renovations in Yaquina Bay, evaluating how species use different habitat types is vital for anticipating the ecological consequences of future coastal development, and could be used as a future model for other similar environments.

93 - Spatiotemporal biochemistry of a 3.5-year experimental bioreactor and a treatment wetland in Monterey County, California

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Historic wetlands in Monterey County largely have been converted to agricultural land; such loss is associated with reduced water quality and eutrophication. Locally, the Central Coast Wetlands Group (CCWG) cooperates with farmers to create treatment wetlands with three goals: mitigate excess nutrients in runoff, provide habitat for native species, and buffer against flooding. CCWG established SeaMist Treatment Wetland (SMTW) in 2006 for such purposes and by 2008, nitrate concentrations in runoff dropped from 45.9 mg/L near SMTW’s inlet to 4.4 mg/L by the outlet. An onsite woodchip bioreactor added in 2016 improved nitrate removal by an additional 42%. To further test the effectiveness of bioreactors, CCWG constructed 12-channel bioreactor experiment with four unique

treatments at the Castroville Slough Treatment Wetland (CSTW) beginning in 2017. To date, data from only one treatment has been analyzed and published. Nutrient removal in local treatment wetlands and bioreactors may be microbial mediated under anoxic conditions. However, the correlation between the microbial community structure and nutrient removal in local treatment wetlands is not well understood. My research focuses on two goals: (1) Model retention time and nitrate removal across all CSTW bioreactor treatments, and (2) analyze spatiotemporal changes in nutrient concentration, microbial community structure, and other biochemical factors at SMTW. This poster will cover progress to date on CSTW bioreactor data analyses and outline upcoming sampling in SMTW.

94 - Pre and Postnatal Growth of the Scalloped Hammerhead Shark (*Sphyrna lewini*) in the Panamanian Pacific

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The scalloped hammerhead *Sphyrna lewini* is the most common hammerhead shark species landed in artisanal fisheries along Panama's Pacific coast, with high levels of neonate and juvenile catches that threaten its populations. However, little is known about the early ontogeny of this species, which hinders its management in the region. Here, we collected vertebrae from 95 young *S. lewini*. individuals, between 45 and 70 cm length, incidentally caught in the Panamanian Pacific Gulfs of Panama and Chiriquí. Pre- and post-natal growth was observed by measuring growth rings under transmitted light microscopy. We also compared growth rates and size distributions between the two gulfs, which are characterized by different oceanographic conditions. We expect that sharks with different sizes at birth will have different post-natal growth rates. Greater prenatal growth, reflecting higher maternal investment, could imply that juveniles face less pressure to feed immediately after birth, which would be reflected in a lower postnatal growth rate. In contrast, neonates with lower maternal investment might face greater pressure to feed once born, potentially leading to higher postnatal growth rates and this response would be mediated by the different productivity and environmental conditions between the gulfs. Our objective is to bring novel insights into the early growth strategies of *S. lewini*, contributing to management measures to protect the most vulnerable life stages of this species and promote fisheries sustainability in the Tropical Eastern Pacific.

95 - Assessing reproductive dynamics in Olympia Oysters using histological and novel non-invasive techniques

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The Olympia Oyster (*Ostrea lurida*) is the U.S. West Coast's only native oyster and has suffered severe declines and reproductive failure due to overfishing and habitat destruction. Restoration efforts are underway, but the complex reproductive cycle of this bidirectionally hermaphroditic species is poorly understood, limiting conservation efforts. Some major barriers include knowledge gaps regarding processes that influence reproduction as well as a lack of non-lethal methods to monitor reproduction. To address these, we combined hatchery experiments with novel monitoring approaches. The reproductive status of hatchery broodstock was monitored by tracking sperm and larvae releases. We also detected the larval brooding period by collecting waste from individuals to monitor reproduction non-invasively. In addition, larval yield was tracked over time. Larvae were detected in pseudofeces, revealing a novel, non-lethal method to track brooding. By tracking hatchery activity, we found unexpected releases and temporal variability in spawning. We have also begun an experiment to study potential effects of temperature on sex ratio and fecundity, using histology to count gametes in 290 oysters across three temperature treatments and incorporating larval tracking via waste to test this new method's efficacy. The temperature experiment is expected to show shifts in sex ratios and fecundity among treatments. Together, this research will identify recruitment-limiting mechanisms and improve tools for hatchery optimization and restoration, informing management along the West Coast.

96 - Environmental DNA as a Tool for Monitoring Stichaeidae and Pholidae Diversity

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Environmental DNA (eDNA) has emerged as a powerful, non-invasive tool for monitoring biodiversity by detecting genetic material shed by organisms into their environment. Typically collected from soil, sediment, water, or air, eDNA enables species detection and may also provide insights into species abundance. In this study, we focused on fishes from the families Stichaeidae and Pholidae. DNA was extracted from multiple species within these families, and primers designed to target fish-specific mitochondrial gene fragments were used. Polymerase Chain Reaction (PCR) was employed to amplify the target fragments, which were then sequenced using Sanger sequencing. The resulting sequences were aligned, and genetic diversity was estimated. These gene fragments will serve as reference material for future studies on these taxa. Overall, this work contributes to ongoing efforts to refine eDNA protocols for reliable species identification and to advance biodiversity assessments in marine ecosystems.

97 - Reassessing the value of eDNA studies in the absence of well-developed barcode reference libraries

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eDNA analysis methods used for marine species identification are severely hindered by incomplete, low-quality barcode reference libraries. We will create a comprehensive barcoding dataset for the Marine Vertebrate Collection (MVC) at the Scripps Institution of Oceanography (SIO), targeting ~750 ray-finned fishes of the California Coast Bioregion, spanning from Point Conception to the U.S.-Mexico border. This will involve DNA extractions and the generation of mitochondrial DNA (mtDNA) data, specifically Cytochrome C Oxidase I (COI) as the cornerstone of a barcoding dataset, complemented by 12S rRNA, 16S rRNA, and Cytochrome b (Cytb), from tissue samples in the MVC linked to vouchered specimens. To ensure data integrity, tissue samples will be transferred from ethanol to a SIO cryogenic facility. To enhance the dataset's scope and utility, we will incorporate existing mitochondrial data from this region available in public repositories such as the National Center for Biotechnology Information and the Barcode of Life Data System. Sequences will be aligned and compared to existing records to refine taxonomy and detect novel or cryptic species. Controls include replicate sequencing and cross-referencing with MVC morphological data. Results will be analyzed using phylogenetic tools to confirm species identities and assess regional diversity patterns. By linking new mtDNA sequences to vouchered specimens and complementing them with existing datasets, this will provide a foundation for advancing evolutionary research and conservation efforts along the California Coast Bioregion.

98 - Testing dark tolerance on microscopic stages of the non-native kelp Undaria pinnatifida to evaluate dispersal via ballast tanks

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The introduction and potential spread of non-native species can impact biodiversity. Non-native seaweed proliferation can be facilitated by multi-phasic life cycles, rapid growth, and a high reproductive potential, all of which are traits found in *Undaria pinnatifida*. *Undaria* is native to temperate Asia and has been found in 16 countries outside Asia. In California, *Undaria* was documented first at Los Angeles in 2000, but subsequently has spread along the coast between San Francisco and Ensenada. The primary vector of global transport is believed to be the ballast water of commercial ships, but the assumptions behind this hypothesis have not been tested. In this study, we address whether ballast water transport is a viable transoceanic pathway for the spread of *Undaria*. To determine if *Undaria* remains reproductively viable within the dark environment of a ship's ballast tank, we counted spores and gametophytes in a 12-hour light/dark control and completely dark treatment at 18°C for 14 days, simulating transit time from Hong Kong to Los Angeles. Spores from the dark treatment then were subjected to the

conditions of the light/dark control for 10 more days to test for spore recovery. Occurrences of sporangia, spores, and gametophytes were recorded. Results for the reproductive viability of *Undaria* in simulated ballast water conditions and implications for the spread of this and other non-native marine species will be discussed.

99 - Salt Creek Study: Macroinvertebrates as Pollution Indicators Upstream and Downstream of Development Activity

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San Diego State University

Macroinvertebrates and other stream inhabitants can be used to characterize water quality and relative organic pollution due to the conditions they are known to be able to survive. The water quality and biodiversity of Salt Creek in Lincoln, Nebraska have been negatively impacted by human activity and natural processes including urban and agricultural runoff, wastewater treatment plant effluent, stream channelization, and streambank erosion. Salt Creek also has a high natural salinity level due to the salt and mineral deposits in the ground around it that are picked up by ionic ground water. Anything living in the water had to have adapted to the salty conditions millions of years ago and adapted within the last hundred years to industrial human activity. Benthic macroinvertebrates in particular are sensitive to pollution because they spend all or most of their lives in the water and lack the swimming ability to move to unpolluted waters. This also makes them easier to study, as compared to fish, because they can be found in large numbers in shallow water bodies and cannot quickly swim away. Salinity is predicted to be a major determining factor for macroinvertebrate survival in Salt Creek. The macroinvertebrates sampled will have adapted to breathing and osmoregulating in saline conditions. These conditions will likely result in reduced species diversity and increased functional homogenization. Several species found in these conditions walk on water, hold an air bubble with them underwater, or use lungs to breathe air instead of polluted or salt water.

100 - The effect of ocean acidification on Mg and Ca ratios of red abalone (Haliotis rufescens) shells

† Caballero Garcia, M.[1*]; Osgood, G.[1]; Kolander, N.[1]; Ebner, C.A.[1]; Graham, M.H.[1]; Gardner, L.[1]; Hamilton, S.L.[1]; deVries, M.S.[2]

1- Moss Landing Marine Labs 2- San Jose State University

Ocean acidification (OA), caused by rising atmospheric CO_2, reduces seawater carbonate availability and threatens calcifying organisms such as the red abalone (*Haliotis rufescens*). Because abalone shells are built from $CaCO_3$, declines in carbonate can weaken structural integrity. Magnesium-rich calcites are especially soluble, making Mg:Ca a useful indicator of shell condition. Integrated multi-trophic aquaculture (IMTA) that co-cultures abalone with red seaweeds has been shown to elevate tank pH and improve growth, potentially buffering OA impacts. We reared juvenile abalone in fifteen tanks across three pH treatments (7.2, 7.5, 8.0) and quantified shell elemental composition via X-ray fluorescence (XRF). Morphometrics (length, height, dry weight) were paired with elemental concentrations. Mg:Ca ratios differed significantly among treatments, with the lowest values at pH 7.2. Shell dry weight also declined significantly at low pH. These results indicate that OA reduces mineral incorporation and growth in *H. rufescens*, producing weaker shells. Because abalone reared under moderate and ambient pH showed higher Mg:Ca and greater shell weights than those at low pH, our findings support IMTA as a strategy to help sustain shell growth and integrity under future OA scenarios.

101 - Ecological Consequences of Juvenile White Shark Range Shifts into Monterey Bay: Effects on California Sea Otter Distribution and Abundance

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1- Moss Landing Marine Laboratories 2- California Department of Fish and Wildlife 3- California State University Monterey Bay

The North Pacific marine heatwave from 2014 to 2016 ignited a range shift of juvenile white sharks (JWS; *Carcharodon carcharias*) from southern to central California. Historically, juveniles of this endothermic species were seldom north of Point Conception compared with the larger-bodied adult sharks abundant in the central California region. The emergence of a juvenile apex predator in Monterey Bay resulted in more spatial and temporal overlap between white sharks and the federally protected southern sea otter (*Enhydra lutris nereis*). Shark bites are a leading source of mortality for southern sea otters, and white sharks are the only species that have been documented to cause these bites. It's believed these interactions are investigative in nature and to-date there's no evidence to suggest white sharks consume sea otters, so evaluating patterns of shark bite mortality in stranded sea otters may be informative for understanding white shark activities. Investigative bites may be more prevalent for JWS undergoing ontogenetic shifts from preying upon fish to blubber-bearing marine mammals. The contribution of bites from JWS is currently unclear. To examine this relationship, we are comparing distribution and abundance data for JWS and sea otters, and sea otter stranding data before (2004-2013) and during/after (2014-2024) the JWS range shift. We will quantify fine-scale spatial and temporal overlap between juvenile white sharks and sea otters within Monterey Bay to evaluate how the presence of JWS may be affecting sea otter distribution and mortality.

102 - Octopus Paralarvae Abundance Study in the Central-South Puget Sound

† Grover, S.*; Gardell, A.

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Enteroctopus dofleini (Giant Pacific octopus) and Octopus rubescens (East Pacific Red octopus) are the only two species of octopus in the Puget Sound yet little is known about their early life stages. The goals of this study were to monitor these species in their paralarval forms within central-south Puget Sound and to evaluate any correlations between their paralarval abundances and environmental parameters. We hypothesized that Reds will have a summer seasonality while Giant Pacifics will have a winter seasonality for their paralarval abundances. Using light-traps in collaboration with Point Defiance Zoo and Aquarium, the MaST Center Aquarium, and the Nisqually Tribe, we attracted paralarvae with samples being collected four times a week from March 2025 to December 2025 at three different sites. Octopus paralarvae were identified for species, counted, measured for length, and all other larvae abundances were recorded. Salinity, water temperature, and outdoor temperature were also recorded during each trap collection period. Preliminary data indicate that time of year is an important factor for the Red octopus, with significantly higher abundances being observed later in the summer season. Red octopus paralarvae were also found to be significantly larger in the later summer months when recorded water temperatures were highest. Giant Pacific octopus were found to be much less abundant compared to Red octopus. Data generated by this study provide a foundation for better understanding the distribution of early life stage octopus paralarvae within central-south Puget Sound.

103 - Investigating allospecific effects on abundance and discharge rate of cnidae in corallimorpharian *Corynactis californica*

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California State University, Northridge

Cnidarians are named for their use of cnidae to catch prey, avert competitors, and deter predators. When triggered, changes in osmotic pressure cause cnidae to discharge a long tightly coiled thread that snares nearby victims. Corallimorpharian *Corynactis californica*, a common cnidarian found along the Pacific coast, is characterized by bulbous structures at the tips of its tentacles that house a substantial bulk of cnidae. Close observation of these structures revealed four visually distinct types of cnidae. As predator, prey, and competitor dynamics have shaped the form and function of defensive and offensive mechanisms throughout evolutionary history, the aim of this study was to investigate a possible explanation for this divergence in cnidae morphology. Fifty-four *C. californica* polyps were collected from floating buoys offshore of Santa Catalina Island and pressed against either a known predator or competitor. Tentacle tips were observed under a microscope for quantification of fired cnidae. No difference in

discharge rate was found between these cnidae types in relation to different triggers, suggesting that the unique forms of these structures are not bio-mechanically tuned to respond to different threats. The relative abundance of these cnidae types remained consistent throughout the individual *C. californica* polyps, except for those that were found on the shells of other marine invertebrates. Significant results of a post-hoc test suggest that these disparate abundances of cnidae may be affected by allospecific interactions.

104 - Beyond Growth: Allometry Reveals the Effects of Ocean Warming on the Development of Larval Grunion.

† Lundquist, A.J.*; Cole, T.; Johnson, D.

CSU Long Beach

Ocean warming poses an ongoing threat to many marine species, with the larval stage often being especially vulnerable to changing temperatures. Temperature can affect both the organ development of larvae and their somatic growth, though these two processes are rarely examined together in detail. Allometric scaling – the rate at which a focal trait scales with body size – can provide a measure of organ development and may yield insight into the nuanced effects temperature can have on larvae. We measured mass, feeding rate, and various morphometric traits of larval California grunion reared under temperatures ranging from 14°C to 26°C. By analyzing images of individual larvae, we calculated the sizes of eyes, stomachs, and snouts relative to overall body size. Our results suggest that larvae raised at warmer temperatures had eyes, stomachs, and snouts that developed faster relative to their standard length than larvae raised at colder temperatures. These larvae also exhibited a higher feeding rate and attained a larger size at warmer temperatures. Accelerated organ development at high temperatures may increase a larva's ability to obtain and digest food and may thus help larvae cope with high temperatures and greater metabolic demands. This mechanism may buffer grunion populations somewhat from the effects of ocean warming, though more evaluation is necessary as these buffering effects may not be sustained at temperature extremes. By analyzing morphological traits, we can disentangle size and developmental patterns – providing a more nuanced understanding of larval dynamics.

105 - Modeling the Past and Present Distribution of the Endangered Santa Cruz long-toed salamander (Ambystoma macrodactylum croceum)

† Porras-Vargas, A.*; Olson, J.

California State University, Monterey Bay

The long-toed salamander (Ambystoma macrodactylum) has five subspecies across western North America. Each population is the relic of glacial refugia that formed the disparate ranges and distinct genetic lineages of each taxon. None is more localized than the critically endangered Santa Cruz long-toed salamander (A. m. croceum), endemic to a few ponds along the coastal terrace of the Monterey Bay in California. Its closest long-toed neighbor, A. m. sigillatum, occurs over 200 km away in the Sierra Nevada. This poses questions about the history of A. m. croceum's range, as the shortest path to relatives crosses the unsuitable Central Valley and the coastal route shows no signs of occupation. Furthermore, this population faces ongoing threats from habitat loss and fragmentation, making identification of suitable habitat essential for its protection. Ecological Niche Modeling (ENM) can predict a species' distribution by linking occurrences to environmental variables to estimate environmental tolerances. Previous studies generating ENMs for the long-toed salamander have overlooked A. m. croceum as an ecologically unique lineage, or relied on limited data. To address this gap, we are developing an ENM for the Santa Cruz long-toed salamander using a larger dataset, which we plan to project onto paleoclimate estimates to explore shifts in its historical range. These results will clarify the factors defining A. m. croceum's range, help explain the ancient processes driving its ecological divergence and geographic isolation, and guide future wetland management and conservation.

106 - Patterns in fish distribution, abundance, and size inside vs. outside a military exclusion zone at San Clemente Island.

† Johnson, K.J.[1*]; Lindholm, J.[2]; Bretz, C.[2]; Lindholm, Z.[3]

1- Moss Landing Marine Labs 2- California State University Monterey Bay 3- Colorado College

Marine Protected Areas (MPAs) are a widely used tool for managing marine resources and ecosystems. However, conservation goals may also be supported by Other Effective Area-Based Conservation Measures (OECMs), which can provide many of the benefits of MPAs without formal designation. This project evaluates how a military exclusion zone influences fish species' abundance, diversity, and size structure, using San Clemente Island (SCI) in southern California as a study site. SCI's waters are divided into eight "naval safety zones" extending three nautical miles offshore (Esgro et al. 2020), with our research focusing on Zone F (unprotected) and Zone G (military exclusion, serving as an OECM).In May 2025, stereo-video mini-lander cameras were deployed in both zones to survey mid-depth rocky reef fish communities (30–60 m). Post-processing included analysis of fish biomass, diversity, size structure, and community composition, combined with habitat mapping. Data from this survey will also be compared with previous surveys from 2019 and 2021 to assess temporal changes. We expect Zone G to support higher fish abundance, diversity, and larger size distributions, with positive trends over time. This work provides insight into the ecological value of OECMs and their potential role in advancing marine conservation and informing management and policy decisions.

107 - Influence of Kelp Detritus at the Temperate Reef-Sand interface on Habitat Utilization of Juvenile Rockfishes

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Exploring variations in the habitat utilization of juvenile temperate reef fishes is essential to understanding the population dynamics of local species and their responses to environmental shifts. The genus *Sebastes* represents a vital component of California's commercial and recreational fisheries, they support nearshore food webs, and recycle nutrients within kelp ecosystems. While the relationship between *Sebastes* and standing kelp forests has been thoroughly studied, the connection to macroalgal detritus adjacent to the reef is still unclear. Using SCUBA, we conducted visual transects along the reef edge of a Central California kelp forest and documented the microhabitat associations of young of the year (YOY) rockfish. We recorded data on 14 rockfish species, including count and identification for every individual, its distance from the reef-sand interface, and the microhabitat it occupied. Data from 2025 were compared to similar data from 2018, collected when kelp coverage at the study site was very different. We predicted that with reduced kelp detritus YOY rockfish would be found closer to the reef-sand interface and that they would be associated more closely with isolated rock and sand microhabitats. We found that in the absence of kelp detritus the foraging distance of YOY was greatly reduced and that there was a greater association with sand microhabitats. However, at shallower depths where macroalgae coverage resembles the earlier study, we saw a greater foraging distance and abundance of juvenile rockfish.

108 - Evaluating the role of structural complexity in rocky intertidal disturbance regimes

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1- University of Washington 2- Cal State LA

Amplified disturbances reduce an ecosystem's ability to recover from shocks such as storms, temperature anomalies, and disease outbreaks. In marine ecosystems, increasing storm severity often amplifies disturbances by causing physical damage to habitats, enhancing coastal erosion, and altering water quality and chemistry. Although they are one of the most dynamic and physically challenging marine environments, rocky intertidal habitats that experience increasing storm severity will experience wave-induced disturbance events, which can dislodge or crush intertidal organisms and physically restructure the system. To investigate the role that structural complexity plays in rocky intertidal disturbance dynamics, we piloted drone flights at ~10 meters above ground

level to capture aerial images of four long-term rocky intertidal monitoring sites in Bamfield, British Columbia. We computed drone-derived variables such as slope, rugosity, and aspect of ~100 points, as well as determined the total number and sizes of mussel disturbances at each site. Generalized linear modeling was completed to determine if any geomorphic variables (i.e., slope, aspect, rugosity) explain the variance seen in the number of disturbances at a given site and their sizes. Akaike information criterion (AIC) was used to select the most parsimonious models for each response variable. Preliminary results suggest that only one geomorphic variable is a driver of the number and size of mussel bed disturbance, rather than a combination of such variables.

109 - Impacts of Macroborers on Corals Along a Water Quality Gradient In American Samoa

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1- Cooperative Institute for Marine and Atmospheric Research 2- NOAA Pacific Islands Fisheries Science Center

American Samoa's coral reefs face threats from land based sources of pollution, potentially leading to increased bioerosion from macroborers. In this study, we examined how macroborer abundance varied along a water quality gradient in American Samoa's Nu'uuli Pala lagoon and back reef habitats. Ten sites were surveyed in each habitat type and assessed for environmental parameters (total suspended sediments, dissolved nutrients, chlorophyll-a, temperature, salinity, and pH). Additionally, photoquads were taken and analyzed to assess macroborer infestation rates and preference for different coral genera, morphologies, and condition of tissue (living or dead coral). Tube worms and vermetid worms were the dominant macroborers observed. Macroborers preferred living coral tissue from the genus *Porites* in both lagoon and back reef habitats. Furthermore, coral morphology influenced macroborer abundance with a higher abundance among mounding *Porites* in the lagoon, and mounding, knobby, and encrusting morphologies in the back reef. A gradient boosted regression model revealed that temperature, total suspended sediments, and nitrate and nitrate had the largest relative influence on macroborer abundance, and the other environmental variables were negligible. Macroborer infestation rates will be incorporated into carbonate budgets calculations to estimate if reefs are net growing or eroding. These findings will help natural resource managers in American Samoa more effectively monitor and manage coral bioerosion.

110 - Heart rate and valve-gaping response of Mytilus galloprovincialis to estuary water quality changes

† Mendez, N.M.[1*]; Miller, L.P.[1]; Klopp, M.J.[1]; Giddings, S.N.[2]; Goodrich, K.A.[3]; Crooks, J.A.[3]

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Los Peñasquitos Lagoon, a coastal estuary in Southern California, experiences frequent changes in water quality driven by terrestrial runoff and seasonal mouth closures. To endure these shifts in environmental conditions, bivalves must change their behavior and physiology through fluctuating heart rate and opening or closing the shell valves. One of the bivalve species found in large quantities in Los Peñasquitos Lagoon is the non-native Mediterranean mussel *Mytilus galloprovincialis*, which have been found in San Diego since the 20th century. Since then, these bivalves have managed to spread to estuaries across Southern California, including Los Peñasquitos Lagoon. We monitored the cardiac and valve-gaping activity of *M. galloprovincialis* in the field using biosensors that non-invasively collect heart rate and gape data. These findings were compared to the concurrent abiotic water quality conditions, such as temperature, dissolved oxygen, and salinity, in Los Peñasquitos Lagoon to evaluate how oysters responded to short-term environmental changes.

111 - Community analysis in seagrass meadows

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1- California State University Monterey Bay 2- Oregon State University

Seagrass restoration represents a critical priority in environmental protection, yet substantial uncertainty remains regarding its capacity to fully reestablish ecosystem services. In estuarine systems such as Coos Bay, Oregon, seagrass meadows support diverse fish assemblages that contribute to ecological function and habitat complexity.

This study investigates differences in fish assemblages between natural and restored eelgrass (*Zostera marina*) habitats within this system. By directly comparing these habitat types, we aim to determine the extent to which biodiversity returns in restored areas and to clarify the ecological functions these habitats provide. We analyzed fish assemblage data collected through 2025 using standardized minnow and crab traps at both natural and restored sites. We will analyze patterns of diversity and community composition to evaluate the degree to which restoration supports biodiversity recovery while also advancing a consistent protocol for standardized biodiversity restoration metrics in future projects.

112 - Comparing Fish Communities in a Created and Natural Marsh, Three Decades after Marsh Creation

† Camara, M.[1*]; Rodriguez, C.[2]; Carpenter, J.[1]; Correa, J.[2]; Garcia, J.[2]; Kitcher, J.[2]; Uyeda, K.[2]; Stowe, T.[2]; Talley, D.[1]

1- University of San Diego, Department of Environmental and Ocean Sciences, San Diego, CA 2- University of California San Diego, Natural Reserve Systems

Restoration of coastal marshes is an important strategy supporting shoreline protection, water filtration, carbon storage, and essential habitat for fish and bird species. However, it is uncertain whether created marshes provide habitat comparable to natural systems. In this study, we examined fish communities in the Kendall-Frost Marsh Reserve (Mission Bay, San Diego, CA), comparing an almost three decade old created marsh to an adjacent natural marsh. Over a ten-week sampling period in summer 2025, we sampled weekly using minnow traps to evaluate differences in abundance, diversity, and the size structure of the dominant marsh fish, Fundulus parvipinnis. While created and natural marshes supported similar species richness, F. parvipinnis tended to be larger in the natural marsh. These results suggest that while created marshes can support fish communities, differences in fish community support still differed between created and natural marshes. This work highlights the importance of long-term monitoring to assess the ecological function of restored marshes.

113 - Spectral variability from space: how well do satellites monitor intertidal zones?

† Cabrera, K.M.[1*]; Luis, K.[2]; Tanner, R.[1]; Shirkey, G.[1]

1- Chapman University 2- Jet Propulsion Laboratory, California Institute of Technology

Coastal intertidal zones are biologically diverse and ecologically sensitive habitats. This biodiversity is characterized by a wide variety of substrate types, including rocks, sand, seaweeds, invertebrates, and more. Field spectroscopic surveys provide fine-scale observations of substrate types but are laborious and costly to retrieve. This highlights the need for fine spectral resolution remote sensing to monitor large-scale biodiversity trends. This study investigated (1) the spectral diversity of in situ versus EMIT observations and (2) how observed in situ and EMIT spectra reflect biodiversity. Field data were collected in May 2025 at three Southern California sites, and hyperspectral data came from NASA's EMIT instrument aboard the International Space Station. Results showed similar spectral patterns between EMIT and field observations, as transects often overlapped multiple EMIT pixels. This overlap allowed spectral signatures to incorporate contributions from several points across different pixels. This demonstrates the instrument's ability to capture spectral variability across heterogeneous habitats. The workflow, built on open-access Earth data, is reproducible and cost-effective. These findings have implications for coastal management: spectral variability can detect shifts in algal cover, bare rock exposure, or invasive species, and track recovery after disturbance. More broadly, this approach provides a scalable framework for seasonal monitoring, complementing fieldwork and enabling researchers to assess ecological change where access is limited.

114 - If you build it, will they come? Evaluating the effects of kelp restoration on nearshore fish assemblages

† O'Hara, B.[1*]; Bugbee, B.M.[2]; Gómez, J.[3]; Grime, B.C.[4]; Hohman, R.[3]; Karm, R.H.[1]; McHugh, T.A.[4]; Hamilton, S.L.[2]; Hughes, B.B.[1]

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The loss of a foundation species and the resulting collapse in biodiversity and ecosystem functions often necessitate intervention through ecosystem restoration. Evaluating restoration efficacy requires assessing not only the structural recovery of the foundation species, but also the return of biodiversity and ecosystem functions relative to unrestored and natural sites. Bull kelp (*Nereocystis luetkeana*), an annual species and the dominant canopy-forming kelp in northern California, has declined by over 90% since 2014. Due to its high seasonal and interannual variability, bull kelp's foundational role remains poorly understood, particularly in the context of recent kelp loss and restoration. This study utilizes two kelp restoration programs in northern California to compare fish density and diversity in restored kelp, natural kelp forests, and urchin barren reefs, with emphasis on the recruitment of young-of-year rockfish (*Sebastes* spp.). We quantified fish density, size, and diversity across fixed transects in each habitat, and on restoration structures with and without transplanted kelp to evaluate the influence of structure vs. kelp on fish recruitment and habitat use. Preliminary results suggest natural kelp supports marginally greater fish density than restored kelp and both support significantly more fish than urchin barrens, and that kelp restoration structure enhances fish recruitment. These findings aim to provide insight into the role of natural and restored bull kelp in supporting nearshore fish communities.

Poster Session II

* indicates presenting author, † indicates eligibility for Best Student Paper Award

115 - Intertidal sand dollar *Dendraster excentricus* larvae are resilient to high temperatures at early development and settlement.

† Mariscal Del Toro, M.[1*]; Lagmay-Alonzo, A.[2]; George, S.[3]; Edsinger, E.[4]

1- Whitman College 2- University of Washington 3- Georgia Southern University 4- University of Florida

Understanding how stages of benthic marine invertebrates respond to environmental stressors is essential to predicting future population dynamics and can be critical to management and conservation of species. This study examined the effects of temperature and chemical cues on larval development and settlement success of the sand dollar *Dendraster excentricus*. Adults collected from an intertidal population on Orcas Island, WA were spawned and embryos cultured under controlled laboratory conditions across a range of temperatures representative of field conditions. Data on early development, growth, and settlement under temperature and chemical cues were recorded. Results show that elevated temperatures for 24 hours starting at fertilization accelerated developmental rates and produced abnormalities starting at 25 °C. In contrast, temperatures as high as 30 degrees had no detectable effect on larval settlement. These findings highlight *D. excentricus* as a model for thermal resilience and underscore the importance of thermal variability in biphasic lifecycles of benthic marine invertebrates. More broadly, this work provides insight into how rising ocean temperatures may influence recruitment dynamics in benthic communities.

116 - Does intertidal position influence the capacity for anaerobic metabolism in acorn barnacles?

† Fabre, N.[1*]; Hardy, K.M.[2]

1- Cal Poly-SLO 2- Cal Poly - SLO

Sessile intertidal organisms experience dramatic fluctuations in abiotic stressors such as oxygen availability, desiccation, and temperature across a tidal cycle. To survive in these environments, species employ diverse metabolic strategies, ranging from maintaining aerobic respiration via moist gills in air to relying on anaerobic pathways due to shell closure and internal hypoxia when in air. We tested whether barnacle species residing at different vertical positions in the intertidal zone differ in their anaerobic capacity, hypothesizing that high-intertidal species would exhibit greater lactate dehydrogenase (LDH) activity than low-intertidal species. Four barnacle

species—*Tetraclita rubescens* (low), *Semibalanus cariosus* (low), *Balanus glandula* (mid-high), and *Chthamalus dalli* (high)—were collected from the Cal Poly Research Pier in Avila Beach, CA. Whole-animal homogenates were assayed for LDH activity using a basic spectrophotometric assay. We found significantly higher (9-fold!) LDH activity in *C. dalli* compared to all other species. These results indicate that *C. dalli* has evolved an enhanced capacity for anaerobic metabolism to avoid desiccation and thereby tolerate prolonged aerial exposure, while species such as *B. glandula* appear to rely more heavily on aerobic respiration in air. This work highlights metabolic plasticity as a key factor shaping intertidal zonation patterns and offers insight into how barnacle species may differentially respond to climate change–driven increases in desiccation and hypoxia stress.

117 - Three-dimensional reconstruction of Deep Sea Octopus Neuroanatomy Could Reveal Unique Chemoreceptive Abilities

Mears, T.J.*; Crook, R.J.

San Francisco State University

Deep off central California, thousands of pearl octopus (Muusoctopus robustus) migrate through cold dark waters to hydrothermal springs near an inactive volcano to mate, nest, and die, forming the largest known aggregation of octopus on Earth. M. robustus exhibits a characteristic, upright reaching behaviour using their front two arms (L1 and R1), and it has been demonstrated that they use these arms by far the least for locomotion. We aim to describe the completely unknown neuroanatomy of M. robustus arms to find if the L1 & R1 arms could be specialized for distance chemoreception. Fine scale Micro-CT and synchrotron scanning of fixed specimens will allow us to gain new insights into the physiology and behaviorof a deep sea octopus. Finding unique neuroanatomical features in their arms will provide insights into how this species navigates over long distance to find the hydrothermal springs they depend on, and will shed light more broadly on the diversity of arm neuroanatomy that has been optimised for the many niches that extant octopods occupy.

118 - Booming solutions: The impact of pollution remediation on marine communities in San Diego marinas

† Kolon, G.F.*; McCoy, K.; Vasa, I.; Zoch, G.; Boudrias, M.

University of San Diego

Coastal ecosystems sustain and provide essential ecological and economic services; however, they are increasingly threatened by anthropogenic pollution particularly in marina environments. Remediation approaches are necessary to reduce contaminant loads in these ecosystems, thereby supporting biodiverse communities. This study aims to assess the effectiveness of sustainable pollution remediation booms in absorbing heavy metals and their impacts on organismal community in San Diego marinas. Heavy metal concentrations on the surface of the polypropylene material, in sediment samples, and in dried ascidians were measured using a hand-held X-Ray Fluorescence (XRF) analyzer. The netting and the sorbent material, along with the sediments, were analyzed for invertebrate communities and sorted to the lowest identified taxa to evaluate community level response to pollutant exposure. This study found that the surface of the booms and ascidians effectively collected the heavy metals like copper and zinc; concentrations were in excess by an order of magnitude of allowable limits. Organismal community composition differed among the sites, with shifts between the recreational and industrial locations associated with changes in the heavy metal concentrations. These findings could have significant implications in operational management in marinas. Continued assessment of these remediation efforts could help in developing better solutions for improved water quality in urban marine environments.

119 - Inferring diversity and population structure of mesophotic fish using environmental DNA (eDNA)

† Marwayana, O.N.*; Barber, P.H.

University of California Los Angeles

Indonesia is the world's largest archipelagic country and home to the most diverse marine ecosystems on the planet (Allen, 2008; Roberts et al., 2002; Veron et al., 2009). Although fish diversity in shallow waters of the Coral Triangle is well studied, little is known about fishes that live deeper on the reef, particularly in the mesophotic zone. Mesophotic ecosystems are characterized by depths between 30 and 150 m (~500 feet) and are distinct from shallow-water ecosystems, both in terms of depth as well as ecological characteristics (Kahng et al., 2017; Rocha et al., 2018; Pyle & Copus, 2019). The unique potential of mesophotic and deep-water Indonesian marine ecosystems to yield novel insights is highlighted by the discovery of coelacanth populations in Indonesian waters. Increasingly researchers are employing metagenomic tools such as environmental DNA (eDNA) to study marine diversity. eDNA offers a promising alternative to traditional approaches to accurately and efficiently monitoring local marine biodiversity, particularly in mesophotic ecosystems, as eDNA can provide information on fish communities that is missed by traditional surveys. Environmental DNA (eDNA) will reveal the effectiveness of eDNA in detecting the Indonesian coelacanth and the patterns of mesophotic fish biodiversity and phylogeography.

120 - Gaps in Environmental Report Card Systems: A Global Assessment of Estuarine Health Indicators

Semmler, R.F.*; Hines, A.H.; Ruiz, G.M.

Smithsonian Environmental Research Center

Environmental Report Card (ERC) systems are prevalent tools to communicate ecosystem health to stakeholders and inform management decisions in estuarine and coastal environments. These systems are typically developed independently by local organizations to address community-specific priorities, potentially creating gaps in ecologically critical indicators. This study presents the first global assessment of ERC systems to identify patterns in indicator selection and evaluate representation of key ecological stressors. We compiled ERC systems through systematic searches of academic databases, grey literature, and surveys distributed to marine ecology research networks. Analysis examined indicator categories, spatial coverage, and inclusion of emerging stressors such as urbanization pressures and invasive species impacts. Despite extensive research demonstrating cascading effects of coastal development and bioinvasions on estuarine function, results reveal little attention to these issues. Instead, we found pronounced emphasis on traditional water quality and pollution indicators, with secondary focus on habitat condition and fish/invertebrate communities. Findings suggest community-driven ERC development, while valuable for stakeholder engagement, systematically underrepresents indicators requiring specialized expertise or cross-jurisdictional coordination. Results highlight the need for guidance frameworks balancing local relevance with comprehensive ecological assessment, ensuring ERC systems capture the full spectrum of anthropogenic pressures facing coastal ecosystems.

121 - The Effects of Artificial Light at Night on Rodent Giving Up Densities

† Duenas, N.W.*

California State University Northridge

Light pollution has been a growing concern for years and has noticeable effects on the health and behaviors of animals at night. Light pollution, or artificial light at night (ALAN), has been shown to increase an animal's sense of perceived risk while out foraging. This increase in perceived risk can cause animals to have higher giving up densities (GUDs) of food at a foraging patch. For populations of small prey animals, such as rodents, this can cause negative trophic effects on plant communities in an ecosystem. For my experiment, I plan to measure the GUDs of rodents foraging at illuminated sand filled trays. This will be done at the UCLA research reserve Stunt Ranch in the Santa Monica mountains. This reserve's location minimizes light pollution and allows moon light to be the main source of light at night. Since the moon is the main source of light at the reserve, I'll be using low levels of light (0.5lux) to illuminate the trays. I anticipate to see these rodents leave more food at foraging trays while they are exposed to low levels of ALAN. Understanding the impacts of ALAN on rodent foraging behavior can help conservation and restoration biologists better protect these animals. This study could also show a new method for deterring rodents from specific areas of rural human development.

122 - Underfoot Ecology: Rocky Intertidal Invertebrate Abundance and Diversity in the Context of Human Disturbance

† Hall, H.D.*; Khen, A.; Smith, J.E.

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The Intermediate Disturbance Hypothesis (IDH) states that species diversity is highest when communities experience intermediate levels of disturbance. We investigated this hypothesis in the benthic invertebrate community at Cabrillo National Monument in Point Loma, California at three intertidal sites with varying levels of human disturbance. The TIDES (Tribal Intertidal Digital Ecological Surveys) project includes seasonal field surveys since 2019, in which high-resolution large-area imagery is taken at each site. For each 180 m^2 plot, thousands of photos are stitched together into a 3D model and uploaded to Viscore software where ~10,000 stratified random points are linked to raw imagery for taxonomic identification. Benthic community composition, invertebrate group abundances, and diversity indices were analyzed from 2019 to 2021. We expected the site with intermediate disturbance to have the highest species diversity, the most trampled site to have the lowest, and the inaccessible site to fall somewhere in between. Our results instead showed that the site exposed to the most human disturbance had higher diversity and invertebrate abundance than the site with intermediate disturbance. Further work is needed to understand why our research did not align with the IDH, or alternatively whether the methodology is not able to capture the entire invertebrate community as compared to traditional field surveys. Developing more robust long-term monitoring methods for this ecosystem is crucial for effective management in the context of local human impacts.

123 - Kelp canopy loss results in benthic algal structure change in Northern California

† Winquist, T.[1*]; Gaylord, B.A.[2]; Edwards, M.[1]

1- San Diego State University 2- University of California Davis

Kelp canopy loss results in benthic algal structure change in Northern T. Winquist (San Diego state university) B. A. Gaylord (university of California Davis) M. Edwards, (San Diego State University)

124 - Are Limpets Locavores? A Test with Carbon Isotope Ratios

† Smith, I.J.*; Eernisse, D.J.; Sandquist, D.R.

CSU Fullerton

Lottia pelta and Lottia insessa are two common limpet species found in the Southern California intertidal zones. L. insessa is a specialist found exclusively on feather boa kelp (Egregia menziesii) whereas L. pelta is found both on feather boa kelp and under rockweeds (Silvetia compressa). Interestingly, L. pelta shell morphology corresponds to these habitat contrasts. We hypothesized that the diet of L. pelta changes in accord with habitat and shell morphology. Through observations of differences in carbon isotope ratio values (δ13C), we tested if limpet diet reflected the potential food sources found in these differing habitats. I.e., Do they eat the associated alga or something else? There was a distinguishable difference among the three main putative food sources, rockweed (-16.2‰), feather boa kelp (-15.5‰), and surface diatom “scuzz” (-14.6‰), and a similar spread among all sampled limpet values (-16.6‰ to -12.8‰). L. insessa δ13C values (the feather boa kelp specialist) overlapped with those of L. pelta living on feather boa kelp. Likewise, the δ13C values of L. pelta living in rockweed corresponded more closely to rockweed δ13C values, and differed by 1.83‰ from those on feather boa kelp. These results provide evidence that the diet of L. pelta corresponds closely to the dominant alga of their respective habitats.

125 - Effects of Interacting Climate Change Stressors on Predation Dynamics in Eelgrass Habitat

† Jorrick, L.C.*; Hovel, K.A.

San Diego State University

Climate change stressors such as ocean acidification (OA) and ocean warming (OW) have the potential to alter many aspects of marine ecosystems, including interactions among predators, herbivores, and producers that influence the persistence of foundation species such as seagrasses. Because OA and OW are occurring simultaneously in the coastal ocean, it is important to understand how the *interaction* of these stressors may affect key ecosystem processes such as predation. We used a laboratory-based mesocosm experiment to test whether OA and OW interactively affect the predation efficiency of a common but understudied temperate seagrass fish, the bay pipefish (*Syngnathus leptorhynchus*). We acclimated pipefish and their prey (gammarid amphipods) to one of four different seawater temperature and pH treatments: ambient temperature and pH, ambient temperature and low pH, elevated temperature and ambient pH, and elevated temperature and low pH. We then measured pipefish predation rates (number of live prey consumed per fish per hour) in each treatment. We found that OW and OA both marginally reduced pipefish predation on amphipods, but that predation rates were not substantially lower when both stressors were present. Our results suggest that OW does not increase predation rates as expected, and that the interaction between pipefish and their prey may be robust to climate change stressors.

126 - Tracking Metals Pollution in Mission Bay with Ulva australis

† Ah Sam, M.[1*]; Reyns, N.[2]

1- Univeristy of San Diego 2- University of San Diego

Trace metal contamination poses risks to coastal ecosystems, and macroalgae such as Ulva spp. have potential as bioindicators of environmental metal exposure. This study examined the concentrations of heavy metals in sediments and Ulva australis collected from marina, dock, rip-rap, and beach sites throughout Mission Bay, San Diego, CA (USA). Field collections of sediments and Ulva were analyzed for 6 metals (Cu, Pb, Zn, Fe, Ni, Cr) in triplicate using X-ray fluorescence (XRF). Sediment concentrations were compared against NOAA SQuiRT guidelines, and biota–sediment accumulation factors (BSAFs) were calculated to evaluate the relationship between sediment and algal metal content to assess whether metals are accumulating in Ulva. There were positive correlations between Cu, Zn, and Fe in sediments and Ulva, suggesting that Ulva can serve as a bioindicator for these metals. Overall, metal concentrations in sediment were highest at marina sites, while with the exception of Cu and Zn, in Ulva were highest at beach sites. Beach sites had the greatest BSAFs. Our results suggest that elevated uptake of metals in Ulva relative to sediment concentrations is at sites with coarse, low- organic sediments where metals may be poorly retained. These findings highlight site- specific differences in metal sources and pathways, and they suggest that Ulva australis may be most effective as a bioindicator of sediment metals in areas with fine-grained, organic-rich sediments, but less reliable in coarse, low-organic environments such as beaches where metals may be accumulating in Ulva.

127 - The effect of nitrate variation on the uptake rates and physiological responses of *Macrocystis pyrifera* juvenile sporophytes

Meyer, K.[1*]; Sedarat, M.[1]; Harris, R.[1]; Ben-Zvi, O.[1]; Layton, C.[2]; Zembsch, N.[1]; Smith, J.E.[1]

1- Scripps Institution of Oceanography, University of California San Diego 2- Institute for Marine and Antarctic Studies, University of Tasmania

Kelp forests, formed by species such as giant kelp *Macrocystis pyrifera* are highly productive coastal ecosystems that provide habitat, food, and ecosystem services. Their growth and physiology are strongly regulated by nitrate availability, yet the uptake capacity and metabolic responses of juvenile sporophytes are not well quantified. Nitrate supply to kelp forests fluctuates seasonally due to upwelling, internal waves, ocean circulation, and stratification, but these patterns are being compounded by ocean warming. Enhanced stratification associated with climate change reduces nutrient delivery to surface waters, leading to lower nitrate availability which may constrain kelp forest productivity in the future. We addressed this knowledge gap through two experiments. In the first experiment, juvenile sporophytes were exposed to a gradient of nitrate concentrations to quantify uptake rates by measuring changes in seawater nitrate concentration over time. In the second experiment, juvenile sporophytes were held under varying nitrate concentrations representing seasonal minima and maxima to evaluate growth and

photophysiological responses to simulated seasonal nutrient regimes. This approach enabled us to quantify nitrate uptake kinetics in juvenile sporophytes of *M. pyrifera* and determine how they responded to nitrate seasonal variability. Collectively, these experiments provide insights into the nitrate requirements of juvenile *M. pyrifera* and their potential resilience to nutrient variability under both natural seasonal cycles and ongoing climate change.

128 - Foraminifera as an indicator of water quality in coral reefs below developed vs minimally developed watersheds in the US Virgin Islands

† Cisneros, I.[*]; Morales, S.; Stevens, N.; Gray, S.C.

University of San Diego

Poor water quality is contributing to the decline of coral reefs in the Caribbean. However, water quality is difficult to monitor in remote areas. The FORAM index is a proxy for water quality based on the proportion of symbiotic-bearing foraminifera in coral reef sediments. Coral reefs in the St. John, US Virgin Islands are negatively impacted in areas below developed watersheds where runoff from unpaved roads and septic systems reduce water quality. The objective of this research is to use the FORAM index to compare water quality among bays below watersheds of variable development in St. John, USVI. Benthic sediment samples were collected near coral reefs in three bays below areas of variable watershed development. At least 150 foraminifera were picked from each sample, classified into three morphological groups and the FORAM index calculated. A greater proportion of symbiotic-bearing forams and thus higher FORAM index was found below watersheds in the US Virgin Islands National Parks compared to the areas below a developed watershed or a mangrove area. Data from this study indicate marginal conditions for coral reef growth in St. John USVI suggesting that corals are vulnerable to disturbance. We found that the FORAM Index (water quality) was lowest when there was a greater percentage of clay in the sediments. These data suggest that management should target areas with developed watersheds in order to mitigate land-based pollution.

129 - Supplementary feeding, but not food type, affects purple urchin (Strongylocentrotus purpuratus) growth and reproductive potential

Dail, S.[*]; Zhang, Z.[*]

Santa Catalina School

The purple urchin *Strongylocentrotus purpuratus* has the ability to enter a low-metabolic “zombie” state that allows for prolonged periods of survival under starvation primarily by resorbing its gonads. Because urchin gonads are a valuable food, there is interest in capturing urchins and rehabilitating them in aquaculture by feeding kelps that promote recovery of gonadal health. We tested four common Monterey Bay macroalga (*Macrocystis pyrifera*, *Nereocystis luetkeana*, *Chondracanthus exasperatus*, and *Stephanocystis osmundacea*) to identify which species yielded the largest increase in gonad size in *S. purpuratus*. Urchins fed any of these kelps or a mixture of them showed similar increase of buoyant weight, diameter, and gonadosomatic size index (GSI) over a 12 week exposure, indicating that all species provide comparable benefits. However, when compared to wild urchins, all fed groups exhibited significantly higher GSI values, highlighting the gap between laboratory-fed development and natural gonadal development. These results indicate multiple native macroalga are similarly effective diets for *S. purpuratus* gonadal recovery beyond natural foraging conditions, supporting their use in commercial production.

130 - What the Kelp! Historical and Aerial Mapping of Kelp Forests off the Oregon Coast

† Combs, J.M.[1*]; Moretto, W.[2]; Heppell, S.[2]

1- University of South Florida 2- Oregon State University

Kelp forests in Oregon play a vital role in the nearshore marine environment. They provide nursery habitat for fish, protect against intense storms, and are among the most productive marine ecosystems. A steady decline in Oregon’s canopy bull kelp *(Nereocystis luetkeana)* has prompted efforts to investigate the extent of the state’s total kelp loss. This project utilizes different techniques such as GIS analysis, aerial imagery, and historic maps to assist

in kelp forest monitoring along the Oregon coast. Data was collected using navigational charts of the Oregon coastline that delineate kelp, and the kelp forest area was analyzed through georeferencing in ArcGIS; additionally, aerial images of known kelp from recent years were obtained from the Oregon Department of Fish and Wildlife and Oregon Kelp Alliance aerial and drone surveys. We evaluated how kelp forests have changed over time, and whether specific regions of the Oregon coast underwent more extensive kelp loss. A kelp species composition analysis of the Hatfield Marine Science Center Guin Library Herbarium was conducted and revealed the presence of kelp species seldom found on on the Oregon Coast today. Ultimately, this study revealed that Oregon's current canopy kelp area and species composition has changed substantially relative to historic records, which may have profound implications on the fish and invertebrate species that reside in these vital nearshore ecosystems.

131 - Determining the Use of Carbon Concentrating Mechanisms (CCM) in 30 Species of Macroalgae from Point Loma

Stodder, K.L.*; Duncan, K.; Edwards, M.S.

San Diego State University

Macroalgae obtain inorganic carbon for photosynthesis via direct diffusion of CO_2 or by conversion of HCO_3^- to CO_2 using carbon concentrating mechanisms (CCMs). The majority of macroalgae use a combination of passive diffusion and CCMs to obtain CO_2, however, "non-CCM" species that rely solely on passive diffusion of CO2 may respond differently to changing ocean conditions than "CCM-species". We collected 30 intertidal and subtidal macroalgal species from Point Loma, California, and examined their δ13C ‰ to determine which species use CCMs. We identified 9 "non-CCM" species from the phylum, Rhodophyta, and 21 "CCM-species" from Rhodophyta, Heterokontophyta, and Chlorophyta. On average, species from Rhodophyta displayed more negative δ13C ‰ compared to Chlorophyta and Heterokontophyta, and more negative δ13C ‰ values correlated with depth. Our findings are consistent with similar studies on macroalgae from Puget Sound, Gulf of California, Australia, New Zealand, and Antarctica, and suggest that carbon use strategy in macroalgae is influenced by both phylogeny and depth. This data serves as a starting point for further investigation into how CCM and non-CCM species respond to future ocean conditions such as ocean acidification, increased temperatures, and ocean darkening.

132 - Geological habitat variability of Pismo clam (Tivela stultorum) populations in Monterey Bay

† Kahn, K.L.[1*]; Weiand, E.C.[1*]; Mallicoat, L.[1]; Beaudoin, O.[2]; Haupt, A.[1]

1- California State University Monterey Bay 2- California State University Monterey Bay, Moss Landing Marine Laboratories

Tivela stultorum, or the Pismo Clam, was once a staple bivalve for commercial fisheries on the California Coast. As a result of overexploitation in the 1900's, populations have declined along the coast of California, and poaching within their native range still remains a threat. This study investigates sediment dynamics and fluid conditions of Pismo clam habitats, which allows us to estimate the strength of geophysical drivers of their population distributions including their geographic location, median sediment grain size, wave height and period, beach slope, and strength of low tide. It is hypothesized that higher abundances of clams are associated with dissipative beaches that have flatter slopes, grain sizes finer than 0.5mm, poorly sorted sediments, and lower wave energy input; it is also hypothesized that juveniles will inhabit dissipative beaches, while adults will be found in more reflective beaches. To test this, over two months across 15 sites, perpendicular 30 meter transects were conducted from Davenport CA to Carmel CA, at tides of -0.8ft or lower. We dug three transects in three meter sections, collected sediment samples at each section, and sized the sediment using sieve stacks to give a median grain size. Wave energy was assessed using the CDIP MOP model. Clams that were found were measured and reburied at the site. Preliminary results found that increased recruitment (size ≤ 2.5 cm) indicates that the Pismo clam population is growing. Identifying the most efficient way to restore their habitat helps ensure long-term survival and population recovery.

133 - Effect of microplastics in prey items (Emerita analoga) on the foraging success of sanderlings (Calidris alba)

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San Francisco State University

Plastic pollution is a growing concern in coastal ecosystems where high concentrations of microplastics (MPs) accumulate from urban run-off, waves, and oceanographic processes. These pollutants are ingested by filter-feeding invertebrates like Pacific mole crabs *Emerita analoga* and can disrupt their burrowing behavior, potentially affecting the foraging of predators such as the sanderling *Calidris alba*. This study investigates how the presence of MPs in mole crab prey affects sanderling foraging on the Northern California coast. We hypothesize that sanderling foraging success will increase with the presence of microplastics in prey due to the decreased burrowing depth of *E.analoga*. Sanderling foraging success was assessed across a presumed gradient of MP contamination at three N. California beaches: Half Moon Bay State Beach, Pescadero State Beach, and Ocean Beach. MP abundance in *E.analoga*., water, and sand was measured. Sanderling foraging was recorded on video to determine capture rates, while predator, human, and dog disturbance and mole crab density was also recorded. Sanderlings exhibited capture rates of 3.27% at Pescadero State Beach, 9.29% at Ocean Beach, and 1.81% at Half Moon Bay State Beach, suggesting variation in foraging success across all sites. Higher success at Ocean Beach, where MPs are expected to be greatest, supports the hypothesis that impaired burrowing ability increases prey availability.

134 - Conditioned by Diversity: Measuring Eelgrass (Zostera marina) Diversity and Microbial Legacy Effects

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1- UC Davis 2- UC Davis Bodega Marine Laboratory

Diversity effects have a long history of leading to increased productivity. In terrestrial systems, plant polycultures can cultivate diverse beneficial microbes in rhizosphere soils, thereby influencing plant-soil feedbacks. This can result in positive microbial legacy effects, in which polyculture-conditioned soils are more productive. However, this relationship has not been studied in eelgrass (*Zostera marina*), an important marine foundation species. To test how diversity influences microbial legacy effects in eelgrass, we conducted a two-part experiment. First, we grew plants from three populations in polycultures (three plants, each from a different site) and in monocultures (three plants from the same site). We then compared their biomass, growth rate, and disease prevalence over five weeks. To understand microbial legacy effects, we transplanted new plants from the same sites into polyculture- or monoculture-conditioned soils to test the effect of pre-conditioned sediment on new plant traits (ongoing). We found that polycultures showed higher total biomass than monocultures, with variation driven mainly by plant origin site. Disease prevalence did not differ between polyculture and monoculture pots. Our findings are consistent with an early stage “sampling effect” among polycultures, in which the most productive population disproportionately drives total growth. Our findings support that diverse plots lead to higher productivity, suggesting this system will be well-suited to testing microbial legacy effects and informing us about marine plant-soil feedbacks.

135 - Evaluating the Impact of a Direct Ocean Capture System’s Effluent on Early Development of Pacific Oyster (Magallana gigas) Larvae

Wu, C.H.[1*]; Kim, D.[1]; Churches, N.[1]; Jacobson, I.[1]; Qi, Z.[2]; Chu, S.[2]

1- Holdfast Aquaculture 2- Captura Corporation

Carbon capture has become an integral part of climate mitigation strategies to curb global warming and ocean acidification. Captura Corporation has developed a proprietary Direct Ocean Capture (DOC) system that removes excess carbon from seawater via electrodialysis. In collaboration with Captura, Holdfast Aquaculture evaluated the effects of effluent on Pacific oyster (*Magallana gigas*) larvae after a 48-hr exposure period immediately following fertilization using six effluent concentrations (0%, 25%, 50%, 75%, 90% and 100%). Larval survival and normal D-

hinge development were assessed by microscopy to determine the LD50 and effects of effluent concentration. Three separate experiments were conducted using either untreated or treated forms of the effluent using those concentrations: untreated effluent, effluent after aeration, and effluent after aeration with added sodium bicarbonate, to test whether treatment of the effluent influenced the results. The treatments were selected based on common standard practices used in shellfish hatcheries to improve larval outcomes. Treatment of effluent by aeration alone significantly improved larval outcomes, and the results of the effluent that was aerated and buffered with sodium bicarbonate are pending. These findings suggest that simple, low-cost treatments may reduce the negative effects of DOC effluent on larval development, potentially offering a practical path for its use in aquaculture and informing strategies to scale the technology in ways that protect the marine environment.

136 - Exploring the Shifting Tides: Variations in Assemblages of Invertebrates on Intertidal Macrophyte *Hedophyllum Sessile* Along the Oregon Coast

† Aldridge, R.A.*; Davis, M.M.; Menge, B.A.

Oregon State University

As a primary space occupier of the rocky intertidal from Alaska through Oregon, many invertebrates rely on *Hedophllum sessile*. *H. sessile* is known to provide cover for several species of understory algae while also acting as a food source and shelter for invertebrate assemblages. However, there has yet to be an assessment of what invertebrate species interact with *H. sessile*, which likely varies spatially. We compared species richness and evenness of invertebrate assemblages on *H. sessile*, at the two sites, Boiler Bay (BB) and Tokatee Klootchman (TK), which experience different physical and biological conditions. We surveyed permanently marked transects at each of these sites for a period of one year, twice monthly, from May 2024 to May 2025, as conditions allowed. I hypothesized that surveyed kelp at BB would have greater invertebrate species richness, but lower overall species evenness than TK on the blades of the intertidal kelp *H. sessile* because BB has greater macrophyte abundance, supporting more unique species more widely dispersed through the dense kelp bed. We found that BB does not support greater invertebrate species richness than TK (Mann-Whitney U Test; $W = 13680$, $p > 0.999$). However, TK does support greater species evenness than BB (Mann-Whitney U Test; $W = 3714$, $p < 0.001$). I believe that the greater species richness and evenness observed at TK may be due to the wider shelf in Cape Perpetua, where this site resides, allowing for higher larval retention.

137 - Hidden World of Purple Sea Urchin: Using Microscopy to Engage the Public in the Phenomenon of Larval Development and Metamorphosis.

De La Piedra, S.[1]; Erwin, J.[1]; Gupta, S.[1]; Liu, J.[1]; Ma, J.[1]; Meriwether, A.[1]; Millis, R.[2]; Nutt, L.[2*]; Semans, S.[2]; Shahar, E.[1]; Yu, K.[1]

1- Exploratorium 2- Noyo Center for Marine Science

Seeing Scientifically is a collaborative project aimed at engaging the public in unassisted scientific observation of phenomena when examining life under a microscope. Learners will be able to ask questions, interpret images, and draw conclusions based on what they see. The Noyo Center for Marine Science seeks to determine if a stand-alone microscopy exhibit will engage visitors and help them make scientific observations about purple sea urchin *(Strongylocentrotus purpuratus)* larval lifecycle and metamorphosis. Furthermore, determine if this exhibit is an effective launching point for visitors to understand how *S. purpuratus* influence their environment. The project required cultivation of *S. purpuratus* larvae, microalgae *Rhodomonas salina*, and development of a seawater system. The exhibit features a microscope with a live feed displayed on a touch screen interface. With artificial intelligence assistance, visitors interact with a storyboard developed to scaffold the learning process. Visitors will be randomly selected and asked to create a concept map of what they know about *S. purpuratus* before and after they interact with the exhibit. The data will help identify overall learning processes and future improvements. While the exhibit is complete, research results are pending. Data collection will start in the fall of 2025. If our research shows that a stand-alone microscopy exhibit can be an effective learning tool and tailored to fit the needs of informal science learning centers anywhere, this could become a model for many institutions.

138 - Spatio-Seasonal Dynamics of Macroalgae in Puerto Morelos Reefs under Varying Vulnerability to Human Impact

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National Autonomous University of Mexico

The spatio-seasonal dynamics of macroalgae in coral reefs serve as key indicators of ecosystem health, reflecting changes in water quality and anthropogenic pressure. This study assessed macroalgal cover, other benthic components, and seawater temperature in three shallow reefs of Puerto Morelos, Quintana Roo, Mexico, from 2020 to 2023. The sites included: Ojo de Agua, near the coast, influenced by human activity, recreational diving, and freshwater input; La Bocana, the reef lagoon outlet with boat traffic and diving activity; and Jardines, located farther offshore, a popular dive tourism area. Monthly quadrat surveys were conducted over three years, encompassing reduced tourism pressure during the COVID-19 pandemic and coral bleaching events. Results revealed clear spatio-temporal patterns in macroalgal cover, with a tendency toward higher abundance at Ojo de Agua, which may be linked to freshwater influence and human impacts. Fluctuations in anthropogenic pressure also affected benthic community structure. These findings emphasize the importance of monitoring multiple environmental variables and local conditions to develop effective coral reef conservation strategies.

139 - Will the Young Survive? Common Bottlenose Dolphin Reproductive Metrics Surrounding the Cres-Lošinj Archipelago to Analyze its Specific Population Abundance and Conservation Needs: 2021 to 2024

† Loo, E.K.*

Blue World Institute / School for Field Studies: Croatia / University of San Diego

While reproductive success is essential for species survival, predictions, and management, within the same species, several population can vary in abundance such as observed with the K-selective common bottlenose dolphin, *Tursiops truncatus*. According to the International Union for Conservation of Nature (IUCN), these dolphins are considered to be of “Least Concern” globally, but within the Adriatic and the research area near Cres-Lošinj, the present population is currently classified as “Vulnerable” in the IUCN Red List.After the four-year period, the average fecundity rate was analyzed to be approximately 0.162 newborns per adult female per year, very similar to other stable *T. truncatus* success rates. The interbirth interval rate had increased in comparison to other studies, which follows the observed rise in offspring mortality. With the usual exhibited weaning rate of three to five years there were some conflicts with data analyses due to the four year study period. Nevertheless, at the end, seven adult dolphins had successfully weaned from its mother. Following this, the capability of reaching age one had the highest survivability: (85.1%). But, the progression from age one to two and then from age two to three dropped continuous to about (72.1%) at age three which could be related to the lack of maternal protection and the increased confrontation to anthropogenic activity such as boats or water activities.Post analyses, the survey displays that the Cres-Lošinj dolphin population with a shrinking non-adult demographic in its already small abundance.

140 - Behavioral Responses of the California Two-Spot Octopus to Changes in Color and Sound

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Recreational and commercial boat activity, military and construction operations, and seismic surveys among other human activities produce excessive anthropogenic noise in the ocean. The intensity and frequency of such noise is often higher than that of natural underwater acoustic stimuli; Thus, marine animals may experience physiological damage to their sound-detecting organs, impacting communication and orientation. In our study, we analyzed the behavioral differences of the California two-spot octopus (*Octopus bimaculoides*) when exposed to various volumes of noise at 54 Hz. To further investigate behavioral changes under varying conditions, we exposed the octopus to 3 different colored environments: orange, yellow and brown. We used a previously published behavior log to quantify octopus behaviors during 10-minexposures to combined sound and color treatments. Of the 9

behaviors we recorded, changes in respiration and color were the two most common behaviors observed. While there were no significant differences in behavior by color and noise treatment, respiratory change decreased with noise volume in the orange and yellow treatments, and was higher in the brown treatments. More replication is necessary to comprehend the impacts of noise on *O. bimaculoides* behavior, but this study was a first step towards developing an experimental protocol for future work. Such studies could help us better understand how anthropogenic noise affects the behavior of invertebrates, which have been historically under-studied compared to mammals and fishes.

141 - Investigating seasonal variation in Southern sea otter raft size and abundance in Monterey and Elkhorn Slough.

† Corbo, A.C.[*]; McDonald, B.[*]

San Jose State University/Moss Landing Marine Laboratories

Understanding seasonal patterns of sea otters can help aid resource managers in determining critical habitats, such as resting or foraging areas. This information can play a crucial role in establishing protective measures, specifically in areas that are more susceptible to human disturbance or habitat loss. A weather phenomenon occurring in coastal habitats known as wind waves may be one of the variables disrupting resting sea otters, resulting in smaller raft sizes during stormy months. Further monitoring is needed to determine how sea otter rafting behavior changes with seasonal variation of environmental factors. While no data has currently been collected yet, this project aims to help clarify the factors affecting sea otter habitat use and possibly be used to anticipate responses to changes in climate or habitat loss. I will simultaneously conduct traditional shore surveys with drone surveys to complete a validation study. The validation study aims to validate drone use across various habitat types and determine if this observation method is more or less accurate than shore surveys. The next goal of this project is to use drone scans to identify temporal dynamics of sea otter groups in Monterey Bay and Elkhorn Slough. This will be achieved by looking at the seasonal fluctuations in raft size and determining if there is a correlation between raft size and environmental factors such as tide, weather, and kelp/eelgrass cover.

142 - Are fish shrinking? Changes in fish biology length in the Southwestern vs. Southeastern United States

† Ortega, E.[1*]; Boyd, D.[2]; Commisso, G.[3]; Goldsmith, J.[4]; Leslie, K.[3]; Perron, B.[3]; Whalen, C.[3]; Kuris, A.[5]; Brant, S.[6]; Turner, T.[6]; Vanhove, M.[7]; Wood, C.[3]

1- New Mexico State University 2- University of South Carolina 3- University of Washington 4- Neumann University 5- University of California, Santa Barabara 6- University of New Mexico Museum of Southwestern Biology 7- Hasselt University

In 2024, an undergraduate researcher discovered that the body length of multiple freshwater fish species decreased over time in the Pearl River, Louisiana. Ourstudy uses the same design and hypothesizes that fish in the US southwest will show similar decreases in sizes over time as did fish in the southeast. Using specimens collected from the Rio Grande and preserved in the University of New Mexico's Museum of Southwestern Biology, we measured the total body length (mm), and retrieved the date, and location caught for 727 randomly selected fish of 3 species (Pimephales promelas, Hybognathus amarus, and Gambusia affinis). The data were analyzed using generalized linear mixed models to assess the relationship between body size and year collected. Our results showed that there was no significant change in Pimephales promelas, Hybognathus amarus, or Gambusia affinis body size over time in the Rio Grande. By understanding how fish body size changes over time differ across the United States, we can turn to other predictors of body size such as overharvesting, water quality, and changing temperatures. This may help narrow down why fish body size is decreasing in the Pearl River and not the Rio Grande. As smaller body size can lead to decreased reproductive output, and over time a decrease in species abundance, this is relevant to fisheries management.

143 - Genetic Insights Reveal Cryptic Diversity in Titanoderma

Homewood, Z.G.*; Lopez, A.R.; Ritson-Williams, R.

Cal State University Northridge

Titanoderma is a genus of encrusting red algae (crustose coralline algae, CCA) distributed across tropical oceans, historically lumped into a single species in many surveys. *Titanoderma* contributes to reef framework stability, facilitates coral larval settlement, and is a primary producer. However, the genus is often treated as a single species because of limited distinguishing morphological features, even though evidence suggests it may represent multiple cryptic species. To investigate this, we sequenced ~1,000 bp of the plastid psbA gene, a widely used barcode in CCA for species discrimination, from 22 specimens collected in the Caribbean and Mo‘orea (French Polynesia), and reconstructed a phylogeny using Maximum Likelihood inference in RAxML. Our analyses revealed four genetically distinct clades within *Titanoderma*, highlighting greater hidden diversity than previously recognized. Clarifying these species boundaries improves estimates of reef biodiversity and advances our understanding of cryptic diversity in reef-building algae.

144 - Understanding SoCal Seafood Consumption in the Face of Safety Concerns and Environmental Disasters

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CSU Channel Islands

Seafood consumption patterns are shaped by both individual perceptions of safety and broader environmental disruptions. In recent years, southern California residents consumed ~5.0 oz of seafood weekly (SD = 6.25 oz, median = 3.0 oz), with 25% reporting no consumption in the past week. While our overall population is currently moderately confident (e.g. 11.6 on an 18-point scale in 2024) in our seafood’s safety, that confidence is generally uncorrelated (r = 0.04) with the quantity of seafood ingested. Interestingly, medium-confidence respondents reported the lowest average consumption (3.0 oz in 2024), while both high- and low-confidence groups consumed more (~5.4 oz in 2024), suggesting a non-linear relationship between trust and behavior. This complements nearly two decades of ESRM opinion polling across southern California, which demonstrates that acute disasters (oil spills, Fukushima, COVID-19) significantly depress seafood consumption and perceptions of regional safety, while recovery trajectories vary by event size, proximity, and media persistence. For example, the Deepwater Horizon spill dampened Gulf seafood perceptions for five (5) years, while Fukushima influenced Japanese seafood views for seven (7). COVID-19 induced the single largest recent decline (43%), with weekly seafood consumption levels in Fall of 2025 still roughly 1 oz per person below pre-2020 baselines. Together, these findings suggest that while immediate disasters drive large but time-limited behavioral shocks, chronic trust in seafood supply acts as a subtler, persistent influence.

145 - Determining the effects of altered survey design on relative abundance indices for groundfish

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1- University of Washington 2- NOAA Northeast Fisheries Science Center

Long-term fishery-independent surveys provide critical data on the abundance and distribution of many species to inform stock assessments. However, changing resources and management priorities may require adjustments to sampling effort. Consistency is important for long-running survey time series, so design changes tend to be infrequent and require additional analysis to assess the consequences. The Northeast Fisheries Science Center’s (NEFSC) bottom trawl survey is a stratified random sample, with strata based on depth and latitude. This results in small strata in areas where depth changes rapidly (e.g., along the continental shelf break) that are proportionally oversampled compared to larger strata. Revising the sampling design for small strata could help redistribute survey effort more evenly and address changing resource constraints. This study implemented a resampling procedure to simulate two alternative NEFSC bottom trawl survey designs (one that preserved stratification by depth and another by latitude) to quantify differences in relative abundance indices based on the current survey sampling

design and the proposed alternatives. We found that the performance of alternative designs varied with the spatial distributions of species and sampling effort, but impacts on final indices were minor. This work will improve understanding of how sampling design impacts uncertainty in survey indices to support informed decision-making about the future of fisheries independent surveys.

146 - Plenty of (Rock)Fish in the Sea: Genetic Species ID of Baja California Rockfish Larvae

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1- California State University, Monterey Bay 2- Southwest Fisheries Science Center, National Marine Fisheries Service 3- Facultad de Ciencias Marinas, Universidad Autónoma de Baja California 4- Instituto Politécnico Nacional – CICIMAR, Laboratorio de Plancton y Ecología Marina 5- CICESE

Rockfishes in the genus *Sebastes* are highly speciose with over 100 recognized species, most of which inhabit the Northeast Pacific Ocean. Adult rockfishes are highly diverse in both ecological niche and morphology. In contrast, many sympatric rockfish species are morphologically indistinguishable as juveniles. In such cases, genetic species identification provides a valuable alternative to traditional visual methods. Here we evaluate the performance of a genetic species identification tool, originally developed for rockfishes of the central California coast, in accurately identifying the species of a cohort of larval rockfish from Baja California, Mexico. We extracted DNA from 166 larval specimens collected during mid-water trawl surveys, and used high-throughput DNA sequencing to genotype 96 nuclear microhaplotype loci. Then we implemented multiple species assignment tests and compared the results to corroborate identifications for each sample. Our findings indicate largely high confidence assignments with strong concordance across assignment methods. These results demonstrate this tool's effectiveness in identifying larval rockfish outside of the region in which it was originally calibrated. When integrated with traditional visual identification methods, this genetic approach could strengthen research surveys and stock assessments in Baja California marine ecosystems. Ultimately, more accurate species identification can support better-informed management decisions and contribute to the sustainability of both commercial and recreational fisheries in the region.

147 - Benthic Cover Response in the Northern Channel Islands Throughout "The Blob" Heatwave

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Ocean warming caused by climate change can negatively impact marine organisms. In particular, habitat-forming macroalgae often have narrow thermal tolerances and cannot withstand periods of prolonged warming. Macroalgae fill many ecological roles: canopy-forming kelp provide shade and shelter for understory kelp, and coralline algae offer settlement surfaces for sessile invertebrates. Additionally, temperate rocky reefs harbor taxonomically rich benthic invertebrate communities. How these benthic groups respond to extreme heat waves remains poorly understood, and this study intends to better understand their resilience and recovery by island. Using 15 years of benthic cover data from Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) subtidal surveys at three of the Northern Channel Islands in California (Anacapa, Santa Cruz, and Santa Rosa), we evaluated the ecological impacts of "The Blob" heatwave. Data were divided into four periods: Pre-Heatwave (2009–2013), Heatwave (2014–2016), Initial Recovery (2017–2019), and Delayed Recovery (2020–2023). Taxa were assigned to functional groups to examine decline, resilience, and recovery at a broader ecological level, and benthic cover composition was compared among islands and periods. Results indicate declines in algal cover across each island during "The Blob", followed by variable recovery patterns in subsequent years. Understanding how benthic communities change due to extreme heat is critical for predicting ecosystem resilience, guiding conservation efforts, and managing temperate reef ecosystems.

148 - Thermoregulatory behavior differences between snails and hermit crabs in Tegula shells

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Chapman University

The intertidal zone is a highly dynamic environment in which daily temperature fluctuations reach extreme limits. To deal with this extreme environment, behavioral thermoregulation enables species to maintain stable internal temperatures despite external changes by moving to cooler shaded areas. Two common tidepool species in Southern California—hermit crabs (*Pagurus samuelis*) and Black Turban Snails (*Tegula funebralis*)— inhabit the same shells, meaning they have the same protection from abiotic conditions but different physiological responses to the climate that shells perpetuate during low tide. Although their thermoregulatory strategies have been studied separately, it's unclear whether they engage in the same behaviors when shell size and color are similar. This study utilizes a lab-based tidepool simulator and escape behavior testing under a heat lamp to address this gap in knowledge. We used equal numbers of white and black shelled *T. funebralis* and *P. samuelis*(n=50 each) to test chronic and acute responses to heat in these lab-based arenas. In the tidepool simulator testing responses to chronic heat (25°C), *T. funebralis* moved between the hot and cold tidepool over a low tide cycle significantly more than *P. samuelis* and were more likely to spend time in the water. However, there were no significant differences in escape behavior under acute conditions (heat lamp reaching 45°C). Survival rate was 100% despite exposure to extreme temperatures up to 45°C, suggesting existing resilience under rising ocean and air temperatures.

149 - Applications of long-term rocky intertidal monitoring by the multi-agency rocky intertidal network (MARINe)

Smith, J.R.[1*]; Ambrose, R.F.[2]; Bell, C.A.[3]; Burnaford, J.L.[4]; Caselle, J.[5]; Gaddam, R.[3]; Gilbane, L.[6]; Miner, C.M.[3]; Parsons-Field, A.[5]; Raimondi, P.T.[3]; Sutton, S.G.[1]; Whitaker, S.G.[7]; MARINe partners, [8]

1- California State Polytechnic University, Pomona 2- University of California, Los Angeles 3- University of California, Santa Cruz 4- California State University, Fullerton 5- University of California, Santa Barbara 6- Bureau of Ocean Energy Management 7- Channel Islands National Park 8- Multi-Agency Rocky Intertidal Network

The Multi-Agency Rocky Intertidal Network (MARINe: pacificrockyintertidal.org), a partnership of over 40 groups including agencies, private organizations, and universities, is the largest and longest-running monitoring project of its kind. There are more than 200 sites, stretching from Alaska to Mexico, some with 40+ years of data, and several sites on the US East Coast in Maine and New Hampshire. MARINe surveys provide valuable information on large spatial and long temporal trends for rocky intertidal communities. Long-term data collection, which allows us to detect changes in species abundances and distributions that are outside the "expected" range, is essential for informing science-based policy and management decisions. Publicly available MARINe data have been used for: performing Natural Resource Damage Assessments (e.g., for oil spills); providing a baseline for designing Marine Protected Areas (MPAs) and evaluating their effectiveness; comparing areas within and outside of Areas of Biological Significance (ASBS); documenting the presence and spread of introduced species and disease outbreaks; assessing impacts of urban runoff, fire related debris flows, and human use; assessing populations for fisheries management; assessing endangered species and critical habitat; examining biogeographic and ecosystem resilience patterns; and detecting range shifts and alterations in community structure associated with climate change. The MARINe partnership has proven to be a successful model for responsibly informing management and the preservation of our coastal ecosystems.

150 - Adopting a land-sea interface approach to link terrestrial and marine habitats of a large marine vertebrate

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Understanding habitat use across the land-sea interface is critical for species that depend on both terrestrial and aquatic environments. While this interface has been well studied for small invertebrates within freshwater and intertidal zones, far less attention has been given to large marine vertebrates. Pinnipeds are unique in relying on both haul-out sites on land and marine habitats to fulfill life history strategies for breeding and non-breeding

activities. Yet, most research is emphasized on breeding sites, while drivers that link non-breeding haul-out sites to adjacent marine habitats remain poorly understood. To address this gap, we surveyed non-breeding haul-out sites across Central California from 2024-2025 using unoccupied aerial systems (UAS) to generate orthomosaic maps and quantify fine-scale population and demographic structures across pinniped species. We paired these observations with environmental data from satellite (e.g., sea surface and air temperature, chlorophyll) and fine-scale UAS derived variables (e.g., coastal rugosity, substrate type). This integrated approach allows us to evaluate how habitats are selected simultaneously by local terrestrial conditions and oceanography. We expect haul-out sites to be selected to support different life history strategies, for example, proximity to productive waters for foraging or cooler areas during molt. Our study provides new insight into habitat selection beyond the breeding season and emphasizes the need to link terrestrial and marine habitats to sustain pinniped populations under a changing planet.

151 - The Effect of Intertidal Elevation on the Prevalence of Epibionts on Mollusks and Barnacles

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Epibiosis is a common ecological strategy in the space-limited rocky intertidal. Mollusks and barnacles both serve as crucial basibionts for several mid-intertidal epibionts, yet the relationships between tidal height, percent algal cover, percent mussel cover, and epibiont abundance are not fully explored. At higher elevations, factors such as sun exposure can lead to greater stress from desiccation, affecting the abundance and distribution of organisms across the intertidal. As a result, we expect that epibiosis would be more prevalent lower in the intertidal and in areas with a greater percent cover of algae, where exposure is lower. This study investigates this hypothesis by performing field surveys of mid-intertidal epibionts across 7 sites on the Monterey Peninsula. We placed quadrats in the upper, middle, and lower mid-intertidal based on algal zonation, with the percent cover of algae and sessile invertebrates, unique epibiont-basibiont pairs, and epibiont counts being documented. A generalized linear model of the data determined that the abundance of mid-intertidal epibionts on mollusks and barnacles is most affected by percent algal cover and mussel cover, while tidal height had no significant effect. The results of this model showed that the abundance of epibionts within the Monterey intertidal is likely not primarily driven by dessication, given that epibionts did not follow the expected distribution across tidal elevation. This implies that the positive effects of epibiosis may lead to differences compared to the expected distribution across the intertidal.

152 - Monitoring eelgrass in Channel Islands National Marine Sanctuary

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1- Cardinal Point Captains Inc., NOAA Channel Islands National Marine Sanctuary 2- NOAA Channel Islands National Marine Sanctuary

The Channel Islands feature extensive open coastal eelgrass (*Zostera sp.*) beds that support diverse communities. Despite the unique nature of these fully subtidal habitats, eelgrass monitoring within the Channel Islands National Marine Sanctuary (CINMS) has been limited over the past decade. To better understand the status of eelgrass and inform management, CINMS researchers have begun implementing monitoring techniques to characterize the distribution and structure of eelgrass beds in the sanctuary. To date, the tools used to estimate eelgrass extent have included SCUBA surveys, autonomous underwater vehicles (AUVs), and drop cameras, as well as remote sensing technologies such as multibeam echosounders and satellite imagery. These large-scale estimations are complemented by structural surveys using SCUBA to quantify shoot morphometrics, eelgrass density, and bed patchiness. Preliminary data from several sites within CINMS indicate a reduction in eelgrass bed area compared to historical extents. Additionally, CINMS researchers have documented potential stressors to eelgrass, such as anchoring damage, mooring chain scouring, and white urchin (*Lytechinus pictus*) grazing. CINMS researchers aim to continue developing partnerships to address critical and complementary questions related to eelgrass health and function such as carbon storage capacity, infaunal and epifaunal community diversity, genetic connectivity, and disease presence across sanctuary sites.

153 - Diving for Data: Citizen Science and Oregon's Kelp Forests

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Reef Check

Kelp forests along the Oregon coast are vital habitats that support many culturally, ecologically, and economically valuable marine organisms. Over the last decade, the effects of marine heat waves, sea star wasting disease, and subsequent overgrazing by purple sea urchins have decimated kelp forests at an estimated two-thirds of Oregon's kelp beds. In 2021, Reef Check expanded its Kelp Forest Monitoring program into Oregon, working in collaboration with the Oregon Kelp Alliance (ORKA). Since its creation, the Oregon program has trained a network of 39 citizen scientist scuba divers in kelp forest monitoring and grown steadily by adding monitoring sites, now totaling 19 sites, which span the entire Oregon coast. Early surveys have documented high densities of purple sea urchins (Strongylocentrotus purpuratus), exceeding 40/m² at some sites, a near-absence of understory and canopy kelps, and a low abundance of predatory species, such as Pycnopodia helianthoides. Reef Check Oregon is now collaborating with ORKA to integrate monitoring efforts with kelp forest restoration projects. Over the next two years, the program will continue to monitor three restoration sites, Macklyn Cove, Nellie's Cove, and Pacific City, while also coordinating recreational diver efforts for urchin removal. Continued monitoring will provide insight into the effectiveness of the restoration approaches. Looking forward, Reef Check Oregon aims to further expand its survey coverage and broaden its volunteer base while continuing to generate data to inform management and conservation decisions.

154 - Invertebrate Assemblages Associated with Bull Kelp Restoration in the Greater Farallones National Marine Sanctuary, CA, USA.

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1- Greater Farallones Association and Greater Farallones and Cordell Bank National Marine Sanctuaries 2- Sonoma State University

Bull kelp (*Nereocystis luetkeana*) forests along the northern California coast have declined catastrophically, with > 90% loss in the last decade due to multiple stressors. Natural recovery has been slow and patchy, motivating urgent restoration efforts and assessment of ecological outcomes in restored versus control areas. To support restoration, Greater Farallones Association, in partnership with Greater Farallones & Cordell Bank National Marine Sanctuaries, culture bull kelp year-round at the UC Davis Bodega Marine Lab, providing material for strategic seasonal outplanting. Using lab cultured kelp, we tested two low-cost restoration methods at Fort Ross Cove and Timber Cove: soral bags and inoculated twine. We investigated invertebrate communities at our restoration sites, testing whether invertebrate assemblages differ between modules with high versus low kelp density and whether patterns varied between sites. In parallel, we analyzed regional monitoring data from five sites within the sanctuary to evaluate how invertebrate assemblages are structured by both natural (Stillwater Cove, Ocean Cove) and restoration-driven (Timber Cove, Fort Ross, Shell Beach) variation in kelp density across rocky reefs. Given that invertebrates contribute to critical ecosystem functions, understanding how restoration influences their assemblages is key to evaluating ecosystem recovery. Restoration efforts that foster diverse and resilient invertebrate communities may accelerate ecosystem recovery and enhance the long-term stability of kelp forest under changing ocean conditions.

155 - Correlation between nutrient levels and seaweed growth in response to an integrated multi-trophic aquaculture system

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Anthropogenic activities have led to ocean acidification (OA), which negatively impacts organisms that build calcium carbonate shells. Increased $_{CO2}$ absorbed by the ocean reduces pH levels. However, algae has been shown to increase pH levels by absorbing carbon dioxide during photosynthesis. Other chemicals such as ammonia, urea, and phosphate provide nitrogen and promote ATP and nucleic acid production in algae. In this study, we used an integrated multi-trophic aquaculture system, where species of different trophic levels are grown together to mutually benefit each other, to examine whether dulse *(Devaleraea mollis)* benefits from exposure to metabolic waste of red abalone *(Haliotis rufescens)* under OA conditions. Specifically, we examined whether focal nutrients (PO_4^{3-}, NH_3, and CH_4N_2O) changed between three pH treatments that were chosen based on ambient (pH 8.0), current high upwelling (pH 7.5), and future high upwelling (pH 7.2) conditions. Ammonia was the lowest in all three pH treatments, urea was highest in the 7.2 and 7.5 pH treatments, and phosphate was highest in the ambient pH treatment. Seaweed production was highest in the two low pH treatments (pH 7.2, pH 7.5). Thus, an increase in urea coupled with increased $_{CO2}$ in the water in the 7.2 and 7.5 pH treatments may have increased seaweed growth. This finding suggests that co-culturing seaweed and abalone enhances seaweed growth, while increasing the buffering capacity of seawater against the impacts of OA.

156 - Impacts of invasive green crab (*Carcinus maenas*) on Juvenile Pacific Oysters (*Magallana gigas*) across environmental gradients

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Portland State University

The establishment of the introduced green crab, *Carcinus maenas*, creates ecological and economic impacts in estuaries, particularly through predation on bivalves. This study evaluates the direct (predation), non-consumptive (presence), and indirect (habitat-mediated) effects of green crab on juvenile Pacific oysters, *Magallana gigas*, under varying conditions. Clearance rates of the Pacific oyster were measured over 72 hours across different temperatures (14°C and 18°C) and predator identities, including green crab and Pacific rock crab, *Romaleon antennarium*. Predator contact was tested at three levels: chemical cues only, claw-bound, and fully unrestrained crabs. Clearance rates were reduced at higher temperature and suppressed by the presence of green crab, indicating compounded stress on Pacific oysters. Field tethering of Pacific oysters was conducted in native eelgrass, *Zostera marina*, and adjacent mudflat habitats at multiple sites in Netarts Bay, OR, and 24-hour survival was monitored under natural predator assemblages. Survival was compared across habitats and predator communities were characterized using paired trapping to estimate abundance and diversity. Results suggest lower Pacific oyster survival in mudflats and increased predation in areas with higher green crab abundance, highlighting combined effects of unstructured habitat and invasive predator presence. Green crab alters estuarine interactions through both direct and indirect effects influenced by temperature and habitat, with implications for invasive species management.

157 - Pearls of wisdom from The San Diego Bay Native Oyster Living Shoreline Project

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1- California State Coastal Conservancy 2- Port of San Diego 3- California State University Fullerton

Southern California’s bays and estuaries have been highly modified and hard shoreline armoring has resulted in the loss of the natural shoreline protection and ecological benefits that marshes, oyster beds, and other intertidal and shallow subtidal habitats previously provided. The San Diego Bay Native Oyster Living Shoreline Project is a collaborative effort by the State Coastal Conservancy, the Port of San Diego, California State University Fullerton, the U.S. Fish and Wildlife Service, and partners to create a biologically rich native Olympia oyster reef that re-establishes an ecological niche and provides protection along an eroding shoreline. 360 baycrete reef balls were deployed in 2021 in South San Diego Bay to restore the native oyster, *Ostrea lurida*, and native faunal community as a nature-based shoreline strategy. Additionally, approximately 200 linear feet of smaller oyster castles were deployed within the project area to supplement the reef balls and create additional habitat. Monitoring efforts are ongoing, and we will highlight results of post-construction monitoring two years after installation, which includes

biological monitoring (eelgrass, oysters, fish, and birds) and physical surveys tracking wave energy and shoreline accretion. This project is one of the first native oyster restorations in Southern California demonstrating the feasibility of installing fabricated reef units in subtidal areas. Results and lessons learned from this project will inform future native oyster restoration and living shoreline projects.

158 - Testing the impacts of marine heatwave duration and intensity on microscopic life stages of giant kelp

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1- Stanford University 2- Stanford University, Oceans Department

Marine heatwaves (MHWs) are one of the biggest threats to kelp forests and have doubled in frequency over the past 40 years. Kelp have a biphasic life cycle, beginning as haploid spores that grow into microscopic gametophytes, which reproduce to form diploid sporophytes. Few studies have tested how MHW intensity and duration affect microscopic kelp, particularly at the gametophyte–sporophyte transition, and most studies have been conducted in static dishes. We grew gametophytes of giant kelp, *Macrocystis pyrifera* , on ceramic tiles and simulated MHWs in 30-gallon seawater tanks. We tested three intensities (12 control vs. 18, 20, 22°C) of MHWs over two durations (1 vs. 2 week). Response variables included gametophyte growth rates and densities from microscope photos taken before and after MHWs, and after a 1-week recovery period. Gametophytes were resilient to warming up to 18°C for 1-2 weeks, and showed increased growth rates at 18°C compared to 12°C. However, gametophyte growth rates sharply declined at 20° and 22°C. Importantly, gametophytes only produced sporophytes at 12 and 18°C. Overall, we found that gametophytes of *M. pyrifera* are vulnerable to 1- and 2-week MHWs of 20-22°C. However, the resilience of gametophytes and the active production of sporophytes at 18°C suggests a higher tolerance than previously expected. Future studies should examine the critical thermal threshold between 18 and 20°C to improve our ability to predict how marine heatwave duration and intensity will impact microscopic kelp life stages and kelp forest persistence.

159 - Urchin health as a tool to inform management of kelp ecosystems in Greater Farallones National Marine Sanctuary

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NOAA Hollings and University of South Florida

Bull kelp (Nereocystis luetkeana) is an annual species that enhances biodiversity by providing essential habitat and trophic support within nearshore ecosystems along the Northern California coast. Sea urchins are a primary consumer of kelp and in normal conditions coexist in a healthy ecological community. However, due to an extreme heatwave, and sudden loss of sea urchin predators, 90% of kelp was lost from this region leaving behind urchin barrens. To reverse this loss, kelp restoration focuses on the out-planting of kelp and sea urchin removal. This project focused on monitoring the effectiveness of kelp restoration by assessing sea urchin health. The hypotheses for this project were: the sites with higher kelp density and lower urchin density would have the healthiest urchins and that the intertidal/shore zones would have healthier urchins compared to the subtidal counterparts. Sea urchins were collected from restoration sites along the Sonoma Coast in Greater Farallones National Marine Sanctuary, including both intertidal/shore and subtidal zones. The removed urchins were then dissected to calculate the Gonadosomatic Index (GSI) that was then used as the metric of sea urchin health. My results indicated that urchin health is positively associated with higher kelp density but showed little correlation with urchin density. Additionally, the intertidal/shallow, which served as controls, displayed healthier urchins. Future steps with this project are tracking density changes in comparison to urchin health over the years to gain a more wholistic view of kelp restoration.

160 - How gross is too gross: comparative predator feeding assays on southern California sacoglossan sea slugs.

† Morris, M.[*]; Krug, P.J.

Cal State LA

Many sacoglossan sea slugs have evolved anti-predator chemical deterrents along with camouflaging with their host algae. Prior studies on the abundant sea slug *Alderia modesta* showed that five novel polyketides rendered slugs unpalatable to a range of local predators; these chemicals also act as keystone molecules with expansive impacts on the community. We screened four additional local species *Placida cf. dendritica*, *Aplysiopsis enteromorphae*, *Elysia hedgpethi* and *Hermaea* sp. for chemical defenses against intertidal predators (crabs, worms, and snails) to characterize consumer responses including prey-handling time and aversive reactions. Eating attempts and rejections were analyzed against squid controls. Trials look3ing at predator learning response over time with controls were compared with the effects of defense on prey handling time. The results of these trials showed that prey handling over time decreased for squid while the time handling sacoglossans increased. Additionally, all sacoglossan sea slugs tested showed signs of rejection by predator due to chemical defense in tandem with the presence of mucus.

161 - Influences of macroalgal traits on epifaunal community structure in temperate rocky reefs

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Marine Science Institute, UC Santa Barbara

Trait-based approaches in community ecology offer a useful way of linking organismal characteristics to ecosystem structure and function. In temperate rocky reefs, macroalgae vary widely in physical structure and tissue chemistry, traits that may shape the composition and diversity of their associated epifaunal communities. Epifaunal invertebrates depend on macroalgal hosts for critical resources such as habitat, refuge, and nutrition, yet the specific traits mediating these interactions remain largely unknown. We applied a trait-based approach to test how macroalgal functional diversity influences epifaunal community structure. We quantified 12 functional traits related to algal morphology and tissue chemistry across 22 subtidal macroalgal species, and related them to epifaunal assemblages using multivariate ordination and generalized linear mixed-effects models. Epifaunal abundance increased significantly with macroalgal height, surface area, caloric content, and phenolic concentration, but decreased with total biomass. These findings highlight the combined importance of structural, nutritional, and chemical traits in shaping epifaunal community patterns associated with macroalgal hosts. Our results support the potential of trait-based approaches to predict macroalgal-epifaunal community structure across global marine systems.

162 - Seasonal and depth-dependent changes of single-celled marine plankton and environmental parameters off northern San Diego County

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Unicellular plankton form the base of the marine food web and are key players in Earth’s biogeochemical cycles. Despite their importance, plankton remain understudied in some parts of the world. One such area is northern San Diego County. To fill this knowledge gap, we collected seawater samples and environmental measurements at the surface and 3 m depth off two sites in northern San Diego County. We found that average chlorophyll concentrations were higher at the surface during the fall and higher at 3 m depth during the winter, spring, and summer. However, these differences were only statistically significant in fall and spring ($p < 0.05$). Most nutrient concentrations did not consistently vary with depth and season. Silicate concentrations were significantly higher at 3 m during the fall, and ammonia concentrations were significantly higher at the surface during winter and at 3 m depth in the summer. Within this environmental context, we are examining the planktonic community composition using traditional microscopy and comparing it with a relatively new, open-source, automated imaging microscope.

163 - Small Fish, Big Stakes: Protecting Tidewater Gobies in Times of Disaster

Bibian, J.E.*; Delgado, Y.; Murillo, A.; Spies, B.

CSU Channel Islands

Southern California's coastal wetlands are increasingly threatened by natural and human caused disasters, including wildfires, drought, flooding, and oil and fracking spills. These events degrade lagoon and estuarine habitats that support both endangered goby species in the genus *Eucyclogobius*. Both are susceptible to habitat degradation despite their physiological tolerance to salinity and temperature fluctuations. Approximately 750 northern tidewater gobies (*Eucyclogobius newberryi*) were rescued in Topanga Canyon from the Palisades Fire in January 2025. While the emergency response successfully prevented immediate losses, a partnership with public aquariums to temporarily house the endangered species revealed key gaps in preparedness, species-specific animal care, and long term planning for disaster response. To address these challenges, faculty and students at California State University Channel Islands, in collaboration with conservation partners, are developing standardized emergency protocols. These include rapid deployment kits, animal care guidance, and coordination plans to facilitate inter-institutional response. This integrated approach enhances survival during emergencies, supports effective temporary care, and strengthens adaptive management strategies for the conservation of both tidewater goby species. The resulting framework may serve as a scalable model for emergency preparedness and long term recovery planning for other sensitive aquatic species threatened by climate and human driven impacts.

164 - Marine Protected Areas and Trophic Cascades on Catalina Island, California

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University of San Diego

In areas with heavy fishing and tourism activity, marine reserves can be put into place to protect the diversity, abundance, and resilience of marine life. Marine Protected Areas (MPAs) can induce trophic cascades by increasing predator populations which in turn increase the pressure of predation on lower trophic levels. A classic trophic cascade involves top predators which decrease grazer density allowing algae to flourish. In this study, we examined how marine protected areas on Catalina Island, California was related to abundance and size distribution of California Sheephead (Bodainus pulcher), California Spiny Lobster (Panulirus interruptus), Crowned Sea Urchin (Centrostephanus coronatus), and Giant Kelp (Macrocystis pyrifera). Replicate transects conducted with SCUBA were completed during summer 2025 within and outside the Long Point State Marine Reserve. Although marine reserves had larger and more abundant populations of California Sheephead and California Spiny Lobster as well higher kelp densities, we did not observe any difference in urchin populations inside and outside the reserve. Our results are consistent with previous studies that suggest marine reserves in the Channel Islands are effective at protecting fished species but that hypothesized trophic cascades are not immediately evident.

165 - Effect of Elevated Copper Concentrations on the Formation and Properties of Marine Snow

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University of San Diego

The ocean's biological pump drives the long-term sequestration of carbon from the surface to the deep sea, through sinking organic-rich aggregates like marine snow, which forms from phytoplankton. However, increasing contamination from heavy metals such as copper, alters the growth of phytoplankton and thus, could further affect the physical properties of marine snow. This study investigates how phytoplankton exposed to elevated copper levels affects the size, shape, and settling velocity of marine snow. Thalassiosira weissflogii cultures were grown in 3 different copper concentrations, including ones known to induce stress and toxicity. After growing for 2 weeks, the phytoplankton cultures were diluted and added to cylindrical tanks, where they were allowed to rotate for 3 days to form aggregates. Aggregates were imaged to compare their size and shape between treatments, and their settling velocities were quantified by analyzing images of the individual aggregates sinking through a rectangular tank. In addition, viscoelastic properties of the cultures were measured with a rheometer before aggregates were formed, since phytoplankton are known to excrete mucous-like substances that are critical to aggregate formation.

Here, we will present results demonstrating how aggregate properties differ based on exposure to elevated concentration of copper. These findings could improve the understanding of how anthropogenic pollution impacts oceanic carbon transport and storage.

166 - Investigating dual impacts of boring sponge (Cliona celatai) and acute thermal stress on eastern oysters (Crassostrea virginica)

† George, S.J.*; Osterberg, J.S.; Wong, J.M.

Duke University

Eastern oysters play a critical role in both environmental and economic spheres on the east coast of the United States. Oysters serve as a keystone species and provide a range of ecosystem services to their local surroundings, in addition to bringing in millions of dollars each year to the aquaculture industry. Cliona species are among the largest and most destructive of the boring sponges in the Atlantic, and are found in 20-40% of eastern oysters along the east coast. Oysters infested with boring sponge often exhibit slower growth rates and poorer body conditions compared to uninfected oysters. Additionally, climate change is leading to previously unprecedented conditions, notably an increase in water temperature. Little is known, however, about how the combination of boring sponge infestation and elevated temperature stress will impact eastern oysters. Here, we performed an experiment to determine how these organisms will respond to this multi-stressor environment. We used x-ray to visualize and categorize boring sponge infestation in oysters. We measured respiration rates to evaluate the physiological impact of boring sponge infestation coupled with acute thermal stress. We also used quantitative PCR (qPCR) to target the expression of stress-responsive genes to examine the molecular-level responses of the oysters to the dual stressors. Overall, this study provides valuable insight into the degree of impact that climate change could have on future oyster populations.

167 - Predictors of Bull Kelp after Outplanting Efforts in the Greater Farallones National Marine Sanctuary

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1- Greater Farallones Association and Greater Farallones and Cordell Bank National Marine Sanctuaries 2- Sonoma State University

The northern California coast has experienced a dramatic loss of kelp forests in the last decade, concurrent with marine heat wave events and population increases of purple sea urchins, *Stronglycentrotus purpuratus*, resulting in denuded rocky reef systems known as urchin barrens. A 90% decline in densities of bull kelp, *Nereocystis luetkeana*, has been documented in the Greater Farallones National Marine Sanctuary (GFNMS). The Greater Farallones Association, in partnership with NOAA's Greater Farallones and Cordell Bank National Marine Sanctuaries, has collaborated with Sonoma State University and Moss Landing Marine Labs to effectively culture *Nereocystis luetkeana* in all life stages and successfully implement two outplanting methods in the Sanctuary. Here we investigate if we can predict recent kelp densities in relation to our outplanting efforts, commercial urchin removals, and the presence of other kelps and macroinvertebrates associated with kelp forests. Understanding the efficacy of these outplanting strategies in GFNMS will help us better steward and protect kelp forest ecosystems.

168 - Environmental drivers shape trait distributions of novel seaweed communities on a tropical reef

Carden, I.C.*; Kim, A.R.*; Medina, B.*; Miller, B.*; Vorlop, M.C.*; Long, A.E.; Hannibal, K.N.; Ford, A.T.; Kane, T.L.; Fong, P.

UC Los Angeles

Coral reefs are diverse marine habitats threatened by a suite of human impacts to critical environmental drivers. As corals decline, novel seaweed-dominated communities have emerged. We used trait-based ecology to link seaweed community traits to two environmental drivers on coral reefs that are impacted by anthropogenic activity: nutrient limitation and herbivory pressure. We selected four sites in Mo'orea, French Polynesia known to differ in

these environmental drivers and confirmed their status with herbivory and nutrient bioassays. We quantified traits of seaweed communities in each site by randomly sampling individuals and measuring seven response traits. A PERMANOVA demonstrated trait distributions varied across sites with differing levels of nutrients and herbivory pressure. PCA and analysis of spatial patterns of individual traits revealed a trade-off among resource acquisition traits, where communities subject to higher nutrients and lower herbivory maximized surface area while communities subject to the opposite environmental contexts were taller and stronger. Thus, herbivory pressure mediated community resource acquisition strategies. Further, intermediate nutrients and low herbivory supported the highest trait diversity, likely due to weak environmental filtering, while high nutrients and low herbivory supported the lowest trait diversity, suggesting competitive dominance. Quantifying links between seaweed community traits and human impacts improves understanding and prediction of the responses of seaweed communities in the Anthropocene.

169 - Raising Reefs: A Comparative Analysis of the Effects of Different Rearing Systems on *Acropora palmata*

Bartley, S.A.[1*]; Leto, C.[2]

1- Univeristy of California, Berkeley 2- Mote Marine Laboratory

Coral reefs in the Florida Keys are facing extinction due to increased ocean temperatures, excessive nutrients, and other pollutants. Assisted sexual reproduction (ASR) can help restore coral populations by promoting genetic diversity and potential resilience. Post ASR, coral recruits can be transferred to various grow out systems, such as flow-through, natural saltwater systems or enclosed, recirculating artificial saltwater systems. Although restoration practitioners have historically utilized both types of systems for coral growth, few studies compare the efficacy of natural versus artificial systems. To investigate how both systems influence coral growth and survival, recruits from two targeted crosses of *Acropora palmata* were reared in both the natural and artificial saltwater systems for 6 weeks. We found that *A. palmata* grew significantly faster in the enclosed artificial system when compared to its counterparts in the natural flow through system, but there was no significant difference in their survivorship. Additionally, familial lineage did not affect either growth or survivorship. These results suggest there is a strong benefit for practitioners to continue rearing *A. palmata* recruits in the artificial recirculating system instead of the flow-through tanks. Additional research should be conducted to assess whether these results can be replicated across additional genotypes, species, and other life support systems. This work will directly inform practitioners on how to further optimize coral rearing methodology across species and systems.

170 - Gonads through the seasons: a multiyear study on purple sea urchins in the Santa Barbara Channel

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UC Santa Barbara

Thermal anomalies and extreme temperatures - often defined as marine heatwaves (MHWs) - have become prevalent in the Santa Barbara Channel. This departure from past average temperatures of the recent past (here, ~pre-2014) have affected the ecology of kelp forests in the region, ranging from mortality events to impacts on biodiversity. Here, we present data on the gonadosomatic index (GSI) of purple sea urchins (*Stronglyocentrotus purpuratus*) from a local kelp forest study site of the Santa Barbara Coastal LTER (SBC LTER), with an eye to addressing impacts on gonad development in adults that experience higher temperatures than usual during the gametogenesis period. For the study, urchins were collected on SCUBA from 2022-2025 at Arroyo Quemado Reef. GSI was measured on 10 individuals for each monthly collection using standard methods. Temperature data from loggers deployed at Arroyo Quemado were obtained from the SBC LTER database. Results indicate significant temporal variation in GSI, with higher values observed in the late fall and winter, coinciding with higher seawater temperatures. Overall, GSI values were higher in 2024 and 2025, coinciding with an increase in giant kelp density during this timeframe. The project’s findings and future work will provide a greater understanding of purple sea

urchin phenology and reproductive resilience, with implications for kelp forest dynamics in the face of a warming ocean. Ultimately, we hope to explore whether the phenology of gamete formation may be in a seasonal "mismatch" compared to decades in the past.

171 - Use of Tracking Tags in Identifying Trends and Attributes of Megafaunal Movement in the Northeast Pacific and Implications for Life History

† Tran, T.*; Fredston, A.

University of California, Santa Cruz

Species distribution studies have historically largely relied upon fisheries dependent/independent studies to inform species distribution models (SDMs) or other quantitative methods. Our study aims to utilize satellite tracking data deployed on large marine megafauna as a means of projecting habitat suitability and elucidating trends in species movements across. Results are utilized to inform upon specific aspects of individual species' ecology, such as foraging behavior, environmental variables driving movement.

172 - Purple sea urchin density and behavior as drivers of patch transition dynamics: implications for kelp forest recovery

Foy, A.P.[1*]; Smith, J.G.[2]

1- Monterey Bay Aquarium 2- UC Santa Cruz, Monterey Bay Aquarium

In coastal and marine ecosystems, the critical value of natural processes in enhancing restoration is gaining increased attention. The continued lack of kelp forest recovery following widespread loss in California over the past decade has created great interest in approaches to restoration that include leveraging natural mechanisms of recovery. In this project, we investigated the role of purple sea urchin (*Strongylocentrotus purpuratus*) density and behavior in driving kelp forest recovery, and assessed whether these factors can be used to forecast kelp forest recovery potential. Subtidal surveys were conducted over the course of two years (2024 and 2025) at 42 sites to quantify the density and cover of adult stage macroalgae, density of macroalgae recruits, and the density and behavior (passive grazing on drift algae vs. active grazing on live macroalgae) of sea urchins. We then used a series of multivariate analyses to test whether purple sea urchin density or behavior explained the recovery of forests from barrens. Results indicate that both sea urchin density and behavior are important correlates with kelp forest recovery, but that macroalgae recruitment can occur despite high densities of sea urchins. By identifying the drivers of natural kelp forest recovery, particularly the threshold at which purple sea urchins can shift a system between alternative states, our work advances the understanding of kelp forest resilience and improves our ability to forecast system changes.

173 - Host and pathogen adaptation drive inter and intra-annual patterns of Seagrass Wasting Disease

Moheed, S.; Stachowicz, J.; Brown, A.*

UC Davis

Foundation species contribute a range of ecosystem services to coastal environments yet are often vulnerable to disease outbreaks. This has been the case for seagrasses, which are attacked by the protist slime mold Labyrinthula zosterae that causes Seagrass Wasting Disease (SWD). In the temperate eelgrass Zostera marina, disease causes decreased growth and productivity, and can lead to plant mortality. Warm temperature anomalies (but not necessarily absolute temperature) increase SWD prevalence and severity, leading to concerns about the influence of warming oceans on disease outbreaks. Northern California is well within the center range of eelgrass and we know that populations can be locally adapted to temperature. This suggests that outbreaks might be difficult to predict based on the environment alone, yet there is little information about how pathogens vary in response to both environment and host traits within this system. Using seasonal field surveys and manipulative experiments, we are investigating the environmental, biotic, and evolutionary drivers that cause spatial and temporal variation of SWD across eelgrass beds in northern California. Five years of annual sampling, combined

with two years of bi-monthly sampling data show that SWD fluctuates in severity depending on time of year, water temperature, and location in ways that suggest differences in pathogens at the strain-level in these estuaries. We have cultured and sequenced pathogens from both warm and cold sites and have conducted cross-infection experiments to evaluate the potential for pathogen and host v

174 - Exploring Patterns of Sexual Dimorphism in Sympatric Ecotypes of Stickleback

Pruette, M.M.*; Tobias, Z.J.C.; Rennison, D.J.

UC San Diego

Marine three-spined sticklebacks colonized freshwater habitats of the Northern hemisphere ~13,000 years ago. Today, diverse forms exist— including the ancestral marine, and freshwater forms in streams and lakes. In British Columbia, there are several lakes with two divergent but coexisting stickleback lineages. These sympatric ecotypes, referred to as the benthic and limnetic morphs, differ in their feeding patterns, microhabitat uses, and variety of predation. The benthic form is a shore specialist while the limnetic tends to inhabit open water. Considerable previous work has focused on morphological differences between the two species. In this project we are using specimens from three lakes where the two ecotypes are found in sympatry (Paxton, Priest, and Little Quarry) to ask how males and females of each species differ in their traits, a pattern known as sexual dimorphism. I measured morphological traits such as eye size and lateral plate numbers to ask three main questions: 1) What characters differ between males and females? 2) Are the same traits sexually dimorphic in benthics and limnetics? and 3) Is the pattern of sexual dimorphism repeatable across the three lakes (i.e. is it evolving in parallel)? Based on prior evidence in other populations of stickleback, which shows considerable sexual dimorphism, I expected to find sexual dimorphism exists within these species pairs and did find it represented in various traits. However, given their distinct niche use, I predicted that there may be unique dimorphism in the two different ecotypes— which held true.

175 - Investigating Macrocycstis pyrifera Response to Antibiotics for Deriving Axenic Cultures

Paeper, R.C.*; Vong, B.; Gracey, A.Y.; Nuzhdin, S.

University of Southern California

Giant kelp (*Macrocystis pyrifera*) makes up some of the most biodiverse and fiscally important marine ecosystems in the world. As a non-model organism, there are no standard procedures for processes such as creating isolated axenic cultures. More molecular biology techniques are being used for conservation research, so there has been an increased need for ways to isolate individuals for further analysis. We investigated the success of culturing giant kelp gametophytes on 1% agarose and filtered artificial seawater plates that are treated with nutrients and antibiotics. We found that antibiotics that targeted bacterial protein synthesis and DNA synthesis were most effective at limiting visual microbial growth and allowing for kelp growth. Examples of these were kanamycin A, streptomycin, and ciprofloxacin. To further investigate gametophyte response to antibiotics, various combinations of two antibiotics of varying inhibition pathways were combined to test for increased antimicrobial activity or impacts on kelp growth. So far, the most effective antibiotic combinations target different inhibition pathways, notably those that target both protein synthesis and cell wall synthesis. These results focused on short-term effects on the plates and it is recommended that long-term impacts should be investigated further. Giant kelp is one of many kelp species that are facing decreasing populations due to environmental stressors, and the development of axenic cultures may help us find ways to make more resistant kelp strains and aid with overall restoration efforts.

176 - Caught in the Casita: Ecological Role of Artificial Shelters for Caribbean Spiny Lobsters in Turks and Caicos

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1- University of San Diego 2- The School for Field Studies Center for Marine Resource Studies 3- University of Vermont 4- Smith College 5- Rice University

To enhance the catch rate of Caribbean spiny lobsters (*Panulirus argus*) in the Turks and Caicos Islands (TCI), fishermen place artificial shelters called casitas. Although controversial in some regions, in TCI casitas are used to increase the aggregation of lobsters, making it easier for them to be harvested. To assess their ecological role in TCI, we surveyed ten sites containing casitas around South Caicos between Fall 2024 and Spring 2025 using mark–recapture methods. A total of 1,061 lobsters were recorded, revealing that casitas primarily function as juvenile refuges, with juveniles consistently outnumbering adults across seasons. The higher proportion of juveniles in casitas with adults may suggest that social or chemical cues influence settlement. Seasonal analysis showed significantly more adults during the closed fishing season, indicating selective fishing of legal-sized adults. Comparisons between our current casita data and historical catch data collected between 2004–2017 revealed that there are significant declines in female size across maturity classes, raising concerns about long-term fishery sustainability or the effectiveness of casitas in aggregating mature adults. These findings highlight both the potential benefits and limitations of casitas, emphasizing the need for long-term monitoring to assess their ecological impacts and role in contributing to the sustainable management of the TCI lobster fishery.

177 - *Pagurus samuelis* shell selection is not sensitive to the pH exposure history of shells.

† Mohan-Black, Z.L.[*]; Ma, Y.[*]

Santa Catalina School

Ocean acidification lowers seawater pH and threatens the stability of calcium carbonate structures, including molluscan shells. Hermit crabs are dependent on these shells for shelter, and previous work has shown that several characteristics of the shells affect the crabs' shell-selection strategy. We are interested in whether exposure to low pH water would change shells in ways that affect behavioral responses of *Pagurus samuelis* crabs during shell selection. Here, gastropod shells were immersed in seawater treatments of varying pH levels, and changes in shell structure were evaluated by measuring changes in mass and image analysis of surface degradation. On average, shells lost 2.4% ± SD 2.0% of their weight after treatment and an average nacre appearance increase of 18.67%, which affected the weight, color, and texture of the shells. This indicates that shells exposed to lower pH conditions exhibited significant structural weakening (simple linear regression) and visible surface erosion compared to control shells. In the second phase, de-shelled *P. samuelis* individuals were presented with a choice between low-pH-treated and untreated shells. Behavioral observations demonstrated that hermit crabs did not show a statistically significant preference for either condition. We also compared potential selection patterns by crab size class, and found no significant relationship. Together, these preliminary findings reveal that ocean acidification may diminish the structural suitability of shells, but may not drive changes in shell selection among hermit crabs.

178 - The effects of fishing on the seasonal density and size distribution of Panulirus interruptus in the Santa Barbara Channel

† Cox, J.S.[1*]; Miller, R.J.[2]

1- University of California, Santa Barbara 2- Marine Science Institute, University of California, Santa Barbara

The California spiny lobster (Panulirus interruptus) supports both a commercially and recreationally important fishery in the United States, valued at $12.7 million in 2018. In addition to their economic value, lobsters play an important ecological role in rocky reef food webs as predators. The impact of fishing on P. interruptus populations has yet to be described over the course of the year. A network of Marine Protected Areas (MPAs) prohibit lobster fishing in designated areas, and thus can be used as tools to isolate the effects of fishing. To determine whether lobster populations exhibit seasonal changes in response to fishing, we conducted lobster abundance and size surveys in the fall, winter, spring and summer inside and outside MPAs in the Santa Barbara Channel (SBC). Surveys spanned from 2023-2025 and occurred in August, during fishery closure, December, during fishing season, and April, just after the fishery closed. We compared densities and size distributions in fished sites to those in MPAs to determine if changes in populations were due to fishing or other factors, such as movement. Preliminary results indicate declines in lobster density at one of the fished sites during the fishing season, and

increased density in an MPA during the fishing season. This suggests that fishing is associated with reduced lobster abundance in some fished areas, and indicates that lobsters are moving seasonally in an MPA. Future work will investigate the seasonal movement patterns of lobsters in the SBC and how movement and fishing concurrently affect lobster abundance.

179 - Characterizing the distribution of the Sicklefin Devil Ray (Mobula tarapacana) along the U.S. east coast

† Torres, I.[1*]; Anneliese, R.[2]; Milles, H.[1]; Pate, J.[3]; Lewison, R.[1]

1- San Diego State University 2- San Diego Mesa College 3- Marine Megafauna Foundation

The distribution of Mobula tarapacana, the sicklefin devil ray, remains largely unknown globally, but particularly so in the western North Atlantic Ocean, among the fastest-warming oceanic regions in the world. We leverage openly available data in a statistical modeling framework to characterize the distributions of M. tarapacana offshore along the U.S. East Coast. Data spanned from 1993 to 2023 (n presences = 422), and were located from the coast of Georgia to offshore Cape Cod, Massachusetts. The developed species distribution model identified that sea surface height (69.9%), bathymetry (9.0%), sea surface temperature (8.1%), and sea surface salinity (2.6%) were the four most influential drivers of suitable habitat for M. tarapacana in the region. Predicted suitable habitat was observed offshore the southeastern United States at all times of year, extending into the Mid-Atlantic Bight, terminating offshore Cape Cod in the summer and autumn months. Areas of suitable habitat were aligned with the continental shelf edge, regardless of season, suggesting biologically productive waters around key physical oceanographic features may play a significant role in shaping observed distributions of M. tarapacana.

180 - Reduction in eelgrass microbiome enhances herbivore preference among leaves from different populations

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University of California, Davis

Eelgrass microbiomes potentially play an important role in plant productivity and resilience to environmental stress by mediating plant growth processes. These microbes may also produce defensive chemicals that mediate interactions with herbivores like crustaceans and gastropods consuming eelgrass and epiphytes. We tested the potential role of microbes in mediating the feeding preference of *Pentidotea rescecata* among different eelgrass populations with intact microbiomes vs those reduced through an iodine wash. We tested isopod preference among all combinations of two populations of eelgrass, one from their home bay (Bodega Bay) and one from a nearby bay (Tomales Bay), with intact vs reduced microbiome. We also measured tissue toughness and nutritional content. We found that despite morphological differences between the two sites, isopods had no preference among the populations when microbiomes were intact. However, once reduced, we found that isopods strongly preferred Bodega over Tomales Bay sites. These differences were not explained by blade morphology or tissue toughness. We are currently assessing the microbiome from all four plant types, but hypothesize that microbes may contribute to plant defenses against herbivores and in their absence, additional plant-based factors lead to stronger grazing preferences. Further work is needed to test this hypothesis, but our study highlights the need to consider microbial communities when exploring plant-grazer interactions to identify factors allowing eelgrass to persist in a range of abiotic and biotic conditions.

181 - Herbaria Pressings as a Potential Proxy for *Pyropia* spp. Abundances in Coastal California from 1875-2024

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University of California, San Diego

Pyropia spp. are economically, ecologically, and culturally important red seaweed worldwide. Herbarium records were analyzed to inform our understanding of its distribution along California's coast. We investigated the relationship between sea surface temperature (SST) and the occurrence of *Pyropia* spp., and how this relationship has changed temporally in association with ocean warming. Herbaria data was collected from the University of California, Berkeley Herbarium and the Macroalgae Herbarium Consortium (1875-2024), and SST data from the UCSD Shore Stations Program (1919-2024). Additionally, a literature review of the biogeographic regions, life cycle, optimal temperature ranges, and speciation was compiled. We found that relative abundance using herbaria pressings is consistent with past research. There is also a greater amount of *Pyropia* spp. north of Point Conception, but pressings do not represent occurrences *in situ*. There was not a clear decline in pressings over time by county, although there are limitations due to convenience sampling and lack of available specimens. Preliminary results suggest a possible relationship between SST and the occurrence of *Pyropia* spp., which may change with warming. Future studies should include visits to various field sites and conduct seasonal sampling to achieve a better understanding of the change in distribution over time. By doing so, we can gain insight into whether herbaria data is a useful indicator of *Pyropia* spp. occurrence and how SST warming impacts the distribution.

182 - Assessing the transgenerational plasticity of gopher rockfish (*Sebastes carnatus*) in response to simulated upwelling stress

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1- California State University Monterey Bay, Moss Landing Marine Laboratories 2- University of California Santa Cruz 3- Moss Landing Marine Laboratories 4- California State University Monterey Bay

Anthropogenic climate change is altering ocean chemistry, leading to ocean acidification (OA) and hypoxia (i.e., low dissolved oxygen [DO]). In the California Current System (CCS), natural seasonal upwelling advects low pH/DO water into nearshore habitats. Climate change is expected to intensify coastal upwelling, which may expose species within the CCS to OA and hypoxia (OAH) levels outside their physiological thresholds. Rockfish, an ecologically and economically important group in the CCS, are thought to have low adaptive capacity due to their late maturity and long lifespans. To evaluate the potential for rapid adaptation through transgenerational plasticity, we exposed pregnant gopher rockfish to projected OAH conditions to test whether maternal exposure affects larval offspring physiology. Because rockfish are viviparous, we manipulated the timing of exposure (pre- vs post-fertilization) to separate maternal from early developmental effects. We then analyzed differentially expressed genes (DEG) alongside DNA methylation in larval offspring to determine whether epigenetic changes correlate with observed DEG responses. If OAH exposure pre-fertilization influences both DEG and DNA methylation patterns, this would provide support for transgenerational plasticity. Future work will evaluate if pooled larvae obscure individual responses and examine the overlap between larval and maternal methylation patterns. Our results may reveal mechanisms of rapid adaptation, offering insights into rockfishes' physiological adaptive capacity under climate change.

183 - Incidence of microplastics in juvenile shortbelly rockfish captured by rhinoceros auklets

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1- Estuary & Ocean Science Center, San Francisco State University 2- Point Blue Conservation Science

Plastic marine debris and its environmental impact has been growing since the 1970s and is one of the most common marine pollutants. Consumed directly or indirectly (through prey), plastic debris can have devastating impacts on the welfare of individual seabirds and their populations. In this research, I am chemically digesting shortbelly rockfish (*Sebastes jordani*), collected as part of a diet study of the rhinoceros auklet (*Cerorhinca monocerata*) on Southeast Farallon Island, from the years 2012 to 2017 and 2024. Except for the years 2012 (73%), 2013 (76%) and 2016 (90%), all other years analyzed had over 95% of the fish contain microplastics when analyzed under epifluorescence. Using FT-IR, I will analyze the plastic particles found to better understand the polymers present in the diet of the rhinoceros auklet and in the waters of the Farallones.

184 - Size of sea slugs: Effects of eelgrass width on phenotypic traits of Phyllaplysia taylori

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1- Chapman University 2- University of Washington

Eelgrass restoration plans along the North American coast continue to be an essential component of resilience under climate change. Despite heavy investment into these plans, they have largely ignored relationships between eelgrass and grazers that maintain its health. The most significant of these grazer relationships exists between the eelgrass and *Phyllaplysia taylori*, a species of sea slug. *P. taylori* are epiphytic biofilm grazers and are crucial to the survival of eelgrass, improving photosynthesis and growth by increasing access to light. However, we are noticing diverging population dynamics in different areas of their range. More southern populations proliferate across multiple seasons at a smaller body size matched to thinner eelgrass leaves, while northern populations have smaller populations at larger sizes. This has large implications for any cross-range restoration plans that include*P. taylori*. We ask if and/or how *P. taylori* modulates size traits due to habitat factors (eelgrass phenotype, temperature), and document size and reproductive behavior differences. To test this hypothesis, we conducted a long-term, fully replicated experiment in San Pedro, CA and Friday Harbor, WA by acclimating *P. taylori*to fake eelgrass representative of both habitats. We recorded multiple life history traits biweekly during the experiment and look forward to further investigating underlying genetic mechanisms. This study has implications for restoration applications and evolutionary biology questions about rapid adaptation to novel habitats.

185 - Don’t be obtuse: Elysia obtusa is five cryptic, ghostly species of sea slugs

† Maritato, A.M.[*]; Lugo, L.M.; Krug, P.J.

CSU Los Angeles

Sea slugs in genus *Elysia* sequester functional chloroplasts from their algal diet (kleptoplasty), and are often specialized to feed on specific host algae. Some *Elysia* spp. exert ecological control over invasive algal species of *Codium* and *Caulerpa*. However, studies aiming to elucidate the mechanisms and applications of kleptoplasty, or assess the potential for sacoglossans in biological control of invasive algae, are compromised by the high proportion of cryptic species in this group. To address this gap, we investigated a nominal pair of species from the Atlantic and Pacific that are poorly known, using an integrative approach combining genetic and morphological data. We sequenced two mitochondrial and three nuclear genes, and compared external morphology and internal anatomy of the radula for samples of nominal *E. obtusa* (Pacific) and *E. flava* (Caribbean). Phylogenetic analyses and radular imaging indicate *“E. obtusa”* is a complex of at least five externally similar species, four of which co-occur in the hotspot of New Caledonia. *E. flava*, described from the Caribbean, was also sampled in the Mediterranean and in Hawaii, suggesting repeated introductions. These findings show how biodiversity in heterobranchs remains highly underestimated by traditional systematics, and increase the recognized species richness of *Elysia*.

186 - Osmotic Performance of Mytilus trossulus compared to Mytilus galloprovincialis Under Hyposalinity Stress

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Climate change has been a leading cause of variation within the marine environment as it increases precipitation leading to a decrease in ocean salinity. The mussel, *M. galloprovicialis* is a heat tolerant species but limited in its salinity tolerance. In contrast, *M. trossulus* is cold tolerant and has a high species-specific tolerance to low salinity. However, little is known regarding what physiological mechanisms underlie the stress tolerance of these species. Thus, our study aimed to determine the osmotic tolerance of *M. trossulus* and identify physiological responses that contribute to the species’ tolerance compared to *M. galloprovincalis*. *M. trossulus* mussels were collected from Coos Bay, OR, and *M. galloprovincialis* mussels were collected from Marina del Rey, CA. Following a two-week acclimation, mussels were exposed to salinity stress for 7 days (ranging from 5-40 ppt), and metabolic rate was

determined. *M. trossulus* demonstrated a similar osmotic performance to *M. galloprovincialis* despite prior literature indicating a comparatively higher salinity tolerance of *M. trossulus*. The greatest metabolic rate was observed under 25 ppt exposure, and we predict that the increase in energy use is due to osmoregulation. The lowest metabolic rate was observed at 5 ppt, which could be due to metabolic depression or valve closure. Overall, our study suggests that prolonged exposure to salinities less than 10 ppt may have detrimental effects on both species due to decreased energy use and valve closure.

187 - Temperature Variability and Oxygen Depletion: Assessing the Vulnerability of Juvenile Flatfish in a Changing Estuary

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Moss Landing Marine Laboratories, San Jose State University

Anthropogenic activities such as nutrient pollution and climate change are disrupting environmental conditions in coastal estuaries, altering water chemistry, nutrient cycling, and habitat structure. This study investigates the impacts of elevated temperature and hypoxia on food consumption, growth, ventilation, and metabolism of juvenile flatfish species (English sole [Parophrys vetulus]) from Elkhorn Slough, California. Using controlled laboratory experiments across three temperatures and two oxygen levels, we simulated future climate scenarios to examine their physiological responses. Based on our hypotheses, we expect increased food consumption, growth, and metabolism with warming, reduced performance under hypoxia, and interactive effects of the two stressors. Preliminary data show emerging patterns consistent with these predictions, with additional results on growth, ventilation, and metabolism currently under analysis. This work will provide valuable insight into the broader impacts of climate change on estuarine flatfishes and their potential resilience or vulnerability under future conditions.

188 - Local Adaptation and Thermal Tolerance of a Range-Expanding Marine Invertebrate

† Brue, H.*; Ewald, H.*; Jenkins, E.*; Johnson, M.; Hutchinson, K.; White, C.

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Many marine species have expanded their geographic ranges in response to climate change, exposing individuals to novel oceans temperatures. Such temperatures can increase mortality, especially in early life stages. Range-expanding species may, however, exhibit local adaptation that mediates effects of temperature on mortality. We conducted a laboratory experiment to quantify temperature effects on mortality and test for local adaptation in the marine invertebrate and fisheries species Kellet's whelk (*Kelletia kelletii*), which recently expanded its range from southern California to colder waters in central California. We collected capsules containing veligers from flow-through sea water aquaria in the species' historical and expanded range, and exposed them to one of 12 temperatures spanning warm and cold ocean temperature extremes exhibited in southern and central California. Temperature treatments lasted 2 days, and were preceded by a 2 day acclimation and followed by a 2 day recovery, both at home temperature. We quantified percent veliger survival in each capsule after both the treatment and recovery periods, predicting veligers from the historical range would have a higher tolerance for warmer temperatures, and vice versa. Preliminary results contain an insufficient sample size for conducting a statistical analysis, yet show a pattern supporting our prediction, but only for treatments excluding the temperature extremes. We interpret these findings in the context of range expansion, and discuss methods for reproducing the experiment with a larger sample size.

189 - Algae Composition and Recovery in The Rocky Intertidal

† Calbow, R.A.*; Wrinkle, J.; Staton, M.; Haupt, A.

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Rocky intertidal communities experience high levels of abiotic and biotic disturbance. In California intertidal communities have recently experienced extreme winter storms and booming sea urchin populations. Marine algae in intertidal ecosystems play an important role as habitat and primary producers. Intertidal fleshy algal cover experiences high seasonal variation and may be more vulnerable to disturbance than invertebrate cover. Understanding this temporal variation is critical to making predictions about intertidal communities. This study aims to further understand how intertidal algae biomass fluctuates after disturbances such as El Niño events, strong winter storms, and rising urchin populations. We conducted visual surveys across the Monterey Peninsula to measure fleshy algal cover. We observed an increase in fleshy algae and no change in non-fleshy algae which aligns with the predicted change in algae abundance. This trend could indicate that fleshy algae biomass can rapidly increase relatively quickly following a climate induced disturbance.

190 - Is the abundance of trematode parasites in the family Diplostomatidae correlated with the abundance of their bird definitive hosts?

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1- Neumann University 2- University of Washington 3- New Mexico State University 4- University of California, Santa Barabara 5- University of New Mexico Museum of Southwestern Biology 6- Hasselt University

Since the 1930s, Albuquerque, NM has experienced substantial environmental change through industrialization, urbanization, agricultural development, and conservation efforts. This has also affected the area's high species richness. We studied how these changes have affected the region's parasites. Diplostomatids are trematodes (parasitic flatworms) that use fish-eating birds as their definitive hosts. Since birds have probably experienced substantial population change over the past 100 years, we predicted that the diplostomatids would track the abundance of their bird hosts. We performed parasitological dissection of 610 fish specimens (Hybognathus amarus and Gambusia affinis) collected in the Albuquerque stretch of the Rio Grande between 1938 and 2002 and held at the University of New Mexico's Museum of Southwestern Biology. We then used the National Audubon Society Christmas Bird Count dataset to obtain data on the abundance of 16 New Mexico fish-eating bird species over the same time period. We found that bird abundance more than doubled over the time period of study, while parasite abundance decreased by 55%. Bird abundance and parasite abundance were negatively correlated. Given the strong association between bird abundance and time, we cannot be sure whether increasing bird abundance drove decreasing parasite abundance, or whether declining parasite abundance is associated with another factor correlated with time. Based on these results, the abundance of diplostomatid parasites may be in decline in the Rio Grande, which should prompt studies to understand and, potenti

191 - Keep calm and beat on: Physiological responses of *Mytilus galloprovincialis* from San Diego estuaries to hypoxia and low salinity stress

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1- San Diego State University 2- Tijuana River National Estuarine Research Reserve 3- UC San Diego

Estuaries in San Diego, CA, often experience rapid and extreme shifts in abiotic conditions driven by tidal inlet closures, runoff, and eutrophication. Sessile organisms, such as bivalves, must adjust their behavior and physiology to withstand these stressors, making them promising candidates for use as biosentinels in long-term monitoring. To test this potential, we examined the cardiac and valve gaping responses of the Mediterranean mussel (*Mytilus galloprovincialis*) collected from the Tijuana River Estuary, Los Peñasquitos Lagoon, and San Diego Bay during controlled laboratory exposures to either hypoxia (< 3 mg L^{-1}) or low salinity (< 3 psu). Under hypoxia, mussels exhibited elevated heart rate variability and short bursts of gaping activity, while low salinity exposure suppressed cardiac activity and prolonged valve closure. Both stressors triggered a sharp increase in heart rate upon recovery, consistent with repayment of oxygen debt following anaerobic metabolism. Although mussels from the Tijuana River Estuary are routinely exposed to stressful conditions in the field, their responses in the laboratory did not differ from those of mussels collected at the other sites. This suggests that gene flow may

homogenize physiological traits along the San Diego coastline. Collectively, these findings highlight the value of bivalve biosentinels for capturing biologically meaningful responses to estuarine stress and demonstrate their potential as a complementary tool to abiotic monitoring for managing and conserving San Diego estuaries.

192 - Nursing of multiple pups in northern elephant seals

Nosbisch, L.*; Springer, O.; Murphy, M.; Davidson, M.; Liwanag, H.E.M.

California Polytechnic State University San Luis Obispo

Capital breeding is a reproductive strategy in which foraging and reproduction are temporally and spatially separated. For capital breeding marine mammals, that means the mother is fasting during the lactation period. Northern elephant seals (*Mirounga angustirostris*, NES) are capital breeding seals with a 4-week nursing period. Although NES mothers only have enough stored energy to successfully wean a single pup, there are cases in which a mother will “adopt” a pup that is not her own, nursing it in addition to the one she birthed. This behavior should be maladaptive, as the mother is splitting resources only meant for one pup among two or more, and this is unlikely to result in survival for any of the pups. However, this behavior is observed in multiple NES mothers each breeding season. To better understand what factors contribute to this phenomenon, we used drone-captured aerial images to examine the incidence of this behavior at the Piedras Blancas breeding site. Using these images, we examined whether the frequency of pup adoption differs among seven breeding beaches at this colony. Preliminary results indicate that frequency of adoption may be influenced by seal density and level of protection from high surf. Given the negative consequences of this behavior, understanding the factors driving it can provide insight into the effects of climate change and habitat loss for this ecologically important species.

193 - Contextualizing the microbiome of contemporary and historical Pisaster ochraceus in the wild and aquariums

† Cheng, A.*; Roopnarine, P.

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Pisaster ochraceus plays a critical role as a keystone species, regulating mussel and barnacle populations to preserve intertidal biodiversity. However, rising sea temperatures have heightened the threat of infectious sea star diseases, including the sea star wasting disease (SSWD), increasing the urgency to better understand and mitigate its impact. As SSWD remains a persistent and recurring issue, addressing the gaps in our knowledge is essential to developing conservation strategies. Limited knowledge of the microbial ecology of sea star hosts under varying conditions has hindered both our understanding of species affected by SSWD and efforts for reintroduction, posing challenges for conservation initiatives. This study aims to describe and compare the microbiomes of Pisaster ochraceus sea stars found in the wild and aquariums. Sea star samples were collected from the wild from different time points and different aquarium conditions to facilitate a comparative analysis of microbial communities and to deepen our understanding of the ecology of SSWD. By examining tube feet from *P. ochraceus*, this study seeks to identify the microbial communities associated with sea stars under different conditions and potentially shed light on the mechanisms of SSWD. It is imperative to contextualize the ecology of wasting disease and identify steps for conservation efforts. These efforts are vital for preserving sea star populations, protecting ecosystems such as kelp forests and intertidal zones, and maintaining biodiversity.

194 - Developing a Model Bryozoan System; Effects of Diet and Temperature on Growth in an Invasive Bryozoan, Watersipora sp.

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1- Cal Poly San Luis Obispo 2- Cal Poly Humboldt

Watersipora is a genus of bryozoans that are invasive in many fouling communities, encrusting on boats and machinery. This increases drag, fuel consumption and rates of corrosion, leading to high maintenance costs. As anti-fouling coatings, namely biocidal copper coatings, have been widely applied to ships, Watersipora has shown

a rapid and unique evolution of tolerance. In addition to this financial burden, the presence of colonies serves as a settlement point for other invasive species, exacerbating the negative effects these species have on native ecosystems and local economies. This history of rapid adaptation makes Watersipora an ideal model organism for testing novel anti-fouling coatings. This study aims to identify optimal temperature and diet conditions for the growth of Watersipora in a laboratory setting as a step towards establishing it as a model organism. Colonies of Watersipora were collected from San Luis Obispo Bay and identified to species through genetic analysis. Offspring are fed Rhodomonas salina, Dunaliella tertiolecta, or Tisochrysis lutea, replicated at three temperatures: 10º, 14º, and 18ºC. Zooid number and colony size are being analyzed as an estimate of growth rate, and zooid size and mortality are being documented. We hypothesize that growth rate is a function of temperature and diet, and we predict that Watersipora will grow quickest at 10ºC with a diet of R. salina. Results will be used to create optimal growth conditions for using Watersipora to identify the most effective anti-fouling (or foul-release) paints for marine environments.

195 - Exploring the foundations of California's MPA network: a deep dive into the role of habitat in influencing fish community responses to marine protection

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Moss Landing Marine Laboratories

Protecting ocean resources has gained global attention as marine ecosystems experience a myriad of anthropogenic stressors. The implementation of marine protected areas (MPAs) is an increasingly common tactic in efforts to better conserve and manage marine resources, especially fisheries. California's statewide network of MPAs was established between 2007-2012 using scientific guidance on size and spacing, with the best available information on habitat and biodiversity. While the spatial distribution of key habitats (i.e., hard bottom) was the foundation of the network's design, detailed assessments of habitat structure and complexity inside and outside of MPAs is still lacking. Complex physical habitat is known to support species abundance, biomass, and biodiversity. Thus, we might expect that protecting areas with more complex physical habitat offers higher degrees of recovery potential. The California Collaborative Fisheries Research Program (CCFRP) was established to assess the efficacy of the network by monitoring fish populations; however, local discrepancies in habitat quality between an MPA and its associated reference site may confound measurements of MPA effects. We describe a framework to use benthic bathymetry data to define fine-scale habitat complexity that better reflects ecological associations with fish, while assessing habitat differences inside and outside MPAs. We then quantify the effects of habitat on catch per unit effort and community metrics to explore how much of the observed positive responses of fish to MPAs is explained by habitat complexity.

196 - Bioenergetic impacts of warming and deoxygenation on reproduction of the dominant nearshore grazer, *Stronglyocentrotus purpuratus*

† Vidal, K.M.*; Spindel, N.B.

Moss Landing Marine Laboratories, San Jose State University

As episodes of intense ocean warming and deoxygenation become more frequent, marine organisms may increasingly reallocate energy from reproduction to survival. Such tradeoffs have consequences spanning ecological scales, particularly for heterotrophs regulating primary production. The purple sea urchin, *Stronglyocentrotus purpuratus*, is a voracious herbivore capable of threatening the resilience of kelp forests on the west coast of North America. Environmental stressors may increase urchin feeding rates and impair reproduction, limiting recruitment and destabilizing populations. These responses threaten foundation species like kelp, resulting in a decline in biodiversity and kelp forest ecosystem services. Changes in urchin reproduction will endanger the long-term sustainability of purple sea urchins as a wild fishery resource and an aquaculture species. While the importance of sea urchins is well-established, effects of warming and deoxygenation on their reproduction remain poorly understood. This study represents Phase 1 of a broader effort to assess how climate-related stressors affect metabolism and reproductive performance in *S. purpuratus*. We manipulated temperature (12 °C, 16 °C, 20 °C)

and dissolved oxygen (8.0 mg/L vs 2.5 mg/L) to test their individual and combined effects on gonad development, gametogenic stage, and feeding rates. Quantifying these bioenergetic responses provides insight for forecasting wild population dynamics and optimizing aquaculture techniques under climate change, with benefits for kelp forest restoration and food security.

197 - Abalone Refugia Across Variable Thermal Regimes

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Red abalone (*Haliotis rufescens*), both ecologically and culturally important to California's coast, declined dramatically after "The Blob" marine heatwave (2014–2015) devastated bull kelp forests, their primary food source. Identifying climate refugia– areas buffered from future environmental extremes– may help support population recovery by mitigating the effects of environmental extremes through lower exposure and/or by promoting local adaptation. Here, we evaluate two definitions of thermal climate refugia definitions for predicting H. rufescens density: (1) areas with lower short-term temperature variability (STV), and (2) areas with low degree heating days (DHD) above temperature thresholds. Using SCUBA survey data from Northern and Central CA (1999–2021) and ocean reanalysis bottom temperature fields, we fitted and evaluated generalized linear, additive, and mixed models by region and before/after the Blob. Only Northern CA showed significant refugia effects: STV refugia were positively associated with density before and after The Blob, while DHD refugia showed no effect before the Blob but a negative association afterward. Results suggest STV refugia is most effective for identifying climate-resilient habitat for *H. rufescens* in Northern CA. Post-Blob DHD patterns indicate shifting stress dynamics that call for further research. This advances our understanding of red abalone responses to shifting environmental stressors, offering critical insights for restoration strategies amid a changing climate.

198 - Predator kairomone ignored by prey unless predator has recently eaten

Ellis, E.[1*]; Layral, M.[2*]; Chavez, C.[3*]; Gowda, R.[4*]; Carrion, E.[5*]; Austen, L.[3*]; Sidun, A.[6*]; Wright, W.G.[3*]

1- Cypress College 2- U.C. San Diego 3- Chapman University 4- U.C. Santa Cruz 5- UC San Diego 6- U. Colorado Boulder

The blue band hermit crab, *Pagurus samuelis* (*Ps*), shares an intertidal environment with many potential predators, each inadvertently releasing kairomones that can alert *Ps* of the risk of being eaten. We investigated the fear response of *Ps* to the kairomones released from one of its predators, the red rock crab *Cancer productus* (*Cp*). In our first experiments, individuals of *Ps* were placed into cups filled with either artificial seawater (ASW), or with ASW from a tank housing a *Cp*. Using a tracking program (C. Chavez), our first experiments detected no increased speed of *Ps* in ASW from *Cp*. The *Cp* individual in these first experiments was fed squid. When we subsequently fed it with thawed *Ps* prior to the experiment, *Ps* velocity increased by 64%. ($P < 0.001$). We conclude that individuals of *Ps* completely discount their predator's kairomones, **unless** the predator has previously eaten other individuals of *Ps*. Previous experiments on fear responses of a related hermit-crab species (*Pagurus granosimanus*) to the same predator (*Cp*) documented a significant fear-related response to the predator alone. Our observation in *Ps*, that fear is only provoked when the predator has recently eaten the prey suggests a qualitatively different predator-prey relationship.

199 - Effects of ocean acidification on red abalone (Haliotis rufescens) biomechanics in integrated multi-trophic aquaculture systems

† Osgood, G.[1*]; Ebner, C.[1]; Cotlear, R.[1]; Hamilton, S.L.[1]; Gardner, L.[1]; Graham, M.[1]; deVries, M.S.[2]

1- Moss Landing Marine Labs 2- San Jose State University

Many different taxa of marine animals have been negatively impacted by ocean acidification (OA) resulting from climate change. In particular, mollusk and arthropod species have struggled, as they rely on calcium carbonate shells to protect them from predation and environmental hazards. Increasing OA decreases the availability of

carbonate ions, making it more difficult for many of these species to properly form shells or exoskeletons. However, algae can remove carbon dioxide from seawater through photosynthesis, thus increasing the local pH. Calcifiers may need to form new interactions with algae to ameliorate some of the negative effects of OA as conditions worsen. Animals raised in aquaculture systems may also benefit from this buffering as they experience increased stress from respiration which reduces pH and is compounded by increased population densities. In this study, we examined how the seawater buffering effect of algae, in the context of current and 100-year projected ocean pH, may impact red abalone growth, shell development, and muscle strength. We examined this through an abalone-dulse (red seaweed) integrated multi-trophic aquaculture (IMTA) system and found that abalone in the most acidified treatment were 33% smaller in terms of shell area and had 20% shorter shells that were approximately 33% weaker than abalone grown in ambient seawater. This study demonstrates that IMTA systems can provide a convenient and simplified model for larger ecological questions and are a potential solution to several water quality problems in the aquaculture industry.

200 - Abundance and composition of nurdles and other large microplastics in a San Diego coastal lagoon.
† Cole, O.*; Gray, S.

University of San Diego

Nurdles are pre-production plastic pellets that have been shown to be harmful to marine organisms. In San Diego County, nurdle pollution has been associated with freight railroad transport. The objective of this study is to determine the concentration, types and spatial distribution of nurdles and other large microplastics within a coastal lagoon adjacent to a railroad. Beach and subtidal sediment samples in San Dieguito Lagoon were collected at varying tidal position and depths and adjacent to nearby railroad tracks. Nurdles and other large microplastics (greater than 1.5mm) (LMP) were sieved and analyzed. The greatest concentrations of nurdles were found adjacent to the railroads (17-40.5 Nurdles/L Average), in comparison to the lagoon (0.30-1.1 Nurdles/L Average). In the lagoon, almost all LMPs, including nurdles, were found at the wrackline (0.089-1.95 LMP/L Average). Generally, nurdle concentrations decreased with increasing distance from the railroad. Nurdles from the lagoon and railroad were similar in shape and composition (polyethylene), suggesting that the railroad is a potential source of the plastic pollution. No nurdles were found near the mouth of the lagoon or on the ocean-facing beach, suggesting that the nurdles are trapped within the lagoon or transported out to sea. Measures to reduce the input of nurdles into San Diego lagoons from railroad traffic are needed. Future research will examine the concentrations of smaller microplastics in order to understand the potential relationship between larger and smaller microplastic pollution.

201 - Reproductive responses to unpredictable heat extremes across the range of an estuarine sea slug
† Aghajani, E.[1*]; Leem, J.[2*]; Tanner, R.L.[1]; Wyllie-Echeverria, S.[2]

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Phyllaplysia taylori sea hares and *Zostera marina* eelgrass have a beneficial relationship, in which *P. taylori* graze excess epiphytes that restrict *Z. marina* from sun exposure, promoting photosynthesis. This relationship maintains healthy *Z. marina* meadows, enhancing nursery habitat for other fishery species, attenuating wave action, and sequestering carbon. However, this ecosystem is being impacted by heat extremes. In this study, we focused on the effects of stochastic heat extremes on *P. taylori* reproduction and adult physiology (see Leem et al. poster) near their range ends: Southern California and the San Juan Islands. Alongside a static control treatment at 15°C (Cabrillo Beach, Southern California) and 13°C (Friday Harbor, San Juan Island), four treatments of heat stress at local maxima of 27°C (Cabrillo) and 25°C (Friday Harbor) were created to replicate the natural occurrence of heatwaves in the two locales differing in frequency (weekly and every other day) and duration (30 min and 1.5 hrs), in a fully crossed design. We found that Friday Harbor *P. taylori* were more fecund (n=314 egg masses) than Cabrillo (n=34). They also produced larger egg masses regardless of the heat stress treatment. In both locales,

quality of offspring decreased with unpredictable heat extremes, resulting in non-viable offspring. *P. taylori* from the northern range limit produce more and higher quality offspring, suggesting the population could maintain higher abundance and genetic diversity, increasing their climate resilience.

202 - Assessing Environmental Stressors on *Zostera marina* in an Urbanized Marsh System in Los Angeles Harbor

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1- Biology Department, Loyola Marymount University 2- Environmental Science, Loyola Marymount University

Salinas de San Pedro Salt Marsh in San Pedro, CA, is a soft-bottom habitat vital in supporting the seagrass *Zostera marina*, a foundational species known for stabilizing sediments, enhancing water clarity, and providing habitat for marine invertebrates and fish. Due to its location within Los Angeles Harbor and its proximity to two major storm drains, this site is potentially vulnerable to the long-term impacts of urban runoff. This study aims to assess sediment composition, water quality, and biodiversity across both interior and exterior zones of the marsh overtime. Yearly fieldwork since 2023 includes YSI water quality measurements, sediment sampling, and biodiversity surveys along three transects within the interior marsh and along the exterior edge of the marsh. Biodiversity metrics focused on *Z. marina* density, percent cover, and maximum blade height, and the abundance of associated invertebrate species were measured within five randomly placed 0.0625m^2 quadrats per transect. Sediment samples were dried and processed for grain size distribution, specific gravity, and organic and inorganic carbon content. Together, this data will offer insight into the long-term ecological impacts of urban runoff on coastal salt marsh ecosystems and help evaluate the resilience of habitats like Salinas de San Pedro Marsh in increasingly urbanized coastal regions.

203 - Evaluating Mobile Measurement Tools for Field-Based Data Collection

Bufferd, T.C.[1*]; Hirsch, S.E.[2]; Hoover, S.R.[2]; Bishop, W.R.[2]; Aoki, D.M.[2]; Fowler, K.J.[2]; Persaud, S.[2]; Carbajal, N.[2]; Reilly, J.D.[2]; Barron, H.W.[2]; Buttrey, S.[2]; Kowalski, A.[2]; Pescatore, J.[2]; Weber, M.[2]; Leali, J.[2]; Perrault, J.R.[2]

1- California State University Northridge 2- Loggerhead Marinelife Center

Morphometric data are vital for ecological research, yet field collection can be constrained by equipment availability and logistics. While calipers are reliable, their portability may be limited in remote or citizen science capacity. This study evaluates whether the iPhone Measure App can serve as a practical, portable supplement to traditional calipers for straight-line carapace measurements in sea turtles. Although iPhones are not inherently low-cost, their widespread ownership may make the app a convenient option when dedicated tools are unavailable. A total of 85 sea turtles representing five species were measured using both methods under standardized protocols. To assess agreement, we applied Passing-Bablok regression (to test proportional and systematic bias) and Bland-Altman comparisons (to evaluate consistency across measurement ranges). Results showed a strong correlation ($r > 0.99$) between methods. Bias was negligible for straight carapace length, but a significant bias was detected for straight carapace width. Both methods had differences in accuracy, as some of the turtles were moving during measurement collection. Given its portability, cost-effectiveness, and ease of use, the Measure App represents a reliable supplemental tool for morphometric data collection in field and clinical settings. This technology has the potential to enhance data collection in field-based conservation, particularly in remote or rapid-response contexts where traditional instruments are unavailable or less practical.

204 - Effects of Anthropogenic Stressors on Nearshore Fish Nursery Habitats in Mo'orea

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CSU Northridge

Nearshore marine environments play an important role for many invertebrates and fish species, often acting as a nursery. These nearshore areas support fish and invertebrate species that go through ontogenetic shifts, aiding in the transition from juveniles to adult life stages. Nearshore areas supply essential nutrients that support growth and

survival, but they are also highly vulnerable to anthropogenic influences and frequently experience intense human activity. The objective of this study is to assess how anthropogenic nutrient enrichment influences the ecological role of nearshore fish nurseries around Mo'orea. I conducted transect-based fish surveys at 15 sites around Mo'orea. Sites were chosen using assumed nearshore nutrient content based on a previous study by Adam et al. 2024. We also collected algae and sediment samples to determine the amount and source of nitrogen and carbon in the system. Preliminary results suggest that there is a difference in fish community composition based on a nutrient gradient, as well as high variability in the terrestrial and marine sediment input. Particularly, sites near anthropogenic disturbances (i.e., storm drains, seawalls, urban development) experienced a higher rate of terrestrial sedimentation. These findings highlight that anthropogenic nutrient enrichment may alter the composition of nearshore fish communities and the balance of nutrient sources. Understanding these shifts is critical for managing and protecting the nursery function of nearshore habitats in Mo'orea.

205 - Developing a course-based undergraduate research experience using photoquadrats to analyze marine diversity and community structure of the rocky intertidal

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Undergraduate marine science students often learn to comprehend and analyze marine diversity and community structure data within coastal and benthic environments. While this can be accomplished using example data, a more powerful approach is to incorporate field and laboratory activities that provide students with experience collecting, analyzing, and interpreting real-life data. Photoquadrat analysis is widely used by ecologists to efficiently collect and share data on the abundance of benthic organisms, and can be used to introduce students to field data collection methods within a classroom or laboratory setting. A fundamental aspect of using this technique is to analyze photos rapidly and accurately by scaling images, generating random sample points, and identifying and labeling species. Students must then export, collate, and prepare the data for analysis. We developed a lesson plan using the image analysis software Papara(ZZ)i to analyze images of quadrats taken in the rocky intertidal along the Monterey Peninsula from 2020-2025. The lesson plan includes step-by-step instructions for installing and using Papara(ZZ)i, and guides students through the process of sampling benthic cover from the images, allowing them to create data sets to explore the diversity of intertidal algae and invertebrates. We hope to implement the lesson as a CURE in a marine biodiversity course in the fall of 2025.

206 - iNaturalist Observations for Monitoring Marine Species

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iNaturalist observations have greatly increased since 2020, corresponding to a tenfold increase in peer-reviewed research. However, citizen science initiatives in marine compared to terrestrial ecosystems may not produce as reliable data due to fewer marine and coastal initiatives worldwide. We compared iNaturalist observations with Maine Department of Marine Resources surveys to investigate temporal patterns of sea star abundance along the coast. We found opposite trajectories: iNaturalist showed a >30-fold increase over 10 years, while scientific surveys indicated a 3-fold decrease. This inspired our questions: 1) How are iNaturalist observations used in marine science literature, and 2) What factors enable successful comparison with scientific surveys? A literature review reveals iNaturalist data is valuable for documenting the existence of species at specific locations, discovering new species, and evidence of range shifts. Two important factors determine successful use: the type of analysis the study seeks to perform and what type of data the study requires. Studies that compared iNaturalist observations with species' densities and frequencies found that the iNaturalist observations did not correlate well with scientific survey data due to higher frequencies of large and easily accessible species. This project highlights that iNaturalist observations are increasing and recognized as valuable for scientific research. However, biases and limitations need consideration when comparing iNaturalist observations with scientific surveys.

207 - Harbor seal (*Phoca vitulina*) haulout behavior in and near Morro Bay

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California Polytechnic State University, SLO

Harbor seals are coastal marine mammals that haul out close to areas of human activity, but they are notoriously reactive to human disturbance. There is currently no formal monitoring program for harbor seals along the central coast of California. Plans for a windfarm offshore of Morro Bay are likely to increase ship traffic and other human activity in the area. This project expanded upon a dataset documenting the location and timing of harbor seal haulout behavior in Morro Bay and surrounding areas. To do this, we used binoculars and a spotting scope to conduct frequent ground surveys of harbor seals at three sites in and around Morro Bay. We examined the relationship between harbor seal haulout behavior and abiotic factors, including tide level, air temperature, and wind speed. Preliminary results indicate that these factors significantly affect harbor seal abundance, but in different ways at different sites. For example, harbor seal abundance was positively associated with tide height at one site but inversely related at another. These data will be used to assess when scat collection would be possible– in the absence of the seals, and before the tide washes it away– to facilitate future scat sampling for diet composition and health markers. Ultimately, we hope to understand the impacts of increased activity associated with the offshore windfarm on our local harbor seals' abundance and health.

208 - Documenting the behavior of Black Oystercatchers (*Haematopus bachmani*) in the Monterey Peninsula

† Hill, L.G.*; Bergsma G.S.,

CSU Monterey Bay

The Black Oystercatcher (*Haematopus bachmani*) is a shorebird found in rocky intertidal ecosystems along western North America. Although it is a species of conservation concern, due largely to habitat loss and human disturbance, relatively little is known about its behavior and food selection in the southern part of its range. Documenting the behavior of such species is important to understanding their ecological roles, informing conservation efforts, and detecting changes in response to the environment. To document the behavior of Black Oystercatchers, we constructed an ethogram based on *ad-libitum* observations of wild oystercatchers at study sites along the Monterey Peninsula in California. We then conducted focal time samples to record behavior and build an activity budget, a description of behaviors used to quantify how an animal or population spends their time. We also recorded feeding and identified prey species. Observations were conducted during both low and high tides to capture a broad range of behavioral variation influenced by tidal conditions. The time budget and identification of prey species will serve as tools for future research assessing the effects of disturbances to Black Oystercatcher populations.

209 - Environmental variation and its influence on community assembly in marine islands.

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Environmental variation, population dynamics, and biotic interactions occur across a variety of spatial scales and can help us understand how communities assemble. A lot of studies about community assembly use terrestrial environments, but relatively few focus on the marine realm. Marine lakes – seawater surrounded by land – are marine island ecosystems showing limnological differences that may give insights into how communities could be re-shaped in a world changed by climate. This raises an important question: how might ecological factors shape communities in marine lakes? I used metabarcoding analysis and microscopy to assess plankton communities within and between 17 Palau sites for two years (2011 and 2015), as well as gathered environmental data (water temperature, salinity, pH, and dissolved oxygen). The species data, combined with environmental data, contribute

to the knowledge related to how environmental gradients shape biodiversity. Also, it provides valuable insight into how island-like ecosystems may respond to climate-driven shifts, enhancing our knowledge of island environments under climate change and anticipating community shifts, consequently managing and conserving these habitats.

210 - Leather star (Dermasterias imbricata) predation on purple urchins: prey frequency and size-specific mortality

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Predators in kelp forest ecosystems can contribute to persistence and recovery by preventing overgrazing by herbivores. Mesopredators, such as sea stars, may play an important role in controlling urchin populations, either through consumptive or trait-mediated responses. The leather star (*Dermasterias imbricata*) is a benthic predator in kelp forest ecosystems, capable of feeding on a wide variety of prey, including the purple urchin (*Strongylocentrotus purpuratus*). Laboratory assays have investigated feeding behavior and secondary response cues; however, little is known about diet preferences, including frequency of urchins consumed relative to other available prey, and size-class preferences. This study assessed the diet composition and prey frequency of leather stars to better understand their role as kelp forest predators. We conducted SCUBA surveys at 14 sites in Monterey Bay and Carmel Bay and observed 426 individual stars to determine prey selection and urchin size relative to star size. We carefully inverted each star, classified prey type, and measured the test diameter of consumed urchins. We observed 27 stars eating urchins, 96 consuming other prey, and 303 non-feeding stars. Analyses on the size frequency of consumed urchins revealed that the mean size was 3.074 cm. We expect larger stars to consume urchins more frequently in comparison to smaller stars. This study adds to a growing body of literature surrounding the role of mesopredator control of herbivore populations by revealing the diet frequency of prey in leather stars.

211 - Do Sea Stars Dread Taking Baths as Much as My Dog? How Might Freshwater be Impacting our Pentaradial Friends?

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Cal Poly Humboldt

Iconic and charismatic sea stars are found all over our oceans, but how might they fare near a freshwater input? Sea stars are a part of the phylum Echinodermata, meaning they utilize a water vascular system by using the surrounding sea water for physiological function. This water vascular system makes them susceptible to changes in sea water chemistry- such as decreases in sea water salinity. Understanding echinoderm tolerance to decreased salinities has become increasingly popular in recent years, with groups studying how freshwater runoff impacts sea urchins and sea stars as important characters in their ecosystems. By examining sea star populations near freshwater sources, we can expand our understanding of echinoderm tolerance to areas with lower salinities. My thesis counted several species of sea stars near river mouths in Mendocino County, CA as a part of a greater project examining their relative sea urchins. To understand the differences in sea star distribution near river mouths, counts were made at four river and four non-river sites for comparison. Eight 5 by 2 meter transects were conducted by scientific divers on SCUBA at all eight sites. The field results revealed intriguing differences in sea star populations, with fewer stars present at the riverine sites compared to non-riverine. This sea star data can be used to broaden our knowledge and understanding of echinoderm tolerance (or intolerance) to lower salinity areas such as river mouths and to help inform local managers on future environmental resource management decisions.

212 - Energy dissipation in biological systems is governed by the length and efficiency of dominant metabolic pathways, which set the tradeoff between per-step dissipation and system-level flux.

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Coral reef degradation often involves a shift from coral- to algal-dominated states, driving a change from a *viralized* to a *microbialized* microbial regime. In microbialized reefs, low-yield metabolic pathways dominate, leading to inefficient energy use, excess heat dissipation, and hypoxic conditions that accelerate coral disease and mortality. This reinforcing cycle, known as the **DDAM loop** (Dissolved organic carbon, Disease, Algae, and Microbes), illustrates how shifts in microbial metabolism destabilize reef ecosystems.From a thermodynamic perspective, these shifts reflect a tradeoff between pathway length and heat dissipation. Viralized systems favor long oxidative pathways that require many steps but dissipate little heat per step, whereas microbialized systems rely on short, incomplete routes that involve fewer steps yet dissipate more heat per step.We hypothesize that **energy dissipation in biological systems is governed by the length and efficiency of dominant metabolic pathways**, setting the tradeoff between per-step dissipation and system-level flux.To test this, we use **isothermal calorimetry** to quantify heat dissipation across microbial states. We **designed and built a custom microcalorimeter** capable of resolving subtle thermal signals, providing a diagnostic tool for identifying dominant metabolic strategies in reef systems. More broadly, this approach tests the **ladder theorem of thermodynamics** in living systems.

213 - New sea spiders (Pycnogonida) from deep-sea methane seeps.

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The deep seafloor generally lacks nutrients, light, and other life-supporting elements, so biomass and diversity tends to be low. However at methane seeps, simple hydrocarbons leak into the ocean from Earth’s crust and get used in metabolic processes by archaea and bacteria, leading to hotspots for biodiversity. Ecosystems are then built by organisms that rely on these microbes directly or indirectly, creating diverse communities in an otherwise difficult place to survive. One animal group found at these hotspots are pycnogonids, commonly known as sea spiders. These arthropods are found at all depths of the ocean, from tide pools to the sea floor, but the genus *Sericosura* is exclusively found at extreme environments such as hydrothermal vents and (occasionally) whale falls. There are currently 15 named species in *Sericosura* ranging from Alaska to the Southern Ocean, discovered at depths from 1500-3500 m. Recently there have been four new species discovered from methane seeps in Costa Rica, Chile, Del Mar, and Alaska, creating a clade in a previously unknown habitat for this genus. Several of these new species has been shown to consume epibiotic methane-oxidizing bacteria as their main food source. This study will formally name these new *Sericosura*, expanding previous knowledge of deep-sea pycnogonids and their role in deep-sea communities.

214 - Relationships Between Vegetation Greenness, Temperature, and Income in SantaClara County

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Green spaces are vital for providing ecosystem services such as urban cooling, air purification, and improved well-being. However, green spaces are unequally distributed in several cities, often because of historical or discriminatory land practices, which results in an unequal access to their benefits. This study leverages remote sensing data to examine how income and vegetation cover modulate exposure to urban heat during and outside of droughts. We used census tract-level data to analyze the relationships between vegetation greenness (measured by the Normalized Difference Vegetation Index; NDVI) and average median temperature seasonally from 2019 to 2024 with income as the sociodemographic variable. Spatial and statistical analyses conducted in ArcGIS Pro revealed that vegetation has a significant cooling effect, with NDVI explaining over 50% of temperature variation in summer and fall seasons. Preliminary results also indicated that income impacts vegetation cover with wealthier census tracts showing higher NDVI and more cooling benefits, while lower-income areas are exposed to higher temperatures and lower vegetation cover, revealing disparities in ecosystem benefits. This study highlights the need for equitable urban greening strategies to mitigate climate risks and ensure that ecosystem services are accessible to all communities.

215 - Science in the surge: Pioneering SCUBA surveys for endangered black abalone in the shallow subtidal

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Conservation and monitoring efforts for endangered black abalone (Haliotis cracherodii) have focused almost exclusively on the rocky intertidal zone. However, historical fisheries and anecdotal observations indicate this species also occupies the shallow subtidal fringe—a habitat never systematically surveyed in California's Northern Channel Islands. To address this gap, we adapted existing intertidal protocols for SCUBA and developed a novel methodology, surveying 21 sites at Anacapa and Santa Cruz Islands during Fall 2024. When possible, subtidal sites were collocated with existing intertidal black abalone survey sites to better understand the fine scale spatial distribution of abalone populations at these locations. Survey bounds were designed utilizing tide tables to define the upper limit of the shallow subtidal fringe, ensuring surveys would not overlap spatially with the intertidal zone. Divers systematically searched all rocky habitat, recording species, shell length, depth, time, and nearest-neighbor category, while GPS and surface photography aided in mapping survey plots. Despite the challenges of swell and surge, divers were successful in safely completing over 60 survey dives which revealed thousands of subtidal black abalone, representing the first quantitative assessment of shallow subtidal populations in the region and highlighting the value of integrated monitoring across the intertidal–subtidal boundary.

216 - The Genome Assembly of an Omnivorous Fish, Xiphister atropurpureus, and the Identification of Chitinase Loci

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Black pricklebacks (*Xiphister atropurpureus*) are marine intertidal fishes distributed from northern Baja California, Mexico, to Kodiak Island, Alaska. This species exhibits an ontogenetic dietary shift, beginning as carnivores and transitioning to omnivory in adulthood. Similar shifts are observed in other intertidal prickleback species, raising important questions about diet, development, and adaptation. To address these, we employ bioinformatics tools such as BLAST, CANU, and Platanus to analyze data generated from Pacific Biosciences and Illumina sequencing platforms. This research seeks to provide new insights into nutrition, digestive physiology, and the genomics of marine fishes. In this study, we assembled PacBio data using CANU, which we obtained 2,674 contigs and an N50 of 2.5 Mb. In addition, we located two chitinase loci, the enzyme that breaks down the exoskeleton of invertebrates, in the *X. atropurpureus* genome. Orthologs from other stichaeid species were identified, and the chitinase loci were analyzed for signatures of positive selection. By linking chitinase gene evolution to dietary shifts, this study advances knowledge of how intertidal fishes adapt to variable food resources and contributes to broader efforts in marine biodiversity, physiology, and conservation.

217 - Growing at a snail's pace: Integral projection models of range-expanding whelks indicate demographic drivers of population growth

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1- University of California, Irvine 2- University of Oregon 3- University of California, Santa Cruz 4- Bodega Marine Lab, University of California, Davis

Species are redistributing across the globe due to a suite of anthropogenic drivers. There is a pressing need to understand the population dynamics of range-shifting species to anticipate future expansions and contractions as well as ecosystem impacts. Two species of intertidal carnivorous whelks, *Acanthinucella spirata* and *Mexacanthina lugubris*, are expanding their ranges poleward in northern and southern California, respectively. To link demographic rates to population sizes across California, we used integral projection models to integrate population-level data from field surveys, lab experiments, and a literature review. We asked the following

questions: First, are demographic rates and overall population growth related to site-level temperatures? And second, does the population growth rate describe site-level abundances? We found that while individual-level growth rates are negatively affected by increased local temperature for both species, these effects do not manifest as clear temperature effects on population-level growth rates. Instead, interspecific and intersite differences in reproductive rates determine projected population growth rates of local populations. These results, which are among the first attempts to fit population models to marine gastropods, suggest that understanding drivers of variation in fecundity and recruitment may be key to understanding local population as well as larger distribution dynamics of these species.

218 - Decoupling Oxygen and Glucose Production using Targeted Selection Pressures

† Calugaru, K.*; Rohwer, F.

San Diego State University

Microbialization is a detrimental process affecting coral reefs globally. It is characterized by the progressive degradation of reef ecosystems due to the accumulation of microbes. This phenomenon is commonly initiated by the DDAM loop, a negative feedback loop involving dissolved organic carbon (DOC), disease, algae, and microbes. As algal populations increase, they release elevated levels of DOC into the surrounding waters. This excess DOC fuels microbial proliferation, creating zones of hypoxia and exacerbating the spread of coral diseases. As a result, corals are more susceptible to death and the ecosystem declines into microbial dominance. We propose that by applying selective pressures favoring marine microbial communities that produce oxygen without contributing to organic carbon levels, we can cultivate a community capable of sustaining itself in microbialized environments while disrupting the negative feedback loop driving reef degradation.To decouple oxygen and glucose production, our selections will target the photosystem II complex, which splits water into oxygen and hydrogen ions, and the carbon fixation pathway of photosynthesis. Through a concurrent application of pressures including growth in 3.2% saline media, algal sugar supplementation, full spectra light, nitrogen purging, and trace metal addition, we will select for oxygen production and heterotrophy, while selecting against organic carbon production and non-oxygen producing fermenters.This system would offer a transformative, sustainable solution to coral reef degradation.

219 - Over the last 51 years, variable high intertidal algae zonation tended to rise at a sheltered marine refuge of south Monterey Bay

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CSU East Bay

Accelerating sea level rise disrupts global shorelines. At durable granite shores near Monterey, CA, NOAA reports a 10cm relative sea level rise over the last 51 years. This study tested for changes in an upper algae zone at Hopkins Marine Life Refuge, CA, over that period of 51 years,1974-2025. Previous analyses at more turbulent rocks there, by Hunt with Kitting's and other images, had shown little monthly change in elevation of this contiguous Endocladia muricata plus Mazzaella affinis red algal upper border, and generally quite constant elevation between ~1920 and 2007, except for a single 20cm rise around 1970. We tested the hypothesis that sea level rise would result in these algae rising by approximately 10cm during these recent 51 years. We analyzed Kitting's standardized images covering a 10-m-wide area of granite surfaces, for November 1974, May 1975, June 2002, August 2016, and May 2025. Using a consistent scaling method to quantify vertical distances with pairs of optical transect locations, our data revealed that over the last 51 years there has been at least one major shift downward for this contiguous border, with a 22cm overall upward shift of this contiguous algal edge here (N=12), with standard deviation of 28cm, indicating some variability but overall algal rise, over time. Other factors beyond sea level rise, such as recruitment characteristics of these algae, may be responsible for occasional rises in this zone boundary. We highlight the importance of remote nondestructive image-based observations to detect ecological changes and threats through time.

220 - Assessing the distribution of spore dispersal in bull kelp (*Nereocystis luetkeana*)

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Sonoma State University

Dispersal abilities of r-selected species are a crucial part of understanding population connectivity and recruitment patterns. Understanding dispersal dynamics are especially important for declining foundation species, such as bull kelp (*Nereocystis luetkeana*) in northern California, a species that has suffered declines of 90-95% in the last decade from a confluence of factors. Bull kelp has sori (reproductive tissue) located on its blades near the water surface (unique for kelps), that release spores while still attached to the blade while sinking, and when on the seafloor. Burnett et al. (2024) recently modeled a bimodal distribution of spore dispersal for northern California's bull kelp, where the greatest settlement occurred within 10 m from the source (bottom dispersal) and at 1-10 km away from the source (surface dispersal). Using this information, we report on preliminary findings from field tests of the bimodal dispersal potential of bull kelp. To test the bimodal hypothesis, we deployed spore collection units (SCUs) at increasing distances from an isolated kelp patch in Mendocino, California. The SCUs were composed of frosted microscope slides mounted onto acrylic boards replicated at the seafloor and in the midwater. The midwater slides were used to quantify spore release from surface sori. SCUs were set within the forest, at the edge and 3, 8, 20, 55, 150, 450, and 700 m away from the forest edge. This study will provide evidence as to whether substrate in proximity to bull kelp patches are spore limited, aiding current and future restoration efforts.

221 - How flexible is plasticity? Assessing changes in sand dollar larvae when switched from high to low food conditions.

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Feeding echinoid larvae possess food-conditioned phenotypic plasticity where in low food conditions larvae grow long larval arms to increase feeding capacity and in high food conditions larvae grow short larval arms. Previous research has established that larvae of the sand dollar, *Dendraster excentricus*, can induce the short arm phenotype throughout the larval stage when switched to high food conditions. The goal of the current study was to test if larvae could reverse this plasticity response (i.e., change from short- to long-arm phenotype) when switched from high to low food conditions. Sand dollar larvae were reared at 16˚C and fed at low or high algal concentrations (1,000 or 10,000 cells mL^{-1}, respectively). When a subset of larvae were switched from constant high to low food conditions at 7 days post-fertilization (DPF) they immediately increased arm length compared to constantly high-fed larvae and eventually had arms that were longer than constantly low-fed larvae (ANOVA, $p < 0.001$). Currently we are assessing if this reversal of plasticity is maintained throughout development by switching food conditions from high to low algal concentration at 4, 8, and 12 DPF. We are also assessing what biochemical reserves (i.e., protein and/or lipid) are used to fuel the rapid arm growth that occurs upon switching larvae to low food conditions. The results of this study will provide important knowledge as to the phenotypic flexibility of larval morphology to changing food levels and the role of algal nutritional quality in supporting such changes.

222 - Peer into the Past: Insights from 70+ Years of the State of the California Current Reports

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We completed a literature review of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) reports, currently consisting of 60 editions, from the first in 1950 to the most recent in 2021. Reports span from roughly 200 to 400 pages in length, and contain scientific articles from a range of disciplines: oceanographic, biologic, ecological, and even engineering. They are narrative-driven scientific archives that merge traditional natural science methods with more anecdotal inclusions: shipboard observations, strange sightings, and general notetaking. These qualitative records are absent from the long-term databases published and maintained by CalCOFI. This makes the reports unique, and a great source for unusual observations recorded before the

influence of modern perspectives and methods, and thus less affected by today's biases. We reviewed the reports in search of anomalously spotted invertebrates along the California coast, and were successful in identifying a number of species with unusual appearances, including the pelagic red crab, by-the-wind sailors, and humboldt squid. CalCOFI reports are distinguished on account of their comprehensive summarization; the ability to look into past ecology, technology, oceanography, and fisheries biology on a near-yearly basis for over 70 years is rare. The reports are an untapped qualitative data source that allows us to connect environmental changes on both a technological and observational basis with context that inspires new avenues of discovery.

223 - Bringing Kelp Forest Restoration from the Ocean Floor to the Classroom Door.

Chace, J.*; Sullivan, D.E.; Peterson H., ; Swanwick, B.; Bartel, S.

Catalina Island Marine Institute

Following a prolonged marine heatwave and major storms (2014–2016), Catalina Island's once-thriving kelp forests were greatly reduced, giving way to invasive Sargassum horneri and native understory algae. Nearly a decade later, kelp is naturally recruiting again—offering both a rare ecological opportunity and a powerful educational moment. At the Catalina Island Marine Institute (CIMI), the CIMI Kelp Restoration Project combines cutting-edge technologies—drone imagery, multibeam sonar, environmental sensors, and diver surveys—to track kelp recovery at Toyon Bay and Fox Landing. Importantly, these tools are also integrated into CIMI's hands-on marine science curriculum, where students engage directly with restoration science. Students explore GIS maps to visualize kelp recruitment patterns (cimikelp.org/our-maps), visit restoration sites to observe recovery in progress, explore data to hypothesize about environmental drivers, and even participate in kelp surveys during Catalina Sea Camp. By transforming Catalina's living laboratory into an outdoor classroom, CIMI empowers students to become active participants in marine conservation. This program not only cultivates ecological curiosity—such as why some reefs rebound while others remain dominated by understory algae—but also fosters resilience, stewardship, and a new generation of conservation leaders. Since 1979, CIMI has provided hands-on marine science education to more than one million students on Catalina Island.

224 - Lined shore crabs of North American muddy estuaries and rocky shores: Indeed, a single species diverged from Asia ~1MYA

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The lined shore crab, *Pachygrapsus crassipes* (Grapsidae), is a widely distributed intertidal species in East Asia and West North America that is common in both wave-exposed rocky shores and calm, muddy estuarine habitats. These strongly contrasting environments raise questions about whether crabs in estuaries versus rocky shores represent distinct evolutionary lineages or a single species. Further, the possibility that they may be different species motivates a reconsideration of whether the disjunct populations in Asia and North America are the result of an ancient or a recent human-mediated dispersal. Using new samples from 13 estuaries and 23 rocky-shore sites in North America and previously available mt COI and nuclear 28S DNA sequences, we assessed genetic differentiation across habitats and regions. In North America, estuarine and rocky-shore populations showed no genetic separation for both markers, with interspersed, shallow lineages and shared haplotypes across habitats. This result suggests high connectivity, likely driven by planktonic larvae from individual parents regularly dispersing into both habitats. In contrast, we confirm and bolster prior work indicating an ~1MY divergence between American and Asian crabs. We consider the question of whether the original ancestral range for the species lies in Asia or the Americas. Our results clarify that *P. crassipes* is genetically cohesive across habitats in North America, while persistent, historical barriers have shaped deeper divergence across the Pacific Ocean.

225 - Activity of wolves in captivity at the California Wolf Center

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1- University of San Diego 2- California Wolf Center

Wolves are keystone species and are essential to the diverse ecosystems they inhabit across North America. Research on captive wolves is important so that we can better understand their behavior in response to humans, particularly in the context of habitat destruction. My objective for this study was to determine whether wolves in captivity had different activity levels depending on their pack size. For this study, I interned at the California Wolf Center in Julian, California and put 2-4 motion detecting cameras in 5 different habitats, some that housed only 2 wolves and others that housed a pack of 6 of Mexican Gray wolves. The cameras were left in each habitat for 4 consecutive days to observe the wolves for 24 hours a day of data. Videos were analyzed to identify times of activity for the wolves in each habitat. Here we will present results comparing activity levels and behavior types between pack sizes. We found that certain wolves were more active than others and activity level varied by time of day. This study provides insight into our understanding of factors that affect the behavior of this important species in the presence of humans.

226 - Tracing Stephanocystis: Exploring Miocene brown algal fossils with an extant morphogenetic lens

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1- UCLA 2- Natural History Museum of Los Angeles County

What did our near-shore ocean ecosystem look like ~10 MYA? The Los Angeles Basin (Tovaangar) has provided the single largest Phaeophycean (brown algal) fossil collection in the world, whose specimens (~15), characterized by Gardner (1923) and Parker & Dawson (1965), have provided the most robust anchor in time-calibrated estimates of brown algal evolution. Here, we present a revision of the original collections, as well as descriptions of ~150 new specimens, with an updated morphological lens informed by the phylogeny of extant species. Here we 1) propose a reclassification of specimens from the historical collection under the genus *Paleostephanocystis*; 2) propose a morphotype system of classification for existing and new specimens given our understanding of morphological variation in extant species; and 3) detail observations that lead us to believe that the morphology of extant *Stephanocystis* was also present in *Paleostephanocystis* anchoring complex branching patterns in the Fucales in the Miocene. Uncovering and describing brown algal fossils helps us understand the evolution of brown algae and imagine what our near-shore ecosystem might have been like millions of years ago.

227 - Impacts of physical extremes on the reproductive output and dispersal of Stephanocystis osmundacea populations

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Stephanocystis osmundacea (chainbladder kelp), a dioecious perennial alga, provides habitat during spring and summer when reproductive fronds become canopy-forming. Once reproductive fronds reach the surface, they become fecund and develop conceptacles: specialized cavities containing reproductive materials. However, little is known about the growth and output of these fronds across depth gradients. This project aimed to estimate the reproductive output of *S. osmundacea* populations across depth, investigating the impact of varying sunlight availability, wave action, and trade-offs in life history strategy. We hypothesized that due to the decrease of light availability with depth, shallower individuals would develop greater quantities of conceptacles than deeper individuals. We also predicted a greater quantity of conceptacles higher along the fronds and closer to the surface. Reproductive fronds were collected at peak season (July–September) from Stillwater Cove, Carmel Bay, CA. For each month, 5 cm fragments were sampled at varying heights, and photos taken under a dissecting scope were used to quantify the number of conceptacles per gram using ImageJ. Counts were used to estimate the total output of both collected individuals and those at a shallow and deep population within the cove. Results demonstrated output varies with month and depth, and the ultimate consequence of this variation depends on the dispersal of the released zygotes, a topic further analyzed in a larger project modeling propagule dispersal.