Western Society of Naturalists

105th Meeting – Abstracts

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Contributed Talks

Session 1: Conservation and Restoration (Speed Talk)

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A SNAIL'S PACE TO RECOVERY: PINTO ABALONE RESTORATION IN THE SALISH SEA

Loose, E.L.[1*]; Sowul, K.A.[1]; Carson, H.S.[1]; Flanagan, K.D.[1]; Bouma, J.V.[2]; Bates, E.H.[2]; , [3]

1- WDFW 2- Puget Sound Restoration Fund 3- affiliation not listed

Pinto abalone *(Haliotis kamtschatkana)*, known for their delectable flesh and mesmerizing nacre shells, have long captivated humans. The allure of these charismatic gastropods has led to overfishing and poaching, which, coupled with habitat degradation and changing ocean conditions, has resulted in a dramatic decline in their population within Washington State. As a result, the pinto abalone was listed as state endangered in 2019. Working closely with the Puget Sound Restoration Fund and other partners, the Washington Department of Fish and Wildlife has been working toward pinto abalone restoration since 2003. Juvenile abalone raised in hatcheries are outplanted to various sites around the San Juan Islands, and these sites are closely monitored to track survival. Given the pivotal role abalone play in kelp forest ecosystems, the continued success of these restoration efforts will be instrumental in preserving biodiversity and enhancing the resilience of marine ecosystems in the face of future environmental challenges.

CONSERVATION TRADE-OFFS IN OREGON'S NEARSHORE: THE CASE OF SEAOTTERS AND ABALONE

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1- Oregon State University, Oregon Kelp Alliance 2- Oregon Kelp Alliance

Serving as crucial ecosystem engineers along the Oregon coast, kelp forests support many cultural, ecologic, and economically valuable marine organisms. In 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 along Oregon's southern coast. The environmental stressors, coupled with habitat loss and food competition from proliferated seaurchin populations, have caused significant declines in culturally important abalone, resulting in the permanent 2023 closure of the recreational abalone fishery in Oregon. Without thorough information on the roles and importance of abalone, it is challenging to support species recovery efforts properly. Using current and historic survey data, the Oregon Kelp Alliance assessed the intertidal and subtidal presence and depth preferences of *H. rufescens*, *H. walallensis*, and *H. kamtschatkana*. Current data indicates a preference for shallower depths and the significant rarity of the species. New research shows that the current purple sea urchin GI is unsustainable for sea otters. Abalone serve as a favored food source for otters; therefore, reintroduction efforts may prove catastrophic for remaining abalone. Continued and more frequent monitoring will give a more comprehensive understanding of the condition and preferences of this iconic species. Monitoring will greatly inform the best route of conservation strategies to increase restoration efficacy and fully restore kelp forest ecosystems to the southern Oregon coast.

EARLY WARNING SYSTEM? ANALYSIS OF SUBTLE SYMPTOMS AS AN EARLY INDICATOR OF SEA STAR WASTING DISEASE: IMPLICATIONS FOR SUNFLOWER STAR RESTORATION

Schwab, C.J.[1*]; Valdez, V.V.[1]; Robidoux, J.[2]; Kalytiak-Davis, A.R.[3]; Curliss, F.S.[1]; Weertman, W.L.[2]; Hodin, J.A.[1]

1- UW Friday Harbor Labs 2- University of Washington 3- Oregon State University

The threatened sunflower sea star (*Pycnopodia helianthoides*) has faced devastating population declines due to sea star wasting disease (SSWD). As captive breeding programs strive to support species recovery, early detection of SSWD symptoms is crucial for successful restoration efforts.

This study analyzed three years of twice-daily health check data from our multi-generational captive breeding program at Friday Harbor Laboratories to evaluate the predictive value of mild symptoms for major wasting events. We developed a detailed symptom-tracking system, categorizing a range of symptoms in individual stars from subtle posture changes to severe conditions, such as lesions. Our preliminary findings suggest that certain mild symptoms may precede more severe wasting conditions. Early identification of at-risk individuals allows for prompt isolation and treatment, mitigating disease spread within our captive population. Moreover, this improved understanding of SSWD progression in sunflower stars can add confidence to individual sea stars' health, with implications for transfer, reintroduction and release strategies. By enhancing our ability to predict and manage SSWD outbreaks, this research directly supports ongoing efforts to rebuild sunflower star populations and restore their crucial ecological role in Northeast Pacific marine ecosystems.

EDNA AND VISUAL CENSUS REVEAL CHANGES TO KELP FOREST BIODIVERSITY ACROSS A RAPIDLY WARMING GULF OF MAINE

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1- Bigelow Lab for Ocean Sciences 2- University of Maine

Kelp forests are the foundation of temperate coastal ecosystems globally, but ocean warming is altering their distribution. For example, the Gulf of Maine (GoM) is one of the fastest warming ocean basins in the world and its kelp forests are rapidly disappearing from the warm edge of their range. However, concomitant shifts in animal communities are poorly understood. Here, we used eDNA metabarcoding and SCUBA-based visual censuses to document changes in algae, invertebrate, and fish communities across 11 monitoring sites (spanning 250 km) over a 3-year period (2021-2023). Our results show that the use of eDNA provides new and complementary insights into regional biodiversity and reveal that the habitat phase shift now underway (from kelp forests to diminutive red turf algae) goes in hand with changes among animal communities. Our study – the first in this region to assess kelp forest change across multiple trophic levels using molecular techniques – demonstrates that eDNA can be a powerful, complementary tool for monitoring biodiversity in an era of rapid change. Additionally, it will underpin forecasts of "species on the move" as well as functional trait analyses, which will be used to predict how further warming will reshape ecosystem structure and function.

SEA OTTER, ENHYRDA LUTRIS, CONSERVATION LEGACY AND POTENTIAL FOR RECOVERY, THE IUCN GREEN LIST ASSESSMENT

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Seattle Aquarium

Sea otters, Enhyra lutris, are marine mammals in the otter family (Lutrinae), a subfamily of the weasel family (Mustelidae). They are found throughout north Pacific nearshore areas, from intertidal areas to 100 m) from Northern Japan in the west Pacific to Baja California in the east Pacific. Sea otters were nearly hunted to extinction by the international maritime fur trade from 1741-1910. To date, they have recovered to almost half their pre-exploitation numbers, yet they remain absent or depleted in many areas of their historic range. Sea otters are keystone species stabilizing and recovering nearshore ecosystems in many areas after recovery from the fur trade. Their effect is particularly notable in kelp forest, sea grass and salt marsh systems where they exert top-down control by eating benthic invertebrate grazers. They are listed as Endangered on the IUCN Red List of Threatened Species due to declining populations in the western portion of their range linked to orca (Orcinas orca) predation and range stagnation in the southern part of their range linked to great white shark (Carcharodon carcharias) predation. The IUCN Red List is an assessment of a species' extinction risk. Newly complementary to the Red List is the IUCN Green Status Assessment, which is an assessment of the effect conservation efforts past, present and future may have in species recovery. The Green Status for sea otters was recently completed and based on efforts after the fur trade and others to recover sea otters throughout their range such as reintroductions and reducing the potential risks of oil spills in nearshore areas, sea otters are considered still largely depleted. Sea otters have a high conservation legacy and high potential for further recovery. Here I will walk through how we came to this assessment and what future conservation efforts could do for sea otters range wide.

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CONSUMPTION PRESSURE IN ESTUARIES PEAKS AT INTERMEDIATE SALINITIES

de Rivera, C.E.[1]; Larson, A.A.[1*]; Chang, A.L.[2]; Rubinoff, B.G.[3]; Soto, L.R.[1]; Wright, S.L.[1]; Grosholz, E.D.[4]; Ruiz, G.M.[2]

1- Portland State University 2- Smithsonian Environmental Research Center 3- UC Davis, Washington SeaGrant 4- UC Davis

The nature and strength of biotic interactions change with environmental stress but the importance of these interactions across estuarine gradients is unresolved. Therefore, we examined the relationship between consumption pressure and distance into estuaries by deploying standardized baits along the salinity gradient of four Oregon estuaries. The relationship between consumption and stress was nonlinear: as shown by segmented regression, consumption pressure peaked mid estuary in the four estuaries, which supports neither the Consumer-Stress Model nor the Prey-Stress Model. The pattern of consumption partially aligns with the Invasion-Stress hypothesis, that successful invasion by stress-tolerant predators extends consumption pressure further upstream along estuarine stress gradients, so we examined the effect of the introduced crab *Carcinus maenas* on consumption. Our catch data did not support the expectation of greater numbers of these invasive, stress-tolerant predators mid estuary. Although the catch data did not support this hypothesis, *C. maenas* was trapped throughout each estuary, and, in lab tanks, *C. maenas* ate more squid when at intermediate salinities than fresher salinities. Also, *C. maenas* catch was highest mid estuary in other studies of northeast Pacific estuaries. Our uniform finding of a consistent relationship between stress and consumption across the salinity gradient of all these temperate estuaries can help with predicting ecological impacts from changes in precipitation patterns, biological invasions, and other stressors for estuarine food webs.

DISTRIBUTION OF CALIFORNIAN CRYPTIC CORALLINE ALGAE

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Coralline algae are difficult to identify using morphology, and populations can consist of multiple cryptic species. At six sites (from Santa Cruz to Pacifica), 3-5 pools were surveyed to better assess the diversity of algae in central Californian intertidal habitats. From each pool ten geniculate coralline algae were haphazardly collected, preserved in silica gel, and subsequently identified by sequencing the psbA gene region. *Calliarthron tuberculosum* was the most abundant species in the pools, but there were two genetically distinct species that co-occurred in most pools. Three genetically distinct species of *Bossiella cf. plumosa* were collected, but were relatively rare. The distributions of *Bossiella* spp. were very patchy with only one or two species of these algae per pool and per site. These results show that the geniculate coralline algae of California are more diverse than can be predicted using morphology alone, and highlight our poor understanding of algal diversity and distribution along the Californian coast.

RESOLVING A LAW GOVERNING THE DISTRIBUTIONS OF SPECIES

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Stanford University

Taylor's Law is one of the few relationships that ecologists can find in nearly all species across space and time. It describes how the variance of population sizes changes with the mean of those sizes, and it follows a power law. The exponent of this relationship is often interpreted as dependent on species or environmental context. Many mechanisms have been proposed to explain Taylor's Law, including animal behavior and demographic stochasticity, causing population aggregations. However, this relationship often holds true outside of ecological contexts, such as within genomes and physical phenomena, suggesting more fundamental properties. We resolve the true nature of Taylor's Law, showing that it is a useful statistical artifact with predictable limitations, including that it is only a law when the exponent equals 2.

THE TROPICALIZATION OF BAJA'S SEA URCHINS

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1- UABC 2- UABCS 3- CICESE

In the past decades positive temperature anomalies have modified the abundance and distribution of species. The poleward distribution shifts of species at the tropical and subtropical transition zone can lead to a tropicalization of the communities in the subtropical areas. In the Northeast Pacific, this transition zone is located in the Baja California Peninsula. This study documents the change in the abundance and distribution of sea urchins on the Pacific coast of the Baja California Peninsula in recent years. We found 7 species of urchins in the area and observed changes in the presence probability through the years and latitude, likely in response to temperature anomalies. Finally, we recorded a change in the echinoid community structure and a poleward range shift for *Echinometra vanbrunti*.

UNRAVELING THE CHEMICAL COMPLEXITY OF DISSOLVED ORGANIC MATTER DERIVED FROM CORAL AND MACROALGAE EXPERIENCING NUTRIENT ENRICHMENT

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A significant proportion of carbon fixed by coral reef benthic producers is released into the water column as dissolved organic matter (DOM). DOM is composed of diverse chemical structures that are transformed and consumed by the heterotrophic microbial community. The interactions between microorganisms and DOM support the efficient recycling of carbon and nutrients required for coral reefs to thrive in nutrient poor waters. This study employed an experimental system to capture, extract, and characterize DOM released by an assortment of foundational coral and macroalgae experiencing chronic low-level nutrient enrichment collected from the forereef of Moorea, French Polynesia. Measures of bulk DOC and essential nutrients, nitrogen (N) and phosphorus (P), reveal significant differences in the quantity and nutrient content of organic matter produced by each organism in the study. Liquid chromatography–tandem mass spectrometry was used to discern the structural complexity of coral and macroalgae derived exometabolites. The findings indicate that coral-derived exometabolites were consistently enriched in large subnetworks of fatty acids. The fleshy algae, Asparagopsis, uniquely produced entire subnetworks identified as amino-acid and peptide derivatives. Finally, the calcifying algae, Halimeda, produced a diverse assortment of terpenoids, despite exuding low levels of bulk DOC. Additionally, the exometabolites derived from the nutrified coral exhibit variable C, N and P stoichiometric ratios compared their counterparts collected from ambient non-nutrified sites. For instance, the nutrified coral, *Acropora cerialis* produced significantly more carbohydrates than its ambient counterpart. This study indicates that the benthic composition of the reef will have implications on the quantity and chemical diversity of organic molecules which directly influences the composition of the seawater microbiome.

USING FORAGING PITS AS AN INDICATOR OF SEA OTTER PREDATION DYNAMICS ON BIVALVES

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1- Simon Fraser University 2- Nhydra Ecological Consulting

The recovery of sea otters (*Enhydra lutris*) is typically viewed as a conservation success story, yet recovery of this keystone predator often occurs at the expense of subsistence shellfish harvest and local food security – this has been the experience of Ka:'yu:'k't'h' Che:k'tles7et'h' First Nations (KCFN). After over 2 decades without access to shellfish, KCFN is now working to restore community harvest of clams while upholding their guiding principle of balance, which dictates there should be enough food for people and sea otters. In support of KCFN-led stewardship, we surveyed clam populations and measured sea otter foraging activity at 7 soft-sediment beaches. Given sea otter foraging events are highly volatile in space and time, making direct region-wide observations resource intensive, we piloted a novel method to use sea otter foraging pits as a time integrated indicator of foraging activity. To do this we combined in situ measurements of sea otter pit depth with a 'fill-in' rate that we quantified through digging and monitoring replica pits. We also collected remote camera observations of sea otter presence to compare with our novel foraging pit method. This novel, non-invasive method has the potential to reveal changes in sea otter effects on soft-sediment ecosystems over

time and space given stewardship actions. This research is conducted with guidance from, and with the consent of, the Hereditary Chiefs of KCFN, who are the original rights holders and deep time stewards of these places, responsible for maintaining food security for both people and sea otters.

Session 3: Intertidal Ecology (Speed Talk)

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

A BIRD'S-EYE VIEW OF PISMO CLAM POPULATIONS: INSIGHTS FROM WESTERN GULL PREDATION

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Pismo clams (*Tivela stultorum*) were once abundant on Pismo Beach until the 1980s when populations declined. However, recent years have seen a notable increase in their numbers. With the potential return of clam populations, it is important to understand possible sources of mortality. While conventional wisdom suggests that humans and otters are important predators of Pismo clams, this study focused on quantifying the unknown extent of avian predation. We observed a specific clam-dropping predation behavior, where avian predators dropped clams onto compact sand to crack them open, allowing them to feed on the clam. Our research aimed to identify the species of avian predators involved, the size of clams they targeted, and the spatial distribution of predation on the beach. We found that Western gulls (*Larus occidentalis*) were the sole avian predators engaging in this behavior. The median size clam targeted by gulls matched the median size clam present on the beach, but gulls targeted a narrower range of sizes, avoiding the largest and smallest clams. There was a significant negative relationship between the number of vehicles on the beach and predation intensity indicating that anthropogenic disturbance from vehicles is a major factor influencing predation frequency. This research provides valuable insights on previously unknown avian predation dynamics, a factor that has the potential to negatively impact Pismo clam population recovery.

DIFFERENTIAL SENSITIVITY OF AN INTERTIDAL CNIDARIAN SYMBIOSIS TO EXTREME HEAT AND COLD STRESS

Johnston, S.J.*; Harley, C.D.

University of British Columbia

Despite their importance in facilitating resource acquisition amongst species, the role of mutualistic interactions in determining species distributions and community composition is often overlooked in the context of a changing climate. Symbiotic relationships, a special case of mutualism where species are closely associated (often referring to symbionts living on or within a host), are excellent systems to study the response of mutualisms to abiotic stress. In the marine context, zooxanthellae-hosting cnidarians including corals and sea anemones are abundant, widespread models of endosymbiosis that permit close study of their association across environmental gradients. Here we determine how the aggregating anemone (*Anthopleura elegantissima*) and its dinoflagellate symbionts (*Breviolum muscatinei*) respond to extreme heat and cold stress. Interestingly, we find extreme cold triggers more severe bleaching at the critical thermal limits of anemone hosts compared to extreme heat, suggesting host and symbiont differ in their thermal tolerance limits at opposite ends of the thermal spectrum. Further, to examine long-term changes in the anemone-algal holobiont system, we determine how the symbiont assemblages of three species of sea anemone (*Anthopleura elegantissima*, *Anthopleura xanthogrammica*, and *Anthopleura sola*) have shifted over the past 30 years of climate change across a latitudinal gradient from Calvert Island, British Columbia, to Sunset Cliffs, San Diego.

GEOLOGICAL HABITAT VARIABILITY AND ITS EFFECT ON POPULATIONS OF PISMO CLAMS (TIVELA STULTORUM) WITHIN MONTEREY BAY

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1- Moss Landing Marine Labs 2- CSU Monterey Bay

The Pismo clam (*Tivela stultorum*) was once a strong commercial asset to the fishing industry along the California coast until a decline in population sizes due to overexploitation in the 1990s. Although relatively less abundant in their northernmost ranges compared to their southern counterparts, Monterey Bay supports several populations along its local beaches. This project aimed to investigate how the distributions, abundances, and ages of Pismo clam populations are influenced by the sedimentary habitat of Monterey Bay. Among all geological characteristics of sample sites, beach slope was the strongest indicator of clam presence, while sediment grain size and degree of sorting were variable predictors. There was a strong presence of juveniles at all sites where clams were found, but no legal-sized adults were observed. By identifying the physical drivers that exert the most significant impact on Pismo clam population dynamics, the findings of this study will enhance our understanding of the habitat conditions necessary to rehabilitate Pismo clam populations in Monterey Bay.

LONG TERM MONITORING ON THE RECOVERY OF PISASTER OCHRACEUS POST SEA STAR WASTING DISEASE

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1- CSU Monterey Bay 2- Eastern Carolina University

The rocky intertidal is home to a diverse community mobile and sessile invertebrates well adept to constant disturbances such as temperature, wave exposure, and pH. The Ochre star (*Pisaster Ochraceus*) play an important role as keystone species regulating prey populations, typically mussels. Presence of *Pisaster Ochraceus* promotes species diversity in the rocky intertidal by mitigating mussel cover. In this study, we aim to understand the relationship between sea star abundance and habitat type within the Monterey Bay National Marine Sanctuary. Substrate determines the diversity in mobile species because sessile organisms - food sources for mobile species - require specific substrate types. Additionally, sea star wasting disease has heavily affected distribution patterns of *Pisaster Ochraceus*. This study aims to understand factors driving sea star distribution and subsequently how different habitats may be more conducive to a population's recovery from sea star wasting disease. Transect surveys were conducted from winter to summer the last three years quantifying food availability, substrate type, and population density of sessile and mobile organisms. Analysis has shown that there is a trend of association with mussels and continuous rocky substrate and variability in sea star recovery across Monterey Peninsula. By understanding recovery patterns, this study will help ecologists understand how intertidal communities respond to disease to help limit future pandemics.

THE OTHER EXTREME: IMPACTS OF RECENT COLD SNAPS ON INTERTIDAL COMMUNITIES AND WINTER THERMAL PATTERNS IN THE SALISH SEA

Park, S.[*]; Harley, C.D.

University of British Columbia

While most studies focus on high-temperature impacts, extreme low temperatures can also significantly affect intertidal community composition and drive biogeographical shifts, especially for species near poleward range edges. Over the past three years, three cold events of two consecutive days or more were recorded in the Salish Sea. During and after the January 2024 cold snap around Vancouver, upper intertidal foundation species, such as *Balanus glandula* and *Fucus distichus*, seemed tolerant to freezing conditions. In contrast, lower intertidal species, including *Semibalanus cariosus* and mobile predators like *Cancer productus*, *Nucella lamellosa*, and *Pisaster ochraceus*, might suffer immediate and delayed sublethal/lethal damage. Furthermore, local differences within the Salish Sea are critical for predicting biodiversity changes and range shifts under extreme climate. Freezing temperature impacts can vary across sites due to climatic and ecological differences, e.g., between the east and west coasts of Vancouver Island. On January 13, 2024, minimum atmospheric temperatures differed, with –15.8°C in Nanaimo and –7.2°C in Tofino. Conversely, on December 27, 2021, the west coast experienced a more drastic drop, with –9.8°C in Tofino while –6.4°C in Nanaimo, suggesting that west coast communities, with greater biodiversity and milder temperatures, may be more vulnerable to extreme changes. Overall, extreme low temperatures should be carefully considered to improve the predictions of climate change impacts on intertidal communities and biodiversity conservation.

Session 4: Population Biology and Ecology (Speed Talk)

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

A CONCEPTUAL MODEL OF DEPTH REFUGES

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1- Brown University 2- University of Florida 3- Climate Central 4- University of North Carolina Chapel Hill

As the shallow ocean warms, sessile benthic ectotherms may escape high temperature stress by dispersing to higher latitudes or to deeper, cooler habitats achieving a depth refuge. Correlative Species Distribution Models based on the fundamental niche may exaggerate the extent of actual depth refuges by failing to consider the role of temperature variability and how it changes with depth, the limitations imposed by cold deep water and lack of suitable substrate. Here we explore the implications of temperature variability in a globally widespread pattern of water column stratification where a thermocline is sandwiched between a warm upper mixed layer and a cold deep layer. We predict and demonstrate that the thermocline is the most thermally variable zone. Prior exposure to high frequency temperature fluctuations in the thermocline may be beneficial when organisms encounter future temperature shocks if it leads to adaptive processes as a form of stress hardening (ecological memory), indicating that the thermocline zone is an effective depth refuge. Or an opposite detrimental situation may occur, where future large temperature fluctuations lead to decreased fitness, indicating an ineffective refuge. Focusing attention on the consequences of changes in temperature variability across ocean depths may provide a fruitful avenue to develop a more dynamic understanding of depth refuges in an era of climate change.

BIOGEOGRAPHIC EFFECTS IN LIFE HISTORY TRAITS OF BLACK ROCKFISH (*SEBASTES MELANOPS*) IN THE CALIFORNIA CURRENT AND GULF OF ALASKA

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Oregon State University, Coastal Oregon Marine Experiment Station

Black rockfish (*Sebastes melanops*) are recreationally and commercially valuable and support numerous coastal communities from Alaska to California. Recent stock assessments, however, suggest that relative spawning output is at or below management targets. Although these models are highly sensitive to life history parameters, the lack of fine-scale spatial information required assumptions that some traits did not vary in time or space. We are testing this assumption by assessing latitudinal variation in growth and maturation rates of black rockfish throughout the majority of their range. We worked with fishery stakeholders to collect and analyze biological data from central California to the US-Canada border and in Alaska. In addition to the Gulf of Alaska, this spatial extent spans four well-established biogeographic breaks within the California Current: Cape Flattery, Columbia River, Cape Blanco, and Point Arena. We collected samples from recreational and commercial fisheries and fishery-independent surveys. We then used macroscopic and histological characteristics to estimate maturity stages and the break-and-burn method to estimate ages. Results from this work will provide spatially-explicit estimates of growth and maturity for use in future stock assessment models. Because life history traits tend to vary with sea surface temperature, prey availability, and a myriad of other ecological variables, these estimates can improve state-specific biomass, which can have profound impacts on local communities.

DEATH HATH HAD NO POWER YET UPON THY BEAUTY: SUNFLOWER STAR LARVAE SETTLE PREFERENTIALLY ON NECROTIC EELGRASS LEAVES

Hodin, J.[1*]; Valdez, V.V.[1]; Schwab, C.J.[1]; Pieples, S.[1]; Kalytiak-Davis, A.R.[2]; Curliss, F.[1]; Wyllie-Echeverria, S.[1]

1- UW Friday Harbor Labs 2- Oregon State University

Sunflower star (*Pycnopodia helianthoides*) populations throughout the NE Pacific were devastated starting in 2013 by an unprecedented outbreak of seastar wasting disease, and are now on the cusp of endangered species listing in the USA. In order to facilitate its recovery in the wild, we have much to learn about the biology and ecology of this top predatory star throughout its life cycle. The critical early juvenile stage is the least

studied of all. An emerging picture is that native eelgrass (*Zostera marina*) may be a crucial nursery habitat for this key transitional life stage. *Z. marina* is itself a threatened foundational habitat in the NE Pacific, with the causes of their declines remaining unclear. Here we report on sunflower star larval responses to eelgrass leaves at the settlement stage, when the planktonic larva makes its irreversible commitment to complete metamorphosis to a benthic juvenile. The leaves were clipped from adult eelgrass ramets growing in our Friday Harbor Laboratories culture system. Our results suggest that sunflower star larvae preferentially settle on necrotic rather than live eelgrass leaves, and that the resultant juveniles may have an initial growth advantage on necrotic leaves as well. We will briefly discuss some ideas for why it may be advantageous for sunflower star larvae to behave in this manner, including the possibility that necrotic leaves offer a refuge from herbivorous grazers during the stars' sessile settlement transition period.

EXAMINING THE DIET AND HABITAT USE OF SALMON SHARKS (LAMNA DITROPIS) THROUGH EDNA AND FATTY ACID ANALYSIS

† Boyt, R.[1*]; McInturf, A.G.[1]; English, M.[1]; Meyer, L.[2]; Goodfellow, C.[1]; Carlisle, A.[3]; Hillier, L.[4]; Lowry, D.[5]; Chapple, T.K.[1]

1- Oregon State University 2- Flinders University 3- University of Delaware 4- WDFW 5- NOAA Fisheries

Determining the diet of predators in marine systems is critical to understanding their impact on the function of their ecosystem. For elasmobranchs, diet studies often employ traditional stomach content analysis, simply counting the undigested prey in an animal's stomach. However, stomach contents only provide evidence of recent feeding from prey that is not yet fully digested, and prey are often digested beyond recognition. Complementary dietary analyses can provide accurate and robust data on prey sources over longer periods of time. In this study, we use two recently developed techniques, eDNA and fatty acid analysis, to study the diet of salmon sharks (*Lamna ditropis*), an apex predator in the Northeast Pacific. eDNA from the stomach can identify prey down to the exact species, while fatty acids extracted from tissues can be used to determine influences of habitat on recent shifts in diet. We present our methodology and a comparison to published foraging data, using more traditional techniques. Taken together, the complement of these techniques provides a well-rounded approach to dietary studies in elasmobranchs.

FIGHT OR FLIGHT: DOES RELYING ON BEHAVIOR EXACERBATE OR BUFFER THE EFFECTS OF CLIMATE CHANGE FOR THE LINED SHORE CRAB?

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As climate change continues to increase temperatures, understanding how organisms, particularly ectotherms, thermoregulate is vital. Highly mobile ectotherms, like reptiles, can exhibit the Bogert Effect, where they will select microhabitats that keep their body at safe temperatures. However, since they rely primarily on behavior, they may lack the physiological mechanisms to protect themselves from elevated temperatures, particularly if their refuges become warmer. One habitat where organisms are particularly vulnerable to habitat loss due to warming is the rocky intertidal – one of the most thermally dynamic environments on Earth – and it is vital to understand how intertidal ectotherms will be impacted. The lined shore crab (*Pachygrapsus crassipes*) presents a good model to study the Bogert Effect in the intertidal, since it is highly mobile and has a large geographic range that exposes it to a wide range of temperatures. From 2021-present, we have been measuring crab body and environmental temperatures in the field in Bodega Bay, CA using an infrared camera and biomimetic models (devices that heat up and cool down at the same rate as the live animal) respectively. Additionally, we have measured their aerial respiration rates in both the spring and fall under elevated temperatures. Preliminary data indicates that crabs have the same thermal limits in both the spring and fall, which may indicate that lined shore crabs exhibit the Bogert Effect, which could exacerbate the effects of elevated temperatures caused by climate change on this species.

USING PREDATORS AS SAMPLERS TO QUANTIFY FORAGING LANDSCAPES IN THE GULF OF ALASKA

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Numerous studies aim to quantify population and community responses to climate change, especially in high latitude systems where ecological effects are most pronounced. Species distributions and spatiotemporal overlap among predators and prey are driven, in part, by how marine predators alter their behavior in response to localized prey densities. Standardized bottom trawl surveys are often used to understand changes in predator distributions in the Gulf of Alaska (GOA). They do not, however, adequately sample key prey (e.g., euphausiids, forage fishes, benthic invertebrates) and the capacity to expand survey scope is limited. We used diet data from groundfish predators and joint species distribution models (JSDMs) to quantify variation in prey densities throughout the GOA. Specifically, we used the *tinyVAST* package in R (Thorson et al., 2024) to model prey densities as a function of time, space, predator species and size, and a suite of environmental covariates (e.g., depth and bottom temperature). A multivariate model allowed us to quantify correlations among prey to improve predictions for more rare taxa. Focal predators included arrowtooth flounder (*Atheresthes stomias*), Pacific cod (*Gadus macrocephalus*), Pacific halibut (*Hippoglossus stenolepis*), and walleye pollock (*Gadus chalcogrammus*). Important prey taxa were walleye pollock, capelin (*Mallotus villosus*), Pacific sandlance (*Ammodytes hexapterus*), Pacific herring (*Clupea pallasii*), tanner crabs (*Chionoecetes bairdi*), euphausiids, amphipods, shrimps (Malacostraca), and copepods. We used best-fit models to index prey predictions across predator species and make inferences about spatiotemporal variation in foraging landscapes throughout the GOA (1990 to 2023). A continuation of this work will involve using model results as ecological covariates for species distribution models used to describe essential fish habitat (EFH) in the region. Our time-varying and spatially explicit estimates of relative prey densities can also be used to inform predation and competition studies, which often rely on assumptions about resource availability.

Session 5: Fisheries Ecology (Speed Talk)

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

EXAMINING THE INTERACTIONS BETWEEN SEA OTTERS AND PISMO CLAMS ON PISMO BEACH

Mattioli, I.M.*; Bills, M.; Ruttenberg, B.I.

Cal Poly, San Luis Obispo

Pismo clam (*Tivela stultorum*) populations were previously abundant on the California central coast before declining dramatically in the late 1970s and 1980s. However, recently their population has been increasing. The southern sea otter (*Enhydra lutris nereis*) was hunted to near extinction in the 1800s, leading to a dramatic reduction of their range, including their extirpation from Pismo Beach. Their population has since been recovering, and they are repopulating historic range locations. Their return to the CA Central Coast and Pismo Beach in the 1970s-1980s coincided with the decline in clam populations locally, which led many people to conclude that otters were the cause of the lack of Pismo clam abundance. Since sea otters are known to be an important predator of Pismo clams, we sought to explore the potential impact of sea otter predation on Pismo clam population abundance and recovery by conducting otter foraging surveys on Pismo Beach. Our results found that sea otter foraging occurs primarily at the north-most point of Pismo Beach, with the majority of their diet in that area consisting of Pismo clams. This data will help illuminate the impact of sea otter

INTEGRATING CLIMATE VULNERABILITY OF SUBSISTENCE FISHERIES INTO MARINE SPATIAL PLANNING

Cortese, M.R.*; Canty, S.W.J.; Nowakowski, J.A.

Smithsonian Environmental Research Center

As countries around the world wrestle with how to achieve the 30x30 target under the Global Biodiversity Framework, there has been increased emphasis on marine spatial planning to conserve and protect biodiversity. The expansion of marine protected areas (MPAs) and other effective area-based conservation measures (OECMS) is intended to conserve biodiversity across vast swaths of ocean. It will be important to strategically

select locations of conservation areas that advance multiple sustainable development goals and maximize co-benefits for people. With millions of people in coastal communities relying disproportionately on a subset of fish species for livelihoods and subsistence, integrating climate vulnerability of those species into planning is one path toward achieving co-benefits. Here we propose a framework focused on Caribbean finfish species that are important for subsistence fishers. First, we will assess changes in regional climate suitability for important species using physiologically informed distribution models, associated population trends, and potential consequences for subsistence fisheries in the region. Second, we will integrate information in climate suitability into planning models to select ideal areas for MPA creation while safeguarding food security and human wellbeing, two of the UN Sustainable Development goals. This talk highlights work beginning in the Mesoamerican Reef region that can be expanded across the Caribbean or applied to other regions around the world.

PRODUCTION AND ATTRACTION DYNAMICS OF CALIFORNIA SHEEPHEAD (BODIANUS PULCHER) ON AN ARTIFICIAL REEF

† Huang, J.L.[1*]; White, J.W.[2]; Nickols, K.J.[3]; Steele, M.A.[1]

1- CSU Northridge 2- Oregon State University 3- Ocean Visions Inc.

Artificial reefs can increase the availability of suitable hard-bottom habitat for many species. With intentional design and material choice, artificial reefs can be built to replicate natural habitat characteristics. However, a key question is whether such reefs actually increase the overall biomass of a fish community, or simply draw organisms away from natural habitats (the 'attraction vs. production' debate). In California, an artificial reef complex was constructed starting in 1999 to mitigate habitat damage from operation of San Onofre Nuclear Generating Station. This artificial reef has been monitored annually via SCUBA surveys, producing over 20+ years of fish size and abundance data. These data show that fish, including ecologically and economically important species such as California Sheephead (*Bodianus pulcher*), have colonized the artificial reef, but it is unclear if it is due to new production or merely attraction. We fit size-based population dynamics models to the dataset to test for the signatures of attraction (immigration of large fish) versus production (new larval recruitment) on the artificial reef. Preliminary results suggest the population is supported by a pulse of attraction after the initial construction, followed by a mixture of both processes. Such efforts to quantify this dynamic could inform managers how artificial reefs could be an effective tool at bolstering marine resources.

SHIPBOARD RESEARCH FROM THE HISTORIC *WESTERN FLYER*

Thomas, K.N.[*]; Mostow, R.S.

Western Flyer Foundation

In 1940, author John Steinbeck and marine ecologist Ed Ricketts chartered the wooden sardine purse seiner *Western Flyer* for a six-week exploration of Mexico's Gulf of California, resulting in the groundbreaking work, *Sea of Cortez* (1941) and later *The Log From the Sea of Cortez* (1951). The Western Flyer Foundation carefully restored this historic vessel to its original state while incorporating modern components and tools to equip it as a marine research vessel. The R/V *Western Flyer* now operates out of Monterey Bay and supports marine research and education programs through the Western Flyer Foundation as well as serving as a capable research platform available for charter. Here, we explain the unique mission for the vessel, describe our research goals and early data from oceanographic and ecological monitoring in Monterey Bay, outline opportunities for research partnerships and collaboration, and seek feedback from the WSN community on how we can best use our integrated education and research programs to collect and share meaningful data.

SLIM PICKINGS? ASSESSING THE VIABILITY OF PURPLE URCHIN HARVEST AS A FISHERY AND RESTORATION TOOL FOR OREGON'S KELP FORESTS

† Rice, C.J.[1*]; Calvanese, T.P.[1]; Hamilton, S.L.[2]

1- Oregon State University 2- Oregon Kelp Alliance

Oregon's kelp forests have seen a notable decline in kelp canopy recently as many forests have transitioned to highly-dense purple urchin *Strongylocentrotus purpuratus* barrens. The loss of kelp is expected to have negative impacts on Oregon's urchin fishery where red urchins

Mesocentrotus franciscanus make up the majority of landings and are subsequently declining in quality. Commercial urchin divers in Oregon have observed this shift in the fishery and ecosystem and are collaboratively working with the Oregon Kelp Alliance, a non-profit kelp forest restoration group based in Port Orford, Oregon, to grow the purple urchin fishery as a means to support their economic livelihoods and kelp forest restoration efforts. Commercial divers are limited to harvesting purple urchins 2-3.5 inches in diameter which may impede the expansion of the fishery as the purple urchins in barrens are not growing to this size. To determine the viability of commercial purple urchin harvest, we will analyze urchin size and density data collected by Reef Check Oregon at kelp forest restoration sites. We will compare purple urchin harvest "potential" at these sites- quantified by estimated pounds of harvestable purple urchins- to determine where commercial harvest could draw substantial landings and/or have a restorative impact to the ecosystem. Policy changes and market development may be required going forward to support a purple urchin fishery that mitigates economic loss for commercial divers and invests in kelp restoration efforts.

YES WE SURVEY KELP FOREST COMMUNITIES IN WASHINGTON STATE AND YES YOU CAN HELP

Samhouri, J.F.[1*]; Shelton, A.O.[1]; Tolimieri, N.[1]; Andrews, K.S.[1]; Feist, B.E.[1]; Frick, K.E.[1]; Harvey, C.J.[1]; Liu, O.R.[1]; Lonhart, S.[2]; Shaffer, M.[3]; Turner, T.[4]; Williams, G.D.[1]

1- NOAA Northwest Fisheries Science Center 2- Monterey Bay National Marine Sanctuary 3- University of Washington 4- UC Santa Barbara

Once upon a time on the remote coast of Washington state, a team of intrepid scientists initiated an annual SCUBA survey of kelp forest communities. Specifically, in 2015 we filled a geographic gap in knowledge of dynamics in these nearshore habitats, complementing extant surveys to the south and north. Now, ten years later, we routinely survey the fishes, macroinvertebrates, and kelps at five index sites spanning ~100km of coastline. During this period, we have observed >3 orders of magnitude variation in the abundance of rockfishes (Sebastes spp.), witnessed alternate community states (kelp forests / urchin barrens), and discovered 16 new species of sponges. Our data informed a recent stock assessment for black rockfish (S. melanops) and are a core component of monitoring recovery efforts of listed rockfishes in Puget Sound. Most importantly, there remain many opportunities for novel research but we lack the capacity to pursue them. For example, there are several major surveys along the west coast (NWFSC trawl survey, offshore larval surveys, nearshore SCUBA surveys, ROV surveys) that span the entirety of rockfish life-history but have not been integrated to date. In addition, there are prospects for process-based, experimental studies to complement the observational data we collect on grazer/canopy/understory kelp dynamics. We recently expanded our Washington survey to include eDNA sampling, which will broaden our understanding of these communities, but these data have yet to be analyzed. Come work with us, it will be fun, we will learn new stuff.

Session 6: Physiological Ecology (Speed Talk)

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

FEAST-FAST LIFESTYLE: PHYSIOLOGICAL EFFECTS OF DAILY FORGAGING FLEXIBILITY IN BLUE WHALES (BALAENOPTERA MUSCULUS)

† Benasfre, N.[1*]; Fahlbusch, J.[2]; Cade, D.[2]; Calambokidis, J.[3]; Savoca, M.[2]; Blawas, A.[2]; Goldbogen, J.[2]

1- CSU Long Beach 2- Hopkins Marine Station, Stanford University 3- Cascadia Research Collective

Blue whales (*Balaenoptera musculus*), the largest animals on Earth, have highly variable daily feeding effort on the foraging grounds. Little is known about how this behavioral plasticity is reflected in their energetic costs .Here, we investigated how extreme foraging flexibility, a proxy for energy gain, affects respiration rate, a proxy for metabolic rate, by analyzing long-term, high-resolution measurements of feeding and respiration rates in blue whales. From 2017 to 2023, 24 minimally invasive dart-attached tags were deployed on blue whales in the California Current ecosystem, yielding deployment durations from 1.5 to 18.3 days (Mean = 6.59, S.D. = 4.46). We used depth and kinematic data from tags and custom MATLAB tools to identify all feeding lunges and breaths performed during each deployment. We found significantly higher daytime feeding (11.5±11.0 lunges/hr) compared to nighttime feeding rates(4.3±9.4 lunges/hr). We also determined breathing rates during post-feeding recovery periods had a positive relationship with lunge rates during immediately preceding feeding periods. These findings will enhance our understanding of blue whale metabolic flexibility and resilience to anthropogenic change in the ocean, which, in turn, can inform conservation efforts of this endangered species.

INTERANNUAL VARIABILITY AND CONTROLS ON MACROALGAL PRODUCTIVITY DETERMINED BY NOVEL IN SITU 13C ENRICHMENTS IN BENTHIC CHAMBERS

Jacobs, J.M.[1*]; Zummo, S.[2]; Nichols, K.[2]; Brigham, M.[2]; La Valle, F.F.[2]

1- UC Santa Barbara 2- Pepperdine University

Macroalgae form important ecosystems in dynamic coastal environments, yet the interannual variability of productivity and its drivers are not well documented, particularly using preferred *in situ* methodologies quantifying carbon uptake directly. To refine and scale macrophyte carbon uptake rates and understand the mechanisms impacting productivity over time in a variety of marine systems, experiments must be reproducible, non-invasive, iterative, and long-term. Here, we present a novel benthic chamber design paired with ^{13})C enrichments that allows for the non-invasive collection of macrophyte productivity rates *in situ* and directly in carbon units as well as the first data from an ongoing long-term macroalgal productivity study on reef flats in Hawai'i with submarine groundwater discharge (SGD). Benthic chambers (n = 34) were deployed over consecutive dry seasons and identified a decrease in productivity from 3 dominant macroalgal species *Acanthophora spicifera*, *Bryopsis pennata*, and *Pterocladiella* sp. of -0.004 mg C g dw^{-1}) h^{-1}) (-75.7%), -0.008 mg C g dw^{-1}) h^{-1}) (-84.1%), and -0.0006 mg C g dw^{-1}) h^{-1}) (-63.3%) respectively from 2022 to 2023 according to increases in inorganic nutrient concentrations. These results highlight the plasticity of ubiquitous macroalgal species to the local environment and offer a potential explanation for the algal community shifts in highly urbanized reefs in Hawai‘i. Over time, these reproducible and non-invasive productivity studies will allow us to constrain how and why productivity and community structure change on longer time scales.

LETTING OFF STEAM: DYNAMIC THERMOREGULATORY STRATEGIES OF THE BELUGA WHALE

† Bartosik-Velez, S.G.[1*]; Nazario, E.C.[1]; Chambault P., [2]; Dennis, C.R.[3]; Flammer, K.L.[3]; Kendall, T.[1]; Reynolds, A.H.[1]; Tom, B.[1]; Williams, T.M.[1]

1- UC Santa Cruz, Ecology and Evolutionary Biology Dept. 2- Greenland Inst. of Natural Resources 3- Georgia Aquarium

As obligate aquatic mammals, cetaceans must maintain thick blubber layers to prevent excessive heat loss across the body during constant immersion. “Thermal windows”, vascularized areas with high surface area to volume ratios such as flukes and dorsal fins, allow many cetaceans to bypass this insulation by creating regions for rapid heat dissipation during high-energy behaviors or migrating between polar and equatorial waters.

In view of this, beluga whales (*Delphinapterus leucas*), which lack dorsal fins, would appear to be thermally challenged in their ability to remove excess heat as oceans warm or when fleeing from anthropogenic disturbances (e.g., naval sonar, vessel presence). To investigate beluga whale thermoregulation, we used FLIR thermal images to identify the location of alternate thermal windows for beluga whales (dorsal ridge and flank), as determined from skin temperature (Tskin; minimum, maximum, and mean). Comparable measurements were made for bottlenose dolphins (*Tursiops truncatus*), a cetacean with a dorsal fin. For resting beluga whales, the flank contained unique sites for heat loss where mean Tskin = 2.7° ± 4.2° was higher than thermally inactive sites. No such flank thermal windows were found for dolphins. The dorsal ridge displayed the hottest Tskin (dorsal ridge max = 26.7°; flank max = 20.3°). Thus, beluga whales use their flank as a supplementary thermal window to the dorsal ridge to regulate body heat, a unique "dynamic" thermal adaptation that may enable belugas to survive a wider variety of thermal conditions than initially anticipated.

RESPONSE OF MACROCYSTIS PYRIFERA ZOOSPORES TO MARINE HEATWAVE TEMPERATURES: DIRECT EFFECTS AND EXPLORING A LEGACY EFFECT OF EXTREME THERMAL STRESS

Hofmann, G.E.*; Cabral, S.

UC Santa Barbara

We examined thermal sensitivity of zoospores of the giant kelp, *Macrocystis pyrifera*, to thermal anomalies typical of marine heatwave (MHW) events occurring in the Santa Barbara Channel. The broader rationale for the project was three-fold: (1) MHWs have become a dominant environmental regime in the Santa Barbara Channel, (2) a legacy effect of thermal history has not been examined in our locale and lastly, (3) there are significant data gaps regarding how thermal stress impacts microscopic stages of *M. pyrifera* as a function of season. Using a thermal table that creates a temperature gradient across an aluminum plate, research conducted on zoospores released from summer-acclimatized *M. pyrifera* sporophylls showed that zoospores germinated successfully from 14 to 20 °C, forming germlings 18-24h post-release. Germination success abruptly fell to zero at 22 °C. We also tested the effect of temperature on developmental success and progression using the end-member temperatures of 14 °C and 22 °C, temperatures that are non-MHW average habitat temperatures for our study sites, and an extreme MHW temperature, respectively. At the MHW temperature of 22 °C, germination occurred, but the germlings were abnormally shaped. Over time, gametophytes failed to grow and were decolorized. By Day 7 at 22 °C, the cultures of gametophytes collapsed. Overall these results indicate that *M. pyrifera* zoospores are thermally sensitive, and that extreme MHW temperatures that are occurring today in the Santa Barbara Channel cause complete failure of gametophytes. We will discuss these performance data and the future exploration of a legacy effect of MHW thermal anomalies for *M. pyrifera* microscopic stage performance.

SLIMESTAR: LASTING IMPACTS OF CHEMICAL CUES LEFT BEHIND BY SUNFLOWER SEA STARS ON SEA URCHIN GRAZING BEHAVIOR

† Ian J. Kittell, [1*]; Miles E. Rough, [1]; Jake R. Metzger, [2]; Aaron W.E. Galloway, [3]; Kristy J. Kroeker, [4]; Sarah A. Gravem, [1]

1- Oregon State University 2- UC Santa Cruz 3- University of Oregon 4- UCSC

The decline in *Pycnopodia helianthoides* populations due to sea star wasting disease may be linked to the increase in sea urchins along North America's west coast. We hypothesized that these stars emit chemical cues in the water column in addition to a 'slime trail' which may limit the grazing behavior of grazers for several days and create a 'landscape of fear'. We tested this experiment in Sitka, AK using four 10x4ft tanks that were marked in half and divided into twelve clines to measure upstream/downstream movement and grazing. One half had 'slime cue treatment' while the other had 'waterborne cues' from nearby slime. Control tanks lacking star cues were included. To every tank we added 24 red and 24 green urchins. 24 blades of kelp were also added for urchin response and grazing rate. Overall, neither waterborne nor slime trail cues reduced grazing rate. However, grazing was displaced downstream when either slime cue or waterborne cue was present. Green urchins escaped slime trails, and moved downstream for at least 3 days where either slime cue or waterborne cue was present. Red urchins did not escape slime trails, and instead moved downstream when either cue was present, but this response diminished when kelp was present. We conclude that urchins can generally detect slime trails left by the stars for up to three days, even when not directly on the trail. This suggests that the star's movement may

result in a ‘landscape of fear’ as they roam a reef, but benefits to kelp are unclear since it is possible that grazing is simply displaced to a new location.

TRANSGENERATIONAL PLASTICITY AS A MECHANISM OF THERMAL ADAPTATION IN PORCELAIN CRABS

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San Francisco State University

The porcelain crab, *Petrolisthes cinctipes*, is an intertidal crab native to northern California that gets thermally stressed during low tide. Some mothers produce broods of embryos sensitive to thermal stress, while others produce thermally tolerant broods, though the source of thermal tolerance remains unclear. I hypothesized that transgenerational plasticity (TGP) is an important mechanism of thermal tolerance. TGP may occur when mothers experience increased thermal stress during oogenesis and make thermally tolerant embryos. To investigate this, I exposed 48 crab pairs, held immersed at 14°C, to one of four different arial heat stress treatments of 32°C 0, 0.5, 1, and 3 times per week for one hour over 7 months. Broods of embryos were collected within a week of oviposition and divided into two groups of 12 embryos each; a treatment group that was subjected to heat stress for one hour (32°C) and a control group held at 14°C. Embryos were placed in a 96-well plate and imaged weekly to measure yolk-consumption and growth rates, and time to mortality or hatching. In all four treatments, control embryos hatched ~50% of the time. Hatching increased in treatment embryos from a little over 0% in the control group to over 25% in the high treatment. These results suggest TGP is an effective mechanism of adaptation to environmental heat stress. Analysis of growth and yolk-consumption is ongoing.

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

A JELLYFISH TO BE JEALOUS OF? THE APPLICATIONS OF AEQUOREA VICTORIA AS A MODEL ORGANISM

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1- CSU Fresno 2- Friday Harbor Labs, University of Washington 3- Whitney Lab for Marine Biosciences, University of Florida

The Medusozoa clade of Cnidarians (Scyphozoa, Cubozoa, Staurozoa, & Hydrozoa) exhibit a wide diversity of developmental strategies and behavioral responses. Their distinct position in evolutionary history also provides a unique opportunity to study a broad scope of research inquiries. However, there is minimal genomic, transcriptomic, and developmental data available for Medusozoa. *Aequorea victoria*, the hydrozoan Crystal Jellyfish known for its role in the discovery of Green Fluorescent Protein (GFP), is a promising model organism that is easily culturable, durable in laboratory settings, and adaptable to employ a range of experimental methods at different stages of its life cycle. This project explores the different applications and discoveries of *A. victoria* as well as discusses its potential to be used as an alternative to *Clytia hemisphaerica* as a model organism. So far, this jellyfish has inspired thesis research, genomics, and even a Functional Biodiversity class taught at the University of Washington's Friday Harbor Labs!

EFFECTS OF SEDIMENTATION ON GROWTH AND SURVIVAL OF BULL KELP (NEREOCYSTIS LUETKEANA) DURING ITS MICROSCOPIC LIFE PHASES

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University of Washington

In the past two decades, declines in kelp forests have been documented across many temperate coastal regions. While some of these declines can be clearly attributed to marine heatwaves or trophic cascades, the lack of a mechanistic explanation for other kelp forest losses suggests that a broader range of drivers should be considered. For example, increased sediment loads, linked to land use changes and climate change-associated shifts in runoff may be negatively impacting kelp populations. Previous studies have suggested that reduced light availability, increased physical scour, and increased smothering by sediment can reduce the success of kelp spores and germinating gametophytes. However, the long-term effects of sedimentation on the success of gametophytes and microscopic sporophytes have not been experimentally demonstrated. To address this knowledge gap, we investigated the effects of sedimentation on microscopic bull kelp (*Nereocystis luetkeana*), one of two canopy-forming kelps found in the Salish Sea, a region whose coastal urban centers and restricted marine circulation may lead to high sedimentation rates. We predicted that higher sediment loads would reduce growth and survival for vegetative and gametogenic gametophytes as well as microscopic sporophytes. If high sediment loads reduce the survival and growth of *N. luetkeana* during these critical life phases, as our preliminary data suggest, management and restoration work should address sedimentation in order to improve kelp forest health in the Salish Sea.

EVALUATING STORMWATER AND CLIMATE-ASSOCIATED ECOSYSTEM SERVICES IN TWELVE URBAN PARKS IN EAST LOS ANGELES

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Loyola Marymount University

Parks are routinely recognized for their recreational benefits, yet the magnitude and value of other ecosystem services parks provide are often overlooked. In this study, we quantify the ecosystem services, the free benefits imparted by nature to humans, provided by twelve urban parks in east Los Angeles, specifically as they pertain to stormwater and climate. The species of each tree, its location within the park, tree condition, and the diameter at breast height were recorded for all trees over three meters in height at each park. These data were analyzed in the tree-benefit estimation tool, i-Tree Eco, to quantify carbon sequestration, rainfall-runoff avoided, and other parameters. Output is quantified both ecologically (e.g., lbs of CO2 stored) and economically (monetary value). Results were then projected back onto a park map and examined in relation to

proximity to each stormwater grey infrastructure (gutters, drains, etc.) and stormwater green infrastructure (bioretention basins, bioswales, etc.).

Our findings enhance understanding of the ecological and economic importance of urban parks, particularly in underserved communities. The significance of this research lies in advocating for better design and evaluation of urban parks and contributing to Los Angeles' sustainable development goals.

FIELD STUDY OF THE MICROPLASTIC POLLUTION EFFECTS ON PACIFIC MOLE CRABS (EMERITA ANALOGA) PREDATOR AVOIDANCE BEHAVIOR, REPRODUCTIVE OUTPUT AND PARASITISM

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1- Portland State University 2- CSU Channel Islands 3- UC Davis

To explore the potential consequences of consumption of microplastics, we conducted a field experiment to see if gravid, female, Pacific mole crabs (Emerita anolaga) displayed a change in their predator avoidance behavior (burrowing into the sand) if they had internalized microplastics. In this paper we test the hypothesis that mole crabs that have ingested high levels of fibers and other anthropogenic particles will burrow more slowly, suffer from greater prevalence of parasites, and produce fewer eggs. This was the first field experiment done to determine effects of microplastics on the important indicator species Emerita analoga, the Pacific sand crab (Dugan et al. 1994). We found a measurable correlative effect between microplastic ingestion and predator avoidance behavior (burrowing speed), showing that intermediate-sized crabs (size classes of 20-21.99 & 22-24.99mm) burrowed slower when they had ingested microplastics, as well as an increase in parasitism of Pacific mole crabs smaller than 25mm when they ingested microplastics and found to have decreased the number of eggs in a clutch when microplastics were internalized, compared to those that had not ingested microplastics.

PERCEPTIONS ABOUT USE OF MILITARISTIC LANGUAGE AND PLACE-BASED COMMON NAMES OF AQUATIC INTRODUCED SPECIES

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1- Portland State University 2- Wisconsin Sea Grant 3- Oregon Sea Grant 4- Michigan Sea Grant

Scientists and managers benefit from clear communication with each other and the public but some language conventions may undermine our messages. For example, militaristic language is deeply enmeshed in invasion biology but could alienate readers, especially when combined with place-based common names of introduced species (e.g., Oriental sea slug). We therefore conducted a survey to determine perceptions about placed-based names of invasive species, which yielded 664 respondents. We found younger respondents had more negative reactions to militaristic metaphors than older ones did. The combination of militaristic language and place-based invasive species names most often invoked feelings of 'curious' and 'frustrated'. Few felt optimistic (34%) or hopeful (35%), and only 34% felt at least moderately motivated. This language combo made some feel slightly to extremely excluded (20%) or targeted (37.4%), especially respondents who described themselves as at least part Asian (n = 27), 48.1% of whom felt at least somewhat excluded and 69% felt at least somewhat Targeted, and 27% felt very to extremely targeted. Even larger proportions of all respondents reported feeling threatened when militaristic language and place-based common names are used. We offer suggestions based on the survey responses for more inclusive naming conventions. These results may also apply to other fields of conservation and ecology given that the proportion of articles that use at least some militaristic language is similar across ecology-related fields and the common names are the same.

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

DEVELOPMENT OF A MACHINE LEARNING TOOLKIT TO RAPIDLY ASSESS OVERGRAZING IMPACTS OF SEA URCHIN SPECIES IN NEW ZEALAND AND AUSTRALIA

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1- University of Auckland 2- University of Tasmania 3- Greybits Engineering

Across New Zealand and Australia sea urchin overgrazing has become a focal issue for kelp forest ecosystems. Greater resource is being put towards understanding impacts of native and range-expanding sea urchin species, while kelp restoration efforts are increasing. Evaluating overgrazing impacts and restoration effectiveness requires robust monitoring data. Benthic imagery is an ideal tool for this as it can be acquired rapidly over ecological relevant spatial scales. However, the resultant datasets are typically large and laborious to manually annotate, slowing data analysis and inference making. Here we outline the development of a machine learning (ML) toolkit designed to automate benthic image annotation associated with urchin overgrazing and kelp forest habitats. The open-source toolkit contains an urchin detector and habitat classifier which work in tandem to identify key urchin species and dominant habitat forming biota. This information helps provide a whole-frame annotation for image assessed, classifying each as one of several habitat types. Training data has been sourced from a range of imagery platforms across New Zealand and Australia making it robust and widely applicable. Integration within existing and future projects, locally and in other areas such as the Pacific Coast of North America, will significantly improve data analysis timeframes, enabling greater understanding of the extent of overgrazing impacts and restoration success.

EXPLORING THE POTENTIAL ENERGY RESILIENCY BENEFITS OF COASTAL ECOSYSTEMS AND PROTECTED AREAS IN PUERTO RICO

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Hazard risk reduction is an important regulating service of coral reefs, mangrove forests, and other coastal ecosystems. These habitats buffer shorelines and have potential to improve resilience for nearby communities and energy infrastructure in Puerto Rico. However, not all of these ecosystems benefit from protected area status. To identify where protected and unprotected ecosystems could reduce exposure to coastal hazards under future sea-level rise, we used a spatial model that takes in biophysical data to estimate an exposure index. Our model shows that the number of people highly exposed to coastal hazards would nearly triple if coastal ecosystems were lost – and the number of electrical substations at highest risk would nearly quadruple. In total, ecosystems reduce risk for more than 370 km of coastline under sea-level rise, and over two-thirds of that risk reduction is provided by protected ecosystems. Additionally, the contribution of ecosystems to coastal resilience varies substantially across Puerto Rico's 44 coastal municipalities. By exploring where communities benefit from hazard mitigation provided by corals, mangroves, and seagrasses, our results suggest sites for conservation and restoration projects that would maximize risk reduction ecosystem services. Our model could inform local decision makers in the dual effort to conserve valuable habitats and build resilience to coastal hazards in a changing climate. We encourage researchers in other hazard-prone regions to replicate our methodology and leverage protected ecosystems for coastal risk reduction.

DIGITAL TOOLS TO INFORM CLIMATE-SMART MARINE RESTORATION AND MANAGEMENT DECISIONS

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1- Flinders University 2- University of Western Australia 3- Australian Inst. of Marine Science 4- New South Wales Dept. of Primary Industries and Regional Development

A critical aspect of efforts to restore and 'future proof' degrading ecosystems is to harness genetic data to underpin strategies that seek to enhance the survival and resilience of marine species to climate change and other stressors. However, the complexity of genetic data often limits its accessibility and application outside specialized scientific fields. Addressing this gap, we present Reef Adapt *(www.reefadapt.org)*, an innovative, expandable web platform designed to incorporate genetic data into marine restoration and conservation planning. This interactive tool integrates comprehensive species and population-level genetic data with seascape-level environmental and oceanographic data, facilitating the creation of detailed maps which delineate suitable provenance for restoration or conservation interventions. The tool currently caters to local and climate-adjusted provenancing strategies that improve chances of initial restoration success and resilience over the coming decades. To illustrate its versatility and practicality, we present four case studies spanning ecologically and evolutionarily diverse taxa: two corals (*Pocillopora damicornis* and *Acropora kenti*) and two macroalgae (*Phyllospora comosa* and *Ecklonia radiata*). By making genetic data more accessible and actionable, Reef Adapt stands to significantly aid conservation efforts focused on bolstering ecosystem health and resilience and represents a management-ready tool in the global fight against habitat degradation and climate change.

THE ROLE OF NATURE IN PLANNING FOR A RESILIENT CALIFORNIA COAST

Wallingford, P.D.[*]; Stanley, C.; Mann, A.; Heady, W.N.; Skikne, S.

The Nature Conservancy

California's coast harbors high numbers of endemic and rare species in a diverse array of habitats. However, 59% of coastal habitat area is vulnerable to five feet of sea level rise, with profound implications for ecological communities and biodiversity. Strategic migration and restoration of vulnerable coastal habitat can help mitigate 61% of these anticipated losses. Minimally developed coastal areas such as agricultural lands present prime opportunities for creating future coastal habitat and migration space as sea levels rise. By analyzing existing land use and development patterns we can identify where to target conservation and restoration efforts. To do this, we developed a framework that considers an area's vulnerability to sea level rise, its ecological importance for biodiversity and connectivity, regional acquisition and restoration economics, and the co-benefits of climate change mitigation and adaptation. Through this framework, we identified the extent of habitats that are vulnerable to being lost with sea level rise, how different conservation strategies can offset these losses, and regional hotspots where the development of nature-based solutions could provide multiple benefits to nature and people. As climate change continues and accelerates, migration and restoration of shorelines will be important for California to achieve its goal of conserving 30% of state lands and coastal waters by 2030.

Session 9: Community Ecology I

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

ACCURATE RECOVERY OF COMPLEX ECOLOGICAL DYNAMICS FROM TIME SERIES USING STATE-SPACE UNIVERSAL DYNAMIC EQUATIONS

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1- Oregon State Univesity 2- University of Hawai'i, Mānoa 3- University of Oxford 4- California Dept. of Fish and Wildlife

Ecological systems often exhibit complex dynamic phenomena like chaos and nonlinear regime shifts. Time series data from long-term monitoring programs are valuable for observing these changes. However, modeling these data requires a flexible modeling framework that can capture nonlinear relationships in the context of measurement errors and stochastic variation. Recent advances in machine learning have produced a promising new class of models for recovering complex dynamics from time series data: universal dynamic equations (UDEs). UDEs combine known functions with neural networks that learn unknown relationships directly from the data. However, standard formulations of UDEs do not account for the uncertainty common in ecological data. To address this limitation, we develop state-space UDEs (SS-UDEs), a framework that embeds UDEs within state-space models to account for uncertainty. We test the ability of SS-UDEs to recover biological mechanisms that produce complex dynamics in the context of measurement error and stochastic variability using two empirical and two simulated examples. In each example, SS-UDEs can recover nonlinear biological interactions that produce complex emergent behaviors, including oscillations, chaos, and regime shifts. However, the forecasting skill of SS-UDEs is context-dependent. SS-UDEs perform similarly to or better than linear state space models and empirical dynamic models in oscillating and chaotic time series. However, they are comparatively poor forecasters in systems that have stable equilibrium states.

RELATIONSHIPS AMONG REMOTELY-SENSED HABITAT FEATURES AND FISH ASSEMBLAGE STRUCTURE ON ARTIFICIAL REEFS IN SOUTHERN CALIFORNIA

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California resource management agencies need informed best practices for the design and evaluation of future projects that add artificial reef (AR) habitat along the California coast for compensatory mitigation or habitat restoration efforts. In southern California it remains unclear how existing artificial structures contribute to local and regional-scale ecological dynamics. We have quantified the physical attributes of six existing AR complexes that were built decades ago to increase fishing opportunities in southern California by analyzing geophysical sonar data collected by the Vantuna Research Group at Occidental College with a multi-phase echo sounder. These data were analyzed in ArcGIS Pro and in R with functions from the MultiscaleDTM package. Extent of AR modules were determined through classification of a multiband raster composed of acoustic backscatter and bathymetric derivatives (terrain ruggedness and slope) with object-based image analysis in ArcGIS Pro and then exported as a polygon shapefile. For each AR module we have quantified size and location metrics (e.g., location, depth, reef extent), and relief and complexity metrics (e.g., slope, rugosity, vertical relief). Multivariate analyses were then used to examine which habitat features best explain patterns in the corresponding fish assemblage structure, particularly for ecologically and economically important species.

INVESTIGATING THE RESILIENCE OF KELP FORESTS TO HARVEST AMID A RAPIDLY CHANGING OCEAN

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1- Simon Fraser University 2- Government of British Columbia 3- Confidence Fishing Company 4- Kwakiutl Nation

While kelp harvest and mariculture are considered major components of the global blue economy, the resilience of kelp forests to forest-scale harvest remains understudied. To determine how kelp harvest affects ecological and biophysical characteristics of an entire kelp forest, we conducted a seascape-scale harvest experiment of giant kelp (Macrocystis tenuifolia) on the west coast of Canada. In collaboration with

Indigenous kelp harvesters, knowledge holders, and leaders from the Kwakiutl First Nation, we established harvested and unharvested sections in three kelp forests which ranged from 6.91 to 25.62 hectares. Harvesters decided which forest to harvest when based on a 20% harvest quota, sea condition, and kelp condition. At the scale of the entire forest, we detected a significant 2-fold reduction in surface frond density post harvest at one of the three kelp forests that experienced early season and sequential harvest effort. Bryozoan coverage was found to be significantly impacted by kelp harvest, however the seasonality and directionality of those impacts varied between forests. At the scale of the individual kelp plant, we detected consistent negative effects of harvest on the number of large kelp fronds, yet a significant positive effect of harvest on medium sized fronds. Lastly, we did not detect an effect of harvest on kelp reproduction during our 4 month field study. Our results underscore the resilience, yet context-dependence, of kelp forests to commercial-scale harvest which needs to be carefully considered in the development of future management policies.

SAND DYNAMICS DRIVE KELP FOREST BIODIVERSITY AND COMMUNITY STRUCTURE

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In this study, we leveraged spatially replicated annual survey data spanning more than two decades in coastal southern California, USA, to investigate the effects of sediment dynamics on subtidal reef communities. We applied statistical models to quantify the response of abundance, diversity, and composition to the amount of hard substrate. We examined the effect of substrate type on recruitment, the influence of spatial variation in substrate on community structure, and the effect of temporal variation in substrate on annual species turnover. Lastly, we investigated the oceanographic and landscape characteristics that contribute to substrate variability over time at a reef. Abundance and diversity were positively associated with hard substrate cover, however diversity saturated at higher cover of rock. Species composition exhibited significant changes from sandy to rocky conditions, reflecting morphological differences among taxa. Community dissimilarity increased with greater differences in the amount of hard substrate between two reefs. Finally, temporal variation in substrate at a reef was negatively associated with reef rugosity, indicating the importance of reef complexity in providing stable habitat for benthic organisms. Together, these results provide insight into the role of substrate dynamics in mediating abundance, diversity, composition, and recruitment in reef communities, the consequences of spatial variation of substrate in these systems, and the drivers of substrate variability in subtidal reef environments.

Session 10: Intertidal Ecology I

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

MULTIPLE PARASITE SPECIES ARE WIDESPREAD IN P. HIRSUTIUSCULUS, AND PELTOGASTER SP. INFECTION COULD INFLUENCE HOST THERMAL RESPONSE

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Species interactions, such as parasitism, are likely to both be altered by and alter the response of host organisms to the environmental changes brought on by climate change. Many parasites are understudied, and therefore there remains an incomplete understanding of how both host and parasite may react to climate change. We conducted field surveys to better understand the parasite distributions of the intertidal hermit crab *Pagurus hirsutiusculus* in British Columbia. We found three genera of externally visible parasites (*Eremitione*, *Peltogasterella*, and *Peltogaster*), and one hyperparasite (*Liriopsis*), which were present throughout the surveyed region. However, the prevalence of *Eremitione giardi* was related to salinity while *Peltogaster sp.* was related to host size. At some locations, we observed a decline in prevalence in the parasite *Peltogaster sp.* following the 2021 pacific northwest heat wave event. In the lab, we compared the metabolic rate across a temperature range and survivorship post heat stress in individuals infected with *Peltogaster sp.* and uninfected individuals. We did not find a difference in metabolism based on infection status but found that uninfected individuals had significantly higher survivorship following heat stress. This study highlights the

pervasiveness of parasitic interactions and demonstrates the need to study them in combination with environmental factors to better understand the effects of climate change on populations.

MUSSELS IN MOTION: HOW FLOW AND DENSITY SHAPE BEHAVIOR AND SEAWATER CHEMISTRY IN MYTILUS AGGREGATIONS

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Mussels, as habitat-forming species, modify their surrounding chemical environment through respiration and calcification. This alteration impacts not only the water above but also the interstitial spaces within mussel aggregations. It is well known that the extent of these effects is highly dependent on flow conditions: high flow flushes the bed interior with bulk seawater, while low flow allows dissolved oxygen (DO) gradients to develop. However, the ability of mussel behaviors, such as pumping and gaping, to modulate the chemical concentration boundary layer in varying flow conditions remains unclear.We conducted laboratory experiments and field observations to evaluate the gaping behavior of three *Mytilus* species (*M. trossulus*, *M. galloprovincialis*, and *M. californianus*) and its interdependency with flow conditions and interstitial water chemistry. As expected, the most significant gradients in DO developed during low flow (<5 cm/s). The amount of time a mussel spent gaping was largely independent of flow, however the three species differed in their preferred gape distances. *Mytilus trossulus* and *M. galloprovincialis* spent approximately 51% more time in a closed position compared to *M. californianus*. In a field experiment, we explored how aggregation density influences DO dynamics within interstitial zones on *M. trossulus*. Higher densities were associated with reduced DO availability, prompting increased gaping behavior, particularly in mussels within the bed's interior. These findings underscore the importance of understanding the interactions between mussel behavior, flow-mediated chemical gradients, and aggregation density to predict how environmental change will affect mussel populations and the coastal communities they support.

THE EFFECTS OF HEAT WAVES AND SUBSEQUENT HYPOXIC 'REPRIEVE' ON MUSSEL METABOLISM AND ANTIOXIDANT CAPACITY

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Washington State University

The ecosystem functions provided by intertidal mussel beds may be susceptible to increasingly frequent atmospheric heat waves and coastal deoxygenation. Intertidal species' responses to sublethal heat and hypoxic stress have been studied in isolation, but the interactive effects of these variables are less understood. Here, we address the consequences of sequential exposure to high temperature and low oxygen in the foundation species *Mytilus californianus*. Aerial, sublethal heat stress at low tide leads to reactive oxygen species creation, causing macromolecular damage that is often repaired during high tide periods upon reoxygenation. However, if the surrounding water is hypoxic, mussels may be forced to rely on less efficient anaerobic metabolism, threatening their recovery and performance. Mussels were subjected to a fully crossed set of tidal cycle scenarios wherein air temperature during the daytime low tide (18, 25, or 32°C) and dissolved oxygen during high tide periods (1.12, 2.1 or 6.0 mg L^{-1}) were manipulated for 1 or 5 days. Adductor muscle and gill tissues' aerobic (citrate synthase; CS), anaerobic (PEPCK), and antioxidant (catalase; CAT) enzyme activities were assayed. Exposure to sublethal hypoxia or heat stress, alone or in combination, did not affect CS or CAT in either tissue. PEPCK activity in gill tissue doubled in the most hypoxic condition, but only at the lowest temperature. Although we found little or no evidence for negative metabolic impacts of the sequential stressors, their interactive effects could play out over longer periods.

HOT TO MOW! DIFFERENTIAL EFFECTS OF WARMING AND ACIDIFICATION ON AN INTERTIDAL GRAZER AND MACROALGAE

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As ocean warming and acidification escalate, communities will shift depending on physiological responses. Asymmetries in species-specific physiological responses to climate change may alter the strength of interactions, and lead to changes in ecosystem structure. Such asymmetries can occur between predator and prey, leading to top-down or bottom-up effects on the community. In the California rocky intertidal, organisms

experience vast changes in abiotic conditions (e.g., pH and temperature) over diel and seasonal timescales. Thus, rocky intertidal organisms are especially vulnerable to the effects of climate change. Facilitating macrophytes have already experienced substantial population declines, leading to changes in ecosystem functioning. Here, we aimed to better understand the physiological responses of the foundation species, rockweed (*Silvetia compress*), and an herbivore (*Tegula eiseni*) to future climatic conditions. We assessed individual metabolic rates (respiration and gross photosynthesis) and herbivore calcification after 30 days of exposure to a range of eight pHs (7.2-8.0) at two temperature levels (16, 20°C). *T. eiseni* respiration increased linearly with temperature and varied nonlinearly with pH, and calcification rates increased with pH. For *S. compressa*, respiration increased with temperature, but only at high pH values, and we saw no effects of pH or temperature on gross photosynthesis. These results indicate differential responses to climate change across trophic levels, where shelled mesopredators like *Tegula* may be more vulnerable.

Session 11: Population Biology and Ecology I

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

WIDESPREAD HETEROGENEITY IN DENSITY-DEPENDENT MORTALITY OF REEF FISHES

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Whether and how populations are regulated is a long-standing debate in ecology. Over the past century, it has become increasingly clear that populations often reach significantly high densities that they experience sufficient mortality that facilitates population regulation. However, the strength of density-dependence is rarely quantified, but likely varies among species, and we remain limited in our understanding of what drives this heterogeneity. Using meta-analysis we quantify the strength of density dependence in 47 species of fishes across 58 papers and evaluate the underlying drivers of variation in density-dependent survival at early life stages within and among species. On average, increases in fish density decreases per capita survival; however, how strongly density affects survival is highly variable within and across species. Several covariates explain demonstrable variation in the strength of density-dependent survival. We found the strongest negative effects of density on survival in the presence of predators, for larger-bodied species, and for species found in the Caribbean. The effects of density on survival were highly variable within species, often varying by several orders of magnitude and spanning both positive and negative effects of density on survival. This tremendous heterogeneity within and among species suggests that variation in the environment may supersede the role of species traits, and highlights the need to further study the, as yet undocumented, environmental factors that produce heterogeneity in the strength of population regulation.

GROWTH AND MORTALITY RELATIONSHIPS OF AN ECOSYSTEM ENGINEER SHRIMP AND ITS INVASIVE PARASITE

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1- Oregon State University 2- USDA-ARS

The northeast Pacific intertidal blue mud shrimp, *Upogebia pugettensis*, is in steep decline range-wide due to intense infestations of the introduced Asian bopyrid isopod parasite, *Orthione griffenis*. The absence of refuges for mud shrimp from the invasive parasite preclude assumptions of host resilience or otherwise long-term co-existence. Intervention by delaying or reversing the decline of mud shrimp will only be possible through understanding the ecology, energetics, and population dynamics of this system, which has not been resolved for any other marine bopyrid isopod and hosts. Bopyrid parasites effectively castrate their female hosts by hemolymph extraction, leading to total reproductive losses in female mud shrimp. Although host biomass can only be lost to isopods, mud shrimp mass-per-length does not decline with increasing parasite load. The energetics of this interaction are critical for understanding the population dynamics of this system. However, there are no simple direct measurements of growth, and if mortality rates also change with size, it is challenging to deduce size-dependent growth rates from observations of population size distributions over time. We have addressed that problem by developing size-based integral projection models that incorporate the temporal variation in size frequency of mud shrimp and their parasites. Our model analysis narrows the range of possible patterns of size-dependent age and mortality for infected and non-infected mud shrimp, suggesting new testable hypotheses for the key drivers of mud shrimp

population dynamics.

POPULATION GENOMICS OF *SACCHARINA LATISSIMA* ALONG THE COAST OF MAINE

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Kelp forests in the Gulf of Maine were once dominated by sugar kelp (*Saccharina latissima*). However, the Gulf is now experiencing rapid ocean warming, which is reducing the resilience of Maine's kelp forests through both gradual warming and acute marine heatwaves. Simultaneously, sugar kelp is the most commonly cultivated species in Maine's fast growing aquaculture industry, and this industry is wholly reliant on the harvest of sorus tissue (seed) from wild sugar kelp. Notwithstanding, fine-scale information regarding sugar kelp population structure, diversity, and connectivity is lacking for this region. We therefore conducted an extensive population genomics study to address three objectives: (1) identify genetically unique populations of sugar kelp along the outer coast of Maine, (2) assess the degree of gene flow between these populations, and (3) determine the intraspecific diversity within each population. In this talk, I will describe our findings to-date. This work will lay the foundation for our ability to (1) develop best practices for kelp harvest and aquaculture seed sourcing, (2) gauge changes in kelp forest genetic diversity in response to climate change, and (3) identify genotypes best suited for withstanding thermal stress, which can be applied to both aquaculture and restoration programs.

DOES VARIATION MATTER? INTRASPECIFIC RESPONSE AND RECOVERY OF CORYNACTIS CALIFORNICA TO REALISTIC, SIMULATED MARINE HEATWAVES

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1- UC Santa Barbara 2- Towson University

Given the escalating frequency and severity of marine heatwaves, research on species responses to heatwave events is essential for the development of effective mitigation efforts. The complexity of organismal responses to marine heatwaves mirrors the dynamic nature of heatwave events, and scientists must consider both sources of variation to understand ecosystem resilience to climate change. To account for this variation, we conducted an experiment where we simulated realistic marine heatwaves of varying severities in the laboratory and monitored the responses of five strawberry anemone (*Corynactis californica*) genets over five months. We used a Raspberry Pi to recreate the temperatures experienced by benthic organisms during a historic marine heatwave in the Santa Barbara Channel. We measured each genet's reproduction, growth, mortality, and behavior during a two-month long heatwave event and subsequent three-month recovery period. Our findings revealed significant differences between heatwave severities and between genets, with some genets exhibiting greater sensitivity to the heatwave. We also observed measurable changes in genet responses during the recovery period after the heatwave event. Our results suggest that individuals within a population may exhibit variable responses to marine heatwaves, which has important implications for species resilience and community structure. Moreover, our successful implementation of a novel, more realistic approach to a marine heatwave experiment highlights the potential for infusing more complexity into scientific research.

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

DRIED TISSUE SPOTS FOR AMBIENT-TEMPERATURE SAMPLING OF FATTY ACIDS IN MARINE CRABS

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Fatty acids, key lipid components, are valuable trophic and nutritional biomarkers. However, fatty acids are prone to degradation and are best sampled and stored at ultracold temperatures until analysis. This vulnerability complicates field sampling, where ideal storage requires hazardous materials (liquid nitrogen or dry ice) or expensive equipment (portable ultracold freezers). In human medicine, dried blood spots (DBS) have emerged as a promising method of sampling fatty acids, where a small sample is deposited onto a protectant-infused paper card, air dried, and transported at room temperature. Here, we extend DBS to marine crabs, dubbed “dried tissue spots” or DTS, sampling hemolymph and hepatopancreas of snow crab (*Chionoecetes opilio*) in the Bering Sea and green crab (*Carcinus maenas*) in Maine. In lab testing with green crab, we found that storage time affected both DTS and frozen samples. In a field test using snow crab, fatty acid differences by crab sex and maturity were detected with both sample types. In an application to snow crab in a temperature-disease experiment, fatty acid differences by disease status, but not temperature, were detected with both sample types. In all cases, the effect of sampling type was detectable, but it was small and largely overwhelmed by crab-level variation. Our results show that DTS is a promising method for facilitating fatty acid sampling, but that freezing is preferred when feasible and samples should regardless be promptly analyzed. Future work should optimize DTS and trial its utility for other marine species.

IN SITU IMAGING ELUCIDATES VARIABILITY IN PLANKTON DISTRIBUTION, COMMUNITY STRUCTURE, AND INTERACTIONS ASSOCIATED WITH HYPOXIA

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Hypoxia, also referred to as deoxygenation, is a major environmental stressor in eastern boundary upwelling (EBU) systems, such as the northern California Current (NCC). The occurrence of low oxygen from the seafloor into the water column threatens zooplankton through alterations in distribution and community structure, resulting in changes in predator-prey interactions. Despite the potential for major changes, few studies have quantified the fine-scale influence of hypoxia on zooplankton. We utilized deep-learning classified imagery collected via a plankton imager (In Situ Ichthyoplankton Imaging System, ISIIS) with concurrent environmental sensors (e.g., dissolved oxygen, temperature) to sample plankton in hypoxic and normoxic waters in the NCC from 2018 to 2021 a 4-yr period encompassing variation in the extent and severity of hypoxia. Taxon-specific random forest models and accumulated local effect plots describe relationships between environmental variables and zooplankton abundance along onshore-offshore transects. Non-metric multidimensional scaling with Bray-Curtis distance revealed variation in zooplankton community structure in regions of hypoxic water relative to regions of oxygenated habitat. Interactions of larval fishes and their predators (chaetognaths, siphonophores) and prey (copepods, appendicularians) were estimated by measuring distances between imaged larvae and their predators and prey in variable oxygen conditions. In situ imagery enabled this close examination of how hypoxia alters prey availability and predation pressure in the plankton. Understanding changes in plankton distributions, community structure, and predator-prey interactions in the face of this emerging stressor is imperative for understanding hypoxia-associated variation in the NCC and other dynamic EBU systems.

LIGHTS, CAMERA, MEGALOPAE! DEVELOPING A SOUTHEAST ALASKA LIGHT TRAP NETWORK TO INDEX DUNGENESS CRAB MEGALOPAE RECRUITMENT

Johnson, C.J.*; Eckert, G.L.

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Larval light traps provide a relatively inexpensive index of megalopae recruitment for Dungeness crab (*Metacarcinus magister*) and have been deployed in Alaska, Oregon, Washington, and British Columbia to assess abundance of late stage larvae, larval transport mechanisms, and to better understand recruitment into the fishery. We are working with community partners throughout Southeast Alaska to measure Dungeness crab megalopae abundance throughout this complex landscape and to inform potential larval transport pathways. We are particularly interested in understanding population dynamics of Dungeness crab, given fishery harvest and sea otter predation, both of which are variable throughout the region. An understanding of larval recruitment of Dungeness crab in Southeast Alaska will be an important step in understanding the relative importance of bottom-up and top-down mechanisms in controlling the population and may ultimately help inform fishery management in this region.

UPWELLING EFFECTS ON REPRODUCTIVE TIMING, FECUNDITY, AND ENGERGY ALLOCATION OF DEMERSAL AND PELAGIC ROCKFISH ON THE CENTRAL CALIFORNIA COAST.

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1- Moss Landing Marine Labs 2- CSU Monterey Bay

Climate change is altering the water chemistry of the California Current Ecosystem by changing the timing and intensity of upwelling, which brings deep nutrient rich water to the surface that is depleted in oxygen and elevated in pCO2 (i.e., hypoxic and acidic). These changes are predicted to negatively impact local fish populations by altering physiology, bioenergetics, and ultimately reproduction. Rockfish can be characterized as demersal or semi-pelagic in their life history. Due to differences in reproductive phenology in relation to the upwelling season, we predict that pelagic species may exhibit higher resilience to climate change due to their exposure to a wide range of oceanographic conditions. Here, we tested the impacts of upwelling exposure on reproduction in three demersal and three semi-pelagic rockfish species by quantifying fecundity and the timing of egg and embryo development, while controlling for effects of maternal size and age. Fish specimens were collected during a El Niño year (2023; lower upwelling) and an La Niña year (2024; higher upwelling) that differed markedly. Demersal species exhibited higher weight-specific fecundity and elevated reproductive investment (gonadosomatic index) in 2024, but reduced energy storage in the liver, indicating a reproduction-storage trade-off in productive high-upwelling years. Pelagic species generally showed no significant differences between fecundity between years. All species developed and released broods earlier in a La Niña year, resulting in many demersal species having unreleased broods at the time of the opening of the rockfish fishery (which is supposedly closed during the spawning season). Capturing fish before they spawn may significantly reduce population replenishment of these long-lived, late to develop, and commercially important species.

Session 13: Physiological Ecology I

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

VARIATION IN OUTCOMES OF BOTH NATURAL AND EXPERIMENTAL INFECTION OF THE SOFT-SHELL CLAM (MYA ARENARIA) WITH TRANSMISSIBLE CANCER

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1- PNRI 2- UW 3- UW MCB

Bivalve transmissible neoplasia (BTN) is a leukemia-like clonal lineage of cancer cells that spreads through the water like an infectious disease. Here we investigate the outcomes of infection of *M. arenaria* with BTN, through natural and experimental infection. In our natural infection study, clams found to be infected with low levels of cancer (<10% in the hemolymph) were maintained in the laboratory, and disease was monitored over

2 years by qPCR detection of cancer-specific DNA in the hemolymph. We found 3 different progression schemes: progression to death, long term non-progression, and regression. Out of 21 naturally infected animals, 9 progressed to death, 11 maintained the cancer at low levels without progression, and only 1 showed significant cancer growth followed by full regression. In our experimental inoculation study, animals were injected with neoplastic cells and maintained under four different conditions (4C, 10C, 13C, 16C) to test the effect of temperature on disease progression. We observe that cancer progression correlates with higher temperatures, showing more frequent progression at 16C (5/12 clams) and 13C (8/12 clams), and the least at 4C (2/12 clams). In both natural infection and experimental inoculation, neoplastic animals have a lower survival rate than healthy animals, confirming lethality of this disease. However, both experiments show that disease does not progress to death in all clams, that there is variation in outcome in different individuals, and that environmental variables, like temperature, can strongly affect disease progression.

CHILLIN' WITH URCHINS: HOW TEMPERATURE INFLUENCES LARVAL DEVELOPMENT IN STRONGYLOCENTROTUS PURPURATUS

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While there are many studies comparing larval development of different species at different habitat temperatures, there is little information comparing the same species at different temperatures. This study assessed how temperature influences development, growth, and physiological energetics in larvae of the purple sea urchin, Strongylocentrotus purpuratus, which has an estimated thermal range from 5°C-20°C (Alaska to Baja California). Larvae were reared at 9°C and 16°C and fed 10,000 algal cells ml $^{-1}$ daily. We hypothesized that larval rearing temperature would have broadscale consequences on larval phenotype, resulting in different cumulative energetic costs of development. Larvae cultured at 9°C had lower respiration rates and smaller post-oral arms throughout development compared to larvae reared at 16°C. Both time-to and size-at metamorphic competency were significantly influenced by rearing temperature. Larvae at 9°C achieved 70% competency at 62 days post-fertilization (DPF) with a protein biomass of 2,818 ng ind^{-1}, whereas at 16°C, 70% competency was achieved at 30 DPF with a biomass of 4,732 ng ind^{-1}. Despite having 40% less biomass, larvae reared at 9°C had a cumulative cost of development 2.5-times higher than larvae reared at 16°C (341 and 135 mJ for 9°C and 16°C larvae, respectively). Our results demonstrate how temperature influences more than just the rate of development and may involve substantial tradeoffs between size at metamorphosis and the energetic cost to achieve it.

EFFECTS OF OCEAN ACIDIFICATION AND INCREASED TEMPERATURE ON THE BEHAVIOR AND PHYSIOLOGY OF THE SEA STAR EVASTERIAS TROSCHELII

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1- East Carolina University 2- NOAA, Alaska Fisheries Science Center, Resource Assessment and Conservation Engineering Division, Kodiak Lab

Rising levels of atmospheric CO_2 are lowering pH and increasing temperatures in oceans globally, causing concern about how marine species may be affected. The sea star *Evasterias troschelii* is a dominant consumer in sub- and intertidal ecosystems from California to Alaska. However, little is known about the combined effects of increased acidity and temperature on its physiology and behavior. To fill this gap, we conducted a 40-day full-factorial laboratory experiment where sea stars were kept in crossed pH (ambient and 7.5) and temperature (8^{o}C and 14^{o}C) treatments. Feeding ration, growth, condition index, and respiration rate were measured. Foraging behavior was also observed. Temperature affected all parameters, with sea stars in 14^{o}C treatments consuming more food, finding food faster, respiring faster, and growing more than in the 8^{o}C treatments, although respiration was not statistically different. However, lowered pH did not significantly affect feeding ration, foraging behavior, respiration, or growth, indicating that this species may be resilient to ocean acidification up to the pH used in this experiment. As an ectotherm, *E. troschelii* must consume more food to manage an increased metabolism under higher temperatures, which is supported by our results. Increased feeding with temperature from this predator species may have broader implications on predator-prey dynamics in its ecosystem as the oceans warm.

FROM A FULL GUT TO A FULL GONAD; USING GNRH TO EXAMINE THE LINK BETWEEN REPRODUCTIVE AND NUTRITIONAL PHYSIOLOGY

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1- UC Irvine 2- Bodega Marine Lab

Historic over-fishing reduced white abalone (*Haliotis sorenseni*) populations resulting in their listing to the Endangered Species list in 2001. Captive breeding efforts, led by UC Davis Bodega Marine Laboratory, have increased production substantially over the past decade, but still fall short of the target 100,000 animals a year necessary for recovery. This shortfall is largely due to difficulties inducing gametogenesis and spawning. The diet of the *H. sorenseni* can impact the number of gametes they produce, and lipids have been shown to play an important role in larval development and survival in many marine invertebrates. This led us to explore the effects of a high lipid diet on abalone hormone levels by adding (seeding) a high lipid alga, *Nannochloropsis* sp., to their environment and collecting central nervous tissue (CNS) to measure the reproductive hormone, Gonadotropin-Releasing Hormone (GnRH), which regulates reproductive behavior and gametogenesis, using an ELISA protocol modified for abalone GnRH detection. Here, I am presenting data collected on the relationship between diet and GnRH where we observed that females increased their GnRH production while males decreased their GnRH production. In addition, we saw that the high lipid diet had beneficial impact on body length under heat stress. Examining the environmental factors that stimulate the release of GnRH can prove to be useful for increasing production, as well as aide in future studies focusing on white abalone reproduction.

Session 14: Pollution and Toxicology

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

HARD TO STOMACH: THE EFFECTS OF IMIDACLOPRID AND POLYESTER MICROFIBERS ON THE DEVELOPMENT OF SUNFLOWER STAR LARVAE

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1- Portland State University 2- Friday Harbor Labs 3- U.S. Geological Survey

Sea star wasting syndrome (SSWS) has affected numerous species of sea star, with populations of Pycnopodia helianthoides (Brandt, 1835) left most at risk. As their populations are struggling to recover, it is important to gain a better understanding of the impacts that the multiple stressors in their habitats can have on their populations. Contaminant stressors in particular are of increasing importance, as aquatic organisms can be exposed to a dynamic range of contaminants from nearby anthropogenic activity that may affect their future recovery efforts. This study is the first to quantify the effects of contaminant stressors on the larvae of P. helianthoides. We exposed P. helianthoides larvae to the neonicotinoid insecticide imidacloprid and polyester microfibers, both individually and in combination, at environmentally relevant concentrations to measure the effects of these contaminants on their early life stages. Imidacloprid exposure resulted in stomach malformation in 10% of larvae and increased mortality during early development ($p<0.001$), and all treatments resulted in increased larval lengths relative to controls ($p<0.001$). During settlement, imidacloprid resulted in more rapid settlement responses than in the controls ($p<0.01$). These findings highlight the need for further research investigating the effects of contaminant stressors to endangered organisms during reintroduction, as well as a more comprehensive understanding of the effects of pesticides to non-target organisms.

MICROPLASTICS IN THE PACIFIC NORTHWEST: WHAT WE KNOW AND WHERE WE NEED TO GO!

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1- Portland State University 2- Ocean Conservancy 3- ODEQ 4- NOAA Corps 5- Oregon State University 6- University of Portland

As a pervasive and diverse group of contaminants of emerging concern, microplastics are gaining the attention of a broader swath of scientists and decision-makers. Microplastics research five years ago predominantly focused on aquatic and marine waters and organisms and has expanded to

include terrestrial organisms, air, and human tissues and organs. Despite a decade of active research on and large body of knowledge about environmental microplastics, significant gaps still exist, necessitating increased collaboration among diverse practitioners. We present a synthesis of what is known about Pacific Northwest microplastics in air, water, and organisms and a regional prioritization of research and action on microplastics, laying out a research and policy agenda for the next quarter century.

MYXOZOANS UNDER MULTIPLE STRESSORS: HISTORICAL ENVIRONMENTAL IMPACT AND MITIGATION IN THE PEARL RIVER IN LOUISIANA

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1- University of Washington 2- University of South Carolina 3- Valdosta State University 4- Tuskegee University 5- UC Santa Barbara 6- Tulane University Biodiversity Research Institute 7- Tulane University

Anthropogenic change is known to influence host-parasite interactions, but its influence is rarely examined in a multiple stressor context, missing an opportunity to understand how parasite burdens are likely to change in real ecosystems, where stressors rarely occur in isolation. This study aimed to understand how stressors such as warming (i.e., temperature), drought (i.e., streamflow), and pollution (i.e., pulp-mill effluent, including metals, polycyclic aromatic compounds, and carcinogens such as acetaldehyde) combine to influence myxozoan diversity and abundance in the Pearl River, LA. Seven fish species were seined between 1963-2005 and preserved at the Tulane University Biodiversity Research Institute. We dissected fish individuals of each species and identified myxozoans to the lowest taxonomic level possible in 2024. Six fish species were infected with myxozoans, including the genera: *Chloromyxum* sp., *Henneguya* sp., *Myxidium* spp., *Myxobolus* spp., *Thelohanellus* sp., and *Unicauda* sp.

Across the six fishes, *Carpiodes velifer* presented the highest prevalence of myxozoans and abundance of *Myxobolus* spp. Preliminary results suggest that *Myxobolus* spp. abundance in *C. velifer* increased after the passage of the Clean Water Act in 1972, which might indicate a response of parasites to pollutants. While investigating multiple stressors simultaneously is difficult, identifying the stressors (i.e., pollutants) to which organisms (i.e., parasites) respond most strongly can inform mitigation efforts.

OCCURRENCE OF PESTICIDES IN OREGON COASTAL WATERS AND POTENTIAL EFFECTS ON SYMBIONTS AND REPRODUCTION IN THE AGGREGATING ANEMONE, ANTHOPLEURA ELEGANTISSIMA

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1- Portland State University 2- PSU 3- USGS 4- Oregon State University

While pesticides have ensured efficient crop production, they are frequently transported away from application sites and are ubiquitous in terrestrial and aquatic environments. Pesticides have unintentional toxic effects on non-target organisms by interfering with cellular processes, behavior, feeding, reproduction, and disrupting endocrine processes. Anthopleura elegantissima *is an indispensable species due to its symbiotic relationships with Dinoflagellate and Chlorphyta which contribute to high productivity and nutrient cycling in the intertidal zone. A. elegantissima* undergoes asexual reproduction within aggregated colonies and annual sexual reproduction via spawning in the water column. Commonly used forestry herbicides and other pesticides, detected in Oregon coastal watersheds and rivers, can disrupt photosynthesis, kill off zooxanthellae symbionts, and disrupt reproduction in Cnidarians. Passive samplers were deployed to examine which pesticides are present in Oregon coastal waters. Carbendazim, atrazine, and diuron were among the most frequently detected pesticides. This research explored how these pesticides affect A. elegantissima *symbiont load and gonadal development. Pesticides are predicted to decrease symbiont load by disrupting photosynthesis and increase stress in A. elegantissima* , causing reabsorption of their gonads resulting in no reproductive output.

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

TRIBAL COLLABORATIVE MANAGEMENT IN THE BLUE ECONOMY ERA: A CASE STUDY OF THE CHUMASH HERITAGE NATIONAL MARINE SANCTUARY

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Penn State University

Coastal communities are balancing the complexities of ensuring equitable marine governance and multiple conflicting uses, including aquaculture intensification, fisheries commodification, and renewable energy development. In California specifically, tribal nations are seeking equal governance authority with state and federal marine resource managers for the management of marine spaces. This dissertation research examines an emerging collaborative governance relationship for the proposed Chumash Heritage National Marine Sanctuary between numerous Chumash and Salinan nations and the National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries. The proposed Chumash Heritage National Marine Sanctuary presents a unique case as it is the first Sanctuary to be nominated by a non-federally recognized tribal nation with the intent of creating a collaborative governance structure to include culturally diverse federally and non-federally recognized Indigenous groups. This research specifically investigates the integration of Indigenous self-determination in this emerging collaborative governance relationship through examining 1) social learning among governance actors; 2) how discourses and decision making around current and emerging marine activities are shaped by Indigenous initiation of the governance process; and 3) how narratives of Indigeneity impact the inclusion of Indigenous people in the governance process. Drawing upon an Indigenous Research Paradigm, this research includes a case study using qualitative and quantitative social science research methods, including participant observation, semi-structured interviews, and critical discourse analysis. These methodologies emphasize the perspectives of a diversity of community members involved in the governance process and centers Indigenous history and perspective within the research process. Participants and community members have informed the research process, and the findings of this dissertation research will contribute to the understanding of how collaborative governance arrangements with tribal nations evolve within coastal communities, and how these arrangements influence the social and ecological goals of marine planning in California.

THE EFFECT OF PURPLE URCHIN(STRONGYLOCENTROTUS) REMOVALS ON NON-DOMINANT HERBIVORES(TEGULA SPP.) WITHIN A DECLINING KELP FOREST

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Sonoma State University

In recent years, restoration efforts have largely focused on mitigating overgrazing of foundation species to prevent ecosystem collapse. A potential solution to overgrazing is the manual removal of primary herbivores in the absence of keystone predators. While this can be effective, herbivore removals can create further consequences– such as impacting the remaining, secondary herbivores within the ecosystem. This study aims to explore the effect of purple urchin (Strongylocentrotus purpuratus) removals on remaining, secondary herbivores– Tegula snails (Tegula spp.) within a declining bull kelp (Nereocystis luetkeana) forest in Northern California. We examined the effects of a purple urchin removal experiment on Tegula snails at Timber Cove, California. We used scuba surveys to determine effects on population abundance, size, and structure. We deployed feeding assays to highlight changes in community herbivory rate. We ran laboratory experiments to test differences in individual Tegula snail herbivory rate. We will showcase the results of changes within population abundance, size, community herbivory rate, and individual herbivory rate in response to purple urchin removals within a declining kelp forest, (results will be analyzed by October). This study hopes to improve bull kelp restoration practices and furthermore highlight secondary ecological consequences of manual herbivore removal practices, in an attempt to better understand how to mitigate loss of foundation species across similar ecosystems.

'CLAWS FOR OPTIMISM': ROCK CRABS AS A PREDATOR ENHANCEMENT TOOL IN NORTHERN CALIFORNIA KELP RESTORATION?

Traverso, S.E.*; Bourdeau, P.E.*

Cal Poly, Humboldt

Kelp forests are threatened by regional abiotic and biotic stressors, including overgrazing by sea urchins. On the north coast of California, purple sea urchins, *Strongylocentrotus purpuratus*, are prolific grazers of kelp and with the regional extinction of their main predator (sunflower stars, *Pycnopodia helianthoides*), it is unknown whether any remaining mesopredators could exert top-down control of purple urchin populations. Other known predators of purple urchins in northern California include rock crabs, which have been shown to control sea urchin populations in Atlantic kelp forests. Yet, little is known about the importance of these predators in mediating purple urchin distribution, abundance, and grazing behavior in the eastern north Pacific. To better understand the predatory effects of rock crabs on purple urchins in northern California, we conducted laboratory mesocosm and field experiments to determine (1) the feeding rates of two common rock crab species (*Romaleon antennarium* and *Cancer productus*) on urchin barren and kelp forest urchins, and (2) the influence of crab risk cues on urchin grazing rates. In mesocosms, rock crabs of both species consumed approximately two urchins per day, regardless of urchin condition; over two times the rate reported for sunflower stars. In mesocosms and in the field, the non-consumptive presence of rock crabs altered urchin mobility and reduced urchin grazing by 30-50% compared to the presence of culled urchins and no-crab controls. We therefore suggest that rock crab enhancement could be incorporated with other methods as a tool for kelp forest restoration, until sunflower stars can be re-introduced to these vital ecosystems.

RESTORING ENDANGERED PINTO ABALONE IN WASHINGTON STATE THROUGH CAPTIVE BREEDING AND JUVENILE OUTPLANT STRATEGIES

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1- WDFW 2- PSRF

Pinto abalone (Haliotis kamtschatkana), a key species in Washington State's kelp forest ecosystems, have experienced a drastic population decline even after the fishery closure in 1994. Restoration efforts are critical to reversing this decline and reestablishing healthy populations of this state endangered species. Since 2003, Washington Department of Fish and Wildlife (WDFW), Puget Sound Restoration Fund (PSRF), and many other partners have worked together to reach the shared goal of restoring pinto abalone to self-sustaining populations in the state. The primary method of restoration is outplanting captive-bred, hatchery-raised pinto abalone to handpicked sites in the San Juan Islands and surrounding areas. To date, the restoration program has outplanted over 55,000 abalone to 36 sites – and new sites are being established every year. Success of these outplants is measured by re-encounter rates of >1% during post-outplant dive surveys. Around 2/3 of the sites boast acceptable or high retention rates of abalone. The accomplishments of this collaborative program have led to over 20 successful restoration sites and counting, demonstrating the effectiveness of the captive breeding and outplant restoration strategy. Continued commitment to hatchery productivity, outplanting efforts, and active partnerships is vital in maintaining this success and ensuring the long-term sustainability of pinto abalone populations in Washington State.

NON-INVASIVE IDENTIFICATION OF A GAMMA-GLUTAMYL AMINO ACID AS A PUTATIVE CORAL THERMAL STRESS BIOMARKER

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Coral reefs represent one of the most productive ecosystems in the world, fostering immense biomass and biodiversity. Multiple local stressors (e.g., overfishing, anthropogenic pollution, and marine heat waves), global climate change and poor recruitment are causing coral reefs to decline at prodigious rates. Variability in response to these stressors at a local level makes conservation and management of coral reefs challenging. For example, reef managers lack the ability to accurately predict the relative stress and the reef-specific response to seawater temperature increases

caused by global climate change, as this can be dictated by the endosymbiont variability, bleaching history, flow dynamics and microbial community composition. To evaluate the production of thermal stress biomarkers by the coral holobiont in response to warming events, we investigated the production of stress metabolites in an aquaria experiment in Moorea, French Polynesia and in situ during a marine heatwave event, in Kane'ohe Bay, Hawai'i. Three distinct coral genera were experimentally heat stressed to evaluate the production and composition of dissolved organic matter in response to acute thermal stress. We observed a pulse of dissolved organic carbon (DOC) on the third day of the heating experiment in the unbleached coral treatment. Using untargeted liquid chromatography tandem mass spectrometry, we characterized the composition of the DOC pulse and identified sixty-nine molecular subnetworks (i.e. clusters of structurally similar molecular features) as potential biomarkers of thermal stress. Of these, we identified one molecular subnetwork that was significantly released both in the thermal stress experiment and in situ during the 2019 bleaching event in Kane'ohe Bay, Hawai'i. Using in silico annotation tools, we identified the subnetwork as gamma glutamyl amino acids and further found the spectra within seven distinct, publicly available coral stress experiments. We propose that this putative stress biomarker could be used to create non-invasive diagnostic tools for coral reef management and conservation.

THE EFFECTS OF PHRAGMITES AUSTRALIS INVASION STRESS ON COMMUNITY FUNCTION IN RESTORED TIDAL WETLANDS OF SUISUN MARSH

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Tidal restoration has significant benefits for increasing habitat connectivity and climate change resilience in wetland ecosystems, but the disturbance of physical restoration techniques often welcomes introduced species into the area. In the Suisun Marsh region of the California Delta, *Phragmites australis* (common reed) has increased its coverage over tidal and managed wetlands by over 200% in the past few decades.

Significant resources have been spent on its remediation and removal, but it continues to fill in the marsh plains and waterways that are crucial habitat for listed mammals, fishes, and birds. However, very few studies have looked at whether this spatial domination has consequences for trophic relationships – it has always been assumed that its monoculture tendencies lead to detrimental consequences. In this study, we quantified invertebrate and plant community composition on a fine spatial scale comparing *Phragmites* and native plant canopies within a range of tidal wetland restoration projects in Suisun Marsh. We also investigated treated *Phragmites* patches to determine the effects of herbicide and mowing. We found no widespread differences in pelagic, benthic, and terrestrial invertebrate communities, food sources for higher order animals, between *Phragmites* and native canopies. We also found evidence that *Phragmites* canopies allow for concurrent understory growth of native plants. This research poses a fascinating contradiction to the conventional wisdom of *Phragmites'* ecosystem impacts while producing tangible management recommendations.

EFFECTS OF COASTAL UPWELLING ON PURPLE SEA URCHIN (STRONGYLOCENTROTUS PURPURATUS) GRAZING

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UC Santa Cruz

Environmental conditions can alter trophic interactions between species that drive shifts between alternate stable states. The recent collapse of kelp forests in the North Pacific after a regional warming event and local increases in herbivory, triggered intense interest in understanding the mechanisms driving urchin grazing pressure and strategies for kelp forest recovery. In North Pacific kelp forests, marine species experience simultaneous reductions in temperature, dissolved oxygen, and pH during upwelling events - environmental conditions likely to affect urchin grazing rates. To address how upwelling may affect urchin grazing, I ran an experiment that manipulated temperature, pH, and dissolved oxygen in unison and measured the grazing rates of the purple sea urchins, *S. purpuratus*, from two habitat types (kelp forest and barren). I found that *S. purpuratus* had significantly lower grazing rates under more intense upwelling conditions (lower pH, DO, temperature) over ecologically relevant time frames, and that urchins from barrens ate significantly more than urchins from a kelp forest under intense upwelling. These findings highlight the importance of considering environmental conditions in kelp forest restoration and recovery efforts.

WHEN WILL EVOLUTIONARY RESCUE REVERSE DISEASE-INDUCED POPULATION DECLINES?

Balstad, L.J.*; Baskett, M.L.

UC Davis

Disease-induced population declines are an increasingly relevant concern in marine systems. Outbreaks of sea star wasting disease, eelgrass wasting disease, and abalone withering syndrome have contributed to considerable population declines of Pycnopodia sp., Zostera sp., and Haliotis sp., respectively, in the East Pacific. In these same populations, there might be selection for disease-resistance, allowing for possible evolutionary rescue, however, it is unclear under what general conditions evolutionary rescue might occur. Here, we use a population genetics model to describe evolutionary rescue in host-pathogen systems. We test our model across different dimensions of disease (transmission type, compartment type) and disease-robustness (tolerance, resistance). Our results suggest that evolutionary rescue in host-pathogen systems is possible. Broadly, disease tolerance tends to increase the likelihood of evolutionary rescue but allow the disease to persist, while disease resistance can lead to temporary reductions in disease with or without long-term evolutionary rescue. This suggests that when disease is a temporary selective pressure, classic genetic patterns of evolutionary rescue might be transient.

Session 16: Community Ecology II

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

INTERSPECIFIC DIFFERENCES IN THE FEEDING ECOLOGY AND TROPHIC IMPACT OF M. FRANCISCANUS AND S. PURPURATUS ON UNDERSTORY ALGAE

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UC Santa Barbara

Sea urchins are omnivorous grazers that play a major role in coastal marine ecosystems worldwide, including kelp forests. Changes in urchin grazing patterns due to their abundance, behavior, or food availability can catalyze transitions between kelp forests and urchin barrens. In the Santa Barbara Channel, two species of sea urchins are abundant: the red urchin *Mesocentrotus franciscanus*, and the purple urchin *Strongylocentrotus purpuratus*. To date, most ecological research in this region has focused on a single urchin species or aggregated both, but known differences in their autecology could obviate the assumption that they are functionally homogenous grazers. We used laboratory feeding assays to measure differences in red and purple urchin consumption rates of four common understory algal species, and ecological modeling to estimate the potential removal of kelp forest algal biomass by urchins at long-term research sites. We found significant interspecific differences in the most consumed algae types and in mass-specific feeding rates. Extrapolating from these laboratory-measured feeding rates, the predicted impact of urchin feeding on understory algal biomass was strongly dependent on urchin species identity and season. Overall, removal potential of macroalgae by urchins was a significant negative predictor of mean net primary productivity (NPP) across the four algae species considered, but in situ urchins never eliminated even their most favored species, *Chrondracanthus*. Our results highlight the importance of urchin species identity in kelp forest community ecology.

KAYAK-BASED SURVEYS: A TRACTABLE METHOD FOR MONITORING NARROW LOW-DENSITY FLOATING KELP BEDS

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Washington State Dept. of Natural Resources

Floating kelp forests provide vital habitats and important ecosystem services in temperate nearshore ecosystems worldwide. Kelp losses are a major concern globally. In Washington State (USA), extensive losses of bull kelp (*Nereocystis leutkeana*) have occurred in the inner basins of Puget Sound, an inland sea. Monitoring these kelp beds poses unique challenges; conventional techniques such as satellites and fixed wing aircraft generally fail to detect narrow, low-density beds in areas with strong currents and extreme tides. To cheaply and reliably monitor floating

kelp in these areas of concern, we use kayaks to survey kelp bed area and depth distribution. The protocol combines perimeter delineation by multiple observers with targeted sampling along across-shore transects. At extremely sparse beds, alternative protocols identify individuals. The bull kelp bed at Squaxin Island provides an example of the inherent challenges in these environments and the ability of kayak-based surveys to capture changes over time. At Squaxin, kelp bed area decreased dramatically over a decade, with an extreme drop in 2022 to just 85 plants (97% decline) and a major contraction in maximum depth. A partial recovery was observed in 2023 followed by stability in 2024, which represents a total areal decline of 78% since 2013. In 2024, we expanded the survey protocol to capture density and percent cover, as well as sporophyte morphometrics and condition. We also co-located kayak surveys with UAS and fixed wing surveys to explore multi-modal approaches to status and trends monitoring.

KEY FUNCTIONAL TRAITS DEFINE SPECIES GROUPS IN SOUTHERN CALIFORNIA INTERTIDAL SEAWEED ASSEMBLAGES

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1- UC Irvine 2- UC Irvine, Soka University 3- Swansea University

Human impacts and global change are imposing increasing stresses on intertidal communities. Evidence suggests that functional roles and trait diversity can influence the ability of a community to handle these stressors. In southern California, we aimed to determine the emergent functional groups and redundancy patterns found in intertidal seaweed assemblages. By utilizing an established seaweed trait screening process, we conducted detailed surveys of rocky shores throughout the region and measured a suite of functional traits of the species we found. Measurements were taken for traits associated with structural composition (thallus dry matter content, frond thickness, and carbon internal tissue content), resource acquisition (mass-specific surface area and surface-area-to-volume ratio), light competition (maximum length and aspect ratio), and resource retention (surface area:perimeter, and branching order). Preliminary results reveal four emergent groups: large brown seaweeds, calcified algae, thin-bladed seaweeds, and small red turf species. The key contributing functional traits for these groups include aspect ratio and thickness, total dry matter content, and specific thallus area. This research highlights the major functional roles and redundancy in southern California intertidal seaweed communities. Integrating this data into our growing international database can aid managers and policymakers in prioritization of their conservation efforts.

ARE SEA OTTERS ACTUALLY MESOPREDATORS? EXPLORING THE CHANGING RELATIONSHIPS AMONG TEMPERATE COASTAL PREDATORS OVER MILLENNIA

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Since their recovery along the coast of the Pacific Northwest, sea otters (*Enhydra lutris*) have often been conceptualized as keystone predators at the top of trophic food chains. However, recent scientific evidence from archaeological sources, local observations, and stable isotopes suggests sea otters as having several past and contemporary predators, including, wolves, orcas, bears, sharks, domesticated dogs, and people. Indigenous knowledge reveals that the relationships between sea otters and these diverse predators were complex, revered, and intentionally managed by way of spatially explicit hunting, fear tactics, and ancestral mariculture innovations.To investigate the evidence of sea otters as mesopredators, we partnered with Indigenous Hereditary Chiefs from the Haida, Heiltsuk, and Nuu-Chah-Nulth Nations to document the names, stories, songs, dances, governance principles, and knowledge related to sea otters and their predators. By combining Indigenous and Western Knowledge with ethnographic records, archaeological data, and recent observations, we show that sea otters likely functioned as nearshore mesopredators for much of the Holocene. This research challenges our fundamental assumptions about the structuring role of this notorious keystone predator with implications for who and how we envision managing nearshore diversity, productivity, and resilience into the future.

BULL KELP GROWTH RATES AS CLIMATE STRESS INDICATORS FOR CANADA'S PACIFIC COAST

Rhoades, O.K.*; Salter, N.; Crookes, C.

Fisheries and Oceans Canada

Primary producers' growth rates are ideal bioindicators of changing climate due to their sensitivity to environmental conditions. On the Central Coast of British Columbia, we assessed growth rates of Nereocystis luetkeana, a canopy-forming annual kelp, by assessing baseline variability in growth rates and their response to environmental conditions of over 600 individuals and across three sites (2016–2019). Optimal growth rates for blades and stipes (~13–14 cm/day) occurred within a narrow

range of local environmental conditions. Growth decreased at temperatures > 10 .C, below 1 µm/L nitrate concentration, and surface light availability reduced blade growth at low and high levels (daily light integral or DLI <20 and >40 mol/m2/day). Spatiotemporal variability in these environmental drivers co-occurred with differences in growth rates, suggesting that local conditions strongly influenced growth. In particular, temperature and nutrients were un-coupled seasonally in this region, with more variable responses in growth over the primary growing season (May to September). Overall, the sensitivity of the

growth rates of this annual kelp to changing climatic conditions suggests that it is a useful bioindicator for management and marine planning efforts (e.g., restoration and aquaculture) across its species range and provides a feasible metric for monitoring.

LONG-TERM LOCAL DECLINE OF A KEYSTONE SEA STAR AND INCREASED ABUNDANCE OF A SUBORDINATE COMPETITOR

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The keystone sea star *Pisaster ochraceus* and the smaller stars of *Leptasterias* spp. are prominent intertidal predators that co-occur along the west coast of North America. A series of laboratory and field studies conducted on San Juan Island, WA, in the late 1960s demonstrated that *P. ochraceus* dominates in interference competition with *Leptasterias*, a behavior reflected in marked negative correlation between the abundances of these two species. We surveyed *P. ochraceus* and *Leptasterias* populations at sites across SJI in 1991-92 and 2024 to monitor the competitive equilibrium between these species through time. We found that abundances of *P. ochraceus* declined dramatically beginning at least two decades before the onset of widespread Sea Star Wasting Disease in the region, a trend apparently associated with increased abundance of *Leptasterias*. Additionally, we report increased abundances of other predatory sea stars, including *Evasterias troschelii* and *Dermasterias imbricata*, which may also have been released from competition with *P. ochraceus*. These shifts in the relative prominence of intertidal sea stars may have driven changes in community composition captured in long-term surveys at a subset of our sites. Our findings indicate that, though *P. ochraceus* populations on the outer coast have exhibited unprecedented recruitment following SSWD, the species may be becoming locally threatened in the inland Salish Sea.

CAN FOULING COMMUNITIES IMPACT TRANSIENT REEF DYNAMICS? EXPLORATION OF CORAL SETTLEMENT IN ST. JOHN, US VIRGIN ISLANDS.

† Dahl, A.[1*]; Edmunds, P.J.[2]

1- UC Santa Barbara 2- CSU Northridge

In marine communities, the relative abundance of benthic space holders is influenced by disturbance. Disturbances can drive shifts to community structure, including the transition in coral reef habitats between alternative stable states dominated by either macroalgae or scleractians. In St. John, US Virgin Islands, high disturbance intensities have likely increased the potential for macroalgal dominance. However, other benthic space holders such as sponges or peyssonnelid algal crust have emerged in high abundances on these reefs as the coral-depleted state persists. This study investigated fouling communities on settlement tiles in St. John, US Virgin Islands, and tested the hypothesis that composition of benthic space holders on tiles and on the adjacent benthos, affected the settlement of scleractinians onto the tiles. Using terracotta settlement tiles, we

explored settlement to assess whether the transient benthic dynamics in St. John are susceptible to shift towards coral dominance. Across five sites, we found limited coral settlement impacted by variable benthic communities. Fouling communities, long used as model systems through which classic patterns of ecological competition have been tested, are here utilized to explore coral settlement in a benthic community exposed to disturbance. Our findings highlight the role fouling communities may have in impacting long term shifts from coral to algal dominance on reefs. These cryptic communities may have a significant role in determining the future resilience of coral reef ecosystems, and their ability to escape a transient state.

WHAT ARE THEY NOT EATING?: A GLOBAL REVIEW OF KILLER WHALE PREY AND PREDATORY INTERACTIONS

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Oregon State University

Killer whales (Orcinus orca) are cosmopolitan, apex marine mega-predators with diverse prey types and predation strategies. Jefferson et al. (1991) summarized killer whale prey species and predatory interactions based on a review of published literature and eyewitness accounts, but they included only mammalian prey. In the 34 years since that publication, much new information has become available on killer whale prey preferences. Additionally, several distinct killer whale ecotypes, each with specific prey preferences, have been identified, including two ecotypes recently proposed as separate species. We conducted a comprehensive literature and social media review to update killer whale food habits, identifying ecotypes where possible, and from 103 sources we identified 201 prey species (232 unique taxa), including 46 mammal species (58 unique taxa), 22 bird species (26 unique taxa), 4 sea turtle species, 73 fish and elasmobranch species (93 unique taxa), and 38 invertebrate species (49 unique taxa). In addition, killer whales harassed, attacked, scavenged, or depredated another 23 species (28 unique taxa). These results provide further evidence that the trophic impact of killer whale predation extends to every large animal species that lives in the ocean.

Session 17: Intertidal Ecology II

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

INVASIVE SPECIES TO THE RESCUE: PACIFIC OYSTERS AS A FUNCTIONAL REPLACEMENT FOR A THERMALLY VULNERABLE ECOSYSTEM ENGINEER

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1- University of British Columbia 2- Simon Fraser University

There is growing recognition that the persistence of ecosystem engineers is critical for promoting and maintaining biodiversity in a warming climate. However, their role in shaping patterns of biodiversity under heatwave conditions remains poorly understood. As heatwaves are expected to increase in frequency and severity by the end of the 21st century, understanding how ecosystem engineers tolerate thermal stress and facilitate species persistence during extreme heat events is imperative for conservation and management strategies. On the rocky shores of British Columbia, bay mussels (*Mytilus trossulus*) and invasive Pacific oysters (*Magallana gigas*) modify the physical environment via the generation of shell structures and provide habitat for epifaunal and infaunal communities. During extreme heat events, these structures serve as cool microhabitats for associated species as the interstices between shells create shade and trap moisture. Here we compare how atmospheric heatwaves alter the survival of *M. trossulus* and *M. gigas* and the composition of their associated communities. Following simulated heatwaves, we find that oysters have a significantly higher survival rate than mussels, as well as an associated community with greater diversity, richness, and abundance. These findings indicate non-native ecosystem engineers may be more resilient to rapid environmental change than their native counterparts, and thus have the potential to revitalize ecological roles that would otherwise be lost alongside native species as climate change progresses.

KELP RECRUITMENT; SPATIAL AND TEMPORAL VARIATION ALONG THE OREGON COAST

Sellke, S.N.*; Menge, B.A.

Oregon State University

As a foundational taxon, kelps are dominant components of intertidal habitats. Although literature on the ecology of intertidal kelps is extensive, much of the foundational intertidal kelp research has focused on adult life stages, such as competition between kelp and sessile invertebrates, and on the impact of herbivory. Recent evidence suggests that kelp populations in Oregon are becoming increasingly unstable, taking longer to recover from disturbance, but little is known about patterns of kelp recruitment. To gain insight into these patterns, in 2023 and 2024 we quantified the density of kelp recruitment at seven sites across the Oregon Coast, focusing on six intertidal kelp species - *Alaria marginata, Egregia menziesii, Hedophyllum sessile, Postelsia palmaeformis, Laminaria sinclairii*, and *Lessoniopsis littoralis*. Using autocorrelation analysis, we determined that the recruitment period for each of these kelps ranges from 20-40 days. There were temporal differences in peak recruitment timing between each species, with some species recruiting nearly year-round and others experiencing recruitment peaks in specific months. Despite differing among-site oceanographic conditions, kelp recruitment did not differ consistently among sites. Our data provide baseline information about kelp recruitment dynamics on spatial and temporal scales, and thereby can be used to inform future research regarding the resistance and resilience of kelp to climate change, as well as for management decisions.

TRIBAL INTERTIDAL DIGITAL ECOLOGICAL SURVEYS (TIDES): CO-CREATING EQUITABLE AND RELEVANT MARINE RESEARCH.

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1- Simon Fraser University 2- Santa Ynez Band of Chumash Indians 3- Kashia Band of Pomo Indians 4- Amah Mutsun Land Trust 5- Pulikla Tribe of Yurok People 6- Scripps Institution of Oceanography 7- Tolowa Dee-ni' Nation 8- Amah Mutsun Tribal Band 9- Kumeyaay Community College

Intertidal monitoring is a foundational marine ecology tool that often proceeds without the consent and partnership of Indigenous communities who have cared for and lived in reciprocity with these systems for millennia. To address this equity gap, the Tribal Intertidal Digital Ecological Surveys (TIDES) Project is a knowledge co-production partnership that includes the Tolowa Dee-ni' Nation, Pulikla Tribe of Yurok People, Kashia Band of Pomo Indians, Amah Mutsun Land Trust, Santa Ynez Band of Chumash Indians, Kumeyaay Community College, Scripps Institution of Oceanography and Simon Fraser University. This transdisciplinary collaboration uses large-area imaging to photogrammetrically reconstruct 3D habitat maps, capturing the entire vertical extent of the rocky intertidal in sub-mm level detail at ecologically relevant scales to address community-identified research priorities. Since 2019, we have tracked community-level dynamics of benthic organisms seasonally or annually at 14 survey locations representing six bioregions along the coast of California. Initial findings from a subset of surveys within Kumeyaay Territory (San Diego) suggest that rocky intertidal community structure varies strongly between sites and responds to high-frequency sea-level changes more rapidly than previously documented. By upholding Indigenous knowledge systems and values alongside Eurocentric scientific approaches, the TIDES project is building an equitable research foundation to improve our collective understanding of climate impacts to the rocky intertidal with broad management implications.

RESTORING NATIVE EELGRASS (Z. MARINA) MEADOWS, WITH SEEDS, IN THE SAN JUAN ARCHIPELGO, WA

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1- UW Friday Harbor Labs 2- Madrone Institute, Coast Salish Youth Stewardship Corps 3- Washington Dept. of Ecology, SEA Program 4- Northwest Indian College, Native Environment Science Program 5- College, Native Environment Science Program 6- Reefgen

The global decline of seagrass biomes, fundamental to the cultural, ecological and economic sustainability of coastal systems is challenging restoration ecologists to develop techniques that are scalable, efficient, and sustainable. In the San Juan Archipelago of the Salish Sea in Washington State, Zostera marina (eelgrass) in the intertidal zone is in decline. Washington State Dept. of Natural Resource (WDNR), which is

responsible for the yearly monitoring and recovery of seagrass species, has identified the decline as a cause for concern. To address this issue, Friday Harbor Laboratories University of Washington, WDNR, San Juan Islands Conservation District, Washington Department of Ecology SEA Program, Coast Salish Youth Stewardship Corps, Native Environmental Science Program Northwest Indian College and Reefgen have launched a program to restore eelgrass in intertidal regions in the Archipelago. Eelgrass restoration in the greater Salish Sea often occurs by transplanting adult plants to recolonize eelgrass meadows which can impact donor sites and require significant labor and implementation costs. A potentially more sustainable and less costly method of restoration is seeding the areas in decline to reestablish healthy intertidal meadows. Seagrass scientists and restoration practitioners are experimenting with various methods of seed collection, culturing, and seeding that have been conducted throughout the range of this species in the Northern Hemisphere to restore declining and fragmented populations. The restoration methods implemented, and results will be described.

BRIDGING ENCOUNTERS AND ENVIRONMENTAL DNA: COMPARING INTERTIDAL BIODIVERSITY SURVEY METHODS ALONG THE HEWATT-SAGARIN TRANSECT

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Stanford University

As anthropogenic stressors increasingly threaten coastal ecosystems, the need for scalable biodiversity monitoring approaches grows. Environmental DNA (eDNA)–genetic material left behind by organisms–represents a promising avenue for generating an ecosystem census from just a sample of water. Yet particularly in heterogeneous intertidal zones, the utility of eDNA for capturing small-scale biodiversity changes and its concordance with conventional observational methods remains understudied. The Hewatt-Sagarin Transect at Hopkins Marine Station in Pacific Grove, CA, a line through the rocky intertidal first surveyed in 1931, has provided some of the earliest evidence of climate-induced shifts in marine communities and continues to reveal ecological changes today. The transect, with its concentrated surveying along small spatial gradients, also provides an excellent system for understanding the intersection of visual and molecular monitoring. In this study, we collected water samples from small tidepools within or alongside nine quadrats where simultaneous visual invertebrate surveys were conducted. DNA from the samples was extracted, amplified using a well-established metazoan metabarcoding assay, sequenced, and taxonomically assigned. Molecular samples replicated some, but not all, spatial patterns from the observational data, while also detecting organisms, from algae to marine mammals, not captured by visual surveys. Thus, this research demonstrates the value of coupling molecular and observational methods to expand the scope of intertidal biodiversity data generated.

SPATIOTEMPORAL VARIABILITY IN EELGRASS SEXUAL REPRODUCTIVE PROPERTIES IN AN OREGON ESTUARY

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1- Oregon State University 2- South Slough National Estuarine Research Reserve 3- IMEDEA

Eelgrass, an essential habitat-forming marine flowering plant in West Coast estuaries, is threatened by increasing anthropogenic disturbances and climate change, including marine heatwaves (MHWs). Considering future climate predictions that include more frequent and intense MHWs, it is critical to understand eelgrass recovery potential after stressful events. Sexual reproduction, a mechanism of bed recovery and maintenance, bolsters genetic diversity and dispersal through flower and seed production. Using data collected from extensive field surveys spanning two flowering seasons, we investigate how flowering effort, timing, seedbank production and seed size differ between and within intertidal beds in an estuary that has suffered extensive recent eelgrass losses and differential recovery trajectories (South Slough, OR). Flowering effort averaged two-fold greater and seed bank densities averaged three-fold greater at lower tidal heights. Seeds were larger at lower tidal heights, and this discrepancy was preserved across seeds collected from shoots and seedbanks, suggesting limited seed dispersal across tidal heights. Observations and predictive models suggest flowering occurs earlier at sites with higher temperatures and faster heat accumulation during spring, with overall peaks in flowering effort spanning a twelve-week period across sites spanning only seven kilometers. These data contribute to a detailed understanding of the dynamics and drivers of sexual reproduction of local eelgrass populations, which is critical for effective conservation and restoration efforts.

IDENTIFYING POSITIVE SPECIES INTERACTIONS TO AID EELGRASS RESTORATION

Castiglione, R.R.*

San Diego State University

Global warming has decimated marine ecosystems worldwide. As a result, conservationists and researchers are taking interest in restoring seagrass meadows because of the myriad ecosystem services they provide, including acting as nursery habitats, protecting coastal habitats through sediment stabilization, providing food for endangered animals, and perhaps above all, sequestering carbon through photosynthesis. Unfortunately, these ecological engineers have declined 30-60% in the last century due to human activity and climate change, and the rate of decline is accelerating. Eelgrass (*Zostera marina*) is one of the most abundant seagrass species along many temperate coastlines but its populations are in decline, especially throughout southern California. Restoration efforts for eelgrass have had just over a 30% success rate, suggesting new methods need to be explored to enhance the effectiveness of these projects. However, there is newfound hope for eelgrass restoration by incorporating positive species relationships. I am proposing to examine the facilitative effects of growing eelgrass along different bivalve species found in San Diego Bay while also performing bacterial inoculations to the sediment. Using mesocosms, I will grow eelgrass with each bivalve species while measuring eelgrass response and environmental changes. Ultimately, I will establish what conditions are most beneficial for eelgrass growth and survival, and thereby determine the best practices to guide future restoration projects.

CHARACTERIZING DRIVERS OF MARINE COMMUNITY CALCIFICATION UNDER OCEAN WARMING AND ACIDIFICATION

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1- UC Irvine 2- UC Santa Cruz 3- SDSU

Global environmental change can lead to alterations in ecosystem functions through multiple biological mechanisms. This study employed a novel, in situ factorial field-manipulation of pH and temperature on rocky intertidal communities over a 6-month period. We examined individual- and population-level mechanisms driving changes in net ecosystem calcification (NEC). Our results indicate that the relationship between metabolic rates of the calcifying mussel *Mytilus trossulus* and NEC was dependent on CO_2: higher metabolic rates were associated with higher NEC except when individuals were exposed to elevated CO_2, in which case, increased metabolic rates were associated with decreased NEC. While increased calcifier abundance generally enhanced NEC, this relationship was reversed under elevated CO_2. These findings suggest warming and acidification will primarily affect NEC through individual metabolism until physiological limits are exceeded. Beyond this point, population-level dynamics, including survival and recruitment, will likely play a more significant role. Individual- and population-level responses are likely to act on different time scales to influence ecosystem functioning. Understanding these complex interactions within a changing climate is crucial for predicting the vulnerability of ecosystem function across levels of biological organization.

Session 18: Population Biology and Ecology II

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

TROPHIC ONTOGENY OF A GENERALIST PREDATOR IS CONSERVED ACROSS SPACE

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1- University of South Florida 2- University of Georgia 3- CSU Monterey Bay 4- NOAA Fisheries 5- Florida State University

Consumers can influence ecological patterns and processes through their trophic roles and contributions to the flow of energy through ecosystems. However, the diet and associated trophic roles of consumers commonly changes during ontogeny. Despite the prevalence of ontogenetic variation in trophic roles of most animals, we lack an understanding of whether they change consistently across local populations and broad geographic gradients. We examined how the diet and trophic position of a generalist marine predator varied with ontogeny across seven broadly separated locations (~750km). We observed a high degree of heterogeneity in prey consumed without evidence of spatial structuring in this variability.

However, compound specific isotope analysis of amino acids revealed remarkably consistent patterns of increasing trophic position through ontogeny across local populations, suggesting that the roles of this generalist predator scaled with its body size across space. Given the high degree of diet heterogeneity we observed, this finding suggests that even though the dietary patterns differed, the underlying food web architecture transcended variation in prey species across locations for this generalist consumer. Our research addresses a gap in empirical field work regarding the interplay between stage-structured populations and food webs, and suggests ontogenetic changes in trophic position can be consistent in generalist consumers.

TRANSGENERATIONAL EFFECTS OF MARINE HEATWAVES AND FISH PREDATOR CUES ON THE CALANOID COPEPOD PSEUDODIAPTOMUS INCISUS

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Marine heatwaves (MHWs) are emerging as a severe stressor in marine ecosystems. Extreme warm sea surface temperatures during MHWs often exceed the optimal thermal range for more than one generation of tropical coastal zooplankton. However, it is relatively unknown whether transgenerational plasticity (TGP) to MHWs may shape the offspring's fitness, particularly in an ecologically relevant context with biotic interactions such as predation stress. We addressed these novel research questions by determining the survival, reproductive success, and grazing rate of the copepod *Pseudodiaptomus incisus* exposed to MHW and fish predator cues (FPC) for two generations (F1 and F2). The experiment was designed in a full orthogonal manner with 4 treatments in F1 and 16 treatments in F2 generation. In both generations, MHW reduced *P. incisus* survival, reproductive parameters, and grazing by 10%–62% in MHW, but these parameters increased by 2%–15% with exposure to FPC, particularly at control temperature. F2 reproductive success and grazing rate as indicated by cumulative fecal pellets were reduced by 20%–30% in F1-MHW, but increased by ~2% in F1-FPC. Strikingly, MHW exposure reduced 17%–18% survival, but transgenerational exposure to MHWs fully ameliorated its lethal effect and this transgenerational effect was independent of FPC. Increased survival came with a cost of reduced reproductive success, constrained by reduced grazing. The rapid transgenerational MHW acclimation and its associated costs are likely widespread and crucial mechanisms underlying the resilience of coastal tropical zooplankton to MHWs in tropical coastal marine ecosystems.

POPULATION COMPARISONS OF THE ENERGETIC AND REPRODUCTIVE INVESTMENT OF PURPLE SEA URCHINS IN MARINE HEAT WAVE CONDITIONS

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1- UC Berkeley 2- Kashia Band of Pomo Indians 3- CA Fish and Wildlife

Marine heatwaves in northern California have resulted in recent explosions in purple urchins (*Strongylocentrotus purpuratus*), due to a combination of factors including increased larval supply and loss of predators. In contrast, heatwaves and warmer waters in the southern range, where temperatures are often much warmer than northern California, have coincided with reductions in adult densities. Yet how warming and heatwaves shape urchin energetic investment and reproductive capacity across the range remains an unclear. We experimentally compared the influence of five static temperatures from 10-22C and variable heatwave conditions from 18-21C, across Sonoma (north), Santa Barbara, and San Diego (south) urchin populations. The two southern populations exhibited similar respiration rates across temperatures and heatwave conditions; however, urchins from the north had significantly higher rates of oxygen consumption. Although gonad sizes did not differ across temperatures and populations, urchins in cooler temperatures across all populations were further along in gametogenesis, with mature gametes, compared to those in warmer temperatures, where gametes were in early stages of development. The increased metabolic costs associated with warmer temperatures may require greater resource consumption, leading to a trade-off between energy storage and maintenance when temperatures exceed optimal thermal windows. Warm (16-22C) temperatures will result in destructive urchin herbivory due to compensatory feeding and varied reproductive potential of urchins under future warming.

NORTHERN SEA OTTER (ENHYDRA LUTRIS KENYONI) POPULATION TRENDS IN WASHINGTON STATE

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1- Seattle Aquarium 2- USFWS 3- WDFW

Northern sea otters (*Enhydra lutris kenyoni*) were translocated from Alaska to Washington in 1969/1970 to repopulate a previously occupied area within their range. The native otters had been extirpated during the Pacific maritime fur trade, and the last Washington sea otter was killed in 1910. Fifty-nine animals were translocated from Amchitka Island, Alaska to the outer coast of Washington, where the population has now grown to an estimated 3,000+ individuals. An annual population census occurs in June with collaboration from the U.S. Fish and Wildlife Service, U.S. Geological Survey, and Washington Department of Fish and Wildlife. The Seattle Aquarium (and other groups) participate by conducting ground surveys to ground truth photos of rafts taken by small plane. Here, we present an analysis of population growth along with challenges in survey method and suspected offshore range expansion of the population.

INCREASING INCLUSION IN MARINE SCIENCE STARTS WITH MENTORS

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CSU COAST

When considering the lack of representation of people from historically excluded backgrounds in marine science, it’s critical to recognize that the challenge lies not with the students but with the environment in which we want them to succeed. Data from across California State University (CSU), the nation’s largest and most diverse university system, show notable decreases in representation at every step of the academic pathway from choosing a major to earning an advanced marine science degree. This lack of representation in marine science (and related fields) significantly limits the quality of the science and its societal implications. There are myriad barriers to accessing the field of marine science including systemic inequalities and a culture of exclusivity. High-impact student-centered initiatives (e.g. undergraduate research, peer-to-peer mentoring, first-year seminars, etc.) may fail to create more inclusive environments if faculty mindsets, and a sometimes hostile culture, are not addressed alongside. To address this, we have adopted a multi-faceted approach to mentor development that incorporates training in inclusive mentoring, cultural competence, and unconscious bias. This enhances the success of high-impact practices, maximizing the return on investment and improving outcomes. Cultivating a growth mindset among mentors will allow for more holistic assessment of student potential that promotes diversity and fosters a sense of belonging that allows students to thrive. These initiatives are funded by NOAA, NSF, and the Sloan Foundation.

MULTIDECADAL REMOTE SENSING OF KELP FORESTS IN ARGENTINA

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1- Woods Hole Oceanographic Institution 2- Por el Mar

In recent years, satellite imagery has been utilized to monitor the dynamics of kelp forest canopies across vast temporal and spatial scales. Previous research has focused heavily on Eastern Pacific Ocean coastlines in the northern hemisphere, despite the southern hemisphere having highly productive and abundant kelp forests. Even though the coast of Argentina is home to some of the largest Macrocystis pyrifera kelp forests in the world, there have been few long term studies in Argentina due to its vast remote coastlines, making satellite imagery an invaluable research tool. Landsat satellite imagery was utilized to gather long term data (25 years) across three Argentinian provinces; Chubut, Santa Cruz, and Tierra del Fuego. Given the high variability of kelp forests, long-term data is necessary to elucidate patterns and environmental drivers that are influencing their abundance and distribution. This study found that Santa Cruz and Tierra del Fuego provinces have the largest kelp habitat, and all three provinces showed significant increases in kelp forest canopy area over decadal timescales. Additionally, we found the Antarctic Oscillation (AAO) to be significantly related to kelp forest canopy dynamics in Santa Cruz and Tierra del Fuego provinces. This study provides valuable insight on the size, location, and dynamics of kelp forest ecosystems to inform future conservation efforts.

RISK ANALYSIS OF ELASMOBRANCH SPECIES AS BIOVECTORS USING SATELLITE TELEMETRY

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1- CSU Monterey Bay 2- Channel Islands National Marine Sanctuary 3- University of Hawai'i at Hilo 4- CSU Long Beach 5- Georgia Aquarium

Bioaccumulation of Persistent Organic Pollutants (POPs) in seafood is a topic of concern in Southern California and the recent discovery of a Deep Water Dumpsite off Catalina Island with Dichlorodiphenyltrichloroethane (DDT) has heightened public concern. The high trophic position of elasmobranchs mean they can bioaccumulate POPs, presenting an unknown risk to humans if consumed. This study utilized satellite telemetry to compare the movements of Bat Rays (Myliobatis californica<//i>), Leopard Sharks (Triakis semifasciata<//i>), and Angel Sharks (Squatina californica<//i>), predator species commonly caught by sustenance fishers off of local piers that could be potential biovectors of POPs. Fourteen Pop-Up Archival Satellite Transmitting tags were deployed, providing depth, temperature, and estimated location data on these three species. Angel Sharks (n = 5) and Leopard Sharks (n = 4) used a limited shallower depth range, while Bat Rays (n = 5) made a number of deep dives (over 300 feet). Using Minimum Convex Polygons we found that Bat Rays had large home ranges (avg = 7231.285 +/- 6084.04 km2) that encompass five of the eight Channel Islands offshore in Southern California. The high movement capacity observed in Bat Rays shows their ability to forage in distant locations with unknown contaminant levels before time of capture. Testing of contaminant levels in tissue samples for these three species is underway, as well as further tagging and tracking of Angel and Leopard Shark movement to assess seafood.

Session 19: Fisheries Ecology II

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

ADAPTIVELY MANAGING KELP ECOSYSTEMS FOR MARINE HEATWAVES

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

Marine heatwaves are increasing in intensity and frequency under climate change. The recent extreme warming event (2014–2016) in the California Current System led to the widespread loss of kelp forests, and corresponding increases in urchin 'barrens' across majority of the Californian coast. This and future heatwaves compromise the capacity of California's kelp forests to produce goods and services. In response, there have been calls to understand how we can best manage these areas when threatened by increasing climate disturbances, such as heatwaves. To help address this, we use an urchin-kelp-predator (where the predator is fishery targeted) model to evaluate the likely success of different short-term management and restoration options (temporary fishery closures, urchin culling, restoration of kelp habitat, or a combination) when undertaken before, during, or after a heatwave event. In general, we found actions need to start as soon as the heatwaves begins, and ideally earlier, if they are likely to notably reduce the chance that kelp forests will shift to urchin barrens. Also, concurrent temporary fishery closures and kelp restoration was the only combination that had a greater than additive effect. Our results suggest that short-term management actions targeted towards providing resilience against heatwaves need quick implementation to be effective, as forecasts can only indicate heatwave likelihoods a year in advance.

GROWING PAINS: ESTIMATING GROWTH RATES OF PISMO CLAMS (TIVELA STULTORUM) ON PISMO BEACH, CALIFORNIA

Bills, M.[*]; Glanz, H.S.; Ruttenberg, B.I.

Cal Poly, San Luis Obispo

Pismo clams (*Tivela stultorum*) supported an iconic recreational fishery in California until populations declined in the 1980s. Legal sized clams were absent from Pismo Beach, the historic epicenter of the fishery, from the early 1990s until the last few years. The clam population on Pismo Beach appears to be recovering after recruitment events in 2015 and 2021 and legal sized (114 mm) clams are becoming more abundant. As the population recovers, current estimates of key fishery metrics, such as growth rates, are essential to determining if existing fishery regulations can

adequately support this recovery. The original estimates of growth rates for Pismo clams were conducted in the 1940s and found that they reached legal size in 6-7 years. A more recent aging study (2018-2019) on Pismo Beach using shell aging found that the time to legal size was 14-15 years. To understand this discrepancy in growth rates between the historic estimates and current estimate, we conducted four growth rate experiments to gain a better understanding of the current growth rates of Pismo clams on Pismo Beach. We used our long term monitoring data to conduct a cohort analysis, ran tank and caging experiments, and conducted a mark and recapture study. Comparing the estimated growth rates from these four approaches allows us to develop robust estimates of growth rate for the current population, compare this to historic estimates, and contribute to the management of this recovering recreational fishery by helping set expectations for population recovery and growth to harvestable sizes.

THE PACE OF HARVEST AND RECOVERY IN GEODUCK CLAM STOCKS FIFTY YEARS INTO THE FISHERIES

Carson, H.S.[*]; Stevick, B.C.; Working, O.

WDFW

The commercial fishery for subtidal Pacific geoduck clams (*Panopea generosa*) in Washington State is substantial both by the amount of biomass extracted (2 million kg in 2019) and by the economic value (US $50 million annual). Management for this fishery, which began in 1970, is challenged by this species' long lives, cryptic behavior, and recruitment variability. Current management, including a 2.7 % annual harvest rate, is based on an equilibrium yield model most sensitive to a natural mortality parameter estimated using sampled agedistributions. We collected a large sample for aging from four new sites in Puget Sound to update the yield model and explore its applicability to individual management regions. Based on the new age distributions, natural mortality varies among regions, but is similar overall (0.0231 per year) to the value used in original formulation of the yield model (0.0226 per year), indicating that a change to the harvest rate is not needed if following the outputs of this model. However, concerns remain about the sustainability of the current harvest rate, particularly the time for harvested tracts (delineated harvest areas ranging in size from 0.06 to 1.45 km^2) to return to their preharvest density. We calculated tract recovery rates from serial post-harvest density surveys, compared them to the expected recovery rate derived from the age-based equilibrium model, and investigated possible mechanisms behind fast or slow tract recovery. Using multiple scuba surveys spaced over four decades from 47 tracts in the South Puget Sound, we estimate that tracts recover on average at 0.03 geoducks per square meter per year. The projected average time to recovery is 55 years, compared to a projection of 39 years when the yield model was developed. There is some support for the hypothesis that tract recovery rates have slowed in recent decades. Although there were strong spatial patterns, with higher recovery in central basins compared to within inlets, there was only weak support for the hypothesized mechanisms behind tract recovery such as mean current speed. Our inability to clearly relate recovery to physical variables such as habitat, paired with extreme interannualvariability in recruitment suggested by the age distributions, supports the hypothesis that the strength, timing, and spatial extent of episodic recruitment events is the primary driver of tract recovery. Currently, harvestable biomass estimation and fishery management assume that all previously harvested tracts will eventually recover to preharvest densities. However, in the South Puget Sound, only 40% of tracts are likely to recover on a 50-year time frame relevant to management. Despite our validation of the key parameter used in the yield model, we advocate switching geoduck management to a tract-recovery-based strategy in which harvest is paced to known tract recovery, and biomass estimation is restricted to only those areas likely to hold renewable resource. This study highlights the importance of evaluating recovery patterns of stocks once data over appropriate timescales are available, and comparing to the management model to determine if fishery goals are being met.

LEARNING TO COUNT WITH ENVIRONMENTAL DNA

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1- University of Washington 2- NOAA Fisheries

Resource management often requires quantitative estimates of abundance for species of interest. Consequently it is important to understand and communicate the ways in which eDNA observations do — and do not — relate to underlying abundance. Here I will highlight ongoing quantitative work in both single-species and multi-species contexts and at a range of spatial scales, with particular emphasis on eDNA being used for practical management purposes. As eDNA analyses become more common and more sophisticated, it is increasingly tractable to know more precisely what

we're measuring.

RESULTS FROM TEN YEARS OF PARTNERSHIP DRIVEN YOUNG-OF-THE-YEAR ROCKFISH SURVEYS IN THE SOUTH SALISH SEA

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1- Paua Marine Research Group 2- NOAA Fisheries West Coast Region

Knowledge of rockfish recruitment dynamics and habitat utilization by recently settled rockfishes is valuable for developing appropriate fishery management and recovery actions. Until 2015, no survey effort sought the spatial and temporal data necessary to fill these gaps in the southern Salish Sea. To address this need, NMFS collaborated with state and federal agencies, non-profit groups, and academic institutions to develop a citizen science SCUBA survey program directed at young-of-the-year (YOY) rockfishes. In this program, volunteer and professional divers perform timed roving surveys in discrete habitat types, recording data on rockfish abundance in four morphological classes, as well as qualitative habitat data. Continued and focused outreach effort has led to increased survey participation over time, while better coordination and agency support has allowed for more frequent professional surveys. General trends in YOY encounter across basins, habitat types, and seasons are explored, along with a novel statistical approach for calculating a recruitment index and plans to expand work throughout the northern Salish Sea. The applications of these data are growing as partner participation increases and additional years of data better define a baseline of YOY recruitment in Puget Sound and connected waters. After ten years, the program continues to grow and inform critical recovery actions outlined in the National Marine Fisheries Service Rockfish Recovery Plan for Puget Sound/Georgia Basin.

SEA CUCUMBER SPAWN TIMING IN PUGET SOUND: A CO-MANAGER COLLABORATION

Frierson, T.[1*]; Stevick, B.[1]; Carson, H.[1]; Brown, R.[2]; Stearns, G.[3]; Anderson, S.[4]; Vetak, Z.[4]; McHugh, M.[5]; Raymond, A.[6]; Russell, M.[7]

1- WDFW 2- Squaxin Tribe 3- Puyallup Tribe 4- Suquamish Tribe 5- Tulalip Tribe 6- Jamestown Tribe 7- Lummi Tribe

The commercial sea cucumber (*Apostichopus californicus*) fishery in Washington is co-managed by state and tribal biologists with annual harvest quotas set around a seasonal spawning closure period. This closure period was originally set for June-July, based on available gonad index data from British Columbia sea cucumbers in the 1980s. More recent data collected by tribal biologists in the San Juan Islands in 2014-15 signaled that sea cucumbers from this area may reach their peak gonad index much earlier than the closure period, and that interannual variation in water temperature may be a contributing factor. The co-managers responded by extending the spawn closure period earlier to include March and April, but this can also impede the commercial harvest season resulting in unused quotas. This study is an ongoing collaboration among sea cucumber co-managers that aims to examine their spawn timing on broader spatial and temporal scales to ensure the proper spawn closure period can be enlisted in all fishery management areas while allowing reasonable harvest opportunity. Initial year one results indicate that sea cucumbers in the northern regions may have an earlier peak spawning period than those in the southern regions, contrary to our a priori hypothesis that annual spawning would be initiated by warming waters. Please embark with us on a journey about the sea cucumber reproductive cycle and fishery management decisions.

INVESTIGATING GROWTH POTENTIAL AND FERTILIZATION RATE OF HYBRID EASTERN OYSTERS IN TEXAS

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1- Texas A&M University-Corpus Christi 2- Texas A&M University - Corpus Christi

Oyster aquaculture thrives along many coastal areas in the United States, particularly in Pacific and Atlantic regions of the country where research on oysters is extensive. However, in the Gulf of Mexico (GoM), research on the genetics of eastern oyster, *Crassostrea Virginia*, is limited, leaving significant gaps in scientific knowledge about these organisms. The GoM offers unique environment along the Texas coast, characterized by varying salinity and temperature across the multiple bays. Previous research indicates that eastern oysters in Texas are divided into two populations with distinct environmental tolerances, including a genetic transition zone where naturally occurring hybrid oysters can be found. Therefore, the goal of this research is characterizing growth and reproduction of hybrid oysters. This involves monitoring fertilization rates from

both oyster populations and their hybrids, observing their larval development, and deploying adult oysters at a local farm in Corpus Christi Bay to monitor and compare their growth rates. Currently, environmental stressors and the high demands of commercial fishing have led to reductions in Texas oyster populations over time. The results of this study will offer valuable information that can guide the selective breeding of aquaculture lines, as well as development of conservation and fishery management plans for these vital organisms.

Session 20: Physiological Ecology II

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

INTERTIDAL, PERENNIAL AND THRIVING: LIMITED EFFECTS OF TEMPERATURE ON PHYSIOLOGY AND CALORIC DENSITY OF OREGON KELPS

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Oregon State University

Kelp forests and beds provide coastal primary productivity and contribute to secondary productivity through tropic transfer directly through herbivory and indirectly as detritus. The increasing frequency and duration of marine heatwaves (MHWs) and associated loss of large kelp forests raise concerns about potential effects on intertidal kelp beds. The two most abundant Oregon intertidal kelps (*Egregia menziesii* and *Hedophyllum sessile*) are both perennial species, and *Egregia* has previously been reported to be a favored food source for purple urchins and abalone. The two main objectives of this work were 1) quantify seasonal variation and the effects of MHWs on caloric content of both perennial Oregon intertidal kelps & 2) assess how exposure to various water temperatures in the lab impacts photosynthetic rate and caloric content of *E. menziesii*. The caloric density of *E. menziesii* and *H. sessile* collected every season from January 23' to September 24' (N=180) did not differ between heatwave and non-heatwave months, and the two species exhibited similar caloric densities year-round. In the lab, we exposed young *E. menziesii* to three temperatures (13°C, 14°C, 15°C) and tracked their photosynthetic rates for 24 days. Results indicated initial exposure to 15°C led to significantly higher photosynthetic rates compared to 13°C and higher temperatures maintained these higher rates throughout. Caloric densities were significantly higher in 15°C treatments compared to the other two. Collectively, higher temperatures did not have a negative impact on physiology of this widely distributed species.

THE EFFECT OF DAILY TEMPERATURE RANGES (DTR) ON THE PHOTO-ACCLIMATION OF TROPICAL CORALS

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CSU Northridge

Thermal priming is a form of acclimatization altering organism phenotype in response to initial thermal regimes that improves survivorship to subsequent thermal stress. We tested for acclimatization to daily temperature ranges (DTR) in corals as a mechanism supporting thermal priming as protection against future high temperature. In August 2023, massive *Porites* spp. from two back reef sites with contrasting monthly mean DTRs of 0.84ºC and 1.60ºC in Moorea, French Polynesia, were incubated at 26.71ºC and 29.93ºC to test for thermal priming associated with the DTRs at their collection sites. Massive *Porites* spp. from the high DTR site displayed acclimation of maximum photochemical efficiency of open RCIIs (F_v/F_m); at 29.93°C, F_v/F_m of corals from the high DTR site was unaffected but was reduced 5% in corals from the low DTR site. In April/May 2024, *Acropora hyacinthus* from one back reef site was incubated at stable (29ºC) versus DTRs of 2ºC vs 4ºC to test for acclimation. After 24 hrs, the effective photochemical efficiency of RCIIs in actinic light ($\Delta F/F'_m$) was depressed 14% under 4°C-DTR relative to 29ºC but was indistinguishable between 4ºC-DTR and 29ºC after 18 days. The recovery of $\Delta F/F'_m$ under 4ºC-DTR indicates photo-acclimation. DTR can reduce impacts of thermal stress on corals by diminishing reductions in photochemical efficiency of coral symbionts, but the small effect size and short persistence of effects for these response variables do not support the hypothesis that DTR has universal beneficial consequences for corals exposed to high temperature.

THE EFFECT OF 3-D COLONY STRUCTURE ON HEAT-INDUCED BREAKDOWN OF THE CORAL-ALGAL SYMBIOSIS AND THEIR METABOLIC RESPONSE

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1- CSU Long Beach 2- Hopkins Marine Station, Stanford Univeristy 3- Hopkins Marine Station, Stanford University

The increased frequency and intensity of marine heat waves have been the leading cause for the symbiotic breakdown between the coral host and symbiont, resulting in mass bleaching events. Many studies have assessed the mechanistic cascades and bleaching responses in corals, yet the underlying mechanisms maintaining homeostasis in the face of variable temperatures is poorly known. Here, we investigate the role that multi-cellular colony structure plays in respiration and photosynthesis by comparing small intact microcolonies to single cell suspensions in the coral, *Pocillopora damicornis*. Adult *P. damicornis* were fragmented into 3-5 mm nubbins for the microcolony experiment, while 1-inch nubbins were dissociated into single cell suspensions for the cellular analysis. Corals were exposed to a single acute heat stress during which respiration and photosynthesis were measured. Symbiont densities and colony tissue health were measured after 5 days. Thermal performance curves from 28˚C to 37˚C revealed that microcolonies exhibited 1.5 – 5.0 times greater photosynthesis and respiration rates than single cell suspensions, suggesting that the 3-D structure of coral colonies play a strong role in maintaining metabolic flux. However, microcolonies and cells showed similar temperature maxima and showed similar strong declines of respiration, photosynthesis, and symbiont densities at high temperature exposure. These findings suggest that 3-D colony structure in corals strongly affects overall rates of metabolism but has less effect on the way that heat causes bleaching.

COMPARATIVE 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 death among many sea star species along the North American west coast since its initial outbreak in 2013/2014. Sea star species vary in susceptibility, though it is unknown why. We investigated this question with three species of varying susceptibility, from highest to lowest - *Pycnopodia helianthoides*, *Pisaster ochraceus*, and *Dermasterias imbricata*. A star from each of those species were co-housed in tanks, with half of the bins each containing a focal disease agent of a *P. helianthoides* that was injected with coelomic fluid from a wasting star, and the other half of the bins each containing a focal control agent of a *P. helianthoides* that was injected with heat-killed coelomic fluid from that same wasting star star. Coelomocytes collected from Day 12 of the experiment were selected for RNA extraction and total RNA sequencing. This time point was chosen because it is associated with early disease signs and stars are likely beginning to launch an immune response. 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. The gene expression of the stars was compared across species in order to determine if there are any different genetic responses occurring that might relate to their differences in susceptibility.

SPATIAL AND TEMPORAL DIFFERENCES IN PACIFIC OYSTER PERFORMANCE: INTERACTIONS BETWEEN ENVIRONMENTAL STRESS AND CHROMOSOME COPIES.

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1- University of Washington, School of Aquatic and Fishery Sciences 2- NOAA Northwest Fisheries Science Center 3- Emory University 4- Baywater Shellfish 5- University of South Carolina 6- Bates College

It is essential that we understand how environmental stressors impact individuals to prepare, plan for, and mitigate the impacts of climate change. Bivalves support important ecosystem functions and are important aquaculture species along the west coast of the USA. Triploid (individuals with three sets of chromosomes) Pacific oysters, *Crassostrea gigas*, make up a significant portion of farmed bivalves due to their faster growth and

increased marketability. Triploids, however, experience higher mortality than diploids. Mortality occurs in summer when environmental conditions are more stressful, so it is hypothesised that it is due to interactions between environmental conditions and chromosome number. The physiological mechanisms behind differences in mortality, however, are unclear. Here, we examined how interacting environmental stressors

(temperature, pH, hypoxia) impact Pacific oyster performance throughout Puget Sound, WA. We outplanted diploid and triploid oysters at four shellfish farms, monitored performance (mortality, growth, respiration, shell strength), and collected environmental information in summer 2023 and 2024. In 2023 we observed a pulse of high mortality at only one site that coincided with a drop in oxygen levels. In 2024 triploids exhibited higher mortality at intertidal sites relative to subtidal sites suggesting an environment - chromosomal number interaction. Spatial and temporal differences in respiration existed but did not correlate with variation in environmental conditions or survival. Results indicate performance varies between sites with no clear impact of a single stressor on oyster performance. This highlights the need to consider variation in multiple interacting stressors over small spatial scales to develop strategies to manage the impacts of climate change in coastal ecosystems.

PLASTICITY AND ADAPTATION SHAPE GEOGRAPHIC VARIATION OF THERMAL TOLERANCE IN THE INVASIVE GOLDEN STAR TUNICATE, BOTRYLLUS SCHLOSSERI

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1- UC San Diego 2- Western Washington University 3- Woods Hole Oceanographic Institution

Populations can differ with respect to their thermal physiology, with variation often observed across gradients in environmental temperature with latitude or elevation. The tempo at which phenotypic plasticity and/or local adaptation are able to shape variation in thermal tolerance has implications for species persistence under an increasingly volatile climate. Having encountered novel environments during introduction and subsequent range expansion, non-indigenous species (NIS) present useful case studies for examining thermal tolerance differentiation on contemporary time scales. Here we test for differentiation of heat and cold tolerance among three populations of the invasive golden star tunicate, *Botryllus schlosseri* spanning a 24.3 degree latitudinal gradient in the Northeast Pacific. We observed differentiation of post-larval heat tolerance among our sites, with our southern, putatively warm adapted population exhibiting a significantly higher LT50 than the two more northern populations. We synthesize these results with previous data for this species from the Northwest Atlantic, demonstrating consistent adaptive shifts in heat tolerance coincident with environmental temperatures. We also found that adult cardiac performance at cold temperatures is progressively greater at colder, higher-latitude populations. This pattern of countergradient variation of cold tolerance suggests compensatory genetic adaptation to colder environmental temperatures. By examining both heat and cold tolerance simultaneously among populations of an invasive ascidian, we document how a marine ectotherm is capable of shifting its physiology to novel environmental conditions over compressed time scales, with implications for the spread of this invasive species and, more broadly, for species' responses to temperature in an era of global change.

KETONE BODIES AND THE STRESS RESPONSE IN A LARGE MIGRATORY ELASMOBRANCH (CARCHARIAS TAURUS)

Craig, C.N.[1*]; Lyons, K.[2]; Frazier, B.[3]; Lewis, J.M.[1]

1- Georgia Southern University 2- Georgia Aquarium 3- South Carolina Deparment of Natural Resources

Elasmobranchs have a distinct metabolism in contrast to other vertebrates and are frequently caught in both recreational and commercial fisheries. This capture often involves physical restraint, handling, and air exposure which triggers a stress response. This involves an increase in metabolites like glucose to help meet increased fuel demands and increases in lactate, indicative of metabolic stress. While most vertebrates tend to use glucose as a primary metabolic fuel source, elasmobranchs are known to use ketones. Changes in glucose and lactate in response to stress in elasmobranchs has been well documented, but less work has been done on ketones. In this study, the blood metabolites glucose, lactate, and ketones: beta-hydroxybutyric acid (BHB) and acetoacetate (AcAc), were used to evaluate the response to acute stress. Sharks were captured via longline and after securing animals a blood sample was taken along basic morphometrics (sex and length), soak time and water temperature. Plasma was analyzed for glucose, lactate, and ketones. While lactate had a significant positive relationship with soak time indicating a metabolic stress response, ketones had no relationship. However, sex and length had a significant interactive effect on ketone concentrations. Sex and

ontological differences may account for these trends, but more work is needed to understand these patterns. Additionally, more work is needed to understand the role ketone bodies may have in the elasmobranch stress response.

EFFECTS OF TEMPERATURE ON GROWTH PHYSIOLOGY MAY HELP EXPLAIN LATITUDINAL PATTERNS OF SIZE IN A MARINE SNAIL

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Growth rates often increase with temperature, yet organisms generally grow to larger sizes in colder environments. General reasons for this pattern are unclear, but explanations can be aided by physiological models. In this study, we measured the energetics underlying growth in an intertidal snail, *Tegula funebralis*. The physiological scope for growth was estimated using measurements of energy acquisition and expenditure across a range of body sizes and temperatures. This was paired with field measurements of growth across a broad range of cool and warm water locations to evaluate whether the effects of temperature on bioenergetic processes can explain geographic variation in growth form. We described energy acquisition and expenditure as the best of seven models using AIC scores (acquisition (A): $A=e^{(-2.52+0.03T)}m^{(0.47-0.01T)}$; expenditure (E): $E=e^{(-7.22+0.05T)}m^{(0.41+0.02T)}$ where T is the temperature treatment and m is the mass). The data suggests the scope for growth is highly temperature dependent and largely driven by temperature effects on respiration. These models were then used to obtain the relative surplus energy at a given temperature and size. Taken together these results suggest reduced physiological scope for growth at high temperatures. Higher temperatures shifted the surplus energy curve such that growth reached an asymptote at smaller sizes. Our model accurately predicted the observed gradient of smaller maximal sizes from north to south in the study region. These results suggest that a clearer understanding of the physiology underlying growth can help explain a major gradient in life history differences.

Session 21: Ecosystem Ecology I

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

ENHANCING PISCO KELP FOREST MONITORING THROUGH ENVIRONMENTAL DNA (EDNA) METABARCODING OF THE COI GENE

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1- Moss Landing Marine Labs 2- MBARI

Kelp forests are one of the most highly productive marine systems on the planet. Numerous fish and invertebrate species depend on (Macrocystis pyrifera) *Italic text* as a foundational species and ecosystem engineer by providing a plethora of ecosystem services. Aside from supporting high levels of biodiversity, kelp forests aid carbon sequestration, regulate water flow and coastal erosion, and provide refugia for numerous commercial and recreational fisheries. This research investigates the application of environmental DNA (eDNA) metabarcoding as a tool to enhance kelp forest monitoring and restoration along the Central California coastline. The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) has monitored kelp forests from southern California to southern Oregon since 1999. As kelp forest surveys are highly intensive, eDNA metabarcoding of the COI gene will give us a snapshot of the diverse array of organisms present. The field of eDNA is rapidly progressing and has the potential to redefine contemporary paradigms established by traditional monitoring and survey methods. The COI gene region is one of the most widely available and used sequence region in public reference libraries. It is ideal for community analyses like kelp forest monitoring. In 2020, PISCO divers collected water samples from two paired sites of reference and state marine reserves, in the Big Sur marine protected areas (MPA). After spending ten weeks in the MBARI 2024 Summer Internship, we found that eDNA detected a greater number of phyla and taxa in comparison to the PISCO visual surveys.

FATTY ASTEROIDS: USING FATTY ACIDS AS DIETARY INDICATORS FOR A THREATENED KELP FOREST PREDATOR

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1- University of Oregon 2- Oregon State University 3- UC Santa Cruz

The sunflower sea star *Pycnopodia helianthoides* is a generalist predator which consumes a wide variety of marine invertebrates, including many kelp forest grazers. The population decline of this predator due to sea star wasting disease makes understanding their consumption of kelp forest herbivores urgent. Observation and gut contents have previously been used to estimate diet, but these methods offer “snapshot” data whereas trophic tracers such as fatty acids (FA) offer a reflection of long-term diet assimilation. To determine whether diet has an effect on FA composition within *P. helianthoides* tissues, we fed (n=19) sea stars five monospecific diet treatments of common prey for ten weeks in Sitka, AK: two sea urchins (*Strongylocentrotus droebachiensis* and *Mesocentrotus franciscanus*), abalone (*Haliotis kamtschatkana*), clams (*Saxidomus* sp.), and snails (*Tegula pulligo*). Arm tip tissue was sampled from each star at 5 and 10 weeks. After 10 weeks, the sea star FA profiles were overall significantly different between diet treatments ($p << 0.01$). However, pairwise comparisons showed no significant difference between the two urchin diets, indicating that diet does affect FA composition but that the effects of closely related prey are difficult to distinguish. Additionally, grazers (gastropods, urchins) produced different predator FA profiles than filter feeders (clams). These captive FA profiles will be compared to those of wild stars, potentially providing a way to estimate the trophic effects of these important predators.

BARRIERS TO KELP FOREST RECOVERY IN BAJA CALIFORNIA

† Paz-Lacavex, A.[1*]; Ferreira-Arrieta, B.L.[2]; Beas-Luna, R.[3]; Lorda, J.[3]; Malpica-Cruz, L.[3]; Raimondi, P.[1]; Carr, M.H.[1]

1- UCSC 2- affiliation not listed 3- UABC

Along Baja California, Mexico, there has been substantive loss and subsequent lack of recovery of giant kelp, *Macrocystis pyrifera*, forests. It is unclear whether this lack of recovery is due to 1) ongoing unfavorable environmental conditions, 2) recruitment limitation (i.e. spore delivery) subsequent to forest loss, or 3) early post-settlement mortality, likely from herbivory. Purple urchins dominate at shallow depths, while gastropods are most prevalent at deeper depths. At Campo Kennedy, near Ensenada, we first examined whether environmental factors are still impeding recovery. Long-term data on temperature and nutrients show these conditions have returned to pre-2014–2016 marine heatwave levels, suggesting environmental factors are not the primary barrier to recovery. Next, we experimentally assessed spore limitation and grazer impacts on recruitment. No kelp recruits were observed, even in grazer-exclusion treatments, indicating recruitment failure due to limited spore delivery at the study site. Finally, we evaluated the effects of urchins and gastropods on early-stage benthic community development. Both grazers significantly reduced algal cover and the invertebrate assemblage, with greater richness in grazer-free plots. This study demonstrates that recruitment limitation is a key barrier to kelp recovery at the study site and highlights the broader ecological impacts of herbivory. Moving forward, we will outplant giant kelp sporophytes to further evaluate the effects of grazers on kelp recruitment and their combined effects on benthic community structure.

HOLD THE SALT! IS THERE SPATIAL BULL KELP REFUGIA FROM PURPLE SEA URCHINS AT FRESHWATER INPUTS ALONG THE MENDOCINO COAST?

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Anecdotal observations and preliminary studies of persistent kelp beds at river mouths along the Mendocino coast have been of great interest since the dramatic decline of kelp beds in the mid 2010’s. Our group at Cal Poly Humboldt has been testing the hypothesis that purple urchin grazing is reduced at these lower salinity areas. SCUBA surveys have been conducted at 4 river mouths and 4 references with little to no freshwater influence. Salinity loggers have also been deployed to capture changes in salinity throughout the winter season at these sites. Lastly, laboratory urchin feeding experiments with decreased salinities have been conducted. Field results show dramatic differences in urchin populations, with virtually no urchins present in the kelp beds at the mouths of rivers. There is also little evidence of small juvenile urchins at the mouths of rivers, possibly reflecting a lack of recruitment or high post-settlement mortality at these sites. Field loggers reveal decreases in salinity

below 20 PSU on a regular basis in the winter months and occasionally below 15 PSU. Lab experiments show a strong reduction in urchin grazing with decreases in salinity (at salinities 26 to 22 PSU) and increases in mortality at and below 18-20 PSU. Taken together, these results support the hypothesis that kelp refugia persist at the mouths of rivers on the Mendocino coast due to reductions in grazing by purple urchins.

HISTORICAL AND POTENTIAL FUTURE IMPORTANCE OF MARINE MEGAFAUNA SUBSIDIES TO TERRESTRIAL ECOSYSTEMS

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1- UC Santa Cruz 2- UC Santa Barbara 3- Oregon State University 4- The Nature Conservancy 5- NCEAS 6- Cal Poly SLO

Marine megafauna exert tremendous influence on the structure and function of ocean ecosystems, yet there is mounting evidence that the ecological impacts of marine megafauna also cross the land-sea interface and modify terrestrial ecosystem dynamics. Marine megafauna connect land and sea by serving as large, calorically-rich food sources for terrestrial consumers and by transferring marine-derived nutrients onto land as gametes and excreta. In this presentation, we synthesize empirical studies from around the world to describe the diversity of terrestrial vertebrate consumers that exploit marine megafauna as a food source and outline the ecosystem consequences that are elicited by these cross-ecosystem nutrient subsidies. Given that widespread commercial exploitation has decimated marine megafauna populations globally, we hypothesize that linkages between land and sea once mediated by these animals have been reduced from historical periods to the present day. However, megafauna recoveries are possible and in some cases already underway, potentially leading to the restoration of these marine-terrestrial connections and subsequent shifts in coastal ecosystem dynamics.

BAJA CALIFORNIA KELP FOREST DECLINE THROUGH THE LENS OF SOCIAL-ECOLOGICAL NETWORKS

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1- UABC 2- affiliation not listed

Kelp forests in Baja California have drastically declined, and the small-scale fisheries (SSF) they support are threatened. Using the Social-Ecological System approach (SES), we study a fishing village in Baja California. The objective was to construct a network model of the SSF-SES, with the nodes representing the social and ecological components and the links representing their interactions. Also, we simulated the effects of social-environmental impacts using the built model. We analyzed three node removal simulation scenarios: random failures, direct network impacts, and social-environmental disturbances. Results showed a centralized social system with well-defined subgroups. Secondly, a less centralized ecological system with homogeneous connections, and thirdly a, SES with well-defined subgroups highly connected. We discovered this network is more sensitive to direct changes than randomly removing nodes. Our exercise suggests which nodes play a significant role in supporting network structure. We concluded that affecting social nodes could have a higher impact on the SES than removing ecological ones. We highlight the importance of local stakeholders in SES and maintaining management strategies as co-interventions to support network structure.

TRACKING AN OUTBREAK OF BIVALVE TRANSMISSIBLE NEOPLASIA IN MYA ARENARIA IN THE PUGET SOUND USING HEMOLYMPH AND EDNA SURVEYS

Child, Z.J.[1*]; Weinandt, S.A.[1]; Lartey, D.[1]; Maxfield, H.[2]; Santos, A.[2]; Garrett, F.E.[1]; Smith, P.D.[1]; Dimond, J.[2]; Metzger, M.J.[1]

1- Pacific Northwest Research Institute 2- Western Washington University

Bivalve Transmissible Neoplasia (BTN) is a transmissible cancer in which neoplastic cells are spread through the water column, and taken up by new hosts (likely through filter feeding), after which they proliferate throughout the hemolymph and tissues of the newly-infected animal. In the soft-shell clam *Mya arenaria*, BTN had previously only been observed on the Northeastern Coast of the United States, as well as on Prince Edward Island, Canada. Here we observe previously undetected spread of *M. Arenaria* BTN (MarBTN) on the Western Coast of the United States, in the Puget Sound, Washington. Through use of microscopy, and qPCR assays targeting both nuclear and mitochondrial markers, we have observed

MarBTN and MarBTN-specific DNA in seawater and hemolymph samples taken from multiple locations in the Puget Sound's Whidbey Basin. Disease prevalence was determined through testing of *M. Arenaria* hemolymph with a nuclear qPCR assay, and is highest in Triangle Cove at 81.5%, followed by the greater Stanwood area at 77.3%. MarBTN-specific mitochondrial eDNA can be detected by qPCR in seawater 10 miles northwest of Stanwood in Martha's Bay, with copy numbers remaining high through most of the Skagit River delta, as well as 8 miles west towards Saratoga Passage. Near Triangle Cove, elevated MarBTN copy numbers can be found in Livingston Bay, with low-positive samples as far south as Langley and Tulalip. eDNA samples from the Hood Canal, Admiralty Inlet, and Central and South Basins of the Puget Sound remain negative, but future monitoring remains necessary to track the spread of this disease.

USING MULTI-DECADAL DATASETS TO COMPARE LANDSAT AND AERIAL PHOTOGRAPHY METHODS FOR MAPPING FLOATING KELP IN WASHINGTON STATE

McKenna, G.*; Claar D., ; Berry, H.; Cowdrey, T.

Washington State Dept. of Natural Resources

Kelp forests are a critical nearshore habitat in Washington waters. Because they exhibit high interannual variability, long-term monitoring is necessary to understand population dynamics and trends. Various remote sensing methods have been employed to monitor floating kelp in recent decades. Further research is needed to gain a robust understanding of how methodological factors influence results across distinct environmental contexts. This presentation explores two multi-decadal remote sensing datasets of kelp canopy area on Washington's Olympic coast and western Strait of Juan de Fuca: Landsat satellite imagery by KelpWatch and aerial photography by WA DNR. The Landsat-derived quarterly data covers a large area at a relatively low spatial resolution with coverage dating back to 1984. WA DNR's aerial photography spans a similar time period (since 1989) but was collected at a higher spatial resolution and during low tides, calm seas, and minimal clouds. Comparison of these datasets found that: 1) correlation between aerial- and Landsat-derived kelp canopy area estimates can be increased by using whole-pixel area and Q3 means from the Landsat data, 2) the two datasets showed similar patterns in canopy area at a broad spatial scale, but patterns at more detailed spatial scales were frequently distinct; and 3) multiple factors influenced the strength of the correlation between the datasets. This analysis helps inform managers when, where, and how to use each dataset and their derivative products in decision-making.

Session 22: Conservation and Restoration III

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

NAVIGATING COASTAL ECOSYSTEM RECOVERY: LEVERAGING SYNERGIES OF NATURE-BASED SOLUTIONS

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Universidad Autónoma de Baja California

We implemented a systematic literature review to explore the application of marine Nature-based Solutions (NbS) for coastal ecosystem recovery and how this approach can address key societal challenges such as climate change, disaster risk reduction, and biodiversity loss. Our results reveal the synergistic opportunities between societal needs and NbS's benefits to coastal ecosystems. For example, to achieve climate-resilient agriculture, the risk of flooding can be reduced by restoring mangroves that can serve as nursery areas for fish, which in turn benefits economic development, food security and biodiversity. We also found critical gaps in current knowledge and applications of NbS, highlighting the urgent need for interdisciplinary collaboration and strategic co-intervention. As a case study, we focus on challenges specific to Mexico's heavily impacted temperate reefs and kelp forests, emphasizing the localized approaches needed for effective ecosystem recovery. We aim to promote a holistic interdisciplinary approach that leverages the ecological, social, and economic benefits of NbS to foster sustainable development and enhance ecosystem resilience, benefiting both the environment and local communities.

COMBINING DRONE IMAGERY AND DEEP LARNING TO AUTOMATE SPECIES-LEVEL MAPPING OF KELP FORESTS

Reshitnyk, L.Y.*; Denouden, T.; Holmes, K.R.

Hakai Institute

The accessibility and affordability of remotely piloted aerial systems (RPAS, or drones) has facilitated the use of these platforms for monitoring kelp forests (*Macrocystis pyrifera* and *Nereocystis luetkeana*. However, a large latency exists between a RPAS survey and deriving the spatial extent of kelp from RPAS imagery using currently available methods. Very recently, the application of deep learning artificial intelligence algorithms presents opportunities to develop new methodologies to detect patterns and objects in high-resolution imagery, potentially providing more efficient and accurate methods to study the spatio-temporal dynamics of kelp. Here, we use a dataset of paired RPAS imagery and species-level kelp classifications (n=28) collected in British Columbia, Canada and California, U.S.A., to train two deep learning algorithm to automate the detection of floating canopy-forming kelp in RGB and multispectral RPAS imagery. We compare the performance of the algorithm to classify (1) kelp presence/absence and (2) kelp species. The results demonstrate high accuracy and high efficiency in kelp classification from high-resolution imagery in both validation datasets and novel geographies under a variety of environmental and site conditions. The development of this open-source tool for mapping species level distribution of kelp forests provides an opportunity to improve the efficiency and effectiveness with which we can use RPAS for monitoring kelp forests across the Northeast Pacific and beyond.

OFFSHORE ISLAND EELGRASS (ZOSTERA MARINA) TRANSPLANT CATALYZES RAPID MIRRORING OF STRUCTURE AND FUNCTION OF EXTANT EELGRASSES

† Sanders, R.D.[1*]; Obaza, A.K.[2]; Ginsburg, D.W.[3]; Olivia, C.C.[2]; Grime, B.C.[4]; Burdick, H.[5]; Leichter, J.J.[6]

1- Scripps Institution of Oceanography, Paua Marine Research Group 2- Paua Marine Research Group 3- University of Southern California 4- The Nature Conservancy 5- The Bay Foundation 6- Scripps Institution of Oceanography

Seagrasses are marine angiosperms that function as ecosystem engineers through the creation of complex structure that enhance nearshore environments. Seagrass habitats along the West Coast of the USA are dominated by *Zostera marina* (eelgrass), and advancements in the methodological efficacy of seagrass restoration has mitigated substantial anthropogenic induced losses. Despite this progress, the focus on *Zostera* spp. in shallow, sheltered estuarine environments has forged a dearth of knowledge on seagrass habitats occupying exposed offshore islands in the Southern California Bight. In this study, we conducted a novel transplant of *Z. marina* on Catalina Island, tracked temporal and spatial performance metrics (i.e., areal coverage, morphometrics and fish assemblages) of the restoration site and seven extant *Z. marina* beds on the island from 2021 – 2024. This study created over 0.18 hectare of *Z. marina* habitat, which morphometrically and functionally mimicked or exceeded extant reference beds. Further, these transplanting efforts demonstrate the establishment of vital habitat for the occupancy of, and utilization by, federally listed endangered species and federally managed fishes, and may be used as a model for future management and recovery regimes. These data represent the first holistic study of *Z. marina* transplanting on an offshore island in the region and advance the fundamental understanding of open coast seagrass habitat, while greatly augmenting the capacity to broaden the scope of habitat restoration and improved nearshore temperate ecosystem function.

BLOOD, GUTS, DEATH, AND POOP: CAN YOU TEACH SECOND GRADERS ABOUT PARASITES?

Wood, C.L.*

University of Washington

I teach Parasite Ecology and, every autumn, my classroom fills up with undergraduate students who have never once in their 15 years of education heard a peep about parasites. Parasites are so thoroughly excluded from education at all levels that it isn't uncommon for folks to hold a bachelor's degree in biology without having had a single lecture on parasitism. This makes my job really fun. Few people who are new to the study of

parasites are emotionally prepared for what they will learn, which makes it easy to blow minds.In my new children's book, *Power to the Parasites!*, I do for elementary-aged readers what my undergraduate courses do for unsuspecting bio majors: I take them by the hand, and show them the most important landmarks in the world of parasites - the good, the bad, the ugly, and the sublime. In the end, there is an important lesson: at first glance, parasites might seem slimy, icky, and dangerous. But when you look closer, you learn: we can't live without parasites, and even if we could, we might not want to.In this talk, I will discuss how I took a discipline full of blood, guts, death, and poop and made it appealing, appropriate, and educational for an elementary-aged audience. I hope to inspire you to use Power to the Parasites! in your science outreach efforts. Perhaps you'll even decide to try your hand at writing a children's book in your own area of specialization.

WITH A LITTLE HELP FROM OUR STARFRIENDS: INNOVATIONS AND CHALLENGES TO REGIONAL RECOVERY OF SUNFLOWER STARS IN CALIFORNIA.

Kidd, A.*; Gerald-Yamasaki, C.; Jimenez, M.; Andrade, M.; Lord, S.; Bank, R.; Allen, L.; Freiwald, J.; Fray, J.; Arathoon, R.; Martin, P.; Christian, V.; Kim, A.

Sunflower Star Lab

Sunflower Star Laboratory (SSL) was founded by a community of Californians who witnessed the sea star wasting event off our coast, and were galvanized by the early research and inclusiveness of the Pycnopodia Recovery Working Group to apply sunflower star (*Pycnopodia helianthoides*) restoration solutions in California. Since the non-profit's creation in 2021, we have grown rapidly and played a central role in building partnerships and advancing regional research opportunities, including the first successful ex-situ spawning of sunflower sea stars in the state of California on February 14, 2024. Concomitantly, the laboratory itself has grown into a public facing, multi-system recirculating aquaculture laboratory in Moss Landing, CA rearing offspring from the *cupid* cohort. We have leveraged our community building strengths to ensure that multiple California partners gained institutional knowledge in rearing this species. We engage our global partners by facilitating and coordinating workshops and are actively communicating up-to-date research and developments to the scientific community and beyond through speaking engagements and social media. Through our inclusive volunteer, internship, and outreach programs, we are able to bring our local community along this exciting new path. Here we will lay out how SSL has put our best podia forward to bring us all further along the road to recovery.

MODELING THE DECLINE AND FUTURE RESILIENCE OF KELP FORESTS: INSIGHTS FROM THE ATLANTIC AND PACIFIC COASTS

Balbar, A.C.[1*]; Metaxas, A.[2]; Giraldo-Ospina, A.[1]; Caselle, J.E.[1]

1- UC Santa Barbara 2- Dalhousie University

Kelps, vital ecosystem engineers, create complex three-dimensional habitats that support diverse marine life, enhancing primary and secondary productivity along 25% of the world's coastlines. However, kelp forests are in decline globally due to various stressors, including invasive species and increased storm frequency on Canada's east coast, and extreme warming and overgrazing on America's west coast. Sustained loss of kelp forests is an imminent threat to the biodiversity of coastal temperate environments and the ecosystem services these habitats provide. Restoring degraded reefs to kelp forests presents additional challenges due to hysteresis, where the thresholds for recovery are higher than those that caused the initial decline. Here, we explored the resilience and future distribution of kelp forests through two distinct modeling approaches. On the east coast of Canada, we used theoretical simulations to investigate the effects of habitat loss on metapopulation dynamics, revealing a non-linear relationship between habitat fragmentation and population isolation, showing that patches were primarily self-sustaining at all levels of habitat loss. On the west coast of North America, we used downscaled earth systems models to project future changes to the distribution and abundance of kelp forests under the RCP 8.5 scenario, anticipating significant declines by 2100 due to rising ocean temperatures and decreasing nitrate levels. These findings are crucial for guiding targeted conservation and restoration efforts to protect these important biogenic habitats.

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

THE INFLUENCE OF TEMPERATURE ON THE SEX RATIO OF NEREOCYSTIS LUETKEANA GAMETOPHYTES

Hughes, T.K.*

University of Washington

Recent declines of the canopy-forming kelp *Nereocystis luetkeana* in the Salish Sea have been linked to physical environmental factors such as seawater temperatures and nutrients. While most studies have tested the responses of adult sporophytes to such stressors, the microscopic life stages of this species are also vulnerable. Previous research has demonstrated that temperature significantly affects gametophyte growth, density, and survivorship in *N. luetkeana*, but its differential effects on male and female gametophytes are not well understood. To address this gap, I conducted an experiment to investigate the relationship between temperature and sex ratio in *N. luetkeana* gametophytes, as well as the frequency and timing of juvenile sporophyte production. Zoospores from two sites in the San Juan Islands, Washington, were cultured at four temperatures (10℃, 12℃, 15℃, 18℃) for 28 days. The cultures were photographed non-destructively at weekly intervals during the developmental period, then gametophytes were categorized using morphological criteria and the presence of sporophytes was recorded. Preliminary findings indicate that the gametophyte sex ratio is temperature-sensitive within the range tested, with elevated temperatures exerting a significant negative impact on fertilization success and sporophyte production. These results highlight the potential implications of climate change on the reproductive dynamics of *N. luetkeana* and underscore the importance of understanding the thermal sensitivity of all stages of the kelp life cycle.

BROODING CHITONS DISCOVERED ON CATALINA ISLAND HELP EXPLAIN A RARE CASE OF REGULAR SELF-FERTILIZATION IN MARINE ANIMALS

Eernisse, D.J.*

CSU Fullerton

In the 1980s, I described two species of chitons that are both brooders and are still the only known hermaphroditic chiton species. Both also regularly self-fertilize, which is extremely rare among marine animals. Despite their similarities, multiple lines of evidence imply that selfing evolved convergently in each species, likely related to regular inbreeding associated with brooding. I proposed that the theoretical reproductive advantage of selfing is normally countered by inbreeding depression, except that brooders are already highly inbred so brooders that self can prosper. I supported the first selfing brooder, *Cyanoplax fernaldi* (Eernisse, 1986) as sister species of a more southern and gonochoric brooder, *C. thomasi* (Pilsbry, 1898). I provided allozyme evidence that *C. thomasi* was highly inbred in contrast to free spawning *Cyanoplax* species. The second selfing brooder, *C. caverna* (Eernisse, 1986), was less clearly derived from inbred brooders because its nearest relative appeared to be a free spawner, *C. hartwegii* (Carpenter, 1856). That was long before I discovered another new species of brooding *Cyanoplax* on Catalina Island west of Los Angeles. My preliminary reproductive studies have revealed that males are common in the Catalina brooder population, unlike its selfing sister species, *C. caverna*. Now each selfing brooder is paired with a gonochoric sister species that broods. I found more brooders on other Channel Islands, and a combined mitochondrial and nuclear gene region analysis has helped support how brooding led to successful self-fertilization in *C. caverna*.

DRIVERS OF KELP RECRUITMENT ACROSS A REEF LANDSCAPE

† Beckley, B.A.[1*]; Bell, T.W.[2]; Cavanaugh, K.C.[3]; Castorani, M.C.[4]; Cavanaugh, K.C.[3]; Puerzer, F.[1]; Miller, R.J.[1]

1- UC Santa Barbara 2- Woods Hole Oceanographic Institution 3- UC Los Angeles 4- University of Virginia

Understanding how and why populations vary in space and time is a fundamental goal in ecology. Water temperature, nutrients, and wave disturbance are known regional drivers of giant kelp, *Macrocystis pyrifera* , populations. However, drivers of kelp recruitment on local scales (< 2 km) remain elusive, as recruitment often exhibits uncorrelated spatial dynamics due to environmental and biotic factors, such as substrate and light availability, herbivory, and competition, that can vary at small scales and influence recruitment success. To address this gap, we carried out a field survey campaign with high spatial (55 5x5 m^2 plots) and temporal (10 consecutive months) resolution, which included quantifying giant kelp recruitment and hypothesized abiotic and biotic drivers across a reef off Santa Barbara, CA, USA. Preliminary findings reveal a strong positive correlation between kelp recruits (<1 m tall) and benthic light availability. As kelp plants grew larger (>1m tall) their presence was linked to substrate characteristics, particularly vertical relief. These results increase our understanding of how small-scale variation in resource availability and biotic interactions can influence giant kelp recruitment location and success across a reefscape.

DECREASED LARVAL SIZE OF BARNACLE LARVAE IN WARMER NEARSHORE WATERS

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1- University of San Diego 2- Univeristy of San Diego 3- Woods Hole Oceanographic Institution

For marine organisms with dispersive larval stages, temperature is known to influence fundamental biological processes including metabolism and larval development, which may have important implications for larval dispersal. To better understand the relationship between temperature and larval body size, we investigated whether the size of late-stage larvae (cyprids) of the acorn barnacle *Chthamalus fissus* changed with temperature experienced during development. We hypothesized that cyprids that experienced warmer water temperatures would be smaller than those that experienced cooler water. Cyprid larvae were collected within 1 km from shore in coastal San Diego, California, USA, using a semi-vortex pump during 14 cruises between 2014-2016. Additionally, moorings were deployed to collect high-resolution temperature data in the region, and at the depths of larval development. Cruises represented a range of warm and cool water conditions. We measured *C. fissus* length using a digital stereomicroscope, and we examined chlorophyll-a concentration estimated from satellite data as a proxy for food availability during larval development. There was a significant negative correlation observed between cyprid size and water temperature, with decreasing size in warmer water. Additionally, chlorophyll-a concentrations decreased with increasing water temperature. Our field results support that smaller larvae result from faster larval development in warmer waters, and they also suggest that decreases in food availability in warm water might also contribute to smaller larval size. Smaller cyprid size could make *C. fissus* more vulnerable to predators and shorten the lifespan of cyprid lipid reserves, decreasing their chances of survival and allowing less time to reach adult intertidal habitats.

UNPRECEDENTED REPRODUCTION STRATEGY OF SEAGRASS AFTER A MARINE HEATWAVE

Tomas, F.[1*]; Arona, A.[1]; Hernan, G.[1]; Mañez-Crespo, J.[1]; Orero, E.[1]; Reynés, X.[1]; Albalat, B.[1]; Mas, X.[2]; Haverbeck, D.[3]; San Felix, M.[4]; Dattolo, E.[3]; Procaccini, G.[3]; Ballesteros, E.[5]

1- IMEDEA 2- IES Albarg 3- Stazione Zoologica Anton Dohrn 4- SAONA 5- CEAB

Warming can have dramatic effects on plant phenology and reproduction, with important consequences for reproductive output, plant survivorship, or species dispersal. In seagrasses, “vegetative reproduction” through clones is generally the dominant strategy for meadow maintenance and expansion, with sexual reproduction strongly differing amongst species, being rare for some, and often associated with disturbance. In summer of 2022 the Mediterranean Sea underwent unprecedented warming, and, associated with it, we observed a mass flowering event. Furthermore, we detected pseudovivipary (a very rare phenomenon in terrestrial plants) across numerous (>85 % of 38 sites) *Posidonia oceanica* meadows along the Balearic Islands. Pseudovivipary is an asexual reproduction strategy whereby plantlets replace sexual reproductive structures, leading to the maintenance of the maternal clones. This is the first time pseudovivipary is reported across multiple locations in a marine plant and its ecological consequences are monitored. While pseudovivipary does not provide the genetic variation that enables adaptation to stress, pseudoviviparous

plantlets develop much larger and faster than the products of sexual reproduction. Furthermore, the plants investing on producing flowers do worse than those investing on pseudovivipary, suggesting that pseudovivipary may provide an ecological advantage when seagrass undergoes acute stress from warming.

ON CUE: EXPLORING SETTLEMENT TRIGGERS IN THE LARVAE OF THE SUNFLOWER SEA STAR (PYCNOPODIA HELIANTHOIDES)

Kim, A.[1*]; de Jong, C.[1]; Spindel, N.B.[1]; Kahn, A.S.[1]; Hodin, J.[2]; Hamilton, S.L.[1]; Gardner, L.[1]

1- Moss Landing Marine Labs 2- University of Washington, Friday Harbor Labs

The disease-driven extirpation of sunflower sea stars (*Pycnopodia helianthoides*) from the southern part of their range has had devastating effects on kelp forests due to an increase of sea urchins grazing on kelp in the absence of this predator. Conservation aquaculture techniques can facilitate potential reintroduction to aid in kelp forest restoration but requires optimizing culturing conditions at all ontological stages. A recent spawning attempt in California resulted in the successful production of embryos which were distributed across several institutions. Larvae in our batch began settling at 27 days post fertilization, at which point we conducted a study to investigate larval responses to a variety of settlement substrates. Larvae exhibited the strongest settlement responses to (1) the presence of the red algae Dulse (*Devalerea mollis*) that had been in contact with red abalone (*Haliotis rufescens*) and (2) an articulated coralline algae (*Calliarthron tuberculosum*). Larvae did not settle in the absence of a settlement substrate, indicating a critical need for cues to induce settlement. Interestingly, we observed that most of the non-settled larvae were still strongly motile at the end of the experiment and successfully settled when exposed to a cue, suggesting this species can delay settlement, potentially for extended periods. These results and subsequent observations have important implications for supporting kelp restoration efforts and provide key insights into this critical juncture in the biphasic life history of this benthic predator.

Session 24: Coral Reef Ecology I

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

COMPARING THE IMPACT OF HISTORICAL DISTRIBTION, RESTORATION AND THE ENVIRONMENT ON SPATIAL PATTERNS OF STAGHORN CORAL ABUNDANCE

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Florida State University

Making decisions with limited resources is a universal challenge for conservation, and management interventions must answer the fundamental question: “Where?” A key step is assembling spatial information to assess where species occur, where they are thriving, and where they are absent but might succeed if reintroduced. Here, we apply novel technologies to answer these questions for the staghorn coral, *Acropora cervicornis*. Until recently, staghorn was one of the most ecologically important corals in the Caribbean, dominating shallow coastlines. It is a fast-growing reef-builder that forms architecturally complex thickets, providing habitat for many organisms. The species has undergone catastrophic declines but persists in remnant patches throughout its former range. Huge effort has gone into conserving these patches and encouraging recovery by establishing restored beds in locations where the species has declined.We assessed the present distribution of staghorn along a continuous 10 km stretch of coastline in Bonaire using a combination of autonomous vehicles and artificial intelligence. We compared *A. cervicornis’* current distribution to historical data from this same area, assessing the relative importance of past distributions, modern environmental conditions and recent restoration efforts for predicting current abundance patterns. The emerging technologies presented here are enabling ecological data collection over unprecedented scales and will be increasingly used to guide the placement of restoration and conservation interventions in the future.

NUTRIENT AND CONSUMER PRESSURE LEGACIES INFLUENCE DEVELOPING CORAL MICROBIOMES

† Kawahara, M.[1*]; Vompe, A.[2]; Speare, K.[1]; Epstein, H.[3]; Bistolas, K.[2]; Adam, T.[1]; Burkepile, D.[1]; Vega Thurber, R.[1]

1- UC Santa Barbara 2- Oregon State University 3- University of Essex

Microorganisms are essential for the accurate development of their hosts. Perturbations in ambient conditions alter the abundance and physiology of these microorganisms and their hosts leading to improper or incomplete development. This is particularly true in marine organisms where shifts in nutrient concentrations, temperature, and benthic community dynamics may disrupt the microbiomes of developing animals resulting in shifts in holobiont ontogeny. However, few studies have tracked these shifts under experimentally manipulated conditions. In this Moorea, French Polynesia-based study, we allowed coral recruits to settle and develop under various experimental conditions, and we tracked their microbiomes and health over 3 years, including across 2 marine heat waves. As *Acropora* are ecologically important and sensitive reef-building corals in French Polynesia, we used them as our model coral-microbiome system. Across 32 replicate plots at 10m depth north of Pao Pao Bay, we built a consumer (herbivorous and corallivorous fishes) pressure gradient to alter the benthos. Additionally, each block of consumer treatments was randomly assigned either ambient or enriched nutrient conditions. Coral recruits therefore were exposed to varying consumer and nutrient pressure gradients their entire lives and are considered to have an 'environmental legacy.' Using 16S rRNA analysis and photogrammetry, we found that our treatments resulted in significantly different benthic community structure and altered microbiome metrics of alpha and beta diversity. Additional microbiome changes also occurred during the recovery stage of the experiment. These results can potentially aid local coral restoration groups as part of the global effort to restore endangered coral reefs by outplanting nursery raised corals, including *Acropora* species.

MAPPING AND MEASURING THE DELIVERY EFFECTS OF SUBMARINE GROUNDWATER DISCHARGE ON CORAL REEF PRODUCTIVITY USING DRONE THERMAL INFRARED IMAGERY

Zummo, S.[*]; Himes, L.; Wang L., ; Kim, G.; Rasi, F.; Yamamoto, R.; La Valle, F.F.[*]

Pepperdine University

Maunalua Bay (O'ahu, HI) has experienced dramatic development in the last century, affecting the water quality of its near shore coral reefs. The main source of land-based inorganic nutrients in Maunalua Bay is submarine groundwater discharge (SGD), a chronic freshwater vector that is known to be cooler than its surrounding oceanic water. The goals of this project are to (1) characterize the nearshore localized nutrient inputs via SGD both spatially and temporally using drone thermal imagery, (2) quantify in situ C-uptake of main primary producers on algal-dominated reefs with SGD influence, (3) and understand how the delivery of these nutrients across the water column and benthos affects these systems. In this talk, we will address the first goal. A DJI Mavic 3T drone was used to take thermal infrared (TIR) images across a reef flat with SGD during night time low and high tides. TIR images covered an area of 48,020 m2 and had a side to frontal overlap ratio of 85% x 85%. Orthomosaic thermal maps of the reef were produced using the software PIX4Dmapper and temperature values ranged from 20.34-22.92℃. TIR data was validated using a YSI (average temperature differences = ± 0.15℃). Inorganic nutrient surface water samples and salinity were also collected during drone mapping to validate that the drone was accurately capturing SGD at the surface of the water column. Our thermal maps successfully captured the thermal signatures of SGD plumes and its temporal fluctuations across the tidal cycle. The previously known SGD seep was easily identified by our maps and a second warm-water seep was found for the first time at this site. Our novel combination of drone TIR mapping with in situ experiments is a cost-effective methodology for elucidating the community-scale effects of SGD.

IMPACTS OF MATERIAL LEGACIES ON LOCAL BIOGEOCHEMISTRY AND CORAL PHYSIOLOGY

† Diaz, L.C.[1*]; Rochette-Yu Tsuen, K.[2]; McClintock, R.[2]; Reed, K.[1]; Silbiger, N.J.[1,2]

1- CSU Northridge 2- University of Hawai'i at Mānoa

Disturbance events on coral reefs change community composition, which could lead to an altered biogeochemical environment as a result of changing ecosystem metabolic rates. Using a mesocosm study, we tested the hypothesis that coral-, rubble-, and algal-dominated communities create unique biogeochemical environments. Further, we hypothesized that the distinct biogeochemistry as a result of changing community composition will alter coral physiology. Our study was conducted in Mo'orea, French Polynesia over 25 days in three community treatment tanks plus a seawater only control (n = 4 replicates per treatment). We focused on organic and inorganic carbon to characterize the biogeochemical environment of each community type. Specifically, we took daily measurements of pH, temperature, dissolved oxygen, and salinity and weekly measurements of total alkalinity and dissolved organic carbon during noon and night over the experimental period. These data were also used to calculate net community calcification and production rates of the communities. To test the effect of the chemistry on coral physiology, we channelized seawater from the community tanks into aquaria containing Porites rus. We measured growth rate, tissue biomass, endosymbiont counts, gross photosynthesis, and respiration in n = 96 corals. Our study highlights how material legacies alter reef biogeochemistry, which may have the potential to alter reef resilience and recovery from future disturbance events.

FEEDING IMPACTS OF PARROTFISH SPECIES AND LIFE HISTORY PHASES ON A CORAL REEF COMMUNITY

Choudhry, T.*; Riley, A.; Shakely, M.; Dearborn, R.; Eckardt, Z.; Tricas, T.

University of Hawai'i at Mānoa

Parrotfish feeding activity promotes coral reef diversity by removing filamentous and turf algae. As sequential hermaphrodites, parrotfish start as initial phase (IP) females before transitioning into terminal phase (TP) males, but the respective impacts of sympatric species are poorly known. We hypothesize that the removal of benthic substrates by parrotfish is dependent upon species and life history stage. We document the feeding activity over a one-year period, substrate selectivity, substrate percent cover, size class, and population structure of IP and TP excavator bullethead (*Chlorurus spilurus*) and scraper palenose (*Scarus psittacus*) parrotfish at Hanauma Bay, Oahu marine preserve. Overall bite rate was higher for palenose than bullethead parrotfish, with phase differences in both. The average bite rate for IP was 66.6% higher than TP (12.8 bites/min) for palenose ($p<0.001$) and 24.9% higher for IP bulletheads (TP=8.61 bites/min) ($p=0.004$). The average bite rate for IP was 23.0% higher than TP (6.51 bites/min) for ember ($p<0.001$) and 52.4% higher for IP spectacled (TP=4.33 bites/min) ($p<0.001$). Terminal phase individuals of both bullethead and palenose were found to be significantly longer than their IP counter parts. Current fishing regulations in Hawaii for each parrotfish species are based on a minimum length limit. Adding the feeding rate and unique policy for both TP and IP individuals will help protect the individuals which have the greatest positive impact on coral reefs. These data warrant a re-evaluation of parrotfish fishing regulations.

THE CHALLENGE 0F CORAL CALCIFICATION: HOW CORAL GROWTH IS CHANING IN MODERN OCEAN.

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Texas A&M University Corpus Christi/Harte Research Institute

Coral reefs serve as natural barriers that protect the coast against storms, flooding, and erosion, which are dependent on sustained calcification by corals. But coral calcification is threatened by rising atmospheric carbon dioxide (CO2), which is causing a decrease in ocean pH. Therefore, this study investigated the impact of ocean acidification (OA) on the calcification and growth characteristics of two dominant Hawaiian corals, Pocillopora acuta and Montipora capitata. Corals were grown under OA conditions for 30 days in outdoor flow-through mesocosms at the Hawaii Institute of Marine Biology. Measurements of coral growth including linear extension, buoyant weight, and bulk skeletal density, were measured before and after exposure to experimental treatments. Preliminary results reveal that perforate branching species M. capitata increased in linear extension under OA but did not increase skeletal density. Conversely, imperforate branching species P. acuta had a slight increase in density but no increase in linear extension. These results indicate that calcification of certain species may persistent under OA but will have tradeoff such as reduced skeletal density.

Session 25: Population Biology and Ecology III

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

COASTAL STRESSORS AND THE EVOLUTION OF MARINE POPULATIONS

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Coastal organisms experience natural and anthropogenic stressors simultaneously across multiple spatial and temporal scales; however, the synergistic or antagonistic effects of multiple stressors are largely unknown. In shallow waters, diurnal cycling of respiration and photosynthesis seasonally produce coupled periods of hypoxia (low dissolved oxygen [LDO]) and coastal acidification (CA [low pH driven by elevated pCO2]). Both LDO and CA can be driven to extreme levels by eutrophication and are expected to worsen with global climate change. Larvae of temperate marine species are likely to encounter multiple cycles of LDO and CA during summer spawning months, and, in urbanized estuaries, are also likely to encounter a third stressor, sewage effluent (SE), a common source of eutrophication. The physiological effects of LDO, CA, and SE have been characterized separately, but they are rarely examined simultaneously, especially in early life history stages when organisms are most sensitive to stressors. Additionally, results from many studies have yet to be examined in a mechanistic framework, such as identifying the genes that provide resistance to multiple stressors. Here, we build from previous work investigating CA and SE and use a coupled experimental and seascape genomics approach to investigate how multiple stressors are shaping the marine genomic diversity of the eastern oyster.

KELP SYNCHRONY: A SYNTHESIS

Castorani, M.C.N.[1*]; Bell, T.W.[2]; Cavanaugh, K.C.[3]; Dugan, J.E.[4]; Emery, K.A.[4]; Hubbard, D.M.[4]; Kadiyala, E.S.[1]; Karatayev, V.A.[5]; Lohmann, A.C.[1]; Reuman, D.C.[6]; Sheppard, L.W.[7]; Walter, J.A.[8]; Wanner, M.S.[1]

1- University of Virginia 2- Woods Hole Oceanographic Institution 3- UC Los Angeles 4- UC Santa Barbara 5- University of Maryland 6- University of Kansas 7- Marine Biological Association of the U.K. 8- UC Davis

Spatial synchrony is a ubiquitous and important feature of population dynamics. Here we synthesize research on the patterns, causes, and consequences of synchrony in California giant kelp forests. A 40-year satellite time series revealed kelp dynamics synchronized over broad geographic ranges (100–1000s of km) at varying timescales (years to decades) by the combined action of wave disturbance and seawater nitrate. These factors are underpinned by ocean climate fluctuations that cause synchronized booms and busts of kelp. Over shorter distances (up to several km), kelp is synchronized by spore dispersal. Hence, synchrony declines with distance, but shows distinct geographic patterns related to coastal oceanography. 20 years of diver surveys at the Santa Barbara Coastal LTER show that synchronous loss of kelp by large waves causes synchronous proliferation of understory algae in a cascade of synchrony driven by light competition. Heterogeneity over space and time in sea urchin grazing and sand burial reduces the chance of synchronous kelp collapse, stabilizing kelp forest–barren dynamics. Lastly, kelp synchrony is transmitted across ecosystem boundaries and up food chains via the transport of kelp wrack from the forest to sandy beaches. Wrack deposition is synchronized across beaches (~50 km), thereby synchronizing local abundances of shorebirds that forage on wrack-associated invertebrates. These studies demonstrate how giant kelp has served as a model species to advance knowledge of synchrony, its response to climate, and the effects on community and ecosystem stability.

THE EFFECTS OF MATING FUNCTION AND MICROEVOLUTION ON POPULATION PERSISTENCE OF GREEN TURTLES IN THE FACE OF CLIMATE CHANGE

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1- Coastal Oregon Marine Experiment Station at Oregon State University 2- Florida State University 3- UMass Amherst

As climate change progresses, sea turtle nesting beaches are warming and producing increasingly more female-skewed hatchling sex ratios due to temperature-dependent sex determination (TSD). Whether or not this will decrease population growth rates depends on the breeding ecology of males. Specifically, we don't know the mating function: the relationship between the adult sex ratio and the overall population reproductive rate. In part, this is because males never come ashore, and so are difficult to sample. Using nesting and genetic data collected from three and a half field seasons with the subpopulation of green turtles (Chelonia mydas) that nest on a beach on Fernando de Noronha, Brazil, I constructed a two-sex, age-based population dynamics model to explore the persistence probabilities of this population 100 years into the future, under different temperature change scenarios and with different mating functions. Preliminary results show that as incubation temperatures increase, population persistence requires that males are able to mate with more and more females. However, past a warming of 1.5°C total, even a mating function where a male can successfully fertilize 49 females is not enough. We also added the possibility of evolutionary rescue in the form of adaptive shifts in the pivotal temperature at which clutches produce a 50:50 sex ratio. However, that form of adaptation was also unable to save the population past a 1.5° C increase. The population may therefore require rescue from evolution of thermal tolerance, phenotypic plasticity, metapopulation dynamics, conservation measures, or some combination of all the above to survive in the face of moderate to extreme warming scenarios.

ARSENIC-RELATED HUMAN HEALTH RISK FROM CONSUMPTION OF DORYTEUTHIS OPALESCENS (MARKET SQUID) IN PUGET SOUND, WA

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University of Washington Tacoma

Doryteuthis opalescens, or market squid, is a growing and popular recreational fishery in Washington State. Despite their growing popularity, there is very little research conducted on squid that enter the Puget Sound. Collaborating with the Washington Department of Fish and Wildlife, who are conducting their own population and creel surveys on market squid, we have collected samples at four locations using jigging methods. The two purposes for which we analyzed metal concentrations in squid mantle tissue was to fingerprint differences within the squid population based on location, and to assess for possible carcinogenic pollutants. I hypothesized that squid caught in the South Sound would have trace, but distinctly different concentrations of metals compared to squid caught closer to the entrance of the Pacific Ocean. My results showed very high levels of arsenic, averaging 4.95 mg/kg dry weight of squid mantle tissue. This concentration equates to a human health risk for subsistence consumers that is 5 times greater than the cancer risk threshold (1 in 100,000). These results have been reported to the WA Department of Health to determine if a consumption advisory is warranted. Our results constitute a significant finding of public health risk, and ultimately will be useful for bolstering public safety.

SEA STAR REGULATION OF PURPLE URCHIN POPULATIONS IN THE CHANNEL ISLANDS INCREASES WITH TEMPERATURE

Malakooti, N.J.V.*; Kroeker, K.J.; Kilpatrick, A.M.

UC Santa Cruz

Pycnopodia helianthoides, the sunflower star, was an important subtidal and intertidal predator found from Baja California in Mexico to the Aleutian Islands in Alaska until populations were decimated by the epidemic of sea star wasting disease in 2013. Sunflower star consumption of purple urchins (*Strongylocentrotus purpuratus*) may play a key role in the maintenance and recovery of kelp forest habitats. We examined factors influencing the population growth rate of purple urchins, including sunflower star density, intraspecific density dependence (purple urchin density), and temperature in the Channel Islands, using the National Parks Service's Kelp Forest Monitoring data. We focused our analysis on Santa Rosa Island, which had moderately high and variable sunflower star density. We found strong intraspecific density dependence in urchin population growth rates, a positive effect of temperature, and an interaction between sunflower star density and temperature. The interaction indicated that the negative effect of sunflower star density was stronger at higher temperatures. The fitted model suggested that without sunflower stars, purple

urchin populations would increase with increasing temperature, whereas the presence of sunflower stars, even at low densities, reverses this trend and would lead to urchin populations declining with temperature. These results imply that sunflower stars play a key role in determining the response of urchins, and likely kelp forests, to a warming ocean.

TEMPERATURE-DEPENDENT PROCESSES DRIVE EELGRASS WASTING DISEASE IN AN INTERTIDAL MEADOW

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Bigelow Lab for Ocean Sciences

Eelgrass wasting disease, caused by the protist *Labyrinthula* sp., has been associated with declines of eelgrass meadows in some locations, while other populations appear to experience few negative effects of disease, despite large-scale epidemics. Temperature is also associated with disease and mortality at some locations, however identification of host and environmental thresholds that are associated with disease-related mortality has been elusive. Here we present results of multi-state mark-recapture studies where eelgrass monitored biweekly over the course of an epidemic at Fourth of July Beach in San Juan Island, WA, USA. Rates for disease incidence, progression, recovery and mortality were estimated by fitting multiple environmentally-dependent and -independent models. The best fit model finds that temperature drives disease incidence and progression, but is not associated with survival for the range of temperatures experienced at this site. Disease had no impact on survival for shoots with mild and moderate levels of disease (e.g., with lesions on <5%, or <50% of the second youngest leaf), while weekly survival was < 0.75% for severely diseased shoots. This suggests that eelgrass meadows may tolerate disease if temperature is low enough to progression to severe stages. Epidemiological rates estimated from this study can be used to parameterize mechanistic models of EWD and explore disease dynamics under a variety of temperature scenarios.

Session 26: Fisheries Ecology III

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

INCORPORATION OF DIEL SAMPLING TO QUANTIFY BIAS IN YOUNG-OF-THE-YEAR ROCKFISH SURVEYS FOR CONSERVATION IN THE SALISH SEA

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1- Harbor WildWatch 2- Paua Marine Research Group 3- unaffiliated 4- Friends of Saltwater State Park 5- Sound Water Stewards 6- NOAA Fisheries West Coast Region

Rockfish (Sebastes spp.) are a diverse clade of fishes that are integral components of food webs in the NE Pacific Ocean. Overfishing and habitat loss have reduced populations to a point where two species are listed under the Endangered Species Act and no take of any rockfish is permitted in the southern Salish Sea. Knowledge about larval and juvenile life history, ecology, and settlement patterns was identified as a crucial management gap impeding recovery planning efforts. To address this issue, a partner-driven young-of-the-year (YOY) rockfish survey program was created in 2015, with survey efforts increasing exponentially over the past decade. Data are collected via timed roving visual surveys on SCUBA. While efforts to date have considerably increased the collective knowledge about YOY settlement patterns, nearly all of these surveys have occurred during daylight hours. To explore key habitat use information and quantify a potential survey bias, visual surveys were conducted across the same habitat during day and night hours. In addition, time lapse cameras were placed at sites to augment visual surveys. To date, 28 comparison dives at 13 sites have completed 298 transects over 2,490.5 survey minutes and found a significant increase in encounter rate at night for certain species. 13 time lapse camera deployments have yielded over 19,000 images but no difference in encounter rate was detected for any species across diel periods. Results will refine quantitative analyses and improve the long-term monitoring protocol as it informs rockfish recovery in the Salish Sea.

A DEEPER DIVE INTO OREGON'S SPATIAL NEARSHORE FISHERIES ECONOMICS MODEL

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1- ODFW 2- The Research Group LLC.

Fisheries managers often want to know the economic impact of closing areas of the ocean so they can make more informed decisions that impact fishing and conservation efforts. Starting in 2012, Oregon began implementing marine reserves where fishing and all extractive activities are prohibited. Oregon Department of Fish and Wildlife (ODFW) manages Oregon's marine reserves. ODFW commissioned a spatial fisheries economics model to account for economic impacts on nearshore fisheries of spatial closures. Approximately 14% of Oregon's commercial and recreational fisheries are caught in nearshore ecosystems. This model encompasses Oregon's territorial sea which extends three miles offshore. Oregon's nearshore ecosystem spans 364 miles from the mouth of the Columbia River to the border with California. The model associates specific fisheries with nearshore dynamic habitats of rocky reef and gravel meeting sandy bottom using bathymetric data . The economic impact of closing specific areas for marine reserves, which now comprise 3% of Oregon's territorial sea, was quantified using a regional economic input-output model. The direct activity of fishing "multiplies" the economic contributions of other industries in the local economy, like buying bait and ice. If analysts import this model into a geographic information system (GIS) based platform, it could be even more useful in other marine spatial management contexts, such as laying cables for wind energy infrastructure and understanding potential costs of closing areas to reduce anthropogenic impacts on endangered species.

FORECASTING AND PROJECTING SWORDFISH QUALITY FOR DYNAMIC INDUSTRY ADAPTATION

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Reports from fishers operating in a major longline fishery in the western Pacific suggest that fishing for swordfish in anomalously warm waters is linked with myoliquefaction ("jellymeat"), mediated by infection by *Kudoa* sp. parasites. Jellymeat renders the meat unsuitable for export, reducing profits and increasing wastage. If there is a thermally-sensitive mechanism underpinning jellymeat, future jellymeat events may become more frequent due to climate change. However, the links between physical seascape conditions and jellymeat are unknown. Combining omics techniques with dynamic spatial modelling, we investigated the biophysical drivers of *Kudoa* sp. infection prevalence in swordfish harvested within the fishery. Results indicate higher rates of infection in warmer waters, in regions with high temperature variability, and in the region dominated by the East Australian Current. Using these biophysical indicators, we developed predictive models of spatiotemporal risk zones over the fishery domain, which have been further developed into seasonal forecasts and climate projections of the relative likelihood of harvesting infected swordfish. Advanced warning of high-risk areas could inform best handling practices when fishing in conditions conducive to jellymeat, thereby reducing wastage along the supply chain, and supporting proactive industry adaptation under rapidly changing conditions. In addition, we will briefly introduce a new project on modeling and mapping climate refugia for red abalone across California.

THE SEASONALITY OF RED SEA URCHIN GAMETOGENESIS AND GONAD BIOCHEMISTRY

Cabral, S.R.[*]; de Leon Sanchez, E.E.; Hofmann, G.E.

UC Santa Barbara

The red sea urchin (*Mesocentrotus franciscanus*) is a kelp forest ecosystem engineer and a multi-million-dollar fishery species harvested for its gonads or "uni". The red sea urchin has been shown to be affected by marine heatwaves (MHWs) - events of extreme ocean warming - since previous MHWs have coincided with urchin mass mortality events due to diseases and food shortages. Along the California coast, recent MHWs have caused significant declines in the biomass and nutritional quality of Macrocystis pyrifera, the red urchins' preferred food source. This kelp loss may be detrimental to the urchin gametogenesis and reproductive timing. To observe how kelp abundance and seasonality may affect the timing of

gametogenesis and biochemistry of gonads, red sea urchins were collected on SCUBA from 2023-2024 from two different Santa Barbara Coastal Long Term Ecological Research sites, a kelp forest and an urchin barren. The gonads were then analyzed, comparing gonadosomatic indices (GSIs) and total protein concentration from the two sites. Results show that there is a significant difference in GSI between the two kelp abundance sites across all months except April and a difference in total protein concentration comparing the sexes from both sites. These results may indicate that with increasing MHWs, and thus food shortage events, red sea urchin's gonads may be negatively impacted. The project's findings may provide a greater understanding of red sea urchin phenology and the quality of the red sea urchin fishery in the face of future MHWs.

BLENDING ECOLOGICAL THEORY AND SIMULATION MODELING TO UNDERSTAND FOOD WEB DYNAMICS IN AN EVER-CHANGING MARINE SYSTEM

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With surmounting evidence of climate-driven shifts in community composition, there is a pressing need to consider ecological contexts in fisheries management. It is difficult, however, to quantify the mechanistic underpinnings of ecosystem structure and function in the marine realm. Multispecies size spectrum models (MSSMs) integrate ecological theory and a broad range of data (e.g., biomass estimates, life history parameters, fishery selectivity) to explore controls on marine food webs. Specifically, MSSMs relate individual body mass to population- and community-level processes to approximate ecosystem steady states and simulate changes through time. We constructed a MSSM for the Gulf of Alaska, a highly productive ecosystem that has undergone multiple instances of community reorganization. We focused this work on the demersal fish assemblage, which includes ecologically important species such as arrowtooth flounder (*Atheresthes stomias*), Pacific cod (*Gadus macrocephalus*), Pacific halibut (*Hippoglossus stenolepis*), Pacific Ocean perch (*Sebastes alutus*), sablefish (*Anoplopoma fimbria*), and walleye pollock (*Gadus chalcogrammus*). We calibrated the MSSM using information from stock assessments, standardized surveys, and available scientific literature to quantify nonlinear and nonlocal effects on size-based metrics such as biomass density, trophic level, and predation mortality. We then simulated these metrics under future climate and fishing scenarios, highlighting how MSSMs can be used to understand population- and community-level responses to perturbation in high latitude systems. This project is part of NOAA's Gulf of Alaska Climate Integrated Modeling (GOACLIM) project – a transdisciplinary working group tasked with identifying factors that may impact ecosystem productivity under future climate change.

RELATING SPATIALLY EXPLICIT HINDCASTS OF LARVAL NORTHERN ANCHOVY ABUNDANCE TO ADULT ABUNDANCE

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Changes in habitat suitability caused by climate change are likely to influence the abundance of many species. Such effects have been observed during recent warm years, when larval northern anchovy (*Engraulis mordax*) were present in the northern California Current Ecosystem earlier and farther north and shoreward than previously observed. Accurately predicting larval northern anchovy abundance across space and time could contribute to predictions of adult anchovy recruitment under a changing climate, informing the management of the numerous taxa that prey upon them. We used a species distribution modeling approach to establish relationships between environmental conditions and larval northern anchovy abundance. This species distribution model was fit using larval northern anchovy abundance data from diverse sampling programs. Fine-scale observations of larval northern anchovy abundance were collected during 2016, 2018, 2019, and 2021 using the *In Situ* Ichthyoplankton Imaging System (*IS*IIS) together with depth stratified net sampling. Larval northern anchovy abundance observations of broader temporal coverage were collected during the past decade using nets (NOAA). Using outputs of a regional biogeochemical model, we generated temporally and spatially

explicit hindcasts of larval northern anchovy abundance, which were then aggregated annually and related to estimates of annual age-1 northern anchovy abundance since 2015 from NOAA coastal pelagic species surveys. This modeling approach serves as proof of concept for adapting management to changing environmental conditions.

Session 27: Intertidal Ecology III

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

I'LL HAVE THE SPECIAL: INTERTIDAL HERBIVORE PREFERENCES BETWEEN PERENNIAL AND ANNUAL OREGON KELPS DURING WARMING EVENTS

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Oregon State University

Intertidal kelps are major contributors to the productivity of coastal ecosystems, providing habitat and nutritional value via herbivory and detritus. Previous research shows kelp forest canopy declines with warming temperatures driven by thermal physiological stress and via herbivory by exploding populations of *Strongylocentrotus purpuratus* (purple sea urchin). Metabolic rates have a positive relationship with temperature, further increasing herbivory demands in coastal systems with increasing marine heatwaves. This research aimed to evaluate if temperature influences herbivore consumption and preference of two Oregon intertidal kelps in the lab– *Alaria marginata* (annual) and *Egregia menziesii* (perennial) with three common herbivores 1) *S. purpuratus* (purple sea urchins, N=41) 2) *Tegula funebralis* (black turban snail, N=19) and 3) *Lottia pelta* (shield limpet, N=18). Invertebrates were exposed to 10-11°C or 15-16°C in no choice (*Egregia* or *Alaria*) and then choice (both *Egregia* and *Alaria*) trials. Preliminary results indicated a positive relationship between temperature and overall consumption rates but no significant preference in kelp species for *S. purpuratus*. Similarly, *T. funebralis* and *L. pelta* both ate more under higher temperatures, but they did exhibit a preference, consuming significantly more *Alaria* than *Egregia* in mixed choice experiments. These results reinforced the positive relationship between warming oceans and metabolic rates and indicated there can be strong feeding preference by select herbivores.

SPATIAL AND TEMPORAL VARIABILITY IN NUTRITIONAL PHYSIOLOGY OF PYROPIA PERFORATA

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Moss Landing Marine Labs

The red alga, *Pyropia perforata*, commonly known as nori, thrives in California's intertidal zones and is crucial for marine herbivores. This study examined how environmental heterogeneity affects its internal nitrogen and total protein content across a 4° latitude span from Northern to Southern California and through seasonal changes. Results indicate spatial influences, with higher nutrient levels in northern areas. Seasonally, winter and spring showed increased nitrogen and protein compared to summer and fall. Cultivation experiments revealed that higher nutrient concentrations boost these levels, irrespective of the nitrogen source being nitrate (NO_3^-) or ammonium (NH_4^+). Although abiotic factors like temperature and wind speed showed little correlation with nutrient content, solar radiation, day length, and sea surface nitrogen significantly related to internal nitrogen levels. These findings suggest that environmental nitrogen can act as a proxy for internal nitrogen content in *P. perforata*, highlighting its variability with time and space.

SPATIAL AND TEMPORAL TRENDS IN THE REPRODUCTION OF FOUR PREVALENT INTERTIDAL MACROPHYTES ALONG THE OREGON COAST

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Oregon State University

Though subject to frequent disturbance, rocky intertidal kelp communities along the Oregon coast have persisted for decades in a stable state. This stability is critical as intertidal kelp is a foundation species whose population dynamics can impact overall community structure and ecosystem function. Recent research has indicated that low zone kelp communities are exhibiting slower rates of recovery from disturbance and may be approaching an ecological tipping point. There is a distinct need for baseline data on intertidal kelps, particularly related to early life-stages differentially impacted by climatic and environmental stressors. While there are ongoing efforts to document kelp abundance and recruitment along the Oregon coast, the literature on intertidal kelp phenology remains geographically and quantitatively limited. This study provides the first systematic quantification of the spatial and temporal phenology of four dominant species of intertidal kelp along the Oregon coast: *Hedophyllum sessile*, *Postelsia palmaeformis*, *Lessoniopsis littoralis*, and *Alaria marginata*. Preliminary analysis reveals that peak spore production differs by species and within species along a geographic gradient, indicating that peak spore release by species may be associated with different environmental cues modulated by local conditions specific to each site. These findings represent an important first step in monitoring and managing Oregon's rocky intertidal ecosystems under the projected climate change regime and will be used to guide further research on intertidal kelp phenology.

CRASH AND BOOM: HAS PISASTER OCHRACEUS RECOVERED ITS KEYSTONE ROLE?

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Oregon State University

As is well known, the keystone predator *Pisaster ochraceous* can control intertidal community structure by strongly preying upon mussels. Pisaster populations were devastated by the 2013-14 Sea Star Wasting Disease (SSWD) epidemic a decade ago. After the disease, *Pisaster* density recovered quickly at many sites along the Oregon coast, but most individuals were subadult, raising the question of when, or if, this sea star recovered its keystone role. We tested this idea using predation rate experiments performed yearly at six sites before, during and after the SSWD event. We transplanted 10 plots of 30 mussels each at each site, and used cage or partial cage treatments to prevent or allow (respectively) *Pisaster* predation on mussels for ~6 months each year. We hypothesized that as *Pisaster* recovered their pre-wasting density and size, their keystone role would also recover. We found that predation rate recovered to pre-wasting levels at two of six sites within three years, but these rates have been inconsistent post-wasting, suggesting an unstable ecological recovery. At four of six sites, predation rates remained near zero until 2023-24 but these recent increases are still at lower levels than pre-wasting. We conclude that while *Pisaster* populations have recovered and even overshot their prior density at all sites, the top-down role of this iconic keystone species has not recovered. Thus, SSWD triggered a decade-long period with persistently low or unstable cycles of predation, and when and whether *Pisaster* will recover its keystone role coast-wide remains uncertain.

DEMOGRAPHIC PATTERNS OF WEST COAST ROCKY INTERTIDAL PREDATORS SUGGEST INCREASED POPULATION VULNERABILITY NEAR SOUTHERN RANGE LIMITS

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1- OSU 2- Concordia 3- CSU Northridge 4- Florida State 5- UCSC

In the rocky intertidal, latitudinal ranges are constricted by thermal stress, but tides also create zonation or a 'vertical range' driven by sharp environmental gradients. By investigating demographics along the latitudinal and vertical ranges simultaneously, we can investigate whether populations may be vulnerable to a changing climate. In 2018 we surveyed the demographics of ochre sea stars (*Pisaster ochraceus*), six-armed sea stars (*Leptasterias* spp.), emarginate whelks (*Nucella ostrina and N. emarginata*), and channeled whelks (*N. canaliculata*) at 33 sites spanning >11 degrees latitude from central Oregon to southern California, near the southern range limits of each taxon. We counted and sized individuals from the high to low intertidal zone. For all taxa, population density, the relative proportion of smaller individuals (except for emarginate whelks), and the upper vertical limits on the shore declined from north to south as temperatures increased and high tide height, tidal amplitude and wave

heights decreased. In addition, smaller individual Leptasterias spp. generally inhabited lower shore levels while smaller individual emarginate whelks inhabited higher shore levels coast-wide. For *N. canaliculata*, smaller animals were higher on shore northward but lower on shore toward southward. Our surveys suggest environmentally-related demographic limitation toward southern range limits and demographically vulnerable southern populations. Therefore, a warming climate may cause local extinctions or range contractions near southern limits.

AUTOMATING MUSSEL HABITAT MAPPING: AI-POWERED SEMANTIC SEGMENTATION OF AERIAL IMAGERY FOR ENHANCED ECOLOGICAL MONITORING

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1- Hakai Institute 2- Hakai Institute, University of British Columbia

Mussel beds are crucial ecosystem engineers in coastal environments. We present an innovative deep learning approach that revolutionizes mussel habitat delineation using aerial drone imagery. Our semantic segmentation AI model automates the identification and mapping of mussel habitats from high-resolution aerial photographs. Model robustness was validated on an independent test dataset, yielding precision of 83.14%, recall of 82.62%, and accuracy of 98.47%. This tool enables rapid, large-scale assessments of mussel bed distributions, facilitating; 1) Long-term monitoring of habitat changes due to climate stressors, 2) Quantification of mussel bed expansion or contraction, 3) Identification of potential restoration sites and 4) Assessment of marine protected areas' effectiveness. Drones allow coverage of larger areas faster than field teams, accessing remote or sensitive areas safely. This provides a more comprehensive view of mussel habitats across diverse coastal environments. Challenges include variable lighting, species layering and complex substrates, with ongoing work to enhance model generalization. This interdisciplinary research bridges computer vision, remote sensing, and marine ecology, potentially informing policy decisions and improving marine resource management.

Session 28: Ecosystem Ecology II

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

UNDERSTANDING THE TOP-DOWN TROPHIC ECOLOGY OF THE NORTHERN CALIFORNIA CURRENT SYSTEM USING THE BROADNOSE SEVENGILL SHARK, AN ABUNDANT, APEX PREDATOR

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Oregon State University

The Broadnose sevengill shark (Notorynchus cepedianus) is a large and abundant predator in the coastal ecosystems of Oregon and Washington, but little is known about their ecological and trophic role north of central California. Despite significant efforts to model and maintain the productivity of coastal ecosystems, the role of Broadnose sevengill sharks (and other shark predators) has largely been overlooked—especially in relation to economically important fisheries (e.g., salmon, halibut, and crab) and imperiled species (e.g., federally-listed green sturgeon). We are conducting an ongoing study looking at movement and foraging ecology of Broadnose sevengills sharks caught in Willapa Bay, WA to address this knowledge gap.

REDEFINING OCEAN CARBON CAPTURE: FLOCS AND THE FIGHT AGAINST MICROBIALIZATION AT DEPTH

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1- San Diego State University 2- UC San Diego

Floaters-Coupled-to-Sinkers (FloCS) are proposed devices designed to enhance carbon dioxide sequestration by facilitating the deep ocean export of algal biomass. FloCS consists of “Floaters,” photosynthetic organisms that capture CO2 in the ocean’s photic zone, physically coupled to “Sinkers,” calcifying organisms that increase mass and facilitate the descent of the floaters through the thermocline into the sequestration flux zone (~1000 meters). While sequestering carbon in the deep ocean holds promise, significant uncertainties remain, particularly concerning its effects on microbial communities and seawater chemistry.We conducted experiments using pressure chambers inoculated with *Macrocystis pyrifera* and *Mytilus californianus* under controlled conditions, with incubation periods of two weeks as well as two days at 5,000 meters depth (50 MPa) and 4℃. Epifluorescent microscopy revealed larger and more abundant microbes in non-pressurized treatments. Additionally, the higher Virus-to-Microbe Ratio (VMR) observed in pressurized treatments suggests a reduction in microbialization at depth. These findings emphasize the importance of ensuring algae intended for carbon sequestration reaches sufficient depths to avoid disrupting deep ocean ecosystems. Addressing these issues is crucial before large-scale deployments and carbon credit issuance. FloCS offers a potential mitigation strategy by facilitating deeper algae transport, reducing the risk of algal-induced acidification and deep ocean microbialization

THE BIOENERGETIC CRUNCH OF THERMAL AND NUTRITIVE STRESS INDUCES ANTICIPATION OF AMYLASE FUNCTION.

† James Bond, J.[1*]; Connor, K.M.[1]; Wehrle, B.A.[2]

1- UC Irvine 2- Bryn Mawr College

Anthropogenic activities have induced unprecedented environmental fluctuations in our coastal systems causing elevated air and water temperatures and decreasing dissolved oxygen, inducing a stress response on biological systems. The sessile mussel *Mytilus californianus* must cope with elevated air temperatures and acute heat shocks during low-tide; while the response is energetically demanding, prompting anticipatory responses in model systems. The demand is revealed as an upregulation of mechanisms that are implemented to maintain cellular and organ system function, while reallocating energy away from growth. As a proxy for energy acquisition, we measured amylase activity (starch digestion) in mussels acclimated to simulated tides to isolate the effects of aerial heat on digestion. Previous evidence showed negative effects of elevated aerial temperature on amylase activity. Currently, we predict that elevated feeding and digestion would mitigate this effect while the activity under starved conditions might elucidate conservation or anticipatory processes. We subjected mussels to a two-week tidal acclimation period (one daily low-tide) of two air temperature conditions. Control conditions consisted of a isothermic (15C) temperature, while the treatment was 25C during low tide. They were subdivided into groups of fed and fasted conditions. The acclimation period preceded extreme acute heat shocks (32C) at low tide with feeding cycles at high tide for all groups. The results showed robust enzyme and gene-expression activity in fed (cool and hot) and fasted cold groups at low-tide. Suggestive of preparing to feed and digest starch during oncoming high-tide. Alternatively, the least energetically optimal state, starved and hot, showed reduced enzyme activity during low-tide. The acute heat stress also showed detrimental effects.

COMPARING CARBON STANDING STOCK BETWEEN DIFFERENT KELP BEDS IN THE SOUTHERN SALISH SEA

† Roethler, M.[1*]; Donoguhe, C.[2]; Padilla-Gamiño, J.[1]

1- University of Washington 2- Washington State Dept. of Ecology

Carbon sequestration is a rapidly growing topic in marine science, and it is crucial to understand carbon sources and sinks to optimize ecosystem management and restoration. The extent to which kelp forests contribute to carbon storage is highly debated, particularly in the dynamic and heterogenous Salish Sea. This study aims to establish baseline data on the carbon content of four kelp beds in the Salish Sea and develop a sampling protocol that can easily be implemented by other monitoring groups. We seek to assess how carbon standing stock differs between beds in distinct geographic locations, with varying species compositions and oceanographic conditions. Unlike traditional carbon standing stock calculations focusing solely on canopy-forming species, our approach encompasses all dominant kelp taxa present at each site, including understory species. This broader scope provides a more comprehensive and accurate assessment of carbon storage potential across the entire kelp forest ecosystem. We leveraged open datasets from both new and ongoing monitoring to gather background information on bed size and

species density, including subtidal kelp surveys conducted by Reef Check and Friday Harbor Labs, and canopy surveys conducted by the Washington Department of Natural Resources. We collected morphometric measurements on the dominant kelp taxa, performed biomass assessments, and will measure tissue C and N content. We examined allometric relationships between morphometric data and biomass to develop metrics that are easy for researchers to measure in situ and do not require whole-organism harvest. This study provides a framework for integrating carbon standing stock estimates into existing monitoring structures and provides baseline data for future research on carbon sequestration potential of Salish Sea kelp beds.

INTEGRATING MARINE SCIENCE EDUCATION AND RESEARCH ABOARD THE HISTORIC *WESTERN FLYER*

Mostow, R.S.*; Thomas, K.N.

Western Flyer Foundation

The Western Flyer Foundation is a marine science research and education nonprofit inspired by the cross-disciplinary friendship of ecologist Ed Ricketts and author John Steinbeck. In 1940, Ricketts and Steinbeck chartered the *Western Flyer*, a wooden sardine purse-seiner, for a six-week exploration of Mexico's Gulf of California. Through extensive intertidal surveys they documented over 500 species of marine invertebrates, 50 of which were newly described species. They published the results of these surveys in *Sea of Cortez* (and later *Log from the Sea of Cortez*), a work of creative nonfiction that blends marine science, philosophy, and natural history. Inspired by this history, the newly-restored *Western Flyer* now serves as a platform for marine science education and research. The Western Flyer Foundation provides trips to local colleges and universities during which students explore the diverse marine ecosystems of Monterey Bay, CA aboard a unique and historic vessel. Students are immersed in the rich literary and historical traditions of the *Western Flyer* while collecting valuable oceanographic data from their local environment. Our at-sea programs are hands-on, question-driven, and immersive. Through partnerships with local community colleges and high schools, we aim to serve students with backgrounds or identities currently underrepresented in ocean sciences. Here we will describe Western Flyer Foundation education programs, share insights into the integration of art and marine science, and propose opportunities for future collaborations.

COMMUNITY-LED MARINE RESERVES IN BAJA CALIFORNIA IMPROVING KELP RESILIENCE

Bauer, J.[1*]; Beas-Luna, R.[2]; Lorda, J.[2]; Abadía-Cardoso, A.[2]; Malpica-Cruz, L.[2]

1- CICESE 2- UABC

Kelp forests, dominated by *Macrocystis pyrifera*, are experiencing a significant decline along the Pacific coast of the Baja California peninsula, with far-reaching social, economic, and ecological consequences. Using underwater surveys complemented by satellite imagery analysis, we present evidence of an ecosystem shift from kelp-dominated to urchin-dominated reefs. Our results reveal an alarming 95% reduction in kelp canopy coverage in the northern region in the past decade. This dramatic decrease coincides with a prominent increase in herbivore populations, particularly the purple sea urchin *Strongylocentrotus purpuratus*. Interestingly, community-led marine reserves in the southern region provide evidence of higher abundances of macroinvertivores. Our results provide valuable insights into the potential relevance of herbivore control in kelp forest resilience. In this work, we highlight the urgent need for adaptive nature-based solutions and the role of local communities in marine conservation. As climate change threatens coastal ecosystems worldwide, we aim to inform future conservation and restoration efforts for these vital macroalgal forests.

Session 29: Conservation and Restoration IV

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

ASSESSING THE STATUS OF OREGON'S KELP FORESTS FOR STEWARDSHIP PLANNING

Hamilton, S.L.[1*]; Calvanese, T.[1]; Gravem, S.A.[2]; Galloway, A.W.E.[3]; Chabot, D.[2]; Vidusic, E.[3]; Webster, N.[2]

1- Oregon Kelp Alliance 2- Oregon State University 3- University of Oregon

In 2020, mounting anecdotal and quantitative evidence suggested that since 2014 Oregon had experienced kelp forest loss similar to that which had been documented in other parts of the West Coast. The Oregon Kelp Alliance (ORKA) formed at this time in order to initiate new kelp forest stewardship, including restoration and protection of kelp forest ecosystems. One first step to implementing this stewardship program was to document the extent of the problem. In this talk, we will describe the findings of the 2023 ORKA Kelp Forest Snapshot Project, which coordinated state-wide SCUBA and aerial surveys to map out mosaics in kelp forest condition across Oregon. Coordinating work across multiple institutions, we completed 170 SCUBA transect surveys and 21 UAV based surveys ranging across 3 degrees of latitude. We found that the abundance of kelp and urchins varied strongly across the state, with sites in southern Oregon less likely to support kelp in historic kelp habitat than sites further north. We used this 2023 data as well as historic data taken by the Oregon Department of Fish and Wildlife to quantify hotspots of kelp forest loss across the state and to estimate that 900 acres of kelp forest habitat have been lost in the last decade. Despite documenting the dramatic declines of kelp forests in some parts of the coast, in our 2023 surveys we also found signs of persistence and resilience. To conclude this talk, we will describe what our findings mean for restoration and protection work that ORKA is implementing in 2025.

ASSESSING LONG-TERM DEVELOPMENT OF VEGETATION, ELEVATION, AND BLUE CARBON FUNCTION IN RESTORED TIDAL MARSHES OF THE PACIFIC COAST

Janousek, C.[1*]; Williams., T.[1]; Kirkland, J.[2]; Schmitt, J.[2]; Schroeder, J.[3]; Rybczyk, J.[3]; Poppe, K.[3]; Wasson, K.[4]; Crooks, J.[5]; Schooler, S.[2]; Ferner, M.[6]; Siegel, S.[6]; Cornu, C.[7]; Brophy, L.[8]; Comet, S.[2]

1- Oregon State University 2- South Slough NERR 3- Western Washington University 4- Elkhorn Slough NERR 5- Tijuana River NERR 6- San Francisco Bay NERR 7- Inst. for Applied Ecology 8- Institute for Applied Ecology

Restoration is increasingly used to enhance ecosystem services in estuaries where tidal wetlands have historically been lost or degraded. However, most restoration projects are not monitored for more than a few years, if at all, so many questions remain about the degree and pace of recovery of these ecosystems over the long-term. We sampled 16 older restored tidal marshes in California, Oregon, and Washington (aged 22-62 years) to assess their elevation capital, vegetation communities, long-term accretion rates, and carbon accumulation rates. Overall we found partial recovery of restored marshes compared with reference conditions. About half of the sites had elevations similar to, or exceeding, reference marshes, and this was more likely if sediment had been added to the site at the time of restoration. Most restored marshes had high vegetation cover and were dominated by native species, but they often had lower plant diversity than reference sites. Sediment accretion and carbon accumulation rates were variable, but on average did not differ between restored and reference marshes. These results show partial long-term recovery of key aspects of restored marsh structure and function, but suggest that some characteristics like diversity have not fully recovered. These data are valuable for helping inform management and monitoring and for designing the next generation of restoration projects in Pacific coast estuaries.

RESTORING ENDANGERED WHITE ABALONE (HALIOTIS SORENSENI) IN SOUTHERN CALIFORNIA: OUTPLANTING METHODS, CHALLENGES AND FUTURE PATHS

Carmack, O.[1*]; Obaza, A.[1]; Sanders, R.[1,2]; Burdick, H.[3]; Ford, T.[3]; Hofmeister, J.[4]; Witting, D.[5]; Neuman, M.[6]

1- Paua Marine Research Group LLC 2- Scripps Inst. of Oceanography 3- The Bay Foundation 4- California Dept. of Fish and Wildlife 5- NOAA Restoration Center, West Coast Region 6- National Marine Fisheries Service, West Coast Region

White abalone (*Haliotis sorenseni*) is a species of immense cultural, ecological, and economic significance nearly driven to extinction by overfishing, disease and related causes. In 2001, it became the first marine invertebrate listed under the Endangered Species Act. Given the critically low levels of wild populations, an outplanting regime is essential to recover viable populations. From 2019 to 2024, ~16,000 white abalone (16-126 mm shell length) were outplanted across four sites in San Diego and Los Angeles using various semi-enclosed modules. Sites were

chosen based on the presence of native abalone, macroalgal assemblages, physical characteristics, and logistical considerations. Mortality estimates were comparable between sites with a 37.6% and 32.8% mortality rate in San Diego and Los Angeles, respectively. Estimating post-outplant survival remains challenging due to the cryptic nature of abalone, which complicates resighting without invasive surveys that increase mortality risk. Currently, 64.8% of outplanted abalone remain at large based on confirmed mortality from shell collection. As this project progresses, efforts will focus on refining methods and establishing additional outplant sites around Catalina Island, San Diego, and Los Angeles. Additionally, the project will continue stocking established sites and conducting monitoring to track survival, growth, and changes in the biological and physical characteristics of the sites. These ongoing efforts are crucial to ensuring the long-term recovery and resilience of white abalone populations in southern California.

EXPLORING THE POTENTIAL FOR MULTIPLE KELP RECOVERY TECHNIQUES TO PRODUCE SELF-SUSTAINING BULL KELP FORESTS

Karm, R.H.[1*]; Kim, A.[2]; Bugbee, B.M.[2]; Grime, B.C.[3]; Bauer-Civiello, A.[4]; Huckeba, J.[1]; Strock, S.[1]; Hascall, E.[1]; Elsmore, K.[5]; Hamilton, S.L.[2]; Hughes, B.B.[1]; McHugh, T.A.[3]

1- Sonoma State University 2- Moss Landing Marine Labs/San Jose State University 3- The Nature Conservancy 4- Reef Check California 5- California Dept. of Fish and Wildlife

Combining planting with herbivore suppression has shown greater success in restoring vegetated ecosystems than depending on either technique alone. Therefore, in 2023, we applied this approach to bull kelp forests in northern California by evaluating the effects of kelp enhancement via two outplanting methods (soral bags and seeded twine) alongside urchin reduction at Albion Cove, Mendocino CA following a > 95% decline of kelp in the region. Following these efforts, in 2024 we assessed whether the previous season's outplanted kelp stimulated recovery, driven by both spore release from soral bags and reproductive canopy-forming individuals on seeded twine. Preliminary results from both years highlight the importance of continuous grazer suppression to prevent overgrazing, a challenge for northern California given rough conditions. Among the enhancement methods, soral bags produced a signal in benthic kelp in year one and may produce a continued recruitment signal in subsequent years. Laboratory grown seeded twine produced initial biomass which matured in year one, likely facilitating recruitment on the reef in year two given the greater dispersal compared to soral bags. Deploying both techniques in tandem with grazer suppression creates initial vegetation in the ecosystem in year one and facilitates conditions for vegetative recovery on the benthos in year two and beyond. Given the limited understanding of the long-term viability of kelp restoration, these findings offer valuable insight into the benefits of complementary restoration efforts for this annual species.

DECIPHERING THE COMPLEXITIES OF URCHIN-KELP DYNAMICS AND BENTHIC COMMUNITIES WITHIN OREGON ROCKY REEFS

† Vidušić, E.[1*]; Galloway, A.W.E.[1]; Hamilton, S.L.[2]; Gravem, S.A.[2]; Webster, N.[2]

1- University of Oregon 2- Oregon State University

The North American West Coast has experienced dramatic localized declines in kelp forests in the last decade, in relation to population increases in purple sea urchins, which has been well documented from long-term monitoring efforts in regions such as Northern California. Historical data of kelp forest ecosystems along the Oregon coast is less understood due to the lack of monitoring and methods that could capture holistic ecosystem data. In 2023, the Oregon Kelp Alliance (ORKA) coordinated a state-wide field sampling effort to understand the status of Oregon's kelp forests and better inform future stewardship and protection efforts. SCUBA surveys were conducted to quantify kelps, purple and red sea urchins, and other rocky reef macroinvertebrates. Benthic videos were taken at sites along the southern coast to quantify and characterize the benthos between alternating states of 'healthy' and denuded kelp forests. We found that select southern sites may conversely have focused areas of persisting kelp beds despite high purple urchin densities. Here we explore the complexity of this kelp-urchin relationship and highlight the significance of quantifying populations outside of this binary that are potential biomarkers of kelp forest persistence and diversity. Throughout our documentation, we underscore the importance of establishing long-term monitoring studies to better serve the stewardship of kelp forest ecosystems.

RESTORATION TRAJECTORY OF INVERTEBRATE COMMUNITIES FOLLOWING LIVING SHORELINE RESTORATION

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1- Dept. of Biological Sciences, CSU Long Beach 2- Dept. of Biology, CSU Fullerton

Wetlands are among the most beneficial ecosystems in the world and provide abundant services for humans, fish, and other wildlife. These key functions in coastal ecosystems include protecting and improving water quality, guarding coastlines from flooding and erosion, and providing organisms with habitats. Oyster and eelgrass beds are important components of a wetland ecosystem that provide many of these key functions, but due to pollution, over-harvesting, and development, they are being lost and degraded. This is why effective restoration strategies are vital in bringing back and maintaining these crucial ecosystems. To achieve this, we developed living shoreline restoration projects in Newport Bay, CA in 2016 and 2017. Through time, we evaluated how infaunal invertebrates responded to the restoration efforts. Our evaluations revealed an initially large decline in invertebrate populations that only occurred directly underneath the oyster beds in the intertidal realm. Over time, as the oyster beds broke apart and the eelgrass expanded to cover new areas, infaunal invertebrate numbers have increased. In the subtidal eelgrass regions, restoration increased invertebrate abundance, which has remained high through time. We also found that community composition varied through time with major differences pertaining to habitat category (oyster, eelgrass, or bare). Understanding how key habitat parameters of shell density and cover, and eelgrass cover affect invertebrate composition can inform future living shoreline restoration projects.

Session 30: Community Ecology III

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

EFFECTS OF OCEAN WARMING ON FISH COMMUNITY COMPOSITION AND SPECIES-SPECIFIC DIETARY SHIFTS

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1- University of Florida 2- UC Santa Cruz 3- Pontificia Universidad Catolica de Chile 4- Brown University 5- Woods Hole Oceanographic Institution

Warming oceans are expected to alter population sizes, dietary niches, and individual fitness of marine fishes. We tested the effects of variation in ocean temperature and primary productivity across an upwelling gradient in the Galapagos Islands spanning a sea surface temperature (SST) range of 3 °C. We quantified fish abundance and diversity and benthic foraging rates by each species and collected fish and primary producer tissues to trace dietary pathways. In keeping with global patterns across latitude, herbivore abundance and species richness were linearly and positively correlated with SST, as were total benthic foraging rates for most species. Carbon isotope analysis of essential amino acids revealed that generalists from across families relied primarily on detrital food webs when upwelling was low and temperatures were high. When upwelling was high and temperatures were low, angelfish and damselfish shifted to planktonic food webs while surgeonfish relied on algal production. Body size and weight were positively influenced by upwelling strength, though this effect varied by species. Differential effects of upwelling strength on dietary preferences among generalist species suggests that bottom-up subsidies and variation in consumer traits mediate how marine fishes cope with warming oceans within the evolutionary constraints of digestive physiology. Diet switching is proposed as a compensatory mechanism for adapting to more extreme temperatures due to climate change.

BEYOND GIANT KELP: EXPLORING HERBIVORE PREFERENCES FOR UNDERSTORY MACROALGAE

Hasshaw, L.G.[*]; Wagstaff, M.C.; Miller, R.J.

UC Santa Barbara

Macroalgae and herbivores coexist in shallow marine ecosystems and together play a fundamental ecological role in linking primary production to the rest of food chain. The palatability of macroalgae to herbivores is shaped by factors such as nutritional value, secondary metabolite content, and structural morphology. By selectively feeding on the most palatable macroalgae, herbivores can significantly influence the structure of these

ecosystems. In the Santa Barbara Channel, giant kelp is the dominant macroalgal species and is considered a preferred food source for local herbivores. The depletion of giant kelp forests has long been associated with grazing by sea urchins. However, other macroalgal and herbivore species that persist in the channel are often overlooked. This study compares the feeding preferences of wavy turban snails and purple urchins for 14 understory macroalgal species versus giant kelp. Additionally, it explores whether macroalgal characteristics determine palatability. Contrary to expectations, both snails and urchins favored most of the understory species over giant kelp. While these preferences were primarily driven by nutritional value, secondary metabolite content and structural morphology had unexpected effects. Moreover, this study highlights the complexities underlying macroalgal-herbivore interactions.

A DECADE LATER: MONITORING THE IMPACT AND RECOVERY OF SEA STAR WASTING DISEASE AT 4 CENTRAL CALIFORNIA SITES

Hart, D.M.*

Santa Clara University

A bit over a decade has passed since the onset of Sea Star Wasting Disease (SSWD) in 2013 and we are still observing the impact on rocky intertidal communities along the central coast of California. In this observational study, we follow permanent plots established below the mussel lower limit prior to SSWD to the present. We documented changes in sea star abundance (*Pisaster ochraceus*, the ochre star), abundance of their main prey (*Mytilus californianus*, the California mussel), and biodiversity from before the onset of SSWD (baseline) and on a yearly cycle from 2016 - 2024. We found the expected decline in sea stars after the outbreak of disease with variable recovery across sites over time. While some recovery in sea stars has been observed, some sites still remain below baseline levels. Mussel abundances have generally increased in the absence of sea stars and have remained relatively high over time. Only in the most recent years have we started to observe a decrease in these mussel populations. A reduction in biodiversity was observed across all sites and remained low over time, with increases in diversity only occurring in the past year or two. This study highlights the long and lasting impacts of SSWD on rocky intertidal community ecosystems as well as the importance of long-term monitoring datasets which can provide crucial evidence for baseline and time series data analysis.

WATER BEAR, WATER BEAR, WHAT ARE YOU DOING THERE?

terHorst, C.P.[1*]; Atler, L.J.[1]; Howard, K.D.[2]; Mendelson, A.A.[1]

1- CSU Northridge 2- CSUN

Microcosms have long been used as model systems for testing ecological questions about trophic and competitive interactions. Pitcher plant microcosms are composed of bacteria, protozoa, rotifers, mites, and mosquito larvae, but other invertebrates are occasionally present, such as water bears (Tardigrada). Here we ask whether water bears reduce the population size of ciliated protozoans via predation. Unfortunately, the answer to this simple question is more complex than expected. In an experiment with a senior-level ecology class, water bears were found to significantly reduce the density of *Tetrahymena* populations by 58%. However, a second experiment in our lab group found only a marginally non-significant reduction in the population size of *Tetrahymena* by water bears, but a large significant reduction in a large Colpodid species. In a third experiment, we found no significant effect of water bears on the population sizes of either of the previous two species, but a large significant increase of the population size of *Colpoda* sp. when water bears were present. Although we can speculate about minor differences in experimental design, it is concerning, but also interesting, that estimates of species interaction strengths vary considerably in time and space, even under controlled laboratory conditions. Similar experiments in natural conditions should be skeptical of estimates from experiments that lack replication across appropriate spatial and temporal scales.

DETERMINING THE PHENOLOGY OF NON-NATIVE SEAWEEDS, *UNDARIA PINNATIFIDA* AND *SARGASSUM HORNERI*, IN SAN DIEGO CALIFORNIA

McHaskell, D.A.*; Smith, J.E.

Scripps Institution of Oceanography at UC San Deigo

The potential for invasion following species introduction is one of the many threats to biodiversity. Marine ecosystems are at risk given the ability of non-native seaweeds (NNS) to establish after. Only a small percentage of NNS have been studied to determine impact on the recipient community thus many NNS remain understudied. For instance, *Undaria pinnatifida* is considered a globally invasive seaweed that has spread to over 15 countries and *Sargassum horneri* has spread across 700km of the California coast within a 12-year period. Though the presence of these two species has been documented in southern California since the early 2000's, the known ecological impacts remain ambiguous and there is minimal information regarding the phenology of either species. To better understand the ecology of these two seaweeds, we conducted seasonal scuba surveys for from Summer 2022 to summer 2024 in San Diego. Specifically, we tracked NNS phenology, abundance, and benthic community composition, seasonally within the Mission Bay entrance channel. Results from the first year of data collection show that *Undaria* was most abundant during spring where both juveniles and reproductive adults were present while abundance was lower in the Fall and Summer. Conversely, *S. horneri* juveniles were most abundant during the Fall with adults infrequently seen in subsequent months. These results provide understanding of the phenology for both seaweeds which could allow insight on the potential synergistic impacts on the recipient community.

ENVIRONMENTAL DRIVERS OF NEARSHORE FISH COMMUNITY STRUCTURE OFF CENTRAL CALIFORNIA

† Todd, J.W.[1*]; Lindholm, J.[2]; Starr, R.[1]

1- Moss Landing Marine Labs 2- CSU Monterey Bay

Environmental conditions can influence the composition and distribution of nearshore fish communities. This is especially true in dynamic shallow waters. Remote underwater video (RUV) systems, equipped with cameras situated in stereo format, allow shallow-water fish communities to be surveyed from smaller vessels than other imagery-based tools. These systems can collect spatially explicit visual data to estimate fish abundance, size, and community compositions, as well as species-habitat associations. These data can then be used for a variety of resource assessment purposes, including nearshore MPA monitoring. With sufficient spatial and temporal coverage, these tools could also be used for stock assessments of shallow-water species. Over the course of two summers, we used RUV systems off the central coast of California to survey nearshore rocky reef fish communities. Using high resolution bathymetric maps and randomly selected drop points, we conducted 211 individual drops of RUV systems, across a depth gradient of 20-60m. Within these drops, we observed 4,424 fishes and examined changes in abundance, biomass, diversity, and community composition across the depth gradient within different habitat types and areas of different wave energies. In habitats with high relief and high rugosity, we found that both fish abundance and length increased with depth. We also identified species-specific changes in abundance and length across the depth gradient. Results of this study may contribute to study designs for long term monitoring of nearshore fish communities and their habitats.

Session 31: Coral Reef Ecology II

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

MARINE AND TERRESTRIAL SEDIMENT ON ALGAL TURF LIMITS HERBIVORY PRESSURE AND SPECIES RICHNESS

† Gallegos, A.[1]; Murph, Z.G.[2*]; Palmer, T.A.[3]; Strong, A.J.[1]; Long, A.E.[1]; Barber, P.H.[1]; Fong, P.[1]; Davis, A.C.D.[4]

1- UCLA 2- Hampton University 3- Coastal Carolina University 4- CSUN

When disturbance leads to coral mortality, herbivorous fish provide strong top-down control that maintains turf algae in a short healthy state, favoring coral recruitment and recovery. While it is well known that marine sediment deters fish herbivory, the effect of terrestrial sediment, which is increasing on coral reefs due to climate change and coastal development, remains understudied. This study examines the effect of marine and terrestrial sediment on fish herbivory rate on algal turf. We compared three sites (n=10 plots per site) in Mo'orea, French Polynesia with different

turf height (LME, $p<0.001$) and sediment depth ($p<0.0001$). Total fish herbivory rates, quantified from video recordings of bite rates on replicate experimental plots, did not vary between sites (Kruskal-Wallis, $p>0.05$). Rather, bite rates for individual species as well as the species richness of the fish taking bites differed across sites . Richness and herbivory rates were highest where sediment and turf were lowest. Both herbivory and fish diversity declined at the site with marine sediment and long turf and were lowest by far at the site with terrestrial sediment and long turf. Overall, results showed that terrestrial sediment deterred herbivory more than marine sediment. Thus, increases in sedimentation, particularly of terrestrial sediments, associated with climate change could further degrade coral reefs by decreasing total herbivory and the species richness of the herbivore community, likely further inhibiting coral recovery.

OCEAN ACIDIFICATION IMPACTS CALCIFICATION IN THE MICRO WORLD OF TWO HAWAIIAN CORAL SPECIES

† Armstrong, D.A.[1*]; McNicholl, C.[2]; Bahr, K.D.[3]

1- Texas A&M University Corpus Christi/Harte Research Institute 2- affiliation not listed 3- Texas A&M University - Corpus Christi

Coral animals rely on water motion, such as wave action or ocean currents, to exchange materials for sustaining growth and internal biology. Essential materials concentrate in the seawater surrounding corals and form a thin, quiescent layer important for diffusion. This layer, termed the diffusive boundary layer (DBL), is essential for coral growth. The DBL seawater chemistry (i.e., pH, O2, DIC…) can vastly differ from the surrounding seawater. But, impacts to the DBL surrounding the coral are unclear, with changes in our ocean's chemistry following the increase of anthropogenic CO2–leading to ocean acidification (OA). This study employed a microsensor analysis to investigate the DBL surrounding two Hawaiian coral species, Montipora capitata, and Pocillopora acuta, under OA conditions. Findings suggest microchemical species-specific differences following increased pCO2 that could be related to measured tolerances to OA. Analyses showed coupling of O2 and pH under increased pCO2 in dark conditions, highlighting physical constraints on biogeochemical processes such as calcification. Findings were evident in vertical profiles, surface concentrations, and DBL thicknesses. The physical barriers and species-specific responses found here could inform future directions on assessing the drivers for calcification in a high CO2 world.

OCEAN ACIDIFICATION IMPACTS ON CORAL REEF COMMUNITY METABOLISM

Hampton, A.[*]; Armstrong, D.A.; McNicholl, C.B.K.

Texas A&M University Corpus Christi/Harte Research Institute

Coral reefs are crucial ecosystems that support marine biodiversity through processes such as photosynthesis, respiration, calcification, and dissolution. These processes contribute to the benthic community metabolism of the reef and are linked to the physical and chemical dynamics of the seawater, including carbonate chemistry and pH. But, ocean acidification (OA) will alter these processes and threaten coral reef calcification in ways that still need to be elucidated. Therefore, we conducted 30-day experiments where corals were grown in state-of-the-art flow-through mesocosms under OA conditions. Net ecosystem calcification (NEC) and net ecosystem production (NEP) were measured to assess the metabolism of the coral community. Preliminary results indicate that NEC is enhanced under OA conditions, but no effect was observed on NEP under OA conditions. The enhancement of NEC is contrary to the anticipated negative effects that would be observed under OA conditions, which warrants further investigation on the drivers for calcification. Calculating NEC and NEP under increasing OA could show how changes in coral reef ecosystems are driven by global climate change, and how calcification in coral communities will respond to an acidified ocean.

INFLUENCE OF HABITAT HETEROGENEITY ON THE RESILIENCE OF PATCHY CORAL REEFS

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1- UC Santa Barbara 2- Florida State University

Numerous ecosystems can undergo rapid change to a different, often undesirable, state which can be difficult to reverse. These can represent alternate stable states where multiple ecosystem states may be possible under the same environmental conditions. Experimental evidence suggests that patch reefs in the lagoon of Moorea, French Polynesia represent alternate stable states of coral and macroalgal dominance, but it is less clear how this bistability on individual patches scales up to influence state transitions across the entire reef. We modified a well-known, but nonspatial, coral-macroalgae competition model to run on a grid, where each cell represents either physical reef structure or sand. Each cell representing reef structure models coral and macroalgae which grow internally and interact with nearby cells via dispersal and growth, while cells representing sand act as dispersal barriers. To explore how spatial heterogeneity of reef structure influences the resilience of the system, we ran the model over many different habitat configurations, varying the amount and the aggregation of reef structure in the system. We found that when reef structure was more abundant and aggregated, macroalgae was favored and transitions between states occurred with small changes in environmental conditions. When structure was more fragmented, coral was favored and transitions between states were smoother, allowing regions of coral and macroalgal dominance to coexist. These results suggest that the configuration of reef structure can influence the resilience of coral reefs and provide general predictions on what regions of a reef may be most susceptible to a shift in state.

THE IMPACT OF OCEAN ACIDIFICATION ON CORAL-SYMBIONT RELATIONSHIPS

Arispe, I.*; Armstrong, D.A.; Bahr, K.D.

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The relationship between corals and their symbionts is crucial for the health of coral reefs. In this symbiotic interaction, corals provide a protected environment for their symbiotic algae, which through photosynthesis, benefit the corals by supporting their growth and aiding in waste elimination, resulting in a thriving partnership for both organisms. However, environmental stresses such as ocean acidification (OA) could alter this symbiosis. OA may shift the relationship from mutually beneficial to potentially unfavorable one. To understand this, we investigated changes in symbiont densities, correlated with total protein concentrations, highlighting the dynamic relationship between the symbiont and animal interactions in two Hawaiian coral species, Montipora capitata and Pocillopora acuta. Preliminary results indicate that there are differences in symbiont densities under OA across species. Montipora capitata exhibited lower symbiont densities and P. acuta exhibited higher densities under OA. Understanding host-symbiont interactions in response to ocean acidification is important because it provides insights into how these dynamic relationships may shift with changing environmental conditions.

FISH ARE FRIENDS: HOW FISH HELP CORALS HEAL

Vega, H.A.*; Munk, N.; Stier, A.C.

UC Santa Barbara

Coral reefs are oases of biodiversity and productivity that also protect shorelines and provide extensive economic benefits to fisheries and ecotourism. Devastatingly, we have lost 50% of the world's coral reefs since 19501, largely due to anthropogenic disturbance. In recent years, intensive research has been conducted to better understand how disturbance impacts coral resilience. However, regenerative capacity, or the ability for corals to regenerate lost tissue and skeleton, is an under-studied yet vital aspect of coral resilience. Previous research shows the highest proportion of coral mortality at the greatest level of physical injury, highlighting significant energetic constraints associated with severe damage. The objective of this research is to evaluate the role of exosymbiotic fishes as a potential mechanism to enhance coral regenerative capacity. Our central hypothesis is that increased flow and fish-derived nutrients may significantly enhance regenerative capacity by supplementing energetic resources to fuel tissue and skeletal regeneration.

Session 32: Physiological Ecology III

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

THE PHYSIOLOGICAL RESPONSES OF PREGNANT GOPHER ROCKFISH (S. CARNATUS) TO OCEAN ACIDIFICATION AND HYPOXIA

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Fishes living in California's coastal waters experience ocean acidification and hypoxia (OAH) in response to upwelling, which is increasing in frequency and intensity with climate change. Rockfish may be particularly threatened by climate change due to their long lifespans and late maturation. As viviparous fish, rockfish may have the ability to buffer their young against unfavorable DO and pH during gestation which could influence survival under intensifying OAH conditions. To address this possibility, we examined the ability of female gopher rockfish to compensate physiologically to OAH exposure. Rockfish were collected after mating in the wild and exposed to different combined OAH levels during gestation, simulating current and future upwelling conditions. Blood was taken during gestation and following parturition to assess compensation to OAH conditions. We examined effects on blood parameters known to be affected by DO (pO_2, hematocrit, hemoglobin) and high pCO_2 (pH, pCO_2, K^+, and HCO_3^-); and measured metabolic rate as a proxy of energetic costs. Consistent with prior research, preliminary results suggest non-pregnant fish in OAH conditions may be able to compensate for parameters known to be impacted by low DO but not high pCO_2. Preliminary findings also show that pregnancy may decrease fishes' ability to compensate to OAH conditions. Physiological responses of pregnant mothers will provide a better understanding of how rockfish populations may cope with the steadily changing climate and have important implications for the management of nearshore fisheries.

THE MARINE OTTER (LONTRA FELINA) AS A BIOINDICATOR FOR MERCURY POLLUTION ALONG THE SOUTH PACIFIC COAST OF CHILE

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Mercury (Hg) is a highly toxic trace metal, especially in its organic form, methylmercury, a potent neurotoxin of concern to apex predators due to high bioaccumulation and biomagnification potential in marine food webs. Otters are considered sentinel species and bioindicators in ecotoxicological studies and may be exposed to significant levels of Hg. The marine otter (Lontra felina) is an endangered apex predator distributed through most of the Southeast Pacific coast, which shows a dietary overlap with humans. This study evaluates the toxicokinetics and ecotoxicology of Hg through the measurement of total mercury (THg) in different biological compartments of marine otters, along the northern, central, and southern zones of Chile. The mean THg concentrations registered ranged from 0.1 to 5.2 ppm of dry weight, in the order Fur > Liver > Kidney > Muscle > Lungs > Heart > Brain > Spraints. Mean blood THg was 0.07 ppm in a wet weight basis. Fur and brain were positively correlated ($r=0.89$, $p=0.041$), providing a non-invasive and non-lethal method to evaluate mercury exposure levels in brain and neurotoxic effects. Blood THg levels were higher in the northern and central zones, possibly due to mining, industrial activities, and coastal urban centres, and to a greater extent of fish in the diet. Fur THg was higher in the south, probably due to a greater bioaccumulation rate. The mercury levels registered are concerning, with 70% of analysed individuals surpassing neurotoxicity thresholds. This study showcases this small marine mammal as a potential sentinel of coastal pollution.

CARBON CONCENTRATING MECHANISMS IN MACROCYSTIS PYRIFERA (GIANT KELP) GAMETOPHYTES

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1- San Diego State University 2- Kunsan National University

Subtidal kelps often recruit at different depths, with shallow individuals experiencing higher levels of light than those in deeper water. Toward the deep end of their range, kelps passively obtain CO_2 for photosynthesis, but at shallow depths where rates of photosynthesis are higher, CO_2 can become limited. For this reason, many kelps utilize carbon concentrating mechanisms (CCMs) to convert highly abundant HCO_3^- into CO_2. The adult sporophyte stage of *Macrocystis pyrifera* (giant kelp) upregulates the CCM activity within its blades as they are exposed to increasing levels of light. However, there has been no research investigating CCM activity in the gametophyte life-stage of *M. pyrifera* despite the outsized role these microscopic life-stages play in determining patterns of kelp settlement and distribution. We measured photosynthesis in *M. pyrifera* gametophytes at two temperatures, and for the first time investigated whether *M. pyrifera* gametophytes upregulate their CCMs in response to increasing light levels using the CCM inhibitor acetazolamide. Our results indicate that *M. pyrifera* gametophytes utilize CCMs and appear to upregulate their CCM activity with increasing light and temperature. These findings further our understanding of the kelp gametophyte life-stage and their performance in response to changing ocean conditions with potential implications for the future distribution of *M. pyrifera*.

SET IT AND FORGET IT! INTEGRATED MULTI-TROPHIC AQUACULTURE COMPARISON OF A DUAL AND SINGLE TANK DESIGN.

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Integrated Multi-Trophic Aquaculture (IMTA) with abalone and seaweed offers promise as a climate-resilient system that may mitigate negative effects from ocean acidification, while simultaneously increasing production. This study tested new IMTA innovations for the co-culture of red abalone (*Haliotis rufescens*) and dulse (*Devaleraea mollis*) in traditional dual tanks vs. a single tank system. We built upon a previous study where a 65% recirculation rate in a dual tank system significantly buffered pH and resulted in greater abalone growth and compared it to a single tank design, with flow rates of 0.7, 1.4, and 4.0 gallons per minute. After 6 months, there were no significant differences in total length and weight of abalone in any of the treatments, though on average, abalone grown in the 0.7 GPM treatment exhibited the poorest body condition (g mm^{-2}. Abalone were sacrificed, and their shell strength was quantified with a materials testing device that measured the force required to fracture their shell. There were no differences between the treatments, but there was a trend towards individuals in the paired design having stronger shells. The growth of dulse was positively correlated with flow, where low-flow tanks grew significantly less. Given the lack of significant differences between the dual tank and the single tank designs in the medium and high flow tanks, single tank systems may offer viable cost-savings by removing pumps, significantly reducing maintenance needs and labor, and doubling abalone production in the same footprint.

Session 33: Behavioral Ecology I

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

SEA OTTER DIET SPECIALIZATION RESPONSES TO ENVIRONMENTAL PERTURBATIONS ALONG THE MONTEREY PENINSULA

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Monterey Bay Aquarium

Understanding diet specialization in marine carnivores is crucial for assessing their adaptability to environmental changes. From 2013-2016 the central coast experienced environmental disturbances that significantly impacted the nearshore ecosystem. We investigate shifts in diet specialization among the southern sea otter (enhydra lutris nereis) to discern how sea otters' foraging behavior adapts to changing ecological conditions. We analyzed over a decade of foraging behavioral observations of sea otters along the Monterey Peninsula to identify both inter- and intra-individual variability in diet specialization over time, with notable shifts corresponding to environmental events.This research highlights the importance of considering both individual and population-level responses to environmental disturbances when assessing the ecological dynamics of top predators. The results provide insights into the resilience and adaptability of sea otters in the face of changing environmental conditions and their key role in regulating their nearshore environments.

JUVENILE WHITE SHARKS IN MONTEREY BAY: EFFECTS OF THERMAL HABITAT PATCHINESS ON LOCAL DENSITIES OF A NOVEL RANGE SHIFTING PREDATOR

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1- Moss Landing Marine Labs, CSU, Monterey Bay 2- CSU, Monterey Bay 3- Citizen Scientist 4- Moss Landing Marine Labs

Climate warming has shifted marine species' ranges poleward, including juvenile white sharks (*Carcharodon carcharias*). Previous research has documented a climate-driven range shift on a regional scale, but less is known about the fine-scale habitat selection of this endothermic predator at the cold edge of its range. Monterey Bay provides a unique study system with high spatial temperature variability, due to areas of strong and weak upwelling. We analyzed high-resolution satellite data (sea surface temperature, chlorophyll-a, and turbidity) to identify potential environmental drivers of concentrated juvenile white shark abundance assessed from drone surveys. Preliminary results show that these abundances are correlated with areas of anomalously warm waters within the Monterey Bay region. With increased ocean warming, juvenile white sharks may continue to extend their range further north. We propose that they may be utilizing pockets of warm water as thermal refuges in regionally cooler areas and that their novel and dense concentration in these locations will have important top-down effects on local ecosystems.

MOVIESTAR: TRACKING GRAZER ESCAPE RESPONSES TO AN APPROACHING SUNFLOWER STAR PREDATOR

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In 2013, sea star wasting disease caused severe declines in populations of sunflower sea stars (*Pycnopodia helianthoides*) along the Northeast Pacific ocean. This predator may play a crucial role in preventing the overgrazing of kelp by herbivorous sea urchins within kelp forest ecosystems. Recent research suggests that the future recovery of *Pycnopodia* in urchin barrens could promote kelp forest recovery by reducing urchin populations and influencing grazer behavior through a 'landscape of fear' effect. To test this hypothesis, we conducted field experiments in Sitka Sound, Alaska, using 1.5m tripods to capture 20-minute time-lapse videos of *Pycnopodia* hunting in wild barrens. These were paired with control videos taken nearby in similar habitats without *Pycnopodia* releases. The movement of red urchin (*Mesocentrotus franciscanus*), green urchins (*Strongylocentrotus droebachiensis*), pinto abalone (*Haliotis kamtschatkana*), and *Pycnopodia* were manually tracked using ImageJ software to quantify escape speed and initial flight distance among species depending on individual size. Our results show that all three grazers exhibited a flee response when *Pycnopodia* were introduced, whereas minimal grazer movement was observed in the control treatments. This work suggests that reintroducing *Pycnopodia* to urchin barrens could at least temporarily limit community-level grazing pressure, with implications for kelp forest resilience and recovery and potentially lead to the recovery of kelp forests.

PREY SWITCHING BY A GENERALIST PREDATOR OVER PREY COMMUNITY SUCCESSION

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An important aspect of functional responses is how predators switch between alternative prey. However, previous studies on multispecies functional responses have largely been performed under unrealistic laboratory conditions. We used three years of monthly observations of community structure and predator feeding ininitially cleared intertidal patches to study changes in prey preferences of the carnivorous whelk *Nucella ostrina.* Prey-specific feeding rates were estimated through feeding observations using the method of Novak and Wooton (2008). After accounting for incomplete sampling using coverage-based rarefaction/extrapolation, our results showed the realized diet of *N. ostrina* was overall less diverse than its potential diet, with anear steady number of dominant prey over the three years, despite a substantial increment in the efective number of prey taxa in the environment. Whelk diet showed a strong density-dependence towards the barnacle *Balanus glandula* and both facilitative and interference effects of alternative prey on feeding on the barnacle. In particular, *B. glandula* was the preferred prey at the beginning

of the experiment when prey diversity was low, and was replaced by the mussel *M. trossulus* in the following months. Our results indicate that feeding on mussels is driven by “food quality” (consistent with optimal foraging) whereas feeding on barnacles is driven by availability (consistent with frequency-dependent predation), and that switching may occur for some prey taxa. Such results reinforce the importance of context in multispecies predation.

THE EBB AND FLOW OF *ANTHOPLEURA ELEGANTISSIMA* AGGREGATIONS IN THE ROCKY INTERTIDAL: TRACKING CHANGES IN SIZE OF MARKED COLONIES

Kirk, N.L.*; Winthorne, L.; Stacey, D.; Maechtle, W.; Bourquein, J.D.; Tysdal, E.; Rosen, E.S.; Delgado-Lopez, I.; Students of Z461,

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The intertidal sea anemone *Anthopleura elegantissima* forms clonal aggregations that aggressively defend themselves against conspecifics, which can result in injury to one or both combatants. Although individual aggressive interactions have been described, less is known about the long-term effects of these behaviors on the outcome and how dynamic population sizes are. To help address these knowledge gaps, in July 2022 we started a long-term demographic study by semi-permanently marking 72 colonies in close proximity to each other across separate 2 field sites on the Oregon Coast. Over the past 2 years, we have collected individuals from each colony to determine their aggression, sex and gonadal status, how colony sizes change over time using image analysis. The marked colonies range in size from 55 to 1200 individuals and 57% colonies have decreased in size (avg=-16.5+/- 115) although there was no correlation between the total number of individuals and magnitude of change; some colonies disappeared completely over the two-year period. We hypothesized that aggression and the ability to win competitive interactions may lead to advantages in the field and have been partnering anemones from different colonies in controlled pairwise aggression assays. There was no significant correlation between the ability to win a fight in the lab and the colony size change. However, there was a significant effect of sex in the model indicating that male colonies have grown while female colonies have shrank, possibly indicating tradeoffs between sexual and asexual reproduction.

ARCHITECTS OF THE SAND FLATS: UNCOVERING THE BURROW-BUILDING AND SUBSTRATE SELECTIVITY OF ALPHEUS CF. BERUMENI

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1- American University 2- UCLA 3- Howard University 4- CSU LOng Beach 5- CSUN

Mutualistic associations are common in coral reef ecosystems and one of the most documented is between shrimp goby guards and their burrow-building shrimp. Previous work on this diverse group examined habitat preference, burrow structure, and entrance shape, but what remains unexplored is whether the composition and structure of their highly-ornamented burrow entrances are functional, and if so, are they constructed with intentional design. We observed that *Alpheus cf. berumeni* exhibits peak burrow-stabilizing activity in the afternoon, builds two distinct types of burrow entrances that are equally stable for up to 4 days and utilizes specific shapes and weights of ornamentation that differ from those available in the surrounding environment (LME, p =0.0462). Next, we conducted a choice experiment where we offered the 4 choices of shapes of ornaments we quantified surrounding the burrows: flat, cylinder, globular, and branching *A. cf. berumeni* actively selected for branching and cylinder ornaments and avoided the flat shapes when offered a choice, $X^2(3, N=189)=10.471$, p= 0.01496. Our work establishes that *A. cf. berumeni* is not just an ecosystem engineer that builds a habitat, but an architect that does so with an intentional structural design.

Session 34: Evolutionary Biology I

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

SEA SPIDER COMPARATIVE DEVELOPMENT AT THE UTRASTRUCTURAL LEVEL REVEALS NOVEL LARVAL MORPHOLOGY

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The Pycnogonida, known as sea spiders, are an enigmatic clade of marine arthropods that originated some 500 million years ago, are globally distributed, and can be found intertidally to a depth of 6000 meters (Waloszek & Dunlop, 2002). Pycnogonids are generally accepted as the sister group to all other Chelicerata (Dunlop & Arango, 2005) but have been challenging to place phylogenetically due to their severe divergence from other arthropods. Still, they are expected to provide important insight into the evolution of Arthropoda, arguably the most successful phylum of animals on the planet (Budd & Telford, 2009). Sea spiders exhibit hemianamorphic development, the sequential addition of body segments with each molt up to a finite number in their adult form. This type of progression, commonly attributed to crustaceans, is likely the ancestral condition for the phylum Arthropoda (Fusco & Minelli, 2021) but is rare within the chelicerata. Here, I document the development of two coastal sea spiders of the family Ammotheidae, *Achelia alaskensis* and *Tanystylum sp. aff. occidentalis*. Specimens of each species at each life stage were collected from a variety of sites throughout British Columbia using SCUBA diving and imaged with scanning electron microscopy. Both species exhibit the “typical protonymphon” mode of development as an ectoparasite on colonial hydroid species, one of four life history strategies documented within the pycnogonida (Bain, 2003). These are the first ultrastructural descriptions of these two species of littoral sea spider from larvae to adult.

POPULATION DIFFERENTIATION IN MARINE ISLANDS

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UC Merced

Islands provide simpler environments to explore the intersection of genomic, morphological, and niche diversification. Moreover, empirical research elucidating the diversification of marine island populations could bridge the gap between island and marine biogeography, which historically have been treated as mutually exclusive. We provide a marine example to explore population genomic, morphology, and diet patterns in island-like marine lakes. We collected 154 orbiculate cardinalfish, Sphaeramia orbicularis, from the ‘mainland’ ocean and six ‘island-like’ marine lakes. We performed low-coverage whole genome sequencing to identify genomic diversity, geometric morphometrics to assess shape changes, and stable isotope analysis to evaluate diet differences. All or some populations in isolated lakes have diverged from well-connected lake and ocean populations genomically, morphometrically, and in diet. In contrast, well-connected lakes and ocean populations only differ in diet. Isolated marine lake populations show low genetic diversity, minimal gene flow between populations, the emergence of original phenotypes, and diet niche changes similar to patterns observed in ‘true’ island populations. Incorporating empirical research from marine lakes into theory has the potential to expand and unite island and marine biogeography, given the resemblance of marine lake population patterns with oceanic islands.

HUNGRY TO EVOLVE: COMPARING TOLERANCE TO OCEAN ACIDIFICATION IN A COASTAL FISH

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Ocean acidification can have negative effects on many species. However, the long-term responses of species will depend critically on the degree to which populations can evolve to become more tolerant of high CO2/low pH conditions as the ocean environment changes. To investigate this phenomenon, we evaluated genetic variation in both feeding rates and growth rates for larvae of a coastal fish, the California Grunion. We combined breeding experiments (66 families in a half and full-sib breeding design) with experimental manipulation of seawater conditions (4 pCO2 levels) to examine heritable variation in sensitivity to CO2. Our results suggest that elevated CO2 can strongly impair feeding efficacy, but these results do not emerge until later in the larval phase when the supply of maternal yolk was exhausted. By 11 days post hatching, there was significant, heritable variation in sensitivity of feeding to CO2 (e.g., ~20% of families were unaffected; ~20% experienced over a twofold drop in

mean feeding efficacy at the highest CO2 levels). Moreover, sensitivity of feeding rate to elevated CO2 was genetically correlated with sensitivity of growth rate to elevated CO2 (rG = 0.29). These results suggest that tolerance to ocean acidification conditions may be better understood by considering a suite of related, performance-based characteristics. For Grunion, genetic variation in tolerance may facilitate adaptation, offsetting some of the harmful effects of ocean acidification.

INVESTIGATING GENOME-ENVIRONMENT ASSOCIATIONS FOR EASTERN OYSTERS (CRASSOTREA VIRGINICA) IN THE NORTHERN GULF OF MEXICO

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Along the southern coast of the United States, especially in Louisiana, the eastern oyster, Crassostrea virginica, is a key resource for fisheries and ecosystem functioning. Oysters protect the coast by acting as a natural infrastructure against coastal erosion and storm impacts. They are very effective at keeping coastal waters clean, filtering up to approximately 50 gallons of water a day each (NOAA Fisheries 2022). Oysters also have a large economic impact on Louisiana with the commercial oyster industry providing thousands of jobs and contributing over 300M dollars annually. With climate change rapidly altering many of the world's coastal ecosystems, it is vital to understand how C. virginica reacts to these rapid environmental changes, however responses of individual populations may differ if they are locally adapted to environmental gradients in temperature or salinity. In this paper, we use low coverage whole genome sequencing from a total of 109 individuals across five populations in Louisiana and Northern Texas to investigate fine-scale population differences and genome environment associations for temperature and salinity. ANGSD was used to estimate genotype likelihoods, call SNPS, estimate Genotype posterior probabilities, and estimate a genetic covariance matrix for each individual of each population.Then R was used to analyze and visualize the data from the covariance matrix and .geno files. We found fine scale genetic structure across populations of C. virginica in Louisiana and Texas. Results from this project have important implications for population-specific management of this species in the Gulf of Mexico.

GENETIC VARIATION IN THERMAL SENSITIVITY IN POPULATIONS OF A COASTAL FISH. IMPLICATIONS FOR RESILIENCE IN A WARMING OCEAN.

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CSU Long Beach

Ocean warming poses an ongoing threat to many species. To anticipate how populations will respond over multiple generations, we need to understand the genetic capacity of thermal responses to evolve and the processes that promote genetic variation. One potential source of such variation is local adaptation to environmental conditions. For example, if individuals inhabiting cooler waters tend to have cold-tolerant genotypes and individuals inhabiting warmer waters have warm-tolerant genotypes, then local adaptation could promote genetic variation in the population as a whole. We examined the genetic variation of thermal sensitivity in populations of California Grunion by conducting controlled breeding experiments through two reproductive seasons. We collected the gametes from three separate populations of grunion: North, Central and Southern locations in the southern California bight. We reared these embryos and larvae in a common laboratory environment across temperatures reflecting their natural range, and measured growth and survival. Quantitative genetic analysis revealed substantial genetic variation and local adaptation in thermal performance, suggesting appreciable capacity to adapt. Southern populations had higher thermal performance peaks than northern populations. Grunion experience gene flow at large spatial scales and our results suggest that adaptation to local temperature conditions can increase overall heritability in thermal sensitivity by 25 to 75%. Local adaptation may thus increase the population-wide capacity for evolutionary adaptation to climate change.

EVOLUTION OF ANIMALS FROM PROTOZOAN ANCESTORS: THE INS AND OUTS OF COLONY DESIGN

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Choanoflagellates and animals share a common ancestor, so we use choanoflagellates that can form multicellular colonies as a model system to study selective factors in the evolution of multicellular animals from unicellular protozoan ancestors. Choanoflagellates have a single flagellum surrounded by a row of microvilli on which bacterial prey are caught, like choanocytes in sponges. Hydrodynamic studies of swimming, feeding, and susceptibility to predation of choanoflagellates have focused on single cells and colonies with flagella pointing outward, whereas flagella line cavities in sponges. We studied aspects of hydrodynamic performance that may have affected the evolution of sponges from choanoflagellate-like ancestors using *Choanoeca flexa* cup-shaped colonies that can reversibly invert to form colonies with flagella covering the outer surface or lining the cup's cavity. We used microvideography and PIV to quantify flow fields and behaviors of these colonies. Flagella-in colonies captured 10X more bacteria-sized particles per cell per time than did flagella-out. In contrast, flagella-out were much faster swimmers (38um/s) than flagella-in (5um/s). Although flagella-out produced larger flow fields with velocities detectable by raptorial protozoan predators than did flagella-in, they could swim away from benthic raptors. Our results suggest that having flagella on a colony's outer surface enhances swimming, and thus exploring the environment and avoiding predators, whereas having flagella lining a cavity enhances feeding at the expense of swimming performance.

Session 35: Ecosystem Ecology III

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

BULL KELP DEVELOPMENT UNDER MULTIPLE STRESSORS AND THE ASSOCIATED RESTORATION IMPLICATIONS

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1- Sonoma State University 2- San Diego State University

The near complete decline of kelp forests in northern California is the result of the combination of multiple stressors, specifically, extreme herbivory in the absence of predators, and ocean heat waves that have exceeded the threshold of bull kelp. Freshwater influence is a third, and possibly mediating stressor that researchers often under-appreciate and poorly understand in the context of bull kelp. Evidence suggests it has important effects in persisting kelp beds in northern California, where persisting bull kelp patches are often closer to the coast and near river mouths. With the complex changes in ocean conditions, allochthonous inputs, and ecosystem connectivity in kelp environments, one must consider the impacts of multiple stressors. This study analyzes the physiological effects of interacting temperature and salinity conditions on bull kelp development and considers if these multiple stressors are interacting to influence the persistence of bull kelp. Using a full-factorial design, we grew bull kelp in the laboratory in four different treatments. The treatments were all combinations of ambient and increased temperatures and ambient and decreased salinity. The ambient temperature was 10°C, the increased temperature was 15°C, the ambient salinity was 32 ppt, and the decreased salinity was 25 ppt. We grew the kelp in these treatments for two months and analyzed it every week to monitor microscopic gametophyte and sporophyte growth. Preliminary results suggest that the combination of warming and decreased salinity conditions resulted in decreased growth and percent cover.

BIG FISH, BIG MOUTHS, BIG IMPACTS: GAPE SIZE OF REEF FISH PREDATOR DETERMINES IMPACT ON SEA URCHINS IN NEW ZEALAND

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Understanding the role of exploited predators is essential to managing the indirect ecosystem impacts of trophic cascades, however, size-dependent interactions are often overlooked. Snapper *Chrysophrys auratus* are widely considered an important predator of the sea urchin *Evechinus chloroticus* on northeastern New Zealand rocky reefs and are linked to a fishing induced trophic cascade resulting in an ecosystem shift

from macroalgal forest to urchin barrens. However, limited information exists on the relative importance and size of *E. chloroticus* in the diet of snapper on rocky reefs. Gut contents were collected from adult snapper (≥30 cm fork length) caught by recreational fishers on shallow rocky reefs. *E. chloroticus* was the most dominant taxa, found in 42% of snapper and contributing 30% of total gut contents. *E. chloroticus* were consistently found in gut contents across the adult size range of reef caught snapper (30-80 cm), and snapper ate larger individuals than previously thought (up to 110 mm test diameter). The size of *E. chloroticus* consumed was strongly related to snapper size, and maximum urchin size was limited by snapper gape height, with the largest snapper targeting large urchins. These findings indicate that snapper, in particular large snapper, play a more important role as sea urchin predators than previously assumed. Thus, understanding size-dependent predator prey interactions is essential for effectively managing the ecosystem effects of fishing, as changes in size distribution can affect a predator population's role within an ecosystem.

USING EDNA AND HYPOXIA DATA FROM OLYMPIC COAST NATIONAL MARINE SANCTUARY TO IDENTIFY SPECIES-SPECIFIC RESPONSES TO HYPOXIC EVENTS

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Hypoxic events are increasing in severity and duration in Olympic Coast National Marine Sanctuary (OCNMS) off the coast of Washington State. Hypoxia, generally defined as oxygen saturation below 20-30%, 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 vital recreation, fisheries, and four sovereign tribal communities: the Hoh Tribe, Makah Tribe, Quileute Tribe, and Quinault Indian Nation. Here, we pair mooring-based autonomous eDNA sampling and dissolved oxygen (DO) measurements in OCNMS to track changes in species' occurrence across hypoxia levels. We observed a strong seasonal hypoxic event in September 2022 that lasted 39 days with concurrent significant differences in species community composition as measured by environmental DNA species detections. Specifically, a northern copepod indicator species (*Pseudocalanus mimus*) was detected less frequently during the hypoxic event. Conversely, a southern copepod species (*Paracalanus* sp.) known to have lower lipid content was more common. Northern copepods are known to be more lipid-rich and serve as important food sources for salmon populations. These results suggest northern copepods may be sensitive to hypoxia, and that an increasing frequency of hypoxic events may result in a decline in essential food resources that support the growth and survival of many key pelagic fishes. By co-locating eDNA samplers and DO sensors, we demonstrate the ability to autonomously measure *in situ* effects of hypoxia on marine ecosystems, opening the door to uncrewed observation networks across our National Marine Sanctuaries.

NON-VIRAL PREDATORS OF MARINE PICOCYANOBACTERIA

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As the Earth's most abundant photosynthetic cells, the picocyanobacteria Prochlorococcus and Synechococcus play a key global role in provisioning aquatic ecosystems with organic carbon, nutrients, and oxygen. While bottom-up controls on the marine picocyanobacteria have been well-studied for decades, their mortality from non-viral predation (top-down controls) is less understood. Uncertainties in their understanding losses from the surface ocean leaves the knowledge of marine carbon cycle and microbial ecology unclear. To this end, we integrate a wide body of underappreciated work that identifies and compares the known and potential predators of these abundant phototrophic cells. These predators include pelagic tunicates (salps, pyrosomes, appendicularians, doliolids), pteropods, protists and small crustaceans. We evaluate where the studies agree or disagree on the impact of each predator on picocyanobacterial ecology, evolution, and biogeochemical contributions. Further, we synthesize the mechanisms of picocyanobacterial loss by these sources with the vision of advancing predictions of the effect of predation interactions on microbial ecology and carbon flux and in their parameterization in ecosystem models.

TURF ALGAE FUEL MICROBIAL SHIFTS: UNRAVELING THE COLLAPSE OF KELP FORESTS IN A WARMING GULF OF MAINE

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In the Gulf of Maine, a rapid state shift is occurring due to ocean warming; kelp forests in the warmest regions (southwest) have collapsed and been replaced by low-lying carpets of filamentous turf algae. Meanwhile, kelp forests continue to persist in the cooler, northern reaches of the Gulf. We previously found that this state shift alters algal chemical exudates and dissolved organic matter on the reef, creating feedback loops that prevent reef recovery. However, how such state shifts alter reef microbial communities taxonomically or functionally is unknown. Furthermore, how these microbes use and contribute to these novel chemical environments is unknown. Here, we show through paired non-targeted metabolomics and shotgun metagenomics that turf algae alter local dissolved organic matter pools, which in turn fuel the "microbialization" of turf-dominated reefs. These findings have implications for ecosystem resilience, nutrient cycling, and carbon sequestration.

Session 36: Conservation and Restoration V - Conservation

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

PARENTAL ACCLIMITIZATION AND ITS EFFECTS ON OFFFSPRING GENE EXPRESSION IN WEST COAST OYSTERS, OSTREA LURIDA AND MAGALLANA GIGAS.

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Over the last century, the oyster industry has observed the collapse of the native Olympia oyster (*Ostrea lurida*) wild stock, and the pressing introduction of the Japanese oyster, *Magallana gigas*, along the Pacific coast of North America. Like other marine invertebrates, these marine bivalves are predicted to be challenged by changing ocean conditions as human encroachment rapidly progresses through the Anthropocene. Phenotypic plasticity has been theorized to mitigate the effects of climate change, and transgenerational plasticity (TGP) might extend that buffer across generations allowing time for adaptation in wild populations and artificial selection in broodstock strains and cohorts. Understanding the implications of TGP within hatchery settings and artificial breeding resides in the interaction of life-history events during field conditioning, time of spawning following acclimatization, and effects of parental environment on offspring phenotypes. To elucidate the mechanisms underlying TGP, we utilize next generation sequencing and transcriptomic methodologies to identify gene-environment interactions in native oyster larvae exposed to increased water temperature following parental acclimatization. This study will provide insight for native oyster restoration efforts and for commercial broodstock improvement and production, both critical for species management in future ocean conditions.

DEVELOPING A NON-INVASIVE JUVENILE WHITE ABALONE EDNA DETECTION METHOD

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NOAA leads a multi-partner initiative to recover the endangered wild populations of white abalone (*Haliotis sorenseni*) through captive breeding efforts along the coast of California. Successful species recovery requires monitoring outplanted cohorts to evaluate their status and trends, as well as refining methods for research and repopulation. Obtaining an accurate census is challenging because juvenile abalone hide in crevices, remaining undetectable unless the habitat is disturbed. Current methods of monitoring cryptic organisms involve physically moving objects to survey for presence, which can increase stress and mortality rates due to increased predator access. This research aimed to test the feasibility of using eDNA as a monitoring tool by sampling the water inside and underneath outplanted PODs recently stocked with juvenile *H. sorenseni*. Over the course of a month, 57 water samples were collected using 60ml syringes fitted with 12in tubes to discreetly collect samples while conducting

SCUBA surveys. Samples were filtered through 0.22µm syringe filters at the surface and preserved frozen until DNA extraction. The eDNA was extracted from the filters using the DNeasy Power Water Kit, amplified by PCR using abalone specific primers, and visualized with 2% agarose electrophoresis gels. Results indicate that *H. sorenseni* are detectable using this eDNA method and largely conformed to expected results. The data suggest that eDNA sampling can be a useful method to augment visual diver surveys for cryptic organisms like juvenile abalone.

IT'S IN THE GENOME: HYBRIDIZATION AND LOW LIGHT ADAPTABILITY IN CALIFORNIA EELGRASS

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1- Scripps Inst. of Oceanography, Salk Inst. for Biological Studies 2- Salk Inst. for Biological Studies 3- Scripps Inst. of Oceanography

The temperate eelgrass *Zostera marina* is a marine foundational species and a target for ecosystem restoration. Among numerous services, eelgrass beds provide essential fish habitat, reduce coastal erosion, and sequester organic matter as "Blue Carbon". In California's largest bays, eelgrass conservation and restoration take place alongside various human activities such as dredging and shading from piers and boats, which create an artificially low-light environment for these photosynthetic organisms. Consequently, low light stress has emerged as a leading physiological cause of eelgrass die-offs and transplant failures. Within the genetic diversity of eelgrass, some eelgrass populations have colonized deeper niches and may hold secrets to eelgrass low light resilience hidden in their genomes. A hybrid population (*Zostera marina* X *Zostera pacifica*) in Mission Bay persists in deeper water due to its *Z. pacifica* parentage. *Z. pacifica* is an offshore species endemic to California that lives in 30-80 fsw. This hybrid population lives alongside *Z. marina*, providing a natural experimental system to explore the genetic basis of *Z. pacifica* low light resilience. Using a combination of long read sequencing technologies, we assembled a chromosome and haplotype resolved genome of the hybrid and describe the genomic landscape of the hybridization. *Z. marina* and hybrid eelgrass transplants were maintained in an outdoor mesocosm tank and subjected to a dark treatment paired with transcriptome sequencing. This talk will present *Z. pacifica* and *Z. marina* X *Z. pacifica* genomes, insights on *Z. pacifica* speciation, and findings of differential expression analysis that reveal divergent responses to transient darkness.

URCHIN CULLING AT TANKER REEF IN MONTEREY BAY, CA AND THE GIANT KELP RESPONSE

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1- Monterey Bay National Marine Sanctuary, NOAA 2- California Dept. of Fish & Wildlife 3- Reef Check California 4- Giant Giant Kelp Restoration Project

In April 2024, a temporary sport fishing regulation exempting divers from purple urchin bag limits expired at Tanker Reef in Monterey Bay, CA (Section 29.06, Title 14, California Code of Regulations). For 27 months, sport fishing divers with a valid recreational fishing license culled red and purple urchins at Tanker Reef with manually operated hand-held tools. To track potential changes, scientific divers from MBNMS and CDFW monitored urchins and kelp at both the culling site (aka the grid, 100x100 m), and a nearby reference area of comparable size that was not culled. Replicate transects (n=18) were surveyed at least three times per year at both sites, including prior to the onset of culling and after culling ceased. In the grid, purple urchin densities quickly declined to <2 per m^2, the *a priori* targeted density. Densities of red urchins also declined but were initially low (<0.5 m^2). Densities of adult giant kelp increased at the restoration grid 4-fold in the first year, and densities of juvenile giant kelp increased from near zero prior to culling to nearly 1 per m^2 by spring 2022. In the nearby reference area, where urchin densities were unchanged, adult and juvenile giant kelp densities remained close to zero. After organized culling ended in July 2023, purple urchins increased, mostly in the smaller size classes (1-2 cm test diameter), suggesting recruitment outpaced migration, although both presumably occurred. Giant kelp recruits and juveniles continued to be abundant at the grid in spring 2024, and giant kelp adults persisted through the summer 2024 survey. The lasting effects of the initial culling effort will continue to be monitored through 2025, providing insight on the longevity of the culling effect.

FORCED OPTIONS: MANAGEMENT AND MITIGATION IN CONSTRAINED LANDSCAPES

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CSU Channel Islands

Resource management always involves trade-offs. While balancing benefits and costs has never been easy, we seem to have even more barriers to holistic assessment today, especially when the issues are complex and push us into new methodologies. We increasingly see more single-issue or single-dimension opposition to efforts that reject holistically weighing tradeoffs and net benefits. This problem appears to be exacerbated by at least two trends: 1) worldview polarization and the rapid spread of misinformation on social media/networks, where emotional appeals can override rigorous analysis and 2) resource management agencies/groups constrained by entrenched protocols or philosophical resistance to novel management strategies. We will illustrate the growing challenges to holistic assessment of emerging management issues with two brief case studies:1) proposed out-of-kind mitigation guidance for coastal systems post-impact and2) proposed harvest of deep-sea polymetallic nodules for rare earth metals. Both of these proposed management approaches face potentially significant pushback despite their potential to yield greater ecological benefits. Our experience underscores the need for decision frameworks that facilitate comprehensive assessment of environmental impacts and trade-offs, while also being cognizant of the social and institutional barriers to implementing holistic but novel solutions. Ultimately, addressing complex, system-level environmental challenges will require a shift away from single-issue advocacy towards more nuanced, evidence-based deliberation.

Session 37: Community Ecology IV

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

EFFECTS OF NITROGEN ENRICHMENT ON CORAL MORTALITY DEPEND ON THE INTENSITY OF HEAT STRESS

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1- Arizona State University 2- UC Santa Barbara 3- University of Hawaii at Manoa

Climate change is causing mortality of foundation species worldwide and understanding how local environmental conditions may interact with climate change is a major goal in ecology. On coral reefs, marine heatwaves cause coral bleaching and mortality, and the effects of marine heatwaves may be modulated by the availability of inorganic nutrients. Here we show complex inter-relationships among nitrogen enrichment and heat stress on coral mortality in two genera of reef-building corals following an intense coral bleaching event in Moorea, French Polynesia. Across the lagoon, mortality prevalence (the proportion of colonies with some mortality) and severity (the percent of a colony with mortality) was higher among Acropora than Pocillopora corals. Nitrogen enrichment interacted with the intensity of heat stress to influence the prevalence, but not severity, of mortality in Acropora. Nitrogen enrichment decreased mortality prevalence at low heat stress, but increased mortality prevalence on reefs with high heat stress. For Pocillopora corals, nitrogen enrichment interacted with heat stress to shape the severity, but not prevalence, of mortality. On reefs with low heat stress nitrogen enrichment intensified the severity of mortality, but this effect declined as heat stress increased. Overall, our work shows that nitrogen enrichment can either mitigate or exacerbate mortality from marine heatwaves in two common coral genera but that these relationships can be complex and dependent on levels of heat stress.

SPATIAL AND INTERANNUAL VARIATION IN SALINITY DRIVE BENTHIC PREDATOR-PREY DYNAMICS IN ESTUARINE ECOSYSTEMS

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Benthic community structure is sensitive to environmental conditions, with ecological patterns often driven by a combination of direct effects mediated by physiological tolerance to a stressor and indirect effects mediated by shifting interspecific interactions. We investigated the role of salinity as a driver of benthic community structure on rocky shores within estuaries in British Columbia. On the BC central coast, local stream inputs deter sea star predators, resulting in the release of dominant prey (mussels) at the scale of tens of meters. Because the stratified hyposaline

layer in these systems is not very thick, subdominant predators (dogwhelks) persist and thrive at the stream mouths where their preferred prey are most abundant. In contrast, the salinity of the southern Strait of Georgia is dominated by a large river, the Fraser, and the depth of the hyposaline layer often exceeds the tidal amplitude (i.e., there is no respite from low salinity in the intertidal zone at high tide). As a result, both sea stars and whelks are negatively impacted by low salinity in the Strait of Georgia. Sea stars (*Pisaster ochraceus*) control mussel zonation in the region, but are increasing restricted to the subtidal in areas of low salinity over scales of tens of kilometers. As a result, mussels are more abundant at locations closer to the mouth of the Fraser River, and mussel bed extent is greater in years of high river discharge. Our results emphasize the importance of interspecific interactions in dictating the outcomes of spatial and temporal variation in dominant environmental drivers.

KEYSTONE INTERDEPENDENCE: SEA STAR LOSS IN THE ROCKY INTERTIDAL LEADS TO MUSSEL EXPANSION AND SEA OTTER POPULATION RESPONSES

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1- Conservation and Science Division, Monterey Bay Aquarium 2- Dept. of Ecology and Evolutionary Biology, UC Santa Cruz 3- USGS, Western Ecological Research Center 4- USGS Western Ecological Research Center

The sea star *Pisaster ochraceus* and sea otters (*Enhydra lutris*) are two top predators capable of shaping rocky intertidal and kelp forest community structure and functioning through strong cascading effects. In 2013, a catastrophic sea star wasting event decimated *Pisaster* populations along the west coast of North America. The collapse of this species in the rocky intertidal revealed an unexpected relationship between two keystone predators. In this study, we show how the loss of *Pisaster* along the Monterey Peninsula, California, USA led to an increase in mussel (*Mytilus californianus*) cover and expansion into the lower rocky intertidal zone. Prior to the sea star wasting event, invertebrate prey-limitation in central California kelp forests contributed to sea otters reaching a near equilibrium with slow population growth. However, in the absence of *Pisaster* owing to the sea star wasting event, sea otters increased their dietary intake on mussels, which contributed in-part to a local population-level rise. These results demonstrate how the loss of a keystone predator in one ecosystem may impart changes in another through multiple indirect effects. Therefore, we infer that cross-ecosystem coupling can occur through keystone interdependence.

NEW APPROACHES TO UNDERSTANDING THE FACILITATIVE ROLES OF CANOPY-FORMING SEAWEEDS

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1- UC Irvine 2- Soka University of America

Large, canopy-forming seaweeds can mitigate physical stresses at low tide by protecting understory seaweeds. We took a multifaceted approach to evaluating these roles, focusing on facilitation by the rockweed *Silvetia compressa* on Southern California rocky shores. We combined community surveys, photophysiology, and functional trait measurements to evaluate the characteristics and roles of *Silvetia*. Surveys of canopy layering in areas with and without *Silvetia* identified which understory species were associated with the *Silvetia* canopy. Across multiple sites, increases in *Silvetia* cover were associated with increases in the cover of understory species. However, there was no correlation between the cover of non-understory species and *Silvetia* cover. Pulse-amplitude-modulated (PAM) fluorometry revealed an 86% reduction in photosynthetic yield of an understory species when the *Silvetia* canopy was removed, highlighting the role of the canopy in mitigating stress. Functional trait measurements showed that *Silvetia* was thicker and less finely branched than the species it facilitates, suggesting that morphology can predict the roles of seaweeds. This study highlights the traits and roles of *Silvetia* as it ameliorates stress, enhancing the performance and biodiversity of understory species. Facilitation can mitigate impacts of climate change by buffering vulnerable species against stress, but recent declines in *Silvetia* in Southern California underscore the potential for cascading losses of associated species.

FROM STASIS TO INSTABILITY: RECOVERY DYNAMICS OF THE ARCHETYPAL KEYSTONE SPECIES PISASTER OCHRACEUS AFTER A COAST-WIDE MARINE PANDEMIC

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Echinoderms (e.g., sea stars, sea urchins) have been characterized as a “boom-bust” phylum, with irregular population crashes with no recovery, explosions to new stable densities, and periodic booms then busts, followed by lengthy periods of stasis. After 14+ years of relatively stable population density and body size, the 2014 sea star wasting (SSW) event triggered a decade-long period of instability. The population crash seen coast-wide during 2013-14 was followed by massive recruitment of *Pisaster ochraceus* at multiple sites in Oregon and California. Although afterward SSW never reached the high levels of the pandemic, it persisted at low levels from 2015 to 2024, sometimes spiking at 10% to 20%, while recruitment pulses also occurred but both patterns varied inconsistently among sites and years. These unprecedented dynamics dramatically altered population size structure at all sites, which had been dominated by adults but now had fluctuating proportions of recruits and juveniles, while population densities greatly overshot pre-SSW levels. Predictably, *Pisaster* predation rates dropped sharply, and took up to 8 years to show recovery to pre-wasting levels. Based on the proportion of variance explained in between-year regressions comparing pre- vs. post-wasting size structure, recovery to pre-wasting size structures ranged from 0% to 76.4%. Thus, no population has fully recovered after 10 years post-wasting. We suggest that this represents a fourth boom-bust model: crashes from stable abundances followed by lengthy states of instability.

SHIFTS WITHIN BENTHIC SHALLOW ROCKY-REEFCOMMUNITIES IN NORTHERN CALIFORNIA SINCE 2014

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Cal Poly, Humboldt

An unprecedented ecosystem shift has come to the kelp forests of northern California following a rapid succession of catastrophic events. Rocky reef communities have shifted from kelp forests to large scale urchin barrens due to increased purple urchin densities, the demise of *Pycnopodia helianthoides*, and a series of marine heatwaves (MHW’s). Here I examine the species richness of the benthic community over an 8-year time span (from 2014 to 2021) using annual SCUBA surveys to examine community structure and the specific relationships of distinct species within the Northern MLPA study region. Random Forest modeling results suggest that particular species can be used to predict community richness, and highlights the role of obscure species such as the giant acorn barnacle (*Balanus nubilus*) and stalked tunicate (*Styela montereyensis*)as potential indicators of higher richness based on their presence. Forest forming Phaeophyceans (brown algae) other than *Nereocystis* are better predictors of richness within shallow rocky-reef habitats in the study sites I examined. Furthermore, the composition of indicator species changed throughout the course of the 8-year study period (2014-2021), is different amongst sites of the Mendocino sub-region, and is influenced by depth. These results could be used to inform kelp restoration efforts, help management and recovery of kelp forest communities, and build upon our understanding of ecosystem phase shifts and dynamics within rocky reef communities along California’s north coast.

Session 38: Coral Reef Ecology III

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

SPECIES-SPECIFIC VARIATION IN CORAL THERMAL TOLERANCE LIMITS ACROSS AMERICAN SAMOA

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Rising ocean temperatures and an increase in the frequency and intensity of marine heatwaves threaten the persistence and functioning of the world's tropical reefs by directly increasing mortality of reef-forming corals. The extent to which coral populations will be able to adapt to this altered environmental state is therefore a question of critical importance. If heritable, diversity in thermal tolerance among coral colonies may provide the raw material on which selection may act, yielding an increased population fitness over time. To better understand the range and spatial patterns of thermal tolerances present within coral populations in the tropical Pacific, we used the Coral Bleaching Automated Stress System (CBASS) to assay the heat stress response (ED50 of photosynthetic efficiency) of ~700 colonies of *Acropora hyacinthus* (hyacinth table coral) and *Pocillopora verrucosa* (cauliflower coral) in American Samoa across two years. Using genetic sampling, we also identified the major genera of symbionts (Symbiodiniaceae) present in the tested colonies. We found mostly species-specific patterns in thermal tolerance limits and symbiont communities across space, with some interesting consistencies. For example, the sampling location with the highest mean tolerance was not consistent across species, but some locations maintained similar rankings across both datasets. These data contribute to a better understanding of adaptive diversity in corals, which is critical to informing conservation, restoration, and management strategies for reefs globally.

MICRO-NEIGHBORS DOING BABY CORALS FAVORS: EXPLORING THE INFLUENCE OF SUBSTRATE BIOFILM ON THE DEVELOPMENT OF CORAL RECRUIT MICROBIOMES

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Over the past two decades, microbial symbiosis has become a fundamental tenant of coral reef ecology. Coral animals 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 exude secondary metabolites that influence water and biofilm microbiomes, which importantly act as settlement cues for coral larvae. Unlike adult conspecifics, coral recruits begin life on the reef aposymbiotic, with little known on how the holobiont becomes established. This study examines the benthic "neighbor effect" at the settlement scale, comparing the capacity of different biofilms to influence early life history coral settlement and microbiome development. Settlement substrates were conditioned for six weeks in flow-through aquaria with crustose coralline algae, *Dictyota*, or ambient seawater to promote a "healthy reef", "fleshy algal reef", or control biofilm respectively. Macro-successional organisms were scrubbed from the substrate and swimming coral larvae of the Caribbean brain coral *Colpophyllia natans* were evenly distributed among replicate treatment bins for settlement. Settlement was scored after 72 hours, and bacterial microbiomes of coral larvae and settled recruits were analyzed via 16S rRNA gene amplicon sequencing. Settlement results suggest that biofilm community strongly influenced coral settlement, with "healthy reef" and "fleshy algal reef" biofilms incurring higher settlement than the control and "fleshy algal reef" biofilms displaying the strongest settlement response.

SURVEY OF FISHING IMPACTS ON URCHIN SURVIVORSHIP, ABUNDANCE AND PREDATION REEF, REVEALING EXTREMELY LOW FUNCTIONAL REDUNDANCY OF URCHIN PREDATORS IN FISHED ECOSYSTEMS

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unaffiliated

Urchins play critical functional role in coral reefs – as herbivores, as prey resources for consumers, and as bio-eroding ecosystem engineers. These roles appear to be particularly important in fished ecosystems where other species that play these functional roles (e.g. large parrot fish) are often among the first impacted by fishing pressure. Yet we know little about the controls of urchin population dynamics in coral reef ecosystems and how this varies with fishing pressure. In this study we explore the effects of changing predator communities across a fishing gradient on 1)

urchin survivorship, 2) urchin abundance, and 3) identity of urchin predators. Comparing unfished to moderately fished Pacific coral reefs with similar benthic structure, we find significantly increased rates of predation across all size classes of urchins in unfished vs. fished sites. This increased survivorship is associated with a greater than 10 fold increase in urchin abundance in unfished sites. Even in these diverse ecosystems, there is strikingly low functional redundancy of urchin predators, especially in fished sites, where 100% of urchin predation events (n=51) were by just two species. This low functional redundancy suggests that regulation of urchin populations may be highly vulnerable to any further increases in fishing pressure.

MULTIMODAL SPECIES ABUNDANCE DISTRIBUTIONS AND NICHE DYNAMICS OF RARE AND COMMON CORALS IN MO'OREA, FRENCH POLYNESIA

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CSU Northridge

This study applies theoretical frameworks of species abundance distributions (SADs) to analyze abundance patterns of rare and common scleractinian corals in Mo'orea, French Polynesia, and examines whether rarity restricts species to unique niches. Contrary to predictions that SADs would follow lognormal [Y= log(x)] or log-series [Y = - αln(1-x)] distributions, our analysis revealed a multimodal distribution of coral species. Multimodality, driven by species-specific habitat preferences and differences in spatial aggregation between rare and common species, often indicates high environmental heterogeneity and enhanced ecosystem resilience. To test whether rare species occupy distinct niches compared to common species, coral niches—quantified by their physical dimensions and invertebrate community structure—were measured for two rare and two common corals within 25 cm and 50 cm annulus plots. Assessing niches in these dimensions allowed us to consider the biological and physical aspects of the niche separately, based on the rationale that biological processes typically manifest over smaller spatial scales. Multivariate niches of rare and common corals were indistinguishable at both scales. These findings suggest that coral rarity may not significantly influence niche differentiation, or that niches around corals are defined over spatial scales >100 cm in diameter. Our results underscore the value of SADs in providing insights into coral abundance patterns beyond spatial distribution alone and suggest that multimodality may be a common feature of coral distributions.

RECOVERED CORAL COVER AT LIZARD ISLAND, AUSTRALIA 6 YEARS POST-DISTURBANCE

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From March of 2014 to May of 2017, Lizard Island reefs in the northern region of the Great Barrier Reef experienced four consecutive annual disturbances; Cyclone Ita in 2014, Cyclone Nathan in 2015, and two massive bleaching events in 2016 and 2017. Between the concentrated patches of physical damage from the cyclones and the uniform impact of the bleaching events, these reefs were devastated, with none of the eight study sites harboring more than 20% live coral cover by May of 2017 (Madin *et al.*, 2018). In November of 2023, after six years of relatively calmer conditions with no conspicuous region-wide, large-scale disturbances, I documented the extant coral community on eight previously-monitored reefs around Lizard Island. All of these reefs showed significant ($p<0.001$) improvement from their 2017 post-disturbance degradation. Living coral at my study sites had recovered to 18.4 to 59.9% of the reef area per site by 2023, with many sites towards the higher end of that range. Fast-growing Acroporidae corals drove the recovery of coral extent in these more northern sites. While family richness across all sites improved by 2023 (4.0 ± 0.11; grand mean ± 1 se), Lizard Island reefs have yet to reach their pre-disturbance diversity (4.77 ± 0.58 in 2014). Future annual surveys of the study sites as well as others surveyed in 2017 may better clarify the relationship between reef location and the rate of recovery of coral cover post-disturbance.

FACILITATION ON TROPICAL CORAL REEFS: THE IMPACT OF MILLEPORA SPP. ON ASSOCIATED INVERTEBRATE COMMUNITIES

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CSU Northridge

Coral reefs are experiencing environmental disturbances causing coral community composition to change. Unlike many corals that are decreasing in population size, populations of the hydrocoral, *Millepora* spp., are dynamic over time and have increased in coverage on some reefs. Although *Millepora* has been recognized for providing a surface exploited by other invertebrates, whether *Millepora* can support diverse invertebrate communities and the mechanism by which this occurs remains understudied. Here, we study facilitation between *Millepora* and marine invertebrates on two tropical coral reefs in the Caribbean and South Pacific. We first tested the hypothesis that invertebrate assemblages on/around *Millepora* are distinct, and second, investigated the drivers of the relationships we detected. In Moorea, French Polynesia, invertebrate assemblages on, and < 10 cm from the margin of, *Millepora* differed in taxonomic composition from assemblages at random locations on vacant substrata and on/around colonies of Porites rus. In St. John, USVI, linear regressions revealed a high capacity for variation in *Millepora* size and structure to account for changes in the abundance, diversity, and richness of the associated invertebrate assemblages. Together, our results suggest that *Millepora* can facilitate elevated abundances and diversity of benthic invertebrates, with these effects potentially mediated by refugia created by the physical structure of *Millepora* colonies. This conclusion emphasizes the underappreciated role of *Millepora* in modulating community dynamics in shallow coral reefs.

Session 39: Conservation and Restoration V - Restoration

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

THE GLOBAL KELP FOREST CHALLENGE AND THE OREGON KELP FOREST PROTECTION AND RESTORATION INITIATIVE - THINKING GLOBALLY, ACTING LOCALLY

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1- Oregon Kelp Alliance & Oregon State University 2- Kelp Forest Alliance & University of New South Wales Sydney

Covering a quarter of the world's coastlines, kelp forests are one of the most widespread and valuable coastal ecosystems on the planet, providing a range of important ecological, economic, and cultural benefits. However, kelp forests across every continent are in decline - over the past 50 years, 40–60% of kelp forests have been degraded. A multitude of local pressures and climate change are threatening the survival of this vital ecosystem.[1] In Oregon, the majority of kelp forest habitat is found on the south coast, concentrated on several major offshore reefs. Some, like Orford Reef, have experienced abrupt kelp forest declines in recent years. In response to these alarming declines, the Oregon Kelp Alliance (ORKA) was founded in 2019 to spearhead research and conservation efforts, aiming to safeguard and revitalize Oregon's vital kelp forests. The Oregon Kelp Alliance is part of the global Kelp Forest Alliance and joined forces with other organizations in 2023 to launch the Kelp Forest Challenge Roadmap[2] with the goal of protecting and restoring 4 million hectares of kelp forest, globally, by 2040. The Oregon Kelp Alliance published the Oregon Kelp Forest Status Report with funding from the NOAA National Center for Coastal and Ocean Studies (NCCOS) in 2024. We will outline the Kelp Forest Challenge Roadmap and discuss the Oregon Kelp Forest Protection and Restoration Initiative, a NOAA NMFS Habitat Restoration Program supported project beginning in 2025. [1] United Nations Environment Programme (2023). Into the Blue: Securing a Sustainable Future for Kelp Forests. Nairobi.[2] Eger et al. 2023. A roadmap for protecting and restoring 4 million hectares of kelp forests by 2040. Kelp Forest Alliance, Sydney, Australia

ADVANCING BULL KELP RESTORATION USING ARRAYS TO RECOVER KELP ECOSYSTEM VEGETATION (ARKEV) AND VEGETATIVE DRIFT KELP SUPPLEMENTS

Karm, R.H.[1*]; Kim, A.[2]; Bugbee, B.M.[2]; Grime, B.C.[3]; Bauer-Civiello, A.[4]; Huckeba, J.[1]; Strock, S.[1]; Hascall, E.[1]; Elsmore, K.[5]; Hamilton, S.L.[2]; Hughes, B.B.[1]; McHugh, T.A.[3]

1- Sonoma State University 2- Moss Landing Marine Labs/San Jose State University 3- The Nature Conservancy 4- Reef Check California 5- California Dept. of Fish and Wildlife

Following multiple stressor events, nearshore bull kelp (*Nereocystis luetkeana*) ecosystems along the northeastern Pacific continue to be dominated by overgrazing sea urchins. Thus, recovery efforts must employ both grazer suppression and kelp outplanting techniques as vegetative recovery post-urchin suppression can be delayed for years without sufficient spore supply and continued destructive grazing. Our study tested the combination of three techniques to catalyze regrowth of bull kelp forests in Mendocino, CA. The first technique reduced sea urchin densities via hand harvest. The second involved deployment of a novel, cost-effective kelp outplanting module (**ARKEV**) that utilizes no permanent infrastructure and can be easily deployed by boat. Lab grown juvenile bull kelp sporophytes were directly spliced into rope suspended ~1 m above the reef. The third involved deploying kelp tissue as “drift” to feed remaining grazers, shifting behavior from active to passive grazing. Juvenile sporophytes (n=64) on ARKEV modules (n=4) exhibited 40% survival after four weeks and began soral production after eight weeks. We also documented substantial rockfish recruitment to kelp on the ARKEVs, indicating positive community responses. Drift kelp resulted in a nearly threefold decrease in grazing rate on feeding assays suggesting a reduction in mobile grazing behavior. Results to date suggest that strategic sequencing of grazer suppression, ARKEV outplants, and drift supplementation may facilitate accelerated recovery in an annual kelp forest system.

EARLY INTERVENTION IN URCHIN BARRENS: A CASE STUDY FROM BIG SUR, CALIFORNIA

Freiwald, J.*; Bauer-Civiello, A.; Abbott, D.; Seale, M.

Reef Check

The West Coast of North America has experienced significant loss of canopy kelp species, *Nereocystis luetkeana*, and *Macrocystis pyrifera* due to extreme warm water events from 2013 to 2015. This has led to increased restoration efforts and studies, especially in Northern California. Central California maintained a mosaic of kelp. However, linear regressions using Reef Check’s subtidal surveys from 2015-2023 at sites along the Big Sur coast reveal a significant increase in purple sea urchin (*Strongylocentrotus purpuratus*) densities at eight long-term monitoring sites, from 0.86/m^2 ± 0.25 SE in 2015 to 8.07/m^2 ± 2.0 SE in 2023, with some sites reaching purple urchin densities of 20/m^2. Five of eight sites show significant declines in *M. pyrifera* stipe densities, dropping from 1.52/m^2 ± 0.46 SE in 2015 to 0.35/m^2 ± 0.22 SE in 2023. We tested restoration efforts at a site in Big Sur, which had high urchin densities but is still surrounded by canopy kelp. After 16 days of purple urchin removal across two years, densities dropped from 26.7/m^2 ± 5.3 SE in 2022 to 4.3/m^2 ± 0.9 SE in 2024. Canopy kelp, mostly *N. luetkeana*, increased from 0.008/m^2 ± 0.01 SE in 2022 to to 2.71 per m^2 ± 0.84 SE by the fall of 2023. Kelp has remained abundant at the site in 2024 with densities of 1.3/m^2 ± 0.6 SE in the summer and similar to surrounding kelp forests. These findings suggest that early intervention can yield substantial rewards, even when urchin densities are not reduced to levels below the theoretical threshold of 2/m^2, making it a viable kelp forest restoration strategy.

KELP RESTORATION BY VOLUNTEER CITIZEN SCIENCE DIVERS IN MONTEREY CALIFORNIA.

Rootsaert, K.R.*

Giant Giant Kelp Restoration

Kelp Restoration at Tanker’s Reef, Monterey CA was allowed by a 2020 amendment to the sportfishing rules to allow volunteer divers to cull an unlimited number of purple and red urchins using hand tools. CDFW, MBNMS, OPC and Reef Check were our scientific partners and monitored the before, during, and after ecological effect of the culling effort in a 1 hectare shale bed area. The divers culled 749k urchins in 1527 dives and restored 11 acres of kelp forest in a 10 hectare former urchin barren. Our government allies insisted the project sunset after 3 years and the urchins are rapidly eating the kelp forest as predicted. This presentation examines volunteer outreach and restoration strategies employed and to be developed in our adaptive management petition to restore 2000 acres of kelp in Monterey by 2030. *This is a story of hope.*

LARGE-SCALE KELP RESTORATION IN URCHIN BARRENS IN NORTHEASTERN NEW ZEALAND – USING ARTIFICIAL INTELLIGENCE FOR IMAGE ANALYSIS

Miller, K.I.*; Spyksma, A.J.P.; Shears, N.E.

University of Auckland

Many kelp forests across the world have been decimated by sea urchin overgrazing, leaving behind depauperate “urchin barrens”. While sea urchin removal is often advocated as a tool for kelp forest restoration, few large-scale experiments have been conducted. This is a necessary step to set realistic expectations and improve restoration success. We removed sea urchins (*Evechinus chloroticus*) from four large, semi-discrete areas (1.6-2 ha; designed to minimise reinvasion) of urchin barrens in northeastern New Zealand without any further measures (e.g. additional removals, kelp transplantation/seeding). Ecological monitoring has been conducted for three years post removal using (1) traditional quadrat data to capture fine details on ecosystem change and (2) recently developed artificial intelligence tools applied to geotagged underwater imagery to reveal spatial patterns in recovery. Combined, these monitoring methods demonstrated rapid kelp (*Ecklonia radiata*) and fucoid (*Sargassum sinclairii, Carpophyllum* spp.) densities and canopy cover increases throughout the removal areas, while remaining constant or declining in adjacent control areas. While sea urchin removal can promote rapid (<1 year) macroalgal recovery, after 3 years, sea urchin densities are also increasing, highlighting removal does not address the causes of sea urchin overpopulation. Therefore, additional management strategies (e.g. marine protection or fishing reduction) are needed for maximum benefits.

Session 40: Behavioral Ecology II

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

HEART RATE AND VALVE-GAPING BEHAVIOR OF MYTILUS GALLOPROVINCIALIS IN RESPONSE TO ACUTE HYPOXIA

Klopp, M.J.*; Miller, L.P.

San Diego State University

Low-inflow estuaries in Southern California can experience rapid shifts in abiotic conditions linked to events such as tidal inlet closures and eutrophication. Sessile organisms, such as bivalves, must change their behavior and physiology in order to tolerate the shift in conditions. The Mediterranean mussel *Mytilus galloprovincialis* became established in Southern California estuaries in the 20th century and is abundantly available in the San Diego area. We monitored the cardiac and valve gaping activity of *M. galloprovincialis* in response to rapid declines in dissolved oxygen (DO) associated with tidal inlet closures and eutrophication in the field and in a controlled laboratory experiment designed to mimic the stress of hypoxia. As DO declined, the mussels closed their valves and tended to remain closed throughout the duration of the low-DO exposure. Prolonged valve closure was also found to be associated with a decline in heart rate, but heart rates rose to high levels following the reopening of the valves as DO was increased. Mussels rapidly responded to changing DO and appeared capable of tolerating the short-term impacts of hypoxic conditions, though they likely incur oxygen debt that must be recovered following the reopening of the valves.

INDIRECT EFFECTS OF SUNFLOWER STARS ON THE GRAZING BEHAVIOR OF RED URCHINS FROM KELP FORESTS AND URCHIN BARRENS

† Sridhar, N.S.[1*]; Galloway, A.W.[2]; Gravem, S.[3]; Kroeker, K.J.[1]

1- UC Santa Cruz 2- University of Oregon 3- Oregon State University

Predators in kelp forest ecosystems can prevent transition into urchin barren states and promote recovery back to kelp forests by controlling overgrazing of kelp by herbivores. Predators can promote kelp through direct consumption of herbivores or indirectly, by releasing chemical cues that can change herbivore behaviors in ways that reduce kelp consumption. Most work on trophic cascades in kelp forests has focused on sea

otters and their urchin prey. However, emerging evidence suggests secondary predators, such as sunflower sea stars (*Pycnopodia helianthoides*), may play an underappreciated role in controlling urchins. In this study, we investigated variation in herbivory by red urchins (*Mesocentrotus franciscanus*) on giant kelp (*Macrocystis pyrifera*) with varied hunger states (e.g., collected from barrens versus kelp forests), while subjected to *Pycnopodia* predator cues in large mesocosms (5.5 $^{m}3$). Urchins from both hunger states exhibited reduced grazing of kelp in the presence of a sea star. Reductions in grazing were greater for urchins from barrens compared to urchins from kelp forests. These results indicate that the presence of a sunflower star can alter the grazing behavior of sea urchins from barrens such that their consumption rates of giant kelp are reduced to baseline consumption rates of satiated urchins from kelp forests.

FIDELITY AND FLUX: COMPARATIVE ANALYSIS OF MARINE PREDATOR RESIDENCY

Youngblood, M.R.[1*]; Freedman, R.M.[2]; Duncan, E.A.[2]; Caldow, C.[2]; Lowe, C.[3]; Spurgeon, E.[3]; Logan, R.[3]; Merson, Z.[3]; Lyons, K.[4]; Block, B.[5]; Castleton, M.[5]; Nosal, A.[6]; Chapple, T.[7]; Ben-Aderet, N.[8]

1- University of Hawai'i at Hilo 2- Channel Islands National Marine Sanctuary 3- CSU Long Beach 4- Georgia Aquarium 5- Stanford 6- Scripps Inst. of Oceanography 7- Oregon State University 8- California Dept. of Fish and Wildlife

This study assessed movement and habitat fidelity metrics of seven tagged marine predator species opportunistically detected within the Channel Islands National Marine Sanctuary (CINMS) from 2013 to 2024. Data from 13 acoustic receivers stationed around four Northern Channel Islands revealed both broad-scale spatial patterns and species-specific behaviors. Of 277 transmitters detected, 224 individuals were identified through a collaborative telemetry network of West Coast universities and research institutions. Leopard (Triakis semifasciata), Sevengill (Notorynchus cepedianus) Sharks and Giant Sea Bass (Stereolepis gigas) exhibited high site fidelity; while Soupfin Sharks (Galeorhinus galeus) and Yellowtail Amberjacks (Seriola lalandi) displayed high connectivity and low site fidelity within the sanctuary. Bat Rays (Myliobatis californica) and White Sharks (Carcharodon carcharias) exhibited seasonal site fidelity in Fall and Summer, respectively. Notably, juvenile White Sharks exhibited the greatest maximum daily displacement, the farthest distance between detection locations in a single day, at 45.5 km. These findings highlight the value of CINMS as a multi-purpose habitat for both resident and migratory species in the Northeast Pacific, underscoring the need for expanded long-term, inter-regional, acoustic monitoring networks to inform future conservation strategies.

FIRST STEPS OUT THE DOOR: REPORT ON A RELEASE OF CAPTIVE BRED SUNFLOWER STARS INTO A SUBTIDAL EELGRASS MEADOW

† Weertman, W.[1*]; Sulentic, L.[2]; Knopf, J.[2]; Robidoux, J.[2]; Schwab, C.[1]; Valdez, V.[1]; Ashcraft, B.[1]; Ullmann, J.[1]; McCloskey, M.[3]; Kitaeff, P.[1]; Hodin, J.[1]

1- UW Friday Harbor Labs 2- University of Washington 3- San Juan Islands Conservation District

Sunflower stars (*Pycnopodia helianthoides*) have been severely impacted by sea star wasting disease across the Northeast Pacific since 2013, leaving vast stretches of coastal ecosystems without this key predator and disrupting kelp forest communities. In response to these threats our group pioneered a captive rearing project for sunflower stars in 2019. In the summer of 2024 we conducted the first-ever release and monitoring of captive-bred sunflower stars in the wild, a crucial step towards evaluating the feasibility of restoring populations of this ecologically significant species. We released ten two-year-old and ten one-year-old stars into separate eelgrass beds along the shoreline of the University of Washington Friday Harbor Laboratories in collaboration with the biennial Marine Subtidal Ecology scientific diving course. Divers conducted circular and roaming surveys, documenting stars with photos, and recording their locations. Within a few days, the stars dispersed from release locations, suggesting habitat self-selection. No direct mortality or injury was observed. Stars were more active and easier to locate at night. As a part of this project, we are developing photo re-identification methods using custom software. Using field photos in comparison to pre-release photos, we have found that the task is feasible and that high-quality images with visible madreporites were most effective. We will discuss how this ongoing study will help us refine sunflower star release and monitoring methods while providing crucial insights for scaling up future restoration efforts.

HABITAT STRUCTURAL COMPLEXITY INFLUENCES ANTI-PREDATORY BEHAVIOR OF THE HERBIVOROUS REEF FISH, ACANTHURUS NIGROFUSCUS

† Bascom, D.E.[1*]; Davis, K.A.[2*]; Johnson, A.N.[3*]; Philbois, A.M.[4*]; Long, A.E.[5]; Barber, P.H.[5]; Fong, P.[5]; Davis, A.C.D.[6]

1- North Carolina Agricultural & Technical State University 2- East Carolina University 3- University Of Knoxville Tennessee 4- University of French Polynesia 5- UC Los Angeles 6- CSU Northridge

Intense fish herbivory is critical to maintaining healthy coral reefs by limiting algal proliferation. Healthy herbivore populations are maintained partly by the high structural complexity of coral reefs by providing refuge from predators. However, coral reef ecosystems are increasingly losing structural complexity due to anthropogenic stressors, potentially disrupting the behavior of herbivorous fishes. We examined the relationship between the structural complexity and the anti-predator behavior of a common herbivorous fish, *Ancanthurus nigrofuscus*, on a fringing reef of Mo'orea, French Polynesia. We compared anti-predator behavior in 3 paired plots that differed significantly in rugosity (LME, p=0.0068). Across 181 replicate behavioral trials, individual fish hid from an approaching snorkeler more frequently in high rugosity plots but fled more often in low rugosity plots (chi-squared, p<0.0001). However, counter to predictions, fish size or plot rugosity had no impact on flight initiation distance (LME, p=0.539). This change in fish behavior could have far-reaching implications, as declines in structure that result in fish fleeing more could reduce total herbivory, potentially triggering cascading effects that accelerate the global decline in coral reef ecosystems. Thus, understanding these dynamics is essential for mitigating the ongoing deterioration of reef ecosystems.

EFFECTS OF CLIMATE CHANGE ON PANULIRUS INTERRUPTUS – STRONGYLOCENTROTUS PURPURATUS PREDATOR-PREY RELATIONSHIPS

Johnson, M.[*]

San Diego State University

Southern California kelp forest communities can be strongly influenced by a single type of herbivore, the purple urchin (Strongylocentrotus purpuratus) due to their effects on algal abundance on coastal rocky reefs. Urchin grazing activity, which can dramatically alter the structure of kelp forest communities, can be moderated indirectly through non-consumptive effects from their predators. In particular, the presence of one of the urchin's primary predators, the spiny lobster (Panulirus interruptus), can dramatically reduce the time that urchins forage and consequently the amount of kelp they consume. The mechanisms driving this relationship can be altered under ocean warming (OW) or ocean acidification (OA) scenarios, but studies determining the combined effects of these two stressors have been inconclusive even though they may more realistically describe future ocean conditions. To examine how OW and OA affect purple urchin feeding behavior in the presence versus absence of lobster predators, I quantified urchin grazing behavior and metabolism in the presence and absence of lobsters under four experimental treatments that represent present-day (current), OW (increased by 3oC), OA (decreased by 0.3 pH units), and future (increased by 3oC and decreased by 0.3 pH units) conditions. To do this, I placed purple urchins in laboratory mesocosms reflecting these conditions with shelters and known quantities of kelp for three-day trials and allowed them to graze in both the presence and absence of lobster predators. Urchin grazing movement and activity was quantified using Go-Pro time-lapse recordings taken throughout each trial. Physiological measurements were taken before and after the trials to determine the effects of the ocean change stressors on urchin metabolism. My results reveal that ocean change stressors can dramatically alter how purple urchins react to predators and thus alter their grazing behavior. Specifically, urchins grazed for less time and consumed less kelp in the presence of lobsters under current ocean conditions, but these differences disappeared under ocean warming and acidification conditions. Further, urchin metabolism increased slightly, albeit non-significantly, under ocean change conditions. These results reveal possible implications for how urchins will graze when in the presence of predators and thus affect kelp forest

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

CHASING THE RED QUEEN AND SEX-BIASED PARASITISM IN A VERTEBRATE KILLIFISH SYSTEM

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The University of Alabama

Biparental reproduction is an evolutionary conundrum because it has several disadvantages over uniparental reproduction. Despite this, it is the dominant mode of reproduction among animal taxa, and one hypothesis for its prevalence is that biparental reproduction enables production of genetically variable offspring, some of which might be better at keeping pace with co-evolving parasites. Parasites may also differentially affect the sexes, leading one sex to be more parasitized than the other due to differences in behavior and physiology. We used the mangrove rivulus fish (Kryptolebias marmoratus), an androdioecious killifish species with normally few males and high percentages of self-fertilizing hermaphrodites, to explore the Red Queen hypothesis and sex-biased parasitism. We sampled three populations with high male percentages (Belize) and three with low male percentages (Florida Keys) and conducted parasite surveys on each fish to investigate external and internal macroparasites. We found higher percentages of males in Belize versus the Florida Keys, and parasite density but not total parasite number was strongly associated with higher percentages of males in a population. Additionally, we found no sex-biased parasitism broadly but there was variation in sex bias across populations, including both male and hermaphrodite-biases. Our results show evidence for the Red Queen Hypothesis and exemplify how sexes may vary in their parasite susceptibility throughout their range, highlighting the importance of spatial gradients in ecological interactions.

COMPARATIVE POPULATION GENOMICS OF TEN MARINE SPECIES ALONG THE COAST OF CALIFORNIA

Pedraza-Marrón, C.[1*]; Bay, R.[2]; Bernardi, G.[3]; Cornwell, B.[4]; Grosberg, R.[2]; Kaustuv, R.[5]; Dugan, J.[6]; Emery, K.[6]; Barber, P.[7]; DeBiasse, M.[8]; Dawson, M.[1]

1- UC Merced 2- UC Davis 3- UC Santa Cruz 4- Stanford University 5- UC San Diego 6- UC Santa Barbara 7- UC Los Angeles 8- Radford University

Marine ecosystems are facing unprecedented changes due to global warming, with massive heat waves promoting shifts in species' distributions and connectivity patterns, further influencing multi-species associations and ecosystem dynamics. Understanding genomic diversity, from individuals to entire ecosystems, can help to evaluate the effects of these rapid changes. In this study, we aim to provide insights into spatial patterns of genomic diversity, population connectivity, and responses to abiotic and biotic environmental variation, from individuals to ecosystems levels along the coast of California, in the face of climate change. To achieve this, we generated predominantly chromosome-level reference genomes and 10X whole-genome resequencing data for approximately 120 individuals across 20 localities for each of ten coastal California species, including commercially important species (e.g. Dungeness crab), keystone species (e.g. pink sea star), and indicator species (e.g. beach hoppers). Our analyses based on *ca.* 100k SNPs revealed latitudinal genetic structure consistent with previously known phylogeographic breaks for intertidal species within the California Transition Zone. We also observed a pattern of genetic differentiation between island and mainland populations, which may be related to environmental conditions. By identifying hotspots of genomic diversity associated with climatic variation, corridors of gene flow, and locations suitable for conservation, we aim to enhance the resilience of California's marine biodiversity under changing climate conditions.

EFFECTS OF PLANT COMPETITION ON DIFFERENT GENOTYPES OF AN INVASIVE SPECIES

Atler, L.J.*

CSU Northridge

Competition in terms of space and resources contributes to the success or failure of plants in their native or invasive habitats. Using the legume burr clover (*Medicago polymorpha*), we evaluated the potential costs or benefits of competition for plant fitness. 60 plant genotypes were collected from this species' native and invasive ranges. Three replicates of each unique genotype were exposed to a factorial design of rhizobia and plant competition treatments in the greenhouse. Each *M. polymorpha* genotype was exposed to either intraspecific competition or interspecific competition from a native legume, *Acmispon heermannii*. At the end of the experiment, we quantified the biomass of above and belowground biomass, plant height and root length as a proxy for plant growth. We found that the success of the plant depended both on the range (invasive vs. native) from which genotypes were collected and the specific plant genotype. Range and genotype also influenced plant size, but we found an interaction of competition and plant size as well. To understand the invasive potential of this species around the globe, it may be important to consider genetic variation in the invasion pool, as well as trait evolution during the invasion process. Understanding the interactive effects of mutualisms and competition on this globally invasive species and how they might vary across environmental contexts will contribute to our understanding of how these species interactions contribute to the success of this species.

PHYLOGENETICS OF SYMBIOTIC SNAPPING SHRIMP INDICATE CONVERGENT EVOLUTION OF BURROWING-RELATED CLAW MORPHOLOGY

Hultgren, K.M.[1*]; Anker, A.[2]; Torrance, K.[3]; Thacker, C.[4]; Thompson, A.[5]; Hurt, C.[3]

1- Seattle University 2- King Abdullah University of Science and Technology 3- Tennessee Tech 4- NHM Los Angeles 5- Southwest Fisheries Science Center

Tropical marine decapods are known for their wide range of symbiotic relationships, and often show morphological adaptations when associating with different hosts or habitats. One obstacle to studying morphological evolution in crustaceans is the prevalence of cryptic species, especially in poorly characterized tropical groups. The genus *Alpheus*—known as snapping shrimps—is a diverse group of primarily tropical species, characterized by asymmetrical claws which produce a distinctive snap. The genus is taxonomically challenging, with many cryptic species complexes, and many species live in specialized habitats or with different symbiotic partners. In this study, we examine morphological adaptation in the *Alpheus brevirostris* group, which is comprised of primarily burrowing or burrow-dwelling species, many of which live in symbiotic associations with gobies or echiurans and use their claws to construct burrows. We delimited cryptic species using COI data, constructed a multi-locus phylogeny to trace the evolution of burrowing behavior, and used morphometric analyses to compare claw morphology between burrowing and non-burrowing species. Species delimitation analyses indicated several cryptic species of *Alpheus*, with sister species primarily allopatric. Phylogenetic and morphometric analyses indicated that burrowing behavior evolved multiple times across the tree, and that burrowing species convergently evolved distinct changes in claw morphology. Together these data provide a phylogenetic framework for examining the origins and extent of the goby-shrimp symbiosis.

PREDATION AS A SELECTIVE FACTOR IN THE EVOLUTION OF COLONY FORM IN THE PROTOZOAN ANCESTORS OF ANIMALS

Kim, T.[*]; Hata, T.; Koehl, M.A.

UC Berkeley

Choanoflagellates, protozoans that can form multicellular colonies and that share a common ancestor with animals, are a model system to study selective factors that might have affected the evolution of animal ancestors. A choanoflagellate cell swims with a flagellum surrounded by a collar of microvilli that catch bacteria. Choanocytes of sponges have a similar morphology, but they line chambers where they pump water through the sponge and catch bacteria. Although many types of choanoflagellate colonies have their flagella pointing outwards, *Choanoeca flexa* forms cup-shaped colonies that can turn inside-out. We used videomicrography of the interactions of amoebae with *C. flexa* to study effects of flagella pointing outwards vs. lining a cavity (like in sponges) on susceptibility to predation by benthic raptorial protozoans. Flagella-in colonies swim slowly and settle onto surfaces, where they are eaten by amoebae, whereas flagella-out colonies swim rapidly in the water column and evade benthic

predators. When flagella-out colonies were stuck to the substratum, they were eaten by amoebae. Thus, the ability to swim rapidly into the water column, rather than having flagella covering a colony's outer surface, is the feature that makes flagella-out colonies less susceptible than flagella-in colonies to predation by benthic amoebae.

EFFECT OF GENETIC DIVERSITY ON POPULATION FITNESS

Howard, K.*; terHorst, C.

CSU Northridge

Biodiversity is widely recognized as essential for ecosystem health and functionality. Traditionally, research has focused on species diversity, but genetic diversity within species is also critical for maintaining ecosystem processes. Genetic diversity enhances population resilience and adaptability, allowing ecosystems to recover from disturbances and respond to environmental changes. In this study, we explore how genetic diversity influences ecosystem function, using protozoa found in *Sarracenia* Purpurea as a model system.We focused on two protozoan species, BFC and TA, with three genotypes each. The experiment was conducted under controlled laboratory conditions to investigate the effects of genetic diversity on population growth rate and trait evolution. Both species were exposed to two food treatments (high and low) to simulate resource availability. The cultures were grown for seven days at an optimal temperature of 25°C, with replicate tubes for each genotype and a mixed-genotype treatment. Population growth rates and cell size were measured to assess the impact of genetic diversity on performance.Our findings highlight that genetic diversity plays a key role in shaping population dynamics and can influence traits critical for survival and reproduction. Understanding how genetic variation within species contributes to ecosystem stability offers new insights into biodiversity conservation strategies. These results emphasize the importance of preserving genetic diversity to ensure ecosystems can adapt to changing environmental conditions and maintain functionality over time.

Session 42: Ecosystem Ecology IV

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

INTEGRATING ENVIRONMENTAL JUSTICE INTO SEA LEVEL RISE ADAPTATION: UPDATES AND STRATEGIES IN THE 2024 GUIDANCE

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California Coastal Commission

Integrating environmental justice (EJ) principles into sea level rise planning represents a significant advancement in California's coastal management. The California Coastal Commission aims to protect and enhance the coast through planning, regulation, rigorous science, and public participation. In 2015, the Commission adopted its first sea level rise policy guidance, updated in 2018 to reflect the best available science.This poster reviews the third update of the guidance, integrating considerations for addressing historical and current inequities disproportionately impacting EJ communities, including through the implementation of new external EJ advisors on the project. The update incorporates new science to support local governments and planners in crafting equitable adaptation strategies, aligning with recent legislation on sea level rise planning.Engagement with EJ advisors ensures that planning measures do not disproportionately impact underserved communities but promote a more equitable distribution of environmental benefits and burdens. Grounded in distributive and restorative justice principles, this approach aims to rectify and prevent further injustices through inclusive, community-centered planning. The guidance emphasizes meaningful engagement with EJ communities, integrating their input early into decision-making to enhance coastal resilience and community-specific outcomes.The update details incorporating EJ into Local Coastal Programs and Coastal Development Permits, outlining steps for assessing vulnerabilities and tailoring adaptation pathways to meet EJ communities' needs. This includes developing policies that prioritize EJ in planning and coastal resource management. It provides a model for other states and regions, illustrating how EJ can be integrated into environmental planning and policy-making to foster resilient, inclusive, and sustainable coastal communities.

EVALUATING POTENTIAL DRIVERS OF BULL KELP (NEREOCYSTIS LUETKEANA) RESILIENCE AND LOSS IN THE SALISH SEA

Fieber, A.M.*

University of Washington

Bull kelp (*Nereocystis luetkeana*) forests provide vital biogenic habitats in the Salish Sea, but recent population declines are a growing concern. Elevated temperatures, competition with understory kelp species, herbivory, and sedimentation have all been proposed as potential drivers of *N. luetkeana* losses in this region, and multiple factors may be acting in tandem to influence local populations. To understand these factors and their impacts to bull kelp populations, we SCUBA dive at 13 nearshore sites in Washington (Salish Sea and Strait of Juan de Fuca) and evaluate the environmental conditions underlying stable, declining, and fully disappeared forests. We collect data on both abiotic conditions (temperature, salinity, light availability, substrate composition) and biotic factors (co-occurring macroalgal and invertebrate communities) using a variety of tools and techniques. We then assess relationships between kelp forest dynamics and local conditions, identifying factors that are correlated with resilience or decline, and consider the potential for causal relationships. Preliminary findings from data gathered in 2024 will be discussed, highlighting areas of focus for further monitoring and experimental study. Unraveling the potential causes of *N. luetkeana* losses in the Salish Sea is a critical first step in mitigation of stressors and eventual restoration of essential kelp forest ecosystems.

HISTORICAL & ARCHEOLOGICAL DATA & EXTINCT TAXA EXPAND KELP ECOSYSTEM TROPHIC STRUCTURE INFERENCE ACROSS THE HOLOCENE NORTH PACIFIC

Jacobs, D.K.*; Carden, I.; Proctor, B.; Gray, H.; Lee, W.

UCLA

Estes advanced our understanding of how specific trophic interactions control the regional presence of kelp beds, and their resulting enhanced productivity and diversity at particular places and times. There are now an increasing number of regional case studies focusing on how particular suites of secondary consumers control urchins either permitting or alleviating kelp. Secondary consumers are presumably controlled by disease, changing climate, ecological and actual extinction of trophic interactors, and changing cultural exploitation of resources by killer whales and humans. The flightless duck *Chendytes* lived from Oregon to Baja California and went extinct about 2500 years ago, and represents the loss of a secondary consumer. The apparent trophic overlap between *Chendytes* and sea otters (Jones et al. 10.1016/j.quascirev. 2021.106914) led us to summarize and tabulate the kelp-related trophic players present in 12 regions around the North Pacific back through time to the last glacial maximum. We use historical and archeological literature and climate reconstructions to enumerate the conditions and players present in each region through time. The time resolution we can achieve is increasingly coarse deeper in time. In addition to the likely effect of the loss of *Chendytes* in reducing secondary consumer redundancy, we are struck by the multifaceted impact of the Chinese market on Otters and Lobsters in the 18th and 19th Centuries. Further work in this area can better clarify baseline conditions relevant to modern kelp ecological study.

INVESTIGATING HABITAT FUNCTION OF RESTORED EELGRASS BEDS IN SAN FRANCISCO BAY

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1- San Francisco State University 2- UC Santa Barbara

Despite decades of ecological restoration in many types of ecosystems, assessment of functional equivalency to natural sites is often lacking. Monitoring programs for restored seagrasses have been shifting beyond traditional cover and density measures to include functional attributes, and the globally distributed eelgrass (*Zostera marina*) is increasingly subject to more intensive evaluation. In this study, we assessed epifauna and mobile macrofauna community composition and abundance, and trophic interactions in two pairs of restored and reference eelgrass sites in San Francisco Bay, California. Through repeated measures from May through August 2023, we compared restored and natural beds and whether the setting (location in the Bay and proximity to the reference bed) mattered to the degree of equivalency. In addition, we analyzed a long-term data set

(2016-2022) for eelgrass epifauna and explored whether a trajectory in epifaunal community development is detectable over time amidst a known background of interannual variability in abiotic conditions. Results indicate that trophic interactions show no trend in comparing restored site to natural reference sites. Epifaunal and mobile macrofaunal communities are more strongly influenced by site and local conditions than restored versus natural eelgrass. Further, the more distant natural and restored pair showed less similarity in functional attributes, pointing to the difficulty in assessing convergence in habitat function when there are no nearby natural beds to serve as a reference.

IMPACTS OF GREEN SPACES AND LANDSCAPE CONTEXT ON URBAN ECOSYSTEM SERVICES IN SAN DIEGO, CA

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University of San Diego

Cities increasingly rely on nature and its ecological benefits to support human well-being, but urban expansion and densification challenge our capacity to maintain large green spaces. Previous syntheses have highlighted gaps in our understanding of the impacts of vegetation distribution, diversity, and landscape context on urban ecosystem services, which must be addressed to identify robust greening policies that promote environmental justice. To address these gaps, we leverage open-access remote sensing data and community science observations to measure the effects of green spaces on air filtration, temperature regulation, habitat provisioning, and primary productivity in San Diego. We use aerial images to delineate green spaces and generate landscape metrics to describe their characteristics. Using machine learning and geographically weighted regressions, we assess the role of green space extent, density, connectivity and landscape context in modulating ecosystem services at the census tract level. Preliminary results suggest that census tracts with a greater total extent of green spaces are associated with cooler temperatures, less exposure to aerosols, less variability in temperature and aerosols, and a greater taxonomic and functional diversity of birds. Our analyses indicate that this beneficial effect can be accomplished with both several small green spaces or one large one, and that green spaces are particularly beneficial in non-coastal, less vegetated census tracts. Our study can inform urban greening policies for a more equitable access to ecosystem services.

ENVIRONMENTAL DNA IN GLOBAL BIODIVERSITY HOTSPOT: LESSONS FROM CORAL REEF FISH DIVERSITY ACROSS THE INDONESIAN ARCHIPELAGO

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1- UC Los Angeles 2- National Museum of Natural History, Smithsonian Institution, Washington D.C.

Indonesia is the heart of the Coral Triangle, the world's most diverse marine ecosystem. Preserving the biological and economic value of this marine biodiversity requires efficient and economical ecosystem monitoring, yet our understanding of marine biodiversity in this region remains limited. This study uses environmental DNA (eDNA) to survey fish communities across a well-documented biodiversity gradient in Indonesia. A total of 6,608,693 sequence reads of MiFish 12S rRNA from 39 sites spanning seven regions of Indonesia revealed 1099 fish amplified sequence variants (ASVs), 80.4% of which could be identified to species. Regional fish diversity broadly conformed to expectations, with the highest fish biodiversity in Raja Ampat and lowest in Western Indonesia. Similarly, zeta diversity analysis showed greater community turnover in higher diversity reefs of Eastern Indonesia and greater community similarity in low diversity regions of Western Indonesia. However, despite a twofold difference in fish diversity between Eastern and Western Indonesia, mean ASVs recovered per 1-L seawater was relatively similar across all regions. Moreover, although ASV recovery from individual seawater samples saturated, ASV recovery did not saturate at the site or region level, indicating that sampling/sequencing efforts employed in lower diversity ecosystems are insufficient for biodiversity hotspots like the Coral Triangle. Despite these limitations, eDNA substantially increased (36.3%–84.1%; mean 57.1%) the number of fish species recorded during intensive visual surveys, adding pelagic (tuna, jacks, scads, mackerels), nocturnal (soldierfish, lanternfish), and crevice-dwelling species (eels, blennies, gobies)

that are difficult to document in visual surveys. Results demonstrate the added value of eDNA in biodiversity hotspots like the Coral Triangle and highlight the need for research to understand how best to sample eDNA in high diversity regions to deliver on the promise of eDNA as a tool to monitor marine biodiversity effectively and efficiently.

Poster Sessions

Poster Session

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

1 - FEEDING ECOLOGY OF SERRANUS SCRIBA IN STARESO HARBOR, CALVI CORSICA

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UC Santa Cruz

Serranus scriba is a widespread and abundant benthic mesopredator commonly found in the harbor of the STARESO research station in Calvi, Corsica. Although it's a common species and one that is economically significant, very little research has been done on its trophic ecology. Here, we use fecal pellet analysis to elucidate the feeding ecology of *S. scriba* and determine possible drivers of intraspecific competition in this species. Individuals with diets that were significantly similar were placed into groupings which were used to determine accurate predictors of diet. Both habitat and morphological characteristics were found to accurately predict group membership. This suggests resource partitioning between individuals of this species is a function of size and habitat features.

2 - THE EFFECT OF SUBMARINE GROUNDWATER DISCHARGE ON GREENHOUSE GAS PRODUCTION ON A CORAL REEF IN MAUNALUA BAY, HI

† Nichols, K.[1*]; Arneson, A.[2]; Brigham, M.[2]; Howe, M.[2]; Romo, K.[2]; Vizza, C.[2]; La Valle, F.[2]

1- Pepperdine University 2- affiliation not listed

In the urban coastal environment of Honolulu, Hawai'i, oligotrophic water is enriched with inorganic nutrients like nitrate (NO_3^-), phosphate (PO_4^{3-}), and ammonium (NH_4^+). These nutrients originate from human inputs on land and seep into the ocean via submarine groundwater discharge (SGD). We hypothesized that SGD influences the greenhouse gas (GHG) production of methane (CH_4) and nitrous oxide (N_2O) in coastal systems. Marshes and wetlands are the largest contributors to methane production due to methanogenic bacteria metabolizing large amounts of organic matter. Still, this phenomenon is less studied in coastal systems with SGD because these systems are usually not oxygen-limited. Nitrogenous inputs from leaky septic tanks and sewer lines contribute to the nutrient enrichment we see at our study sites. We hypothesize this could correlate to an increase in N_2O production. We found a relationship between inorganic nutrients and salinity (i.e., a proxy for SGD): for NO_3^- (Black Point: R^2=0.72,p=0.0048; Wailupe: R^2=0.91,p=3.3 x 10-7) and PO_4^{3-} (R^2=0.75,p=0.0031; Wailupe: R^2=0.87,p=2.24 x 10-6), but not for NH_4^+ (Black Point: R^2=0.040, p=0.30; Wailupe: R^2=0.15, p=0.10). We quantified the concentration of methane (0.041 ± 0.014 nM) and nitrous oxide (0.021 ± 0.002 nM) in the water column and the production rates of methane (F = 0.01, df=1, p=0.94; F=0.52, df=1, p=0.49) and nitrous oxide (F=0.99, df=1, p=0.35; F=9.7, df=1, p=0.01) between the two sites and two categories (SGD versus offshore), respectively. Nitrous oxide production rates were significantly higher offshore 200m than at the SGD.

3 - VARIATION OF TOXIC DINOFLAGELLATE COMMUNITIES ON PHASE SHIFT IMPACTED REEFS OF MOORE,FRENCH POLYNESIA

Zerecero Marin, E.R.*; Barber, P.H.

UCLA

Anthropogenic stressors and climate change are transforming reefs worldwide from coral-dominated to macroalgal-dominated communities8, a process known as a phase shift. One important coral reef community overlooked in studies examining changing coral reef ecosystems are dinoflagellates. Some free-living and epiphytic dinoflagellates on reefs can produce toxins that harm marine animals and humans. This taxon may be especially problematic via ciguatera poisoning. Ciguatera is produced by the ingestion of fish or shellfish contaminated with ciguatoxins; a polyether toxin produced in the genus Gambierdiscus. Increased substrate availability associated with phase shifts on coral reefs, indicate the objectives of my study. The macroalga Turbinaria ornata has expanded its range and habitat usage in Moorea, French Polynesia. While few fish consume T. ornata, the epiphytes growing on alga provide food chain support to herbivorous fishes. As such, phases-shifts may not just impact coral reefs but could also directly impact human health by facilitating the entry of toxic dinoflagellates into the food chain. To test that expanding tropical algal populations such as T. ornata could increase toxic dinoflagellate populations and the entry of their toxins into the food chain, I studied three genera of toxic dinoflagellates (Gambierdiscus spp., Ostreopsis spp., and Prorocentrum) and their abundance on T. ornata and three other cooccurring macroalgae. Results showed that T. ornata harbors more Gambierdiscus spp. compared to the three other macroalga ($p = 1e-04$) Ostreopsis spp. showed no preference for any of the macroalgae and Prorocentrum spp. showed no preference for T. ornata. Results show that high abundance of Gambierdiscus spp. dinoflagellates on T. ornata likely increases introduction of ciguatoxins into the food chain.

4 - OYSTER REEF STRUCTURES AS HABITAT: HARNESSING A NATIVE PREDATOR TO COMBAT A PERSISTENT INVASIVE

Khakee, J.S.*; Boyer, K.E.

San Francisco State University

The preeminent strategy used for restoring native Olympia oysters in San Francisco Bay is constructing oyster reefs to provide settlement surfaces for larvae. Constructed reefs provide habitat not only for native oysters, but other native and non-native organisms as well. In many areas of San Francisco Bay, invasive Atlantic oyster drills prohibit restoration of oyster populations, and prior research suggests the absence of native rock crab predators may result in this degraded ecological state. To assess whether the presence of physical structure could reduce drill predation on oysters due to improved conditions for crabs, we manipulated the presence of crabs, drills, and physical structure in a field enclosure experiment. Early evidence suggests that both oyster drills and rock crabs readily consume oysters in a constrained habitat, but that oyster drill predation rates may be less than previously thought at critical densities. As expected, we found evidence that rock crabs consume oyster drills in a field setting. Further, we used experimental reefs with varying degrees of porosity (openness) to assess use by rock crabs, hypothesizing that crabs will prefer more porous reefs due to the increased mobility they afford, thus influencing trophic effects. This ongoing study is suggesting that reef porosity as defined in this experiment is not a meaningful predictor of rock crab usage. However, the novel trapping approach we used routinely found rock crabs on reef structures, supporting evolving hypotheses of rapid colonization of restoration structures by macrofaunal predators. The results of these experiments will inform the design of future reefs to better suit organisms using artificial reef structures as habitat, and help to determine the viability of oyster restoration projects at sites with oyster drills.

5 - IDENTIFYING POTENTIAL DRIVERS OF VARIATION IN GRAY WHALE BODY CONDITION DURING SOUTHBOUND MIGRATION

Provost, S.[1*]; Joyce, T.[2]; Eguchi, T.[2]

1- Duke University 2- NOAA

As eastern North Pacific gray whales (Eschrichtius robustus) complete an annual Southbound migration from their Arctic feeding grounds to their wintering grounds in Mexico, body condition data offers insight into their fitness, foraging success, and overall population health. To determine potential environmental drivers of variability in Southbound body condition, a series of predictive models were created exploring potential correlation between trends in Arctic environmental conditions and gray whale width-to-length ratios. The width-to-length ratios were derived from body condition data collected via visual surveys from 1987 to 2013. Similarly, the timespan for the Arctic environmental data ranged from 1986 to 2012. The results indicated that from 1987 to 2013, variability in interannual Southbound body condition was correlated with an abundance of

Crustacea in Arctic feeding grounds, fluctuating sea ice cover in the Bering and Chukchi Seas, and changes in the Pacific Decadal Oscillation. In a mixed model, the annual averages of the aforementioned factors accounted for 32% of body condition variance during subsequent Southbound migrations. These results demonstrate the importance of looking to trends in Arctic environmental conditions as potential indicators of future gray whale population health.

6 - LOST IN THE CROWD: A GEOMETRIC TRADEOFF BETWEEN FECUNDITY AND OFFSPRING GROWTH IN A COASTAL FISH POPULATION

Hosilyk, H.C.*; Johnson, D.W.

CSU Long Beach

A fundamental life history constraint is the potential tradeoff between offspring number and offspring performance. Here we tested whether the volume of offspring produced by a coastal fish affected their embryonic growth, development, and hatching success. Many organisms lay eggs that adhere together in three-dimensional clutches. Our working hypothesis was that offspring development in such configurations may be limited by gas exchange. If true, then larger clutches of offspring would experience greater limitation because oxygen demand (and production of metabolic waste) scales with clutch volume whereas gas exchange scales with the surface area of the clutch. To test this idea, we pooled gametes from 4 males and 4 females at a time, and randomly allocated developing embryos from this pool into clutches of varying sizes (1.25, 2.5, 5, 7.5, and 15 cm3). This experiment was repeated four times for a total of 32 replicates. After incubating embryos for 12 days under experimental conditions, we measured hatching success, development, and size of the offspring once they reached the larval stage. Hatching success was unrelated to clutch size, but size of the larvae at hatching was much smaller for those larvae that developed within a larger clutch of embryos. Our results thus highlight an underappreciated, but important life history tradeoff. Mothers that produce more eggs do, by virtue of their spatial configuration, produce offspring that are smaller and thus less likely to survive during early life.

7 - WHEN DOES SYMBOLIC REGRESSION BREAK? EXAMINING THE IMPACT OF SAMPLING FREQUENCY ON A MACHINE LEARNING METHOD'S ABILITY TO LEARN POPULATION DYNAMICS

Jarman, C.N.*; Novak, M.

Oregon State University

Machine learning encompasses a variety of algorithms designed to detect patterns in data, which can then be used to predict or explain. Ecologists have a growing interest in machine learning, with one such algorithm – symbolic regression – being well-suited for learning simple, human-readable, explanatory models of population dynamics from time series. Several recent studies have demonstrated symbolic regression's success in reverse-engineering foundational ecological models, like logistic growth and Lotka-Volterra predator-prey dynamics, from simulated and laboratory populations sampled at high frequency. Here, we utilize simulated data reflecting real-world patterns in kelp forest dynamics to understand how the effectiveness of symbolic regression in reconstructing the underlying "truth" is affected by sampling frequency, stochasticity, the asymmetry of population growth and decline, and consideration of population dynamics as occurring in continuous versus discrete time. Our results indicate that while the continuous-time approach generally performs better, symbolic regression requires relatively high sampling frequencies to learn the "truth". Asymmetry of population dynamics coupled with decreased sampling frequency creates a bias towards damped oscillations rather than sustained cycles. Small amounts of stochasticity appeared to help combat this bias, but higher levels destroyed the true signal. These results suggest that symbolic regression may not be an appropriate method for certain monitoring programs that are unable to collect data at a sufficiently high frequency for the focal population. However, monitoring programs that can sample at a high frequency and as new technology and data sources become available (e.g., satellite imagery) symbolic regression can be effective in reconstructing population dynamics.

8 - STORIES OF BIOCULTURAL RESTORATION IN HE'EIA: A FISH-EYE VIEW

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1- NOAA, Duke University 2- Hawai‘i Institute of Marine Biology, He‘eia National Estuarine Research Reserve

We aim to characterize the diversity and abundance of fish species in the He‘eia estuary, and provide preliminary analysis of changes that have occurred over recent years in response to biocultural restoration activities occurring throughout the He‘eia ahupua‘a (social-ecological land division roughly following watershed boundaries) led by community-based non-profit organizations Paepae o He‘eia and Kāko‘o ‘Ōiwi. Fish monitoring has taken place intermittently in the estuary over several decades. In 2019, a collaborative research effort of He‘eia NERR, State Division of Aquatic Resources (DAR), and The Nature Conservancy (TNC) started a comprehensive fish monitoring project in He‘eia using castnet, visual, and eDNA surveys. This project focuses on analyzing data from the ten castnet surveys, conducted from December 2019 to June 2024. Major habitat changes have occurred during the study period, including extensive removal of invasive mangrove trees and ongoing restoration of native wetlands and waterways.Thirty-one unique fish species have been documented. Of the five most abundant species, three are native Hawaiian estuarine species. Comparative analysis of the relative abundance of the native Hawaiian mullet species (Mugil cephalus), a culturally important food species, and the non-native Marquesan mullet (Moolgardia engeli) revealed that there has been a statistically significant increase in the abundance of the native Hawaiian mullet across surveys. Future directions include integration of eDNA, visual surveys, and water quality into the wider fish monitoring project.

9 - BLUE CRAB (CALLINECTES SAPIDUS) COI HAPLOTYPE ANALYSIS OF ORIGINS OF INVASIVES IN THE MEDITERRANEAN

† Sun, H.[1]; George, S.J.[1*]; Rittschof, D.[1]; Schultz, T.F.[1]; Moran, M.N.[2]

1- Duke University 2- James Cook University

Blue crabs are an ecologically and commercially important species native to the West Atlantic. We used COI haplotype analysis to probe the biology of blue crabs in their range and in areas where they have been introduced. We discovered that habitat selection is helpful in explaining genetic variations observed in blue crab populations. With salinity as a proxy for habitat selection, blue crabs occupy habitats ranging from 0 (fresh) to 50+ PSU. Due to short breeding intervals, there is potential for ongoing genetic differentiation due to salinity-based segregation. We identified correlations between genetic differentiation and salinity, suggesting specific genotypes select for high vs low salinity environments. Invasive blue crabs have become part of fisheries in Italy and neighboring regions of the Mediterranean, with unknown biological origins. We sequenced invasive crabs from Turkey and Sardinia to compare them with haplotype networks of crabs from environments of variable salinity across their native range. Analysis of Turkish crabs showed a single haplotype and was inconclusive with respect to geographic origin. Crabs from Sardinia are being analyzed to determine if they are related to Turkish crabs. Determining the biological origins of invasive blue crabs can aid in understanding the expansion of blue crabs into novel habitats across the Mediterranean.

10 - IDENTIFYING THRESHOLDS IN B.C. SHELLFISH VULNERABILITY TO OCEAN ACIDIFICATION

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1- University of British Columbia 2- Hakai Institute

Ocean acidification (OA) is a growing environmental threat to a wide variety of marine species, and endangers the stability of marine ecosystems and the sustainability of wild and cultured shellfish harvests. Although negative effects of OA have now been documented for many species, we have a poor understanding of how OA may increase the vulnerability of shellfish to additional stressors like extreme temperatures and natural enemies. We also lack information on where thresholds and ‘tipping-points’ may lie, where a small additional increase in OA leads to large and potentially unexpected negative consequences. We studied these more complex scenarios of vulnerability in two shellfish species of ecological, economic, and cultural importance in British Columbia: Pacific oysters (*Magallana* = *Crassostrea gigas*), and bay mussels (*Mytilus* spp.). Each were reared at several different simulated intensities of ocean acidification, and then subjected to additional challenges likely to occur in their natural or aquaculture settings: extreme temperatures that mimic heatwaves, along with predation by red rock crabs and sea stars. This work will

help to identify thresholds and vulnerabilities to additional stressors and to other species in coastal BC waters, which can aid in forecasting impacts and in developing mitigation strategies for the aquaculture industry. Because the species studied here also have outsized ecological roles, our results will also improve our understanding of the changing biodiversity and resilience of marine ecosystems in British Columbia.

11 - BROAD-SCALE GENETIC DIVERSITY AND BIOGEOGRAPHY OF SEAGRASS WASTING DISEASE

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1- UC Davis Bodega Marine Laboratory 2- UW Friday Harbor Laboratory 3- UW School of Aquatic and Fishery Sciences 4- Coastal Ecology Lab University of Oregon 5- UC Davis Bodega Marine Laboratory/California Dept. of Fish and Wildlife

Seagrasses are considered ecosystem engineers, creating meadows that provide vertical habitat for organisms, preventing erosion, and serves as a carbon sink. Worldwide, meadows are quickly vanishing due to environmental factors such as eutrophication, sedimentation, temperature, and disease outbreaks. The seagrass native to the west coast of North America, Zostera marina, has shown signs of decline related to disease, specifically due to an opportunistic pathogen Labyrinthula zosterae (Lz). Lz, is a marine slime mold that causes eelgrass wasting disease (EWD), characterized by dark lesions on the blades that eventually progresses to necrotic tissue. Although we are beginning to understand that there are different strains and species of Labyrinthula based on culture-based sequencing, little is known about the broad-scale genetic diversity and biogeography of the pathogen(s). To explore this, we collected seagrass samples from sites across the west coast of North America including: Alaska, British Columbia, Washington, Oregon, Northern California, and Sothern California. We extracted DNA from seagrass blades and targeted the 18S gene using amplicon-based high throughput sequencing (Illumina MiSeq 2X250 bp). Sequencing both genes allows for higher resolution and potential detection of different strains found in the environment. We are developing a phylogeny of Lz which can provide information on strain variation within eelgrass blades and allow for development of more specific diagnostic assays. We expect to detect large scale spatial variation in strains between locations. Additionally, a new suspected strain characterized by a crescent shaped lesion will likely differentiate itself from other strains. By exploring the broad-scale spatial genetic diversity of Lz using molecular analysis, we can improve our understanding of this pathogen and provide data that can help prevent future epizootics and improve overall health of meadows.

12 - ASSESSPOOL: A FLEXIBLE PIPELINE FOR POPULATION GENOMIC ANALYSES OF POOLED SEQUENCING DATA

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Despite the dramatic decrease in high-throughput sequencing costs over time, sequencing the ideal number of individuals for population genetic inference remains prohibitively expensive. When research questions require only population-level resolution, pooling individual samples before sequencing (pool-seq) can substantially reduce costs while still providing allele frequencies of Single Nucleotide Polymorphisms (SNPs). However, analyzing pooled data is comparatively difficult and less standardized than individual-based analyses. Although several programs have been developed to handle pool-seq data, most require extensive formatting or programming skills to operate. Here we present assessPool, an open-source R and Bash pipeline for pool-seq analyses with a focus on population structure. AssessPool accepts a Variant-Call Format (VCF) file and a FASTA-formatted reference, providing a straightforward transition from commonly used pipelines such as Stacks or dDocent. AssessPool utilizes PoPoolation2 and the {poolfstat} R package to generate locus-by-locus pairwise F_{ST} values to estimate population differentiation. Starting with a VCF file containing all identified SNPs, assessPool facilitates several key functionalities for population genetic analyses: i) filtering SNPs based on adjustable criteria with parameter suggestions for pool-seq data, ii) organizing data structures for analysis based on input pools, iii) creating customizable run scripts for F_{ST} calculations using PoPoolation2 and/or the {poolfstat} R package, for all pairwise comparisons, iv) calculating locus-specific F_{ST} values using PoPoolation2 and/or {poolfstat}, v) importing F_{ST} output into a format compatible with R, vi) producing population genomic summary statistics, and vii) generating interactive plots to visualize and explore data.

13 - SENTINELS OF CHANGE: INTERTIDAL BIODIVERSITY WITHIN THE SALISH SEA

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Climate change, through its many drivers, will influence intertidal community biodiversity, which will influence ecosystem stability and resilience. Understanding how increasing temperatures will affect intertidal communities as both a function of long term trends and anomalous events is an important step in understanding community-wide resilience. Our project combines long-term monitoring methods with field experiments to set baselines for intertidal biodiversity metrics while evaluating the mechanisms driving change. We utilize the Multi-agency Rocky Intertidal Network (MARINe) survey techniques in the Salish Sea to systematically assess foundational and mobile invertebrate biodiversity at three different rocky shores over a broad spatial scale. At six sites we attached settlement plates to the rocky substrate, using plate color to passively manipulate temperature. Our results found that intertidal foundational biodiversity varies more than mobile invertebrate biodiversity among sites, preferences for certain foundational species can dictate mobile invertebrate communities. We found distinct ecological communities at each of the sites. Interestingly, temperature stress did not affect larval recruitment across sites, but reduced survival to adulthood at all sites, as far fewer adult barnacles were found on warm tiles compared to similar numbers of barnacle recruits on both warm and cool tile types. Despite the unique biodiversity found across the sites surveyed, when manipulated we found a consistent response to increasing thermal stress. Future anomalous temperature events are predicted to increase along with long-term warming and the way that intertidal communities respond is important when considering the implications of shifts in biodiversity and community makeup.

14 - OCEAN WARMING STRENGTHENS POTENTIAL NEGATIVE IMPACTS OF URCHIN HERBIVORY ON KELP

Cheroske, A.G.[1*]; Baker, E.[2]; Castillo, A.[2]; Cooper, M.[2]; Haynes, A.[2]; Ichimaru, R.[2]; Lake, H.[2]; Steele, K.[2]; Stern, S.[2]; Urfano, K.[2]; Allen, B.J.[2*]

1- Mesa Community College at Red Mountain 2- CSU Long Beach

Rapid increases in environmental temperatures, including recent marine heat wave events, have been implicated in changes in population dynamics, species interactions, and community structure from local to global scales. Virtually all biological structures and processes are affected by temperature, such that higher temperatures typically lead to increases in both photosynthetic rates of primary producers and metabolic rates of herbivores. Differences in temperature scaling, however, mean that metabolism is expected to increase more quickly than photosynthesis. Herbivores will therefore need to consume more plant material to meet their basic energetic needs, leading to stronger top-down effects in ecological systems. Our research was designed to test the prediction that warming sea surface temperatures (SSTs) will strengthen trophic interactions between herbivores and a key foundation species in coastal marine systems. Giant kelp provides extensive vertical habitat that is the foundation for one of the most species-rich, productive, and widely distributed ecological communities in the world. Urchins are an abundant herbivore that can, under certain environmental conditions, tip kelp ecosystems into urchin-dominated “barrens.” We quantified kelp photosynthetic rates, and urchin respiration and consumption rates at different water temperatures – 16°C (ambient) versus 24°C (elevated). Overall, our results were broadly consistent with expectations, suggesting that indirect effects of species interactions may exacerbate direct negative effects of ocean warming on kelp.

15 - THE EFFECT OF NUTRITION ON THE INNATE IMMUNE FUNCTION IN NEMATOSTELLA VECTENSIS

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1- CSU Monterey Bay 2- University of Miami

Due to climate change, it is imperative that we understand as much as possible about cnidarian immunity to push forward coral conservation and restoration, especially as corals are directly impacted by climate change via coral bleaching. One underrepresented aspect of cnidarian immunity in the literature is the effect of nutritional status on cnidarian innate immunity. This study works to understand if there is a difference in innate immune

activity between starved and overfed cnidarians by observing phagocytosis in the model organism **Nematostella vectensis**. Three-week treatments were administered over two experimental trials and data was collected using a flowcytometric bead assay. Statistical analysis via Kruskal-Walls and the Dunn Test determined that there was a significant difference in percentages of cells undergoing phagocytosis between starved and overfed groups. Additionally, over both experimental trails, there was a trend that starved percentages were higher than that of overfed. These results imply an upregulation in innate immune activity due to starvation, which both challenges previous literature also using **N. vectensis** as a model for starvation and shows similarity with innate immune responses due to other stressors to cnidarians. Future studies should focus on better understanding the effect of starvation on cnidarian innate immunity and how different components of the innate immune system are affected by nutritional stress.

16 - ENVIRONMENTAL DNA METABARCODING REVEALS BIODIVERSITY ZONATION AT 45-60 M ON MESOPHOTIC CORAL REEFS

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1- Hawai'i Institute of Marine Biology 2- Aotearoa New Zealand Dept of Conservation

Mesophotic coral ecosystems (MCEs) are tropical reefs found at depths of ~30-150 m, below the region most heavily impacted by heat stress and other disturbances. Hence, MCEs may serve as potential refugia for threatened shallow reefs, but they also harbour depth-endemic fauna distinct from shallow reefs. Previous studies have characterized biodiversity patterns along depth gradients, but focussed primarily on conspicuous taxa (fishes, corals, etc.). Environmental DNA (eDNA) metabarcoding offers a more holistic approach to assess biodiversity patterns across the tree of life. Here, we use three metabarcoding assays targeting fishes (16S rRNA), eukaryotes (18S rDNA) and metazoans (COI) to assess biodiversity change from the surface to ~90 m depth across 15-m intervals at three sites within the Hawaiian Archipelago. We observed significant community differences between most depth zones, with distinct zonation centred at 45-60 m for eukaryotes and metazoans, but not for fishes. This finding may be attributable to the higher mobility of reef fishes, although methodological limitations are likely a contributing factor. The possibility for MCEs to serve as refugia is not excluded for fishes, but invertebrate communities >45 m are distinct, indicating limited connectivity for the majority of reef fauna. This study provides a new approach for surveying biodiversity on MCEs, revealing patterns in a much broader context than the limited-taxon studies that comprise the bulk of our present knowledge.

17 - INFORMING PURPLE SEA URCHIN GRAZER CONTROL METHODS WITH CATCH PER UNIT EFFORT: A CASE STUDY BY THE OREGON KELP ALLIANCE

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1- Oregon State University 2- The Oregon Kelp Alliance

In the past 12 years, Oregon's bull kelp forests *(Nereocystis luetkeana)* have declined 67-73%, in part due to dramatic increases in populations of herbivorous purple sea urchins, *Strongylocentrotus purpuratus*, which is linked to the loss of their predator, the sunflower sea star *(Pycnopodia helianthodes)*. The Oregon Kelp Alliance has been implementing sea urchin culling or removal as a restoration strategy to mitigate overgrazing using two methods: commercial harvest and citizen science diver culling. We analyzed catch per unit effort (CPUE) for several removal events from 2020 to 2024, comparing the two methods. We calculated CPUE based on hours of effort and number of urchins harvested or culled. We also estimated the area covered using each method. We converted CPUE to cost per urchin removed using the expenses required for each method. CPUE was higher for commercial harvest, but the cost per urchin was also higher. Further, Oregon commercial harvest size restrictions made this method less ecologically effective. Overall, citizen science diver culling was more ecologically- and cost-effective for ORKA's goal of reducing grazer populations. But, this conclusion may not be generalizable to other sites or jurisdictions, where effectiveness may depend on local laws, site accessibility, and sea urchin size distributions. ORKA will use this information to assess impacts of interventions on sea urchin populations, inform advisability of grazer control methods, estimate the costs of reaching threshold goals, and to explore potential changes in purple sea urchin commercial harvest size restrictions.

18 - HERBIVORY AND AGGRESSION IN KEYSTONE HERBIVOROUS FISHES IN BOCAS DEL TORO, PANAMA

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1- University of San Diego 2- Whitman University 3- Brandeis University 4- Kenyon College 5- The School for Field Studies

Herbivorous fishes play a critical role in coral reef ecosystems through algal regulation. As the threat to coral reefs grows due to global climate change, it is necessary to study the behaviors and interactions between key organisms in these ecosystems. This study aimed to evaluate behaviors of aggression and feeding in three keystone Caribbean reef herbivores, Striped Parrotfish (*Scarus iseri*), Threespot Damselfish (*Stegastes planifrons*), and Yellowtail Damselfish (*Microspathodon chrysurus*) to understand their impacts on the health of the ecosystem in Bocas del Toro, Panama. Observations of individuals of each species were conducted to analyze correlations between target behaviors that relate to herbivory and both interspecific and intraspecific aggression. Coral transect videos and substrate notes were recorded to assess the reef health of each site. The results revealed that Striped Parrotfish exercised higher rates of herbivory and lower rates of aggression than the other species. Threespot Damselfish and Yellowtail Damselfish demonstrated a similar rate of herbivory, but Threespot Damselfish exercised the highest rate of aggressive behaviors. Furthermore, juveniles exhibited higher rates of herbivory than other life stages in both Damselfish species. No correlation was found between the behavior of all three species and overall reef health. The results of this study provide valuable information about the behaviors and interactions of keystone herbivores in Bocas del Toro.

19 - FORECE OF INFECTION HIGHLIGHTS RAPID DISEASE TRANSMISSION IN A NATURAL EELGRASS (ZOSTERA MARINA) MEADOW

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1- Cornell University 2- University of Washington 3- Bigelow Laboratory for Marine Sciences

Despite the outsized ecological impacts of marine diseases, the amount and pace of disease transmission events are poorly understood. Given the rise of climate-fueled pathogens, many of which threaten foundation species like seagrasses, there is a growing need to understand abiotic and biotic drivers of marine disease transmission. Here, we aimed to: 1) estimate the daily rate of seagrass wasting disease spread in an eelgrass (*Z. marina*) meadow and 2) quantify the presence of the causative agent, *L. zosterae* (Lz), in the water. We tracked disease development in 423 tagged eelgrass shoots in monthly trials from April – June 2022 and 2023 on San Juan Island, Washington, USA. We quantified Lz cells in seawater using quantitative polymerase chain reaction (qPCR) to detect associations between high disease levels in eelgrass and Lz concentrations. Results indicate infections accumulate rapidly in eelgrass in situ, with an average rate of lesion development of 0.79 lesions/day (or mm^2/leaf/day). Disease transmission was higher early in spring, but Lz was detected in the seawater in 11 out of 19 months sampled. Importantly, this work provides early-season estimates of disease spread and of Lz propagules in situ.

20 - INVESTIGATING THE CURRENT POPULATION STATUS OF THE PISMO CLAM (TIVELIA STULTORUM) WITHIN MONTEREY BAY

† Brady, J.R.[1*]; Malicoat, L.[1]; Beaudoin, O.[2]; Haupt, A.[1]

1- CSU Monterey Bay 2- Moss Landing Marine Labs

The Pismo clam (*Tivela stultorum*) was an iconic species for commercial and recreational fisheries, and of the sandy intertidal and subtidal ecosystems ranging from Central California to Baja California, Mexico. Unsustainable harvesting practices and overexploitation led to an uncontrollable decline in their population in the 1990s. There is currently a gap in knowledge regarding the current status of populations at several different beaches across the Monterey Bay. Burial rate trials were conducted on clams collected during tides lower than -1.0ft from both the surf zone with a clam rake and within 30-meter transects split into 3-meter sub-sections we dug using shovels. All clams were sized using calipers then placed into a pool in the sand with little disturbance. The time of initial movement and burial completion were recorded. This study will yield calculated population counts across several beaches, building upon previous studies. Burial rate will be visually represented with a linear regression model, comparing clam size and burial time.

21 - POPULATION STRUCTURE OF KEYSTONE HERBIVOROUS REEF FISHES IN BOCAS DEL TORO, CARIBBEAN PANAMA

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The population health and viability of keystone reef species, such as damselfishes and parrotfishes, play an important role in ecosystem dynamics in coral reefs. In this study, we investigated and analyzed the population health of five of these critical species in the Bocas del Toro archipelago of Panama: Dusky Damselfish, (Stegastes adustus), Yellowtail Damselfish (Microspathodon chrysurus), Threespot Damselfish (Stegastes planifrons), Stoplight Parrotfish (Sparisoma viride), and Striped Parrotfish (Scarus iseri). Our research aimed to determine regional differences in the fish population size and abundance as well as the coral health of these regions. We collected data through the use of belt transects and video surveys at 15 sites across the archipelago. Statistical analysis revealed significant differences in fish abundance, population distributions ,and size distributions between regions. Coral health assessment indicated reef health to be primarily impacted by local zone conditions rather than region-wide trends. Our findings provide important context for conservation efforts and show the need for continued monitoring of the archipelago in the future.

22 - PRELIMINARY FINDINGS IN UNDERSTANDING THE COSTS OF COPPER BASED TOXINS IN INVASIVE BRYOZOANS IN THE GENUS WATERSIPORA

Johnstun, D.J.[*]; Villalvazo J., ; Craig, S.F.

Cal Poly Humboldt

The globally invasive bryozoan *Watersipora* has developed a tolerance to copper based antifouling paint, contributing to its success as a marine invader. With copper acting as the active ingredient in this form of biocide, it is a stressful environment to survive in, and this tolerance may come at a cost to exposed colonies, affecting physical traits in the form of tradeoffs. While the effects of copper on larvae of this species group have been examined, long term effects of copper exposure in adult colonies are poorly understood. We exposed adult colonies to copper antifouling paint over the course of several months, and examined multiple physical traits to try to understand potential effects in copper exposure. To understand the difference in observed traits due to genetic variation among colonies, we placed sibling colonies under different treatments, as well as clones. Utilizing both clones and siblings clarifies whether traits such as colony size, number of zooids, size of zooids, and reproductive output are traits controlled by colony genetics, or are affected by copper exposure.

23 - VALIDATING WIND DATA FROM THE OCEAN OBSERVATORIES INITIATIVE FROM HIGH LATITUDE DEPLOYMENTS.

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1- CSU Monterey Bay 2- Woods Hole Oceanographic Institution

High latitude oceans, such as the Irminger sea, play a disproportionate role in the flux balance of heat, momentum, and biogeochemically important gasses such as CO2. The Ocean Observatories Initiative (OOI) deploys meteorological instruments in order to perform ocean observations in high latitude environments where it has historically been challenging to collect in situ observations. Through these high-latitude deployments, OOI makes long-term quality observations of air and sea fluxes. Previous analysis of data from multiple different sensors has suggested that one type of the multiple sensors deployed, the Gill WindObserver II, has been under-recording wind speeds at higher magnitudes. I analyzed wind sensor data acquired from buoy deployments and from shipboard sensors during the Irminger Sea 11 Cruise. I compared wind data collected from two Gill WindObserver II 2-axis anemometers (“2-axis”), an R.M. Young Wind Monitor anemometer (RM Young), and a Gill R3 3-axis anemometer (“3-axis”), all mounted on OOI buoys, with two Vaisala WXT520 anemometers mounted on the bow of the R/V Armstrong. Data were adjusted to the buoy height using the COARE 3.5 algorithm. Next, I compared all of the sensors with a series of time series plots. The final result of

these comparisons is a plot of the hourly averages with standard deviations of each wind sensor data equipped with error bars. The plot I generated supported the hypothesis and allowed us to identify that the two “2-axis” anemometers attached to bulk meteorological packages of both buoy deployments 10 and 11 are under-recording wind speeds at higher magnitudes. Future work will include individual sensor comparisons to quantify the specific magnitude of the under-measurement and develop a correction.

24 - LA NINA VS. EL NINO: HOW HYPOXIC EVENTS AFFECT THE REPRODUCTIVE OUTPUT OF GOPHER ROCKFISH (SEBASTES CARNATUS)

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1- CSU Monterey Bay 2- Moss Landing Marine Laboratories 3- CSU Monterey Bay and Moss Landing Marine Laboratories

In the California Current Ecosystem (CCE), deep water upwelling creates zones of oxygen-depleted water, known as hypoxic zones. In addition, carbon dioxide (CO2) saturation has increased substantially, leading to ocean acidification. The combined stressors of low oxygen and high CO2 have been shown to alter fish maturation and reproductive output. During El Niño events, warmer water and a relaxation from upwelling occurs in the CCE. We examined the effect of ENSO cycles on Gopher rockfish (*Sebastes carnatus*) reproduction. Rockfish have large brood densities that increase exponentially with age. We predicted that older fish will have greater fecundity and resilience to low oxygen conditions. Larger female fish typically have more stored energy and have far greater reproductive outputs than smaller females, leading us to expect these larger females to be more resilient to changing ocean conditions. To analyze differences within an ENSO cycle, we sampled gopher rockfish from 2023 (La Niña) and 2024 (El Niño), and measured fecundity and developmental stage. Older, larger rockfish gave birth to substantially larger broods across years while individuals caught within the El Niño year produced smaller broods relative to their size and age. If hypoxic waters considerably increase, this could substantially decrease the sustainable yield of rockfish in the future. Yearly revisions are being made constantly to try to sustainably fish rockfish species, and quantifying these environmental conditions is vital for informing future policy making.

25 - PEEER: PUBLISHING FOR AN ETHICAL AND EQUITABLE ENVIRONMENT IN RESEARCH

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1- UC Merced 2- multi-institutional

Current changes in scientific publishing are among the most radical in >350 years and the range of publishing options expanding. Publisher-owned journals often dominate and increasing Article Processing Charges and surging Open Access threaten to leave authors and institutions with few affordable options. These changes increase inequity – among more- versus less-wealthy researchers, institutions, and countries; they also particularly penalize early career researchers (ECRs) who are more dependent on high profile – typically more expensive – journals for establishing careers. PEEER’s mission is to foster a culture in which authors, editors, and reviewers choose publication venues that support affordable and equitable access plus a healthy scientific and research community. Our goal is to channel the community’s shared frustrations with the current predominantly for-profit scientific publishing ecosystem, into joint action, to move the community toward a more affordable, equitable, and inclusive publishing ecosystem.

26 - YOU’RE NOT YOU WHEN YOU’RE HUNGRY: FEEDING EFFECTS IN THE CLONAL SEA ANEMONE *ANTHOPLEURA ELEGANTISSIMA*

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Oregon State University

The aggregating sea anemone, *Anthopleura elegantissima* , is commonly found in the upper and middle intertidal zone in the Western coast of the United States. It clonally divides to form aggregations that engage in interference competition with conspecifics from adjacent colonies using specialized structures called acrorhagi. When anemones come into physical contact, acrorhagi strikes often lead to the other anemone retracting or moving away. In the previous year, we determined that individuals from some colonies were superior competitors in paired matchups. Here we

extended upon this work and examined how feeding influences the outcome of these matchups. We collected 8 individuals from 12 separate tagged colonies, brought them back to the lab to acclimate and then paired them based on past aggressive interactions in competitive assays. Prior to assessing their aggression, we fed some individuals in a fully factorial design: both partners fed, neither partner fed, the larger partner fed only, the smaller partner fed only. Individuals were then paired in aggression assays after 1 and 3 weeks of feeding. Preliminary data suggest that fed individuals were more aggressive compared to the competitors that were not fed with increased numbers of acrorhagi sweeps. Feeding just the smaller individual (treatment 4) also led to increased aggression. In addition, fed individuals regardless of treatment were significantly larger and retained gonads longer than unfed clone-mates. These data indicate that some colonies may be food limited in the intertidal.

27 - THE EFFECTS OF CORAL REEF DEGRADATION ON PREDATOR-PREY INTERACTIONS: THE CYPHOMA AND SEA FAN EXAMPLE

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Coral reef degradation is known through declining abundances of corals and fishes, but less is known about how these trends affect the ways in which predators forage on their prey. On Caribbean reefs, the feeding interactions between the predatory snail *Cyphoma gibbosum* and their gorgonacean prey are well known, and here we use these interactions as a model system to evaluate how invertebrate predator-prey interactions have changed as coral reefs degrade. Using historic data from St. John, US Virgin Islands, that came from the Tektite II program in 1970 (Birkeland & Gregory 1975), we ask whether there is evidence that the behavior of *Cyphoma* has changed over the past 50 yrs. Using surveys conducted in 2024 in Lameshur Bay, St. John, USVI, we tested the hypotheses that *Cyphoma* abundances differ between 1970 and 2024, their preference for prey species has changed, and the rate at which *Cyphoma* consume gorgonians is different. On the same reefs studied as in 1970, *Cyphoma* has not changed in abundance, they continue to favor *Gorgonia* sp. Over other octocorals, and they consume similar amounts of gorgonian tissue as they did 54 yrs ago. Together, these results suggest that some aspects of invertebrate predator-prey interaction on these coral reefs have remained unchanged over five decades even though the coral reef community structure is very different now compared to 1970.

28 - INVESTIGATING TEMPERATURE-DEPENDENT VARIATIONS IN FOOD-INDUCED PLASTICITY OF PACIFIC SAND DOLLAR LARVAE, *DENDRASTER EXCENTRICUS*

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Adult Pacific sand dollars, *Dendraster excentricus*, are sustained through larval recruitment. These larvae possess robust phenotypic plasticity responses to cope with environmental changes. Previous research has only studied plasticity at 16°C or less. We hypothesized higher temperatures would amplify the typical plasticity response, measured by changes in postoral arm length to midline body length (PO:MBL) ratio. Sand dollars were spawned, and resultant larvae were reared at 16°C or 19°C. Larvae were fed 10,000 (high-fed) or 1,000 (low-fed) algal cells per mL. Repeated measures t-test revealed that larvae reared at 19°C exhibited significant feeding treatment differences in PO:MBL ratios earlier than larvae at 16°C. High-fed larvae at 19°C reached metamorphic competency earlier than high-fed larvae at 16°C. Due to the stimulatory effects of temperature on metabolic rate, larvae at 19°C were likely more food-limited than larvae at 16°C. This resulted in both an elevated plasticity response and slower development at 19°C. Underlying physiological efficiencies may also be temperature-dependent thereby contributing to differences in plasticity responses at the same algal concentrations. The amplified plasticity response at 19°C suggests that larval adaptive responses to food availability may persist as temperatures rise, highlighting their capacity to deal with near-term changes in temperature. However, our data also suggests that the compensatory value of increased arm length is diminished at higher temperatures due to it being outpaced by increasing metabolic demands.

29 - TEMPORAL AND SPATIAL DYNAMICS OF DEEP SUBTIDAL SEA STARS ALONG THE WEST COAST OF NORTH AMERICA

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1- CSU Monterey Bay, San Jose State University 2- CSU Monterey Bay 3- San Jose State University

Sea stars (Phylum Echinodermata) are ecologically important members of the benthos community. From 2013-2015, an epidemic decimated several species along the west coast of North America, with downstream effects on their surrounding communities. Most surveys reported change from intertidal and shallow subtidal ecosystems, but sea star distributions extend to deeper water. We aimed to 1) assess spatial and temporal changes in deep subtidal (30 - 100m) sea star populations across the California Coast from 2005 to 2019, and 2) explore environmental factors influencing their distributions in deep subtidal habitats. We used spatial data and sea star counts from remotely operated vehicle (ROV) video surveys collected to assess populations of five species from CA Coast (*Mediaster aequalis*, *Dermasterias imbricata*, *Patiria miniata*, *Pisaster brevispinus*, and *Pycnopodia helianthoides*). Preliminary analyses suggest *P. miniata* and *D. imbricata* populations were stable from 2005 to 2019 (p-value = 0.058) but with major site-specific variations. Populations of *M. aequalis* were significantly smaller in 2011 (p-value < 0.0001) compared to other survey years. A MaxEnt species distribution model (SDM) determined possible environmental factors associated with their distributions in the deep subtidal environment, using counts and environmental data from the Bio-ORACLE database (e.g., SST, pH, depth). Depth was important for sea stars' distribution although more training data are needed and additional SDMs will need to be run to confirm these results. Work is ongoing, and any guidance is welcome.

30 - INVESTIGATING SEDIMENT CHARACTERISTICS TO HINDCAST THE DISTRIBUTION OF THE MARINE ANGIOSPERM *ZOSTERA MARINA*

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1- Oregon State University 2- Friday Harbor Laboratories, University of Washington 3- Idaho State University

In the San Juan Archipelago region of the Salish Sea, ongoing monitoring since 2000 documents that several eelgrass populations disappeared, declined, or became fragmented over this time period. One site where decline and fragmentation occurred is the False Bay preserve on San Juan Island, operated by the University of Washington. To understand the discrepancy between observations of eelgrass distribution made in the early 1990s and the present day, we examined sediment cores obtained in the summer of 2023 from the center of the area where eelgrass was observed in the 1990s. During daytime low tide events, we cored five sites along a 365 m transect through the targeted area and analyzed these for grain size distribution, organic matter content, and stable carbon isotope concentration. We found that approximately the upper 30 cm of each core was composed of a homogeneous layer of fine to very fine sand, with comparatively low and homogeneous organic material content. Below this layer, the variance in both grain size and organic material increased dramatically. We hypothesize that this shift in sediment characteristics may have influenced eelgrass distribution in False Bay by burying seedlings before they can become established.

31 - QUANTIFYING REPRODUCTIVE HORMONES IN SKELETAL MUSCLE TISSUE OF THE SHORTFIN MAKO (ISURUS OXYRINCHUS)

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To conduct accurate stock assessments for elasmobranchs, it is critical to understand the relationship between reproductive characteristics and susceptibility to changes in their abundance and in their environment. With many stocks currently diminished, non-lethal sampling techniques need to be developed in order to better manage threatened or endangered species. Steroid hormones in muscle tissue have been used as a non-lethal indicator of reproductive status in several shark species. The current study utilized muscle tissues and metadata from shortfin mako shark (*Isurus oxyrinchus*) sampling events to quantify testosterone (T) and estradiol (E_2) concentrations in relation to previously-known maturity state. A total of 107 samples (56 males, 51 females) from makos ranging in size from 72.5 to 333.5 centimeters fork length were analyzed. None of the females sampled were gravid, and there was no considerable difference found between the average muscle E_2 concentrations of subadult and adult females. Male samples exhibited increasing trends in average muscle T concentration with maturity stage. These results suggest muscle hormone

concentrations can potentially serve as an effective non-lethal proxy of reproductive stage in oophagous sharks. This study demonstrates that the amount of data obtained from biological samples can be optimized by specimen sharing and the continued use of stored muscle tissue. Employment of these methods in the future would be valuable to threatened species for which lethal sampling is restricted.

32 - THE IMPACT OF EL NINO ON ALGAE COMPOSITION IN THE ROCKY INTERTIDAL

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Many ecosystems are shaped by the chronic disturbances the organisms that inhabit them face as the environment shapes how organisms evolve and adapt over time. The rocky intertidal is no exception, as it is characterized by chronic disturbances such as strong waves, tide fluctuations and temperature changes. Acute disturbances are more severe and sudden, often causing desiccation on a larger scale. El Niño is a climate driven acute disturbance, resulting in larger waves, reduced upwelling, and warmer water temperatures along the west coast which can negatively impact food availability and habitat in the intertidal. Algae communities are an important part of intertidal ecosystems, serving as a major food source, protection from the elements, and habitat for important predators. We aim to understand the impact El Niño has on fleshy algae in Monterey, giving us the potential to understand how the intertidal responds to large scale climate events as a whole. Transects and one meter quadrats were used at 7 sites across the Monterey Peninsula during low tide series to estimate percent cover of main algae functional groups for the years 2022 through 2024. We observed a significant decrease in the proportion of percent cover of fleshy algae at four sites, two from 2022 to 2024 and two from 2022 to 2023. A significant decrease in fleshy algae from 2022 to 2024 could be a result of El Niño. This means the intertidal as a whole could be negatively affected by this, and possibly by climate change, showing what the effects of ocean warming could be in the foreseeable future.

33 - A UNIVERSAL HATCHERY SYSTEM FOR DEVELOPING NEW SEAWEED STRAINS FOR LAND-BASED AQUACULTURE

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U.S. seaweed farming has the potential to become a significant contributor to seafood production, but the industry is still in its infancy and faces regulatory challenges in developing offshore farms. Land-based aquaculture has the potential to augment seaweed farming and mitigate some of the barriers faced by farmers. In order to expand the land-based seaweed aquaculture industry, there is a need for more low-cost and scalable methods of seaweed production. Our goal is to create novel and accessible hatchery technologies which will reliably produce high density, homogenous macroalgae biomass for use in tumble culture. We have developed an affordable and modular system called the Core-Lit Apparatus for Seaweed Hatcheries (CLASH). Bull kelp (Nereocystis luetkeana) and giant kelp (Macrocystis pyrifera) have been successfully cultured in the CLASH system. Additional studies seek to determine ideal stocking densities, nutrient supplementation, and light exposure for maximizing productivity. The future of the project aims to introduce new commercially relevant species for aquaculture, create new seaweed strains for land-based farming, utilize CLASH grown kelp for restoration projects, and scale up the use by the industry. This simple, user-friendly, low-cost device has proven to be a promising hatchery tool which could increase the diversity, efficiency, and yields of land-based seaweed farms.

34 - PLASTICITY OF *LEPTASTERIAS* SEA STAR BEHAVIOR UNDER VARYING TEMPERATURES

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San Francisco State University

Sea stars in the genus, *Leptasterias*, include six-rayed species on the California Central coast. *Leptasterias* are found in rocky intertidal and subtidal habitats that experience variable exposure to wave action. Due to these conditions, *Leptasterias* would have to quickly adapt to harsh abiotic factors. Specifically, two species, *L. pusilla* and *L. aequalis*, are found in high-wave action (wave-exposed) and low-wave action (wave-protected) habitats. Past genetic analysis found *L. pusilla* predominantly in wave-exposed habitats and *L. aequalis* in wave-protected habitats. Previous work also found wave-exposed *Leptasterias* display stronger attachment to substrate and are less mobile. In this study, we investigate the impact of temperature on *Leptasterias* behavior from contrasting wave exposure habitats. In the field, wave-exposed stars had slower righting responses in comparison to wave-protected stars. Stars kept in the lab at two temperatures (12℃ and 14℃) were used to test effects on mobility and attachment weekly over three weeks. We predicted stars from the two habitats in the colder treatment would show weaker attachment and lower mobility than stars in the field or the warmer lab treatment. As climate change brings increasingly frequent and extreme weather events, understanding the impacts of increasing temperatures on *Leptasterias* behavior may lead to predictive insights for coastal habitat monitoring.

35 - CONNECTING GREAT HORNED OWL (BUBO VIRGINIANUS) SPACE USE AND DIET IN AN URBAN PARK

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1- Oregon State University 2- Saint Louis University 3- Saint Louis Zoo Institute for Conservation Medicine 4- World Bird Sanctuary 5- Living Earth Collaborative, Washington University in Saint Louis

As anthropogenic development collides with nature, humans and animals must adapt to living in shared spaces. Cities are spatially heterogenous ecosystems that provide both challenges and opportunities for species across trophic levels. Urban parks act as green islands to provide semi-natural habitats that attract wildlife and create complex communities. Forest Park in St. Louis, Missouri contains numerous species that share 1,300 acres with upwards of 15 million human visitors each year. One such species is the great horned owl (*Bubo virginianus*), a top predator in this urban ecosystem. In this pilot study, we equipped one female owl with a GPS tag to gather movement data over the course of one year. In addition, we collected information on her diet by dissecting pellets found at her roost site. This initiative is unique in that we identified both cranial and post-cranial bones for a more accurate representation of diet composition, which consisted of a large variety of small mammals and birds. Proportions of the diet made up of each prey item varied as the seasons changed, as did with her movement patterns. Her home range was ecologically diverse and consisted of areas both within and directly outside of the park. This project illuminates the behavior of one of the park's most charismatic inhabitants as part of a larger initiative through the Forest Park Living Lab, which studies cross-species movement patterns to elucidate determining factors in community composition and structure, as well as how these may change as restoration efforts are undertaken in the park.

36 - A DIETARY TREATMENT-BASED DYNAMIC ENERGY BUDGET MODEL FOR RED ABALONE IN NORTH PACIFIC MARICULTURE AFTER KELP FOREST COLLAPSE

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1- UC Berkeley 2- UC Davis – Bodega Marine Labratory

The coincidence of El Niño and anomalously warm waters in 2014-2017 produced a historic marine heatwave across the North-Pacific coast that devastated bull kelp forest ecosystems. In California, these shifts imposed a near 80% decline in red abalone (*Haliotis rufescens*) populations resulting in the closure of the red abalone fisheries across the state. As a result, there is an increased need to develop methods for captive rearing of red abalone for conservation and marine mariculture without reliance on wild kelp harvests. In this project, we aim to assess whether an alternative food source, grape pomace feed, is sufficient. We aim to study how grape pomace feed affects the energetics and physiology of red abalone. To do this we fed five different concentrations of grape pomace and fish meal and a sixth comparative traditional kelp feed (AbKelp) to adult red abalone over a 3 month trial conducted in four rounds (beginning, two midpoints, end) of physiological measurements (weight, length, respiration). Preliminary results indicating differences in growth of red abalone raised under different food sources, coupled with a significant

difference in their oxygen consumption rates, reveal disparities in food conversion efficiency due to different feed-associated physiological and energetic dynamics. We use these contrasting outcomes to construct and parameterize a dynamic energy budget model for applications in conservation, restoration, and marine mariculture for red abalone. Our results reiterate the need to measure physiology and energy demands in aquaculture and conservation efforts.

37 - TWENTY DEGREES OF SEPARATION: SKELETAL CONDITIONS OF A COLD-WATER CORAL ALONG A BROAD LATITUDINAL GRADIENT

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Cal Poly Humboldt

Ocean acidification (OA) is an increasingly large threat to calcifying marine organisms, including corals. *Balanophyllia elegans*, a solitary cold-water coral, is found in inter- and subtidal rocky habitats in the eastern North Pacific. A portion of this species' range experiences intense seasonal upwelling and, by extension, exposure to lower-than-average ocean pH. This seasonal exposure to upwelling-driven decreases in pH requires local *B. elegans* populations to tolerate a wider range of conditions than most other corals experience in their natural history. Along much of *B. elegans'* range, the upwelling index decreases south to north (~35N-55°N). At the northern edge of the species' range in Southeast Alaska, downwelling is the norm. We therefore hypothesized that clinal variation in *B. elegans'* performance would partially depend on local variation in organismal experience, linking environmental variation to organismal performance across latitudes. To investigate this possibility, we sampled *B. elegans* from four regions with vastly different oceanographic regimes across 2,500km and 20° of latitude and examined whether skeleton densities differed among locations. We found that skeleton density decreased with latitude and differed between sites with at least 11° of latitudinal separation. These results suggest that subpopulations seasonally exposed to low pH conditions via upwelling may be more resilient to OA-related stressors than those in non-upwelling environments.

38 - CAN LONG WALKS ON THE BEACH CAN BE LINKED TO KELP RESTORATION?

Zepp, A.*; Contolini, G.; Gómez, J.; Hohman, R.; Mears, T.

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

Bull kelp, *Nereocystis luetkeana*, is the foundation species of kelp forest ecosystems in northern California and historically provided essential ecosystem services in Greater Farallones National Marine Sanctuary (GFNMS). Since 2014, bull kelp has declined dramatically—up to 90% in the sanctuary. Simultaneously, purple urchin densities have increased exponentially, which could prevent long-term recovery of bull kelp. Greater Farallones Association and NOAA's Greater Farallones and Cordell Bank National Marine Sanctuaries have been removing urchins and outplanting bull kelp at key sites along the Sonoma Coastline since 2022. Underwater surveys and aerial drone surveys are effective methods to monitor bull kelp restoration progress but are weather dependent, costly and labor intensive. Long walks on the beach however, are cost effective, minimally affected by weather and can help us capture another perspective of kelp restoration efforts. The Greater Farallones Association and Greater Farallones and Cordell Bank National Marine Sanctuaries Kelp Team has developed methods to track changes in beach wrack dynamics before and after restoration efforts. Could our kelp restoration efforts be impacting more than just the underwater kelp forests?

39 - CALORIC DENSITY OF CENTRAL CALIFORNIA SCYPHOMEDUSAE AS A POTENTIAL DRIVER OF LEATHERBACK FORAGING PREFERENCE

† Johnson, S.H.[1*]; Kahn, A.S.[1]; Benson, S.R.[2]; Jones, T.T.[3]; Harris, H.[4]

1- Moss Landing Marine Labs, San Jose State University 2- Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA 3- Pacific Islands Fisheries Science Center, NOAA 4- Upwell

Approximately 30-50% of endangered Western Pacific leatherback turtles (*Dermochelys coriacea*) that nest along the north coast of Bird's Head Peninsula in Indonesia migrate to central California waters seasonally to forage on gelatinous prey. When feeding they select sea nettles (*Chrysaora fuscescens*) over other gelatinous zooplankton, but it is not understood why. We asked whether *C. fuscescens* might be more calorically dense than other options, as this would minimize the energy turtles expend to capture prey. We measured caloric content of bell, manubrium, and feeding tentacles of four prey species (*C. fuscescens*, *C. colorata*, *Phacellophora camtschatica*, and *Aurelia* sp.) using a semi-micro bomb calorimeter (n=10 for *C. fuscescens*, *P. camtschatica* and *Aurelia* sp., *C. colorata* n=1). *C. fuscescens* have the highest caloric content, with *Aurelia* sp. having the lowest. For each species, the manubrium and feeding tentacles had higher caloric density than the swimming bell, a part that is often discarded by turtles. Caloric content of one *C. colorata* specimen showed similar caloric density to *C. fuscescens*, but *C. colorata* populations tend to be sparse, as opposed to *C. fuscescens* tendency to form dense blooms. *C. fuscescens* blooms along the CA coast tend to be difficult to predict temporally, potentially impacting *D. coriacea* presence during foraging seasons. A documented *D. coriacea* population decline at the Bird's Head Peninsula nesting habitat exacerbates the need to investigate *C. fuscescens* dynamics along the CA coast in order to understand declines in *D. coriacea* presence.

40 - WHERE THE KELP ARE THEY: KELP FOREST INVERTEBRATES' DEPTH DISTRIBUTIONS IN COMPARISON TO SURVEY EFFORTS ALONG THE SOUTHERN OREGON COAST

† Buitrago-Yepes, K.V.[1*]; Hamilton, S.[2]; Calvanese, T.[3]; Townsend, F.[3]; Torres, I.[4]

1- CSU Monterey Bay 2- Oregon Kelp Alliance 3- Oregon State University 4- San Diego State University

Kelp Forests sustain a myriad of economic, ecologic, and culturally significant organisms making them essential to the livelihood and historic heritage of coastal communities. Compounding environmental stressors and subsequent habitat loss have led to the decline in grazing and predatory kelp forest invertebrates. The decrease in invertebrate competition and controlling predatory pressures led to urchin proliferation and subsequent overgrazing, causing kelp forest ecosystems to rapidly decline into unproductive urchin barrens. A deficit in information regarding the role and prevalence of kelp forest invertebrates following these pressures creates challenges for species recovery efforts in historically key kelp forest hotspots. Informing kelp forest conservation efforts through a combination of historic and current intertidal and subtidal surveying, the Oregon Kelp Alliance (ORKA) assessed the degree of presence and possible depth preferences of *Pycnopodia helianthoides*, *Solaster stimpsoni*, *S. dawsoni*, *Haliotis rufescens*, *H. walallensis*, and *H. kamtschatkana*. Preliminary data indicates possible abalone preference for shallower depths while urchin predatory *P. helianthoides* was commonly found at about 30ft. Sightings of *P. helianthoides* were limited to juveniles—raising questions about where the fecund individuals reside. A better understanding of the life cycle preferences and current conditions of kelp forest invertebrates will inform which conservation strategies may be best suited to bolster restoration efficacy to return biodiverse kelp forests to the Oregon coast.

41 - DOUBLE DOWN: COMBINED IMPACTS OF TEMPERATURE AND NUTRIENTS LEAD TO OPPOSING PHYSIOLOGICAL OUTCOMES IN EGREGIA MENZIESII

Gil, M.[1*]; Zuelow, A.[2]; Henkel, S.[2]

1- CSU, Monterey Bay 2- Oregon State University

Egregia menziesii, A.k.a feather boa kelp, is a large photoautotroph that inhabits coastal ecosystems in the northeastern Pacific Ocean. It ranges from Alaska to Punta Eugenio, Baja California, Mexico. *Egregia* plays a foundational role in its ecosystem by creating a habitat for marine life and contributing to primary production as food and detritus. Marine heatwaves (MHW) are becoming more frequent, threatening marine ecosystem diversity and creating low dissolved nutrient conditions in ocean waters. Our objective was to assess the impact of nutrients and warm temperatures on the physiology of *Egregia*. In experiment one, 18 individuals collected from Boiler Bay, OR were exposed to 6 MHW temperature days (18℃) and 6 recovery days (10℃). Half of the individuals received sodium nitrate-treated water. In experiment two, a new set of 24

individuals was exposed to one of four treatments (10℃, 10℃+Nutrients, 13℃, 13℃+Nutrients). Photosynthesis and respiration rates were calculated from dissolved oxygen uptake and weight measurements. Data was taken at 0, 6, and 12 days for each experiment. All individuals were dried and processed using bomb calorimetry. The simulated MHW event (Expt 1) led to reduced photosynthetic rates. They did not return to pre-MHW rates post-recovery. In Experiment 2, warm+nutrient conditions maintained photosynthetic rates while ambient+nutrient conditions reduced photosynthetic rates compared to their respective non-nutrient treatments. Nutrients led to higher caloric densities except in the warm treatment in Experiment 2.

42 - RHODOLITH BEDS AS NURSERY HABITATS: INVESTIGATING SETTLEMENT CUES FOR THE WHITE URCHIN, LYTECHINUS PICTUS

de Jong, C.X.*; Steller, D.L.; Kahn, A.S.

Moss Landing Marine Laboratories

Coralline algal rhodolith beds are known diversity and productivity hot spots. Prior studies have demonstrated the role of these habitats as “nursery habitats”, as they support greater proportions of juvenile populations, particularly for benthic marine invertebrates. Previously, it was not known whether invertebrate larvae actively select these beds for settlement, though other coralline species are known to enhance settlement in specific marine invertebrates. The white urchin, *Lytechinus pictus*, was found more commonly within rhodolith beds than in adjacent sandy areas around Santa Catalina Island. The objective of this study was to identify which substrate and water-borne cues may enhance settlement of *L. pictus*. Urchin larvae, reared to competency from adults collected from Santa Catalina Island, were exposed to an array of six treatment cues (live and dead rhodolith, sand, GABA coralline mimic, KCl inducement control, and seawater) for 24 hours. Total settlement was 4.25x greater on live rhodolith than the average of all other treatments and the rate of settlement significantly faster. Globally, rhodolith beds are not widely considered in management policies. Study results provide insight into the behavior and patterns of rhodolith-associated *L. pictus* and bolster existing research identifying rhodolith beds as essential nursery habitats and candidates for environmental protection.

43 - EVALUATING THE FINE-SCALE MOVEMENT AND BEHAVIOR PATTERNS OF OPALEYE (GIRELLA NIGRICANS) IN KELP FORESTS

Zounes, J.A.*; Steele, M.A.

CSU, Northridge

Movement and behavior patterns of fishes can be useful in understanding how ecosystems function. However, the movement and behavior patterns of herbivorous fishes in kelp (Laminariales) dominated systems are under-studied and could help ecologists and conservationists better understand the impacts on kelp forests. In this study, we measured the movement and feeding rate of an herbivorous fish, the opaleye, Girella nigricans, at Santa Catalina Island. We quantified movement and foraging rates of opaleye via observations while snorkeling and SCUBA diving. An observer recorded the number of bites taken on various species of algae, while simultaneously tracking the position of the fish every 5 seconds with a handheld global positioning system (GPS). We found that opaleye move at an average rate of 10.5 m/minute, and feed on several species of macroalgae with Macrocystis pyrifera and Sargassum palmeri being the most frequently consumed taxa. If macroalgal spores can be passed through the digestive tract of opaleye without losing viability (work in progress), this herbivorous fish may help disperse Macrocystis pyrifera and other macroalgae through their fecal matter, potentially contributing to the persistence of macroalgae-associated communities.

44 - COMPARATIVE ANALYSIS OF GROWTH RATES IN AQUACULTURED JUVENILE SUNFLOWER STARS (P. HELIANTHOIDES) FED TWO DIFFERENT FOOD ITEMS

Gerald-Yamasaki, C.[1]; Yemenez, M.[1]; Andrade, M.[1]; Lord, S.[1]; Kim, A.[2]; Kidd, A.[1]; Christian, V.[1*]

1- Sunflower Star Laboratory 2- SJSU Moss Landing Marine Labs

Following the loss of *P. helianthoides* populations from sea star wasting syndrome, several universities, public aquariums, and non-profit laboratories have begun culturing larvae and juveniles to fill critical knowledge gaps necessary for scaling and future reintroduction. *P. helianthoides* are generalist predators that can consume a large variety of prey, but identifying optimal food for juvenile stars in an aquaculture setting requires balancing nutritional value with the costs associated with producing or procuring viable foods. Producing live foods such as purple sea urchins (*Strongylocentrotus purpuratus*), a known food source, can be extremely costly and labor intensive at scale in comparison to other frozen and readily available food sources. In preliminary feed trials we identified frozen brine shrimp (*Artemia sp.*) to be a viable food source eliciting strong feeding behavior and therefore conducted an experiment comparing the variability in growth of juvenile *P. helianthoides* when fed (1) laboratory cultured purple sea urchins, (2) frozen brine shrimp or (3) the combination. We will be presenting preliminary data for this ongoing experiment. Results from this study may help inform future juvenile grow out methods.

45 - GENE EXPRESSION ANALYSIS OF LARVAL GOPHER ROCKFISH (*SEBASTES CARNATUS*) AFTER MATERNAL EXPOSURE TO SIMULATED UPWELLING STRESS

† Jones, D.E.[1*]; Bernardi, G.[2]; Carey, Q.C.[3]; Hamilton, S.L.[3]; Logan, C.A.[4]

1- CSU Monterey Bay, Moss Landing Marine Laboratories 2- UC Santa Cruz 3- Moss Landing Marine Laboratories 4- CSU Monterey Bay

Anthropogenic climate change is altering ocean chemistry, resulting in ocean acidification (OA) and deoxygenation. In the California Current System (CCS), natural upwelling brings cold, nutrient-rich, deoxygenated, low-pH water nearshore during spring and summer. Climate change may soon expose species within the CCS to OA and hypoxia (OAH) levels beyond their physiological thresholds. Rockfish, a key nearshore group in the CCS, may be unable to genetically adapt to these changes due to their late age at maturity and long lifespan. To explore the potential for rapid adaptation via transgenerational plasticity, we exposed pregnant gopher rockfish to projected OAH conditions to assess if and how maternal exposure affects larval offspring. Given that rockfish are viviparous, we also varied the timing of exposure (pre- vs post-fertilization) to disentangle the potential effects of early developmental exposure. We then compared differentially expressed genes (DEG) in larvae from mothers exposed to OAH (DO 3.0 mg/L, pH 7.4) pre- or post-fertilization, with those in ambient conditions. If OAH exposure prior to fertilization impacts offspring gene expression, this would provide preliminary evidence of transgenerational plasticity. Future work will also explore if DNA methylation patterns correlate to these DEGs, to determine if epigenetics plays a role in these responses. Our results may uncover mechanisms of rapid physiological adaptation, offering insights into rockfishes' adaptive capacity under climate change.

46 - DIFFERENCES IN GROWTH RATES CAUSED BY PH AND DIET IN RED ABALONE PROVIDE AN INSIGHT INTO THE SUSTAINABILITY OF ABALONE AQUACULTURE.

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Red abalone (*Haliotis rufescens*) are an economically and culturally valuable species in California. Ocean acidification threatens both natural and farmed red abalone populations. To enhance the resiliency of red abalone for both commercial and restoration aquaculture, more information is needed on how factors such as diet may influence abalone growth, especially in projected future conditions. We exposed adult red abalone (N=166) to two different pH treatments: a low pH treatment of 7.65 and an ambient treatment of 7.9. Within these pH treatments, the red abalone were given three different diet treatments: Dulse (*Devalerea mollis*) only, Ogo (*Gracilaria parvispora*) only, and a mixed diet treatment of both algae. The abalone in reduced pH had lower growth than those in the ambient environment. In addition, abalone fed only dulse had a much higher growth rate than those of other diet treatments regardless of pH treatment. As ocean acidification continues, understanding how diet can influence abalone growth in future projected conditions can provide practitioners with tools for supporting the long-term sustainability of aquaculture and conservation efforts for this valuable species under future climate change.

47 - USING DEEP LEARNING (IMAGE SEGMENTATION) TO DETERMINE MORPHOLOGICAL CHARACTERISTICS OF CUTTLEBONES

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1- Imperial College London 2- Stanford University

The 2023 poster “Combing for Cuttlefish” presented a dataset of 793 cuttlebones collected over 10 months on a 2.8 km section of the Corsican shoreline in the Mediterranean sea. Here, we present a follow-up project focusing on analyzing the morphological characteristics of common cuttlefish (Sepia officinalis) from the same dataset. This analysis is critical for understanding cuttlefish population structure and life cycle in the western Mediterranean, a data poor region for the cuttlefish fishery. We use a computer vision technique known as image segmentation to accurately and efficiently collect metrics including length, width and surface area of the fragmocone and whole cuttlebone. We compare our deep learning results to manual observations of the same data and to published work on the characteristics of cuttlefish in the central-east Atlantic and the south-eastern Mediterranean. Our findings largely align with the morphometric relationships reported in the existing literature, with signs of regional variation. We contribute a consistent and automated method that can be reused to analyze larger datasets, helping uncover new population and regional relationships within the species.

48 - RESTORING BALANCE: ASSESSING SEA OTTER SITE PREFERENCE AND FORAGING BEHAVIOR FOLLOWING GIANT KELP RESTORATION EFFORTS AT TANKERS REEF IN MONTEREY, CA

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San Jose State University

Factors such as marine heatwaves and sea star wasting disease have decreased giant kelp (*Macrocystis pyrifera*) abundance in California, replacing kelp sites with lower diversity areas dominated by sea urchins (*Strongylocentrotus purpuratus*), known as “urchin barrens”. While sea otters (*Enhydra lutris*) are well known to control urchin numbers in healthy kelp forests, the starved urchins within these barrens are typically avoided by sea otters due to their lack of energetic profitability. In 2021, the Giant Giant Kelp Restoration Project began culling urchins to facilitate kelp restoration at Tankers Reef, a site off the coast of Northern California in Monterey Bay. Urchin culling ceased in 2024 with the question, “what happens to the restored kelp forest when urchin management ceases?”. To assess early effects kelp restoration on otter behavior and ascertain if the restored kelp forest is recolonized by sea otters, I observed sea otter use of Tankers Reef and 5 unaltered rocky reef sites along the Monterey peninsula from June to September, I collected data on sea otter behavior, site preference, and prey items. Early results indicate otters prefer long-standing kelp forests and show slow recolonization of the restored site.

49 - FILTER-FEEDING MACROFAUNAL INVERTEBRATE COMMUNITIES AND HEAVY METALS ON POLLUTION BOOMS IN RECREATIONAL AND INDUSTRIAL MARINAS

McCoy, K.C.*; Boudrias, M.A.

University of San Diego

Filter-feeding species are ecologically important for the removal of excess organics and heavy metals from the water column, improving overall water quality of the system. This study explores the quantification of macrofaunal invertebrate communities on the surface area of pollution remediation booms, potentially improving water quality and managing invasive species. Booms were placed in industrial and recreational marinas in Southern California for two months, followed by biological and ecological analyses. Invertebrate species were measured by percent cover, count, size, and heavy metal analysis. Biodiversity, size, and percent cover of invertebrate species in recreational marinas were upwards of two times greater than industrial ones. Conversely, heavy metals were of higher concentrations in industrial marinas than recreational marinas. This suggests that the invertebrate communities living on the booms are indicative of the surrounding environmental conditions, and contributing positively to the system by filtering excess toxins, and removing invasive species.

50 - 'HOOP THERE IT IS': EXPERIMENTAL ACIDWEED (*DESMARESTIA LIGULATA*) PLOTS AS A POTENTIAL TOOL FOR BULL KELP RESTORATION

Wiley, B.T.*; Carrasco, E.M.; Bourdeau, P.E.

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 for them. These characteristics may afford the use of *Desmarestia ligulata* 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 *D. ligulata* as a purple sea urchin (*Strongylocentrotus purpuratus*) deterrent. In the field, we conducted transect surveys to assess the association between *D. ligulata* and bull kelp, and experimentally tested the effect of *D. ligulata* 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 *D. ligulata*, the kelp *Pterygophora californica*, and bull kelp. In the field, we found a strong positive association between *D. ligulata* and bull kelp abundance, and that *D. ligulata* 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 *D. ligulata* and *P. californica* at roughly half the rate of bull kelp. Our results suggest that *D. ligulata* could be an effective deterrent to sea urchin grazing, at least over shorter time scales and during critical growth periods for bull kelp. *D. ligulata* may therefore have value in kelp forest restoration, as a biological deterrent to grazing sea urchin fronts.

51 - TOXIC HEAVY METALS AFFECTING MARINE COMMUNITIES ON SUSTAINABLE REMEDIATION BOOMS BETWEEN INDUSTRIAL AND RECREATIONAL MARINAS

Kolon, G.F.*; Boudrias, M.A.

University of San Diego

Estuaries are vital ecosystems that provide critical habitats and offer significant benefits ecologically and economically, however, they are progressively threatened through anthropogenic pollution, principally from urban runoff and marina activities. This study aimed to assess the effectiveness of remediation booms in reducing pollution and supporting invertebrate biodiversity within industrial and recreational marinas. Water quality parameters were measured using a YSI pro-DSS at both pre- and post-boom deployment. Heavy metal concentrations on the surface of the polypropylene material were measured using a hand-held X-Ray Fluorescence (XRF) analyzer while the netting and remnants of the boom were analyzed and sorted to the lowest identified taxa. This study found that the remediation booms effectively collected the surface heavy metals like copper, zinc, and mercury in excess of regulated levels in the organic layer growing on the boom. There were differences in the composition of the organisms, in particular the ratio of copepods and amphipods, between the recreational and industrial sites as the concentrations of heavy metals changed. These findings could have significant implications in management and remediation efforts in developing solutions towards water quality in estuarine environments.

52 - TWENTY-SIX YEARS LATER: THE STATE OF SAN SALVADOR ISLAND CORAL REEFS

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Coral reefs are one of the most diverse ecosystems housing a wide variety of organisms. These reefs are resilient structures that provide coastline protection, tourism, and fisheries. Over the past 26 years, there have been minimal coral reef surveys associated with San Salvador Island, The Bahamas. Reefs in the Caribbean Sea have become of great interest as loss of coral cover and abundance in conjunction with increases in disease (e.g. Stony Coral) and coral mortality have negatively impacted and altered these reef ecosystems. This study compared data collected from 1998 and 2024 on nearby reefs along San Salvador Island regarding the percent coral cover and coral species diversity. Video transects were

collected at Fernandez Bay and French Bay and isolated into screenshots at 2.5m increments. Thirty random points were assigned to each screenshot using Coral Point Counter (CPC) and when marked, hard and soft corals were identified (at least to genus), counted, and totaled. All data was then compared to the findings of Peckol et al., 2003. Over the time interval of this study, the percent of coral cover has decreased from 28% (Fernandez Bay) and 48% (French Bay) to 5% and 3%, respectively and algal dominance on all reefs has increased. The results of this study have negative implications regarding the impacts of climate change on these reef ecosystems. These important ecosystems will only continue to degrade with ocean warming and coral diseases spreading making it important to consistently monitor and help rehabilitate all reefs.

53 - AN EXAMINATION OF THE ONTOGENETIC SHIFT OF WHITE SHARK PREY PREFERENCE FROM FISHES TO PINNIPED MARINE MAMMALS

Torrisi, M.[1*]; Walter, A.[1]; Yee, K.[2]; Anderson, S.[3]; Andrzejaczek, S.[4]; Block, B.[4]; Chapple, T.[5]; DiGiacomo, A.[4]; Kanive, P.[3]; Jorgensen, S.[1]

1- CSU Monterey Bay 2- San Jose State University 3- California White Shark Project 4- Hopkins Marine Station 5- Hopkins Marine Station, Oregon State University

Adult white sharks (*Carcharodon carcharias*) are known to have a preference for hunting pinniped prey, while juveniles tend to prefer fishes. This project aims to study this ontogenetic diet transition by analyzing the presence and frequency of injurious scars associated with hunting pinniped prey on sharks of varying size classes. Pinniped-inflicted 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, Ano Nuevo Island, and the greater Farallon Islands. Multiple trained student assistants analyzed each video to score scar type, color, and body location. To control for the uncertainty of student identifications, scars were given a confidence score by the student to quantify their certainty in scar classification. Python and SQL scripts were used to create a database and tally confidence scores of scars to reach a consensus score used in analysis. Preliminary results support the existence of a prey handling learning curve as white sharks undergo this ontogenetic diet transition.

54 - SCIENCE AT THE FARM: MEASURING ENVIRONMENTAL DRIVERS AND INTERACTIONS AT SEAWEED AND SHELLFISH FARMS IN ALASKA

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1- University of Alaska Fairbanks 2- Alaska Sea Grant

The Mariculture Research and Restoration Consortium project brings together researchers from the University of Alaska Fairbanks, state and federal agencies, tribal and scientific entities with nine shellfish/seaweed farms throughout three regions of coastal Alaska. This large interdisciplinary project is measuring environmental drivers and examining the ecological effects of aquatic farms through various lenses from the physiochemical properties of the water column to the interactions with invertebrate, fish, avian, and marine mammal communities. We are studying farm productivity across this large geographic gradient using standardized growing methods and a research-scale array with a suite of environmental sensors. One of the highlights of the project is how academic and agency scientists are working alongside aquatic farmers to support their information needs. In turn, farmers are collecting and submitting samples and data that contribute to addressing a suite of questions about how farms are influenced by and interact with their environment. This research project will provide valuable insight to inform site selection of future farms and to inform future farming practices, with the ultimate goal to support an ecologically and economically sustainable mariculture industry in coastal Alaska.

55 - HOW SEDIMENT TYPE INFLUENCES PERFORMANCE OF THE INTRODUCED ANEMONE, ANTHOPLEURA HERMAPHRODITICA

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Phenotypic plasticity allows invasive species to thrive in new habitats. In 2022, the introduced small brown anemone,*Anthopleura hermaphroditica*, was first documented in Tomales Bay, CA. They rapidly invaded shallow, intertidal areas, but are not uniformly distributed. One difference leading to heterogeneity in their invasion success could be benthic habitat (sediment) type, which varies across the bay. As burrowing is a mechanism to withstand desiccation stress, we expect anemones in sediments in which they can bury to show higher performance compared to sediments where they can attach. To test this hypothesis, we conducted field surveys and lab experiments using sediments from three different sites across Tomales Bay and measured growth rate, burrowing depth, photosynthetic capacity, sediment preference and symbiont densities. Experiments demonstrated higher growth rate in rockier sediments, and a preference for attachment compared to burying. No differences in photosynthetic yield or symbiont densities across sites were observed, which may indicate resilience of anemones to different conditions. Contrary to our hypothesis, our results suggest areas with substrates that favor attachment may yield higher invasion success (i.e., growth) than areas with finer sediments where anemones can only bury. As invasions increase globally, understanding how invaders respond to new habitats is critical to predict the progression of new invasions.

56 - UAS-BASED MULTISPECTRAL SURVEYS ENHANCE MANAGEMENT OF CANOPY FORMING KELP IN CENTRAL PUGET SOUND, WASHINGTON STATE

McClure, T.*; Christiaen, B.

WA Dept. of Natural Resources

Bull kelp (*Nereocystis luetkeana*) is an important canopy-forming kelp supporting fisheries and nearshore ecosystem health in the Salish Sea. In the central basin of Puget Sound, the current areal extent of these canopy forming kelps is not well defined. This is an important data gap given the historical loss of kelp in south and in some areas of central Puget Sound. In 2023 and 2024, the Washington State Department of Natural Resources (DNR) partnered with the Suquamish Indian Tribe of the Port Madison Reservation on EPA funding to survey all canopy forming kelp beds in the central basin of Puget Sound, which is part of the Tribe's Usual and Accustomed fishing grounds. The combination of strong current and narrow kelp canopies makes Puget Sound not suited for mapping kelp with multispectral fixed-wing surveys or satellite imagery. Instead, we captured multispectral imagery at 29 kelp canopy sites using UAS, and classified imagery with Blue NDVI thresholds to produce estimates of kelp bed area and canopy density. Sites ranged in size from 0.6 Ha between piers of Elliott Bay, to 418 Ha at overlapping sites off southern Whidbey Island. Of 6 sites completed in 2023, results from 4 sites also surveyed with DNR's kayak-based methods were within 16 ± 4% (mean ± SE) of bed area estimates. In 2024, we surveyed 23 sites and analysis is ongoing. This work enhanced DNR's multispectral UAS mapping capacity through a partnership with the Suquamish Tribe to improve monitoring and management of critical nearshore habitats.

57 - MONITORING NUCELLA SPP. POPULATION DYNAMICS UNDER THE INFLUENCE OF SEA STAR WASTING DISEASE (SSWD)

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The decimation of a keystone predator, *Pisaster ochraceus* (ochre sea stars), due to SSWD is expected to impact species populations in rocky intertidal ecosystems. *P.ochraceus* and *Nucella* spp. (dog whelk snails) share a common food source, *Mytilus californianus* (California mussels). We expect the reduction in sea stars to increase mussels and in turn *Nucella* spp. via a reduction in competition between sea stars and *Nucella* spp. for a shared food source that is increasing. In this study, we documented the change in populations of *Nucella* spp. and mussels over time before and after SSWD at 4 Central California sites. We observed variable change in percent cover of mussels across sites over time. Mussel abundances increased within 2 years following SSWD onset and remained elevated at some sites while other sites are currently showing slight decreases in mussels. Our data did not support our initial prediction that an increase in mussels would lead to an increase in *Nucella* spp.. We found no significant correlation between mussel and *Nucella* spp. abundances over the time period of this study. We found either a decrease or no

significant change in *Nucella* spp. population densities post-SSWD. Variable population changes and unpredicted trends in *Nucella* spp. population dynamics following SSWD highlights the widespread impact that *P.ochraceus* has on rocky intertidal community dynamics. Our study illuminated that there may be additional factors along with sea stars that are influencing the changes observed in *Nucella* spp. populations following SSWD.

58 - VALIDATION OF THE FISH HEMATOCRIT MEASUREMENT USING THE ABL90 FLEX BLOOD GAS ANALYZER

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1- CSU Monterey Bay 2- CSU Monterey Bay/Moss Landing Marine Labs

Marine organisms are subjected to a wide array of environmental variation which influences their physiological condition. Studying blood parameters can provide scientists a rapid assessment of the physiological status of fishes subjected to environmental variation. A blood parameter that responds to environmental oxygen availability is hematocrit (HCT), which is the percentage of red blood cells in the organism's blood and an indicator of oxygen carrying capacity. In this study, we tested whether a point-of-care blood gas analyzer (ABL90 Flex) could provide HCT values comparable to the standard centrifuge method using blood samples from adult gopher rockfish (*Sebastes carnatus*) exposed to variable upwelling conditions. We analyzed whole blood samples (n=46) to determine whether HCT values from the two methods were correlated. Blood was drawn (~1 mL) from the caudal vein in field collected fish, chilled at 4℃, and processed several hours later. Our results show that the measurements from the two methods were moderately correlated (Spearman's ρ = 0.39; p-value = 0.007). The ABL90 flex provided consistently lower values than the centrifuge method, suggesting that relative, but not absolute, values may be a useful indicator of relative differences in HCT among fish. Point-of-care blood analyzers developed for humans may provide environmental physiologists a rapid method for determining fish physiological status in the field but caution should be taken in data interpretation.

59 - OYSTER AND MUSSEL GAPING BEHAVIOR IN RESPONSE TO CHANGING WATER CONDITIONS IN THE TIJUANA RIVER ESTUARY

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1- San Diego State University 2- Scripps Institution of Oceanography 3- Tijuana River National Estuarine Research Reserve

Low-inflow estuaries in Southern California often experience large swings in water quality conditions due to the varying influences of tidally-driven ocean exchange and episodic upstream terrestrial runoff. We deployed groups of naturalized oysters and mussels (*Crassostrea [Magallana] gigas* and *Mytilus galloprovincialis*) on a mooring in the Tijuana River Estuary during spring and summer 2024. These animals had electronic sensors mounted to the shell surface that recorded shell valve opening and closing behavior around the clock for weeks to months. We also monitored water quality parameters including conductivity, temperature, depth, dissolved oxygen, and chlorophyll a. Relative to a group of reference animals in San Diego Bay, the Tijuana River bivalves more frequently held the valves closed or nearly closed, and those closure periods were often associated with the phase of the tide and hypoxic or anoxic conditions in the water column. Mortality during the monitoring period was high, with 13 of 16 animals dying by the conclusion of the deployment in September 2024. Despite the estuary mouth remaining open and connected to the ocean throughout the monitoring period, water quality conditions within the estuary appear to provide challenging conditions for oyster and mussel growth and survival in this heavily human-impacted estuary.

60 - SECONDARY EXTENSIVE AQUACULTURE: HARVESTING MACROALGAE IN CALIFORNIA OYSTER FARMS

Campbell, R.C.[1*]; Fleener, G.B.[2]; Johnson, K.M.[3]; Froehlich, H.E.[4]; Miller, K.A.[5]; Kroeker, K.J.[1]

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

Macroalgal recruits in shellfish aquaculture are considered fouling organisms; however several of these 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, relative growth rates, yield and quality of macroalgae associated with the three primary

gear types for oyster culture in California. We are also looking at effects of macroalgal recruitment on dissolved oxygen concentrations, growth, and mortality of cultivated Pacific Oysters (*Magallana gigas*). We are assessing these metrics over a year, using different harvest strategies, 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. Preliminary results show rapid late summer recruitment of a diverse set of macroalgae with differences between the three estuaries. This research will support important management decisions from the individual farm level to sustainable fisheries and aquaculture policy in the state and beyond.

61 - GRAY WHALE (ESCHRICHTIUS ROBUSTUS) FORAGING IN PUGET SOUND, WA IMPACTS GHOST SHRIMP (NEOTRYPAEA CALIFORNIENSIS) POPULATION DYNAMICS

Green, M.H.*; Clayton, H.; Goldbogen, J.

Stanford University

Bay ghost shrimp (*Neotrypaea californiensis*) are burrowing shrimp that inhabit soft-bottom intertidal zones in estuarine areas along the coasts of North America. They are considered ecosystem engineers because of their ability to alter the chemical and physical properties of the intertidal substrate. *N. californiensis* is regarded as a pest to the aquaculture industry of Washington State because its disturbance of the sediment impedes bivalve growth. In the Northern Puget Sound (NPS), *N. californiensis* is an important food source for gray whales (*Eschrictius robustus*), which feed on densely packed ghost shrimp in the Snohomish Delta. Gray whales create large “feeding pits” as they excavate sediment to feed on ghost shrimp. Estuarine systems like those of the NPS are extremely ecologically important, yet they face threats of both anthropogenic disturbance and climate change. To investigate the effects of an extensive, yet seasonal, disturbance, we explored the impact of gray whale foraging on *N. californiensis* population dynamics in Puget Sound. We collected ghost shrimp (n = 1553) from inside and outside feeding pits at six sites in the NPS. Preliminary findings show that the density (n) and size of *N. californiensis* varies across all six sites, with the largest shrimp located where gray whale feeding has only been recorded for two years, compared to other sites, with feeding recorded since the early ’90s. This study suggests that foraging disturbance may influence prey distribution and offers a unique lens through which to explore a dynamic ecosystem under threat.

62 - WHAT’S IN OUR WATER? AN ASSESSMENT OF MICROPLASTICS IN THE SEAWATER OF THE MORRO BAY ESTUARY

Leback, E.S.*; Wall, Z.C.*; Hawkins, L.C.*; Adams, N.L.

Cal Poly SLO

Microplastics (plastic fragments or fibers smaller than 5mm) are pervasive throughout global ecosystems, having been extensively documented in water, sediments, and both aquatic and terrestrial organisms. For the past three years, the Adams lab has been monitoring microplastics in the sediments and oysters of the Morro Bay Estuary. We have continued our ongoing microplastic monitoring efforts by examining the concentrations and types of microplastics in seawater every two weeks at six well-established field sites within the Morro Bay Estuary watershed (including a freshwater stream, Los Osos Creek). We isolate plastics from samples through filtration and digest the remaining organic material using KOH. We then stain and identify plastics using fluorescence microscopy. We hypothesize that microplastic prevalence will vary among sites, peaking in the back bay where microplastics may originate from terrestrial and agricultural sources and accumulate due to the back bay’s longer flushing time. Early samples contain average concentrations of microplastics ranging from 0.009 to 0.05 microplastics/ml. Using a two-way analysis of variance, our preliminary results indicate some variation in plastic prevalence, but no significant variation among sites and collection dates. This project will establish a long-term monitoring effort to help understand the sources and movements of microplastics we identified in the Morro Bay Estuary. We hope to inform stakeholders about sources of microplastics and ways to avoid further contamination of the watershed in the future.

63 - JUVENILE BIOENERGETIC EFFECTS OF TEMPERATURE AND FOOD AVAILABILITY IN THE ENDANGERED SUNFLOWER SEA STAR, PYCNOPODIA HELIANTHOIDES.

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1- CSU Long Beach 2- Moss Landing Marine Laboratories

Pycnopodia helianthoides plays a significant role in maintaining kelp forest ecosystems by preying on sea urchins, which can overgraze and degrade these habitats. In the 2010s, sea star wasting disease (SSWD) caused mass mortality of *P. helianthoides*, leading to regional extirpation and kelp forest decline. Reintroducing *P. helianthoides* via aquaculture is being explored as a conservation strategy. This study examines how temperature and food availability affect bioenergetics in juvenile *P. helianthoides*, a vulnerable stage crucial for population recovery. We hypothesized that juveniles at 16℃ and ad libitum feeding would show greater ingestion, growth, and respiration rates, and greater food conversion efficiency than juveniles at 9℃ and under starvation. Our results show higher per capita consumption at 16℃ than at 9℃, though this was not statistically significant. Additionally, juveniles reared at 16℃ were larger than those at 9℃, and for a given temperature, fed juveniles were larger than starved ones. These patterns suggest that growth rates were likely higher at 16℃ with sufficient food, while starvation at 9℃ may have stunted growth. These findings align with metabolic theory, which predicts higher metabolic demand at higher temperatures, but also highlight the complexity of bioenergetic responses in juvenile sea stars. These findings and future analysis of respiration will be integrated into a dynamic energy budget (DEB) model to predict how juvenile *P. helianthoides* might respond to changing environments, crucial for conservation efforts.

64 - COMPARING A NOVEL INSTANCE SEGMENTATION MODEL WITH TRADITIONAL TECHNIQUES FOR QUANTIFYING SPONGE PERCENT COVER INSIDE REEF BALLS

Chen, J.S.*; Zacherl, D.C.

CSU Fullerton

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. Based upon personal observation, sponge populations grew expansively in the first two years since reef ball deployment. We sought to quantify sponge growth while exploring alternatives to labor-intensive, human-conducted surveys, through the use of novel instance segmentation machine learning. We compared traditional techniques of quantifying sponge percent cover 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 the machine learning model adjusted for lighting was the most accurate, with a mean that only differed by 0.62% with the control. Using this technique, we determined that the average sponge cover increased 6.3 times from 2023 to 2024 at tidal elevations below 0.6m MLLW. While results from this study indicate that machine learning is the most accurate out of our current sponge quantification techniques, further work will compare time and cost efficiency as well.

65 - TURNING UP THE HEAT? HAVE M. GIGAS DENSITIES CONTINUED TO INCREASE AT NEWPORT BAY, CA?

Aluwihare, A.N.*; Zacherl D.C.,

CSU Fullerton

The Pacific oyster, *Magallana gigas*, is a common non-indigenous species in Southern California estuaries. Wolfe et al. (2024) found that *M.gigas* populations increased rapidly from 2010 to 2020, coinciding with a time period of summers with warmer sea surface temperatures. We aimed to discover if these population increases are continuing, and if the same patterns are occurring on two distinct habitat types (seawall, pier piling) at a site in Newport Bay, CA. In the previous study, seawall and pier piling habitats were treated as interchangeable. We re-surveyed the site in June 2024 and found that when we pooled the habitat types as in the previous study, the populations had not experienced a significant increase in density since last surveyed in 2019. When the habitats were analyzed separately, *M. gigas* density on pier piling did not change from 2019 to 2024, suggesting that perhaps the population density has stabilized, but *M. gigas* density on seawall increased significantly compared to when it was last

surveyed in 2017. Due to the uneven sampling across the two habitat types, we cannot pinpoint the exact years when the increase in *M. gigas* density occurred, but we do know that they have significantly increased across the period of 2010 to 2024 on both habitats. These findings are a useful baseline for resource managers who are undertaking the restoration of our native species, *Ostrea lurida*. The better we can understand *M. gigas'* growth and distribution, the better we can target the restoration of our native species.

66 - EVALUATING THE RECOVERY OF NURSERY HABITAT FUNCTION IN RESTORED EELGRASS BEDS

Boisen, O.B.*; Moretto, W.I.; Heppell, S.A.

Oregon State University

Eelgrass (*Zostera marina*,) beds provide a wealth of ecosystem services, including key nursery habitat for ecologically and economically important fished species. Globally, seagrasses and the ecosystem services they provide are threatened by human development and climate change. To mitigate these impact, mandated restorations have occurred across the United States, including in Oregon's estuaries. My goal is to compare the nursery habitat function of natural seagrass beds, restored beds at different timescales (3 years post-restoration at South Slough and 34 years at Coos Bay), and mudflat sites to determine how restored beds perform relative to natural sites and determine if and when their animal communities become indistinguishable from those of naturally occurring beds. I will follow standardized trapping methods to assess fish and invertebrate communities (species richness and abundance) in a way that is comparable across sites. At the individual level, I will use techniques including otolith aging and stable isotope analysis to evaluate recent growth, diet, and trophic position of juvenile rockfish, as these are indicators of fish health. I will use a mixed model approach to evaluate differences in these metrics between the restoration sites and their respective undisturbed eelgrass beds and mudflat sites. I anticipate a non-linear response to the restoration where the communities will be less diverse in recently restoration locations, reaching a marked increase after a minimum critical threshold is attained. I also predict that fish growth rates will increase, body condition will be improved, and trophic structure will be simplified at older restoration locations, indicating that nursery habitat function has been restored. Preliminary findings show that restored eelgrass beds support several species of juvenile crabs, including Dungeness (*Metacarcinus magister*,) and Red rock crabs (*Cancer productus*,) and have fish communities that are more similar to their natural reference sites. We will continue sampling monthly over two years, allowing us to both determine how well important fishery species are performing in restored seagrass habitats and define expectations and timelines for the recovery of nursery function. Ultimately, this work will promote seagrass conservation by using the recovery of ecological functions as a guiding framework for making informed restoration decisions.

67 - INVESTIGATION OF CARBON CYCLING IN SAN DIEGO COASTAL WATERS BY MEASURING CO2 FLUXUSING EDDY COVARIANCE TECHNIQUES

Duenas, A.L.*; Oechel, W.C.

San Diego State University

Net carbon dioxide (CO2) source and sink dynamics of coastal oceans are poorly understood (Roobaert et al. 2019). Disagreements in net annual CO2 flux have led to an uncertainty of coastal oceans being a net source or sink for CO2 (Chen and Borges, 2009). An eddy covariance tower located on Ellen Browning Scripps Memorial Pier in La Jolla, California has been collecting near continuous CO2 flux data since 2005. Analyzed flux data from 2005 to 2011 provide evidence that the coastal area within the regional footprint are acting as a net sink for CO2 (Ikawa and Oechel, 2015). Interannual flux was show to be influence by surrounding macrophyte communities. The flux data collected from 2005 until present day will be used to determine if the La Jolla coastal zones are still acting as a sink for atmospheric CO2. This data will also be used to identify environmental processes which may control temporal variations at different time scales. Seasonal changes in air-sea CO2 fluxes will be used to understand the sensitivity of these fluxes to environmental changes (Roobaert et al. 2019) such as harmful algal blooms (red tides), marine heat

waves, and El Niño-Southern oscillation (ENSO events). It is hypothesized that La Jolla coastal zones have changed since they were first investigated between 2005 to 2011 in terms of CO2 fluxes as a response to climate change. Air-sea CO2 fluxes are very sensitive to environmental change and are likely different compared to periods without heavy environmental influence.

68 - EXPLORING THE IDENTITY AND ECOLOGY OF AN UNKNOWN INTERTIDAL AND SUBTIDAL SPONGE ON THE OREGON COAST

Weisz, J.B.; VerCauteren, K.H.*

Linfield University

The Sea Star Wasting Syndrome (SSWS) epidemic of 2014 drastically altered the benthic communities of both intertidal and subtidal zones along the Oregon Coast. As the sea stars have made their recovery, so have other organisms, including a number of sponge species whose populations plummeted when SSWS hit. A sponge of particular interest is a purple sponge likely in genus *Haliclona* that was documented and collected subtidally at Netarts Bay pre-SSWS but was not seen during the epidemic or for several years afterward. We have also recently discovered a morphologically similar intertidal sponge that has reappeared on the Oregon coast. This research seeks to analyze the ecological role of these sponges and compare them to samples of the subtidal sponge taken in 2012 and 2013 prior to the SSWS epidemic. We used protocols from the sponge barcoding project to obtain sequences of the 28S gene used in species identification. We also examined tissue samples for the presence of bacteria genes involved in nutrient cycling, including pmoA, amoA, nifH, and norB, to examine the possible ecological impact of the sponge. Our results from 2023 and 2024 suggest that there are differences between the subtidal and intertidal sponges, which may present insight into different ecological niches based on location. By comparing these findings to data collected in 2012 and 2013 regarding the purple sponge that was present at that time, we seek to investigate continuity and change among sponge populations pre- and post-SSWS.

69 - DETERMINING THE SPAWNING PERIOD OF *ANTHOPLEURA ELEGANTISSIMA*, A MODEL SPECIES FOR CNIDARIAN-ALGAL SYMBIOSIS

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1- Concordia University Irvine 2- University of Southern California 3- Soka University

Coral associated symbionts play an important role in bleaching tolerance and coral resilience. Understanding this relationship between corals and their symbiont cells can help us predict how corals may be affected by major bleaching events. Many corals take years to reach sexual maturity, making it difficult to study the cnidarian-algal symbiosis across multiple generations or life stages. Therefore, it may be helpful to establish alternative model species with more favorable life history characteristics in which to study cnidarian-algal symbiosis. The aggregating sea anemone, *Anthopleura elegantissima*, is an symbiont-hosting temperate-water anemone species that is abundant and reaches reproductive maturity quickly but its seasonal reproductive timing is not well understood. This study aimed to describe the peak period of reproduction in a southern California population of *A. Elegantissima* to support its development as a model species of cnidarian-algal symbiosis. We collected *A.elegantissima* samples from intertidal sites during June-August, measured gonad mass and compared this to body mass, body volume and protein content. Protein content and gonad size exhibited a dramatic peak in July leading us to conclude that spawning occurred during that month. This information should allow us to better predict the spawning season of *A. elegantissima* in the future and help support experiments aimed at studying cnidarian-algal symbiosis.

70 - CAPTIVE CONDITIONING OF PISMO CLAM (*TIVELA STULTORUM*) BROODSTOCK FOR AQUACULTURE PRODUCTION

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1- Concordia University Irvine 2- Get Inspired, Inc. 3- Holdfast Aquaculture

Increasing demand for seafood necessitates the exploration of new species for aquaculture production. The Pismo Clam, *Tivela stultorum*, has a storied history as a fishery species and holds potential for development as an aquaculture species, but commercial production has not yet been developed due to uncertainty about the necessary conditions for cultivation. Our study aimed to address a critical step in the creation of a viable commercial aquaculture framework for Pismo clams- development of methodology for broodstock conditioning and spawning. Forty wild adult clams were collected in late spring, held in sand within a recirculating aquarium system, and fed a diet of live *Tetraselmis*, *Chaetoceros*, and *Isochrysis* microalgae. After a 1-month period of acclimation and ad libitum feeding, clams were placed in replicated tanks and received a high- or low-ration diet (3% or 0.6% wet body mass, respectively; n=4) for ca. two months prior to a spawning trial. At the time of abstract submission, we had achieved 100% broodstock survival and an average shell length growth of 2.47 (±1.27 sd) mm over 3-months of conditioning, with minimal differences in growth between rationed groups during the two-month rationing trial. The spawning success of clams from both treatment groups will also be reported. These broodstock conditioning trials serve as a necessary first step towards the development of refined methodology for aquaculture production of Pismo clams and the broader goal of enhancing the availability of sustainable seafood.

71 - ANALYZING URCHIN MORPHOMETRICS AND GONAD INDICES TO QUANTIFY SUCCESS AND INFORM ADAPTIVE MANAGEMENT OF KELP FOREST RESTORATION

† Hall, L.[1*]; Hardcastle, J.[2*]; Marcello, K.[3]; Daniels, C.[4]; Downie, G.[5]; McHugh, T.A.[6]; Grime, B.C.[6]

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Over the last decade, kelp forests in northern California have been negatively impacted by an increased frequency of stressors. Resultantly, an overpopulation of native purple sea urchins are destructively grazing kelp forests creating extensive “urchin barrens”, reducing ecosystem biodiversity. Over 96% of bull kelp forests have been lost in northern California impacting the ecological, economic, and cultural viability in the region and creating a wake of ramifications such as federal fisheries disasters (e.g. Red Sea Urchin). Red sea urchin harvesting is an important fishery in the region and state, as their gonads are sold as a high-value sushi product called “uni”. However, with extensive loss of kelp, red urchins in barrens are smaller and exist in a starved state meaning there is little gonad product available to the fishery. The Nature Conservancy has initiated a scaled, multifaceted project in Mendocino County that works with local commercial urchin divers to harvest purple urchins from two targeted locations in an effort to restore high priority kelp refugia areas. Restoration success is, in part, being quantified by analyzing landed urchins over time, including recording where they are being harvested within the site, diameter, wet weight, and gonad index. This can be used to analyze the variation of reproduction, diet, and structure of urchins in areas with different amounts of kelp across the site. Overall, developing a better understanding of the relationship between urchin gonads and kelp should be used to inform adaptive management of restoration projects.

72 - MARINE RECON: ANALYSIS OF THE SPATIAL AND TEMPORAL PATTERNS OF URCHIN RECRUITS ON THE MONTEREY BAY PENINSULA

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CSU Monterey Bay

Urchin population dynamics in the Monterey Bay play a major role in the health and vitality of local kelp forest ecosystems. Larval recruitment of urchins in Monterey Bay, California plays an important role in the fluctuations and settlement patterns of local purple and red sea urchins (Strongylocentrotus purpuratus and Mesocentrotus franciscanus, respectively). Urchins, like many marine invertebrates, have a marine pelagic larval stage that allows for the distribution of urchin recruits.Variations in oceanographic features can affect the range, survival rates, and final settlement location of recruits. We did an in depth analysis of different oceanographic abiotic features from both public and collected data at two sites - Monterey Bay (MB) and Stillwater Cove (SW) - in order to compare urchin recruitment. Urchin recruitment, water temperature levels, wave action information, and current direction were measured between the two sites. MB faces the bay and has little protection while SW faces the open

ocean and has a higher level of protection. Preliminary data shows MB has 60 times more urchin recruits than the SW site. This study aims to investigate temperature, wave height, and current patterns leading to these recruitment differences between the two study sites. Having these answers will give a clearer understanding of the factors impacting urchin recruitment on the Monterey Peninsula. Being able to understand the local oceanographic differences between MB and SW will give valuable insight into the environmental factors affecting local urchin larval recruitment and potentially impact local kelp forest conservation.

73 - WATERBORNE DISPERSAL OVERWHELMS DIRECT CONTACT AS A MECHANISM OF SEAGRASS WASTING DISEASE TRANSMISSION

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Predicting and mitigating the spread of infectious disease requires knowledge of the primary mode of transmission among hosts. Infection of eelgrass (*Zostera marina*) by Seagrass Wasting Disease (SWD), caused by the protist *Labyrinthula zosterae* threatens eelgrass beds and the services they provide such as habitat provision, biodiversity maintenance, and carbon sequestration. Positive associations between field shoot density and disease prevalence suggest that direct contact is an important transmission mechanism, but there are few experimental tests of this.We compared the rate and severity of lesion development on healthy plants paired with either lesioned or non-lesioned plants in an outdoor flow-through mesocosm experiment. Half of the plant pairs were separated by a mesh barrier that prevented direct contact while still allowing water flow. Focal plants exposed to diseased plants accumulated disease lesions more rapidly and with greater severity. However, the presence of a mesh barrier did not affect the development or severity of lesions. This suggests that direct contact is overwhelmed by waterborne transmission as the dominant pathway for SWD spread. Seagrass density may still contribute to disease spread as suggested by widespread correlations between density and disease, but our results suggest these may be more the result of greater propagule production or retention in dense beds rather than direct contact.

74 - CHATTY CHEETAHS: ANALYSIS OF FORAGING SPRINTS AND ACOUSTICS OF SHORT-FINNED PILOT WHALES

Solomon, A.R.*; Harshbarger, A.E.

Duke University

Exploiting ecological niches at depth allows for some toothed whales to access prey unavailable to species that are not deep divers. In order to capture prey, some of these deep diving whales sprint underwater and use vocalizations to maintain contact during group dives. We studied the diving and foraging behavior of short-finned pilot whales (*Globicephala macrorhynchus*) off Cape Hatteras. Previous studies have documented the use of foraging sprints and vocalizations by short-finned pilot whales during foraging periods; our goal was to investigate the relationship between these behaviors. Specifically we 1) investigated whether short-finned pilot whales off Cape Hatteras, NC produce calls closely following foraging buzzes and, 2) analyzed whether there is a correlation between post-buzz calls and the timing of sprints. We found that this population of short-finned pilot whales produces a call within 10 seconds of the end of a foraging buzz after 4.4% of buzzes. Similarly we found that for a selection of four individuals who produce post-buzz calls, there was no significant relationship between post-buzz calls and sprints; 3.01% of sprints were followed by a post-buzz call, comparable to the rate of these calls across all buzzes. In the future, we will expand this pilot study by incorporating more DTAGs from this population and investigating whether post-buzz calls and sprints co-occur in other populations.

75 - ASSEMBLAGE-WIDE COMPARISON OF RETINAL GROWTH IN ROCKY REEF FISHES AT SANTA CATALINA ISLAND

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For many fish species, vision is a critical sensory modality, especially in the dynamic, visually complex environments of Southern California's rocky reefs. However, no fish within this system have had morphometric measurements taken over an ontogenetic series to document their visual capacity. We compiled a baseline morphological dataset on estimated retinal growth relative to head length across ecologically diverse, rocky reef fish species at Santa Catalina Island. We leveraged behavioral foraging records from Baited Remote Underwater Video surveys nearshore Santa Catalina. We overlaid them with novel morphometric data of the visual system from approximately 15 ethanol-preserved specimens per species from the Los Angeles Natural History Museum. We explored retinal area relationships with diet to assess how foraging ecology may influence sensory modality. Our analysis revealed a strong positive correlation between head length and retinal area across all species, yet retinal area growth rates varied. Herbivorous species had larger retinal areas than carnivores, suggesting visual acuity is more critical for herbivores, likely due to their need to identify stationary food sources. Among carnivores, the correlation was weak, likely due to varied hunting strategies. Our findings show significant interspecific variation in retinal development, suggesting visual system development may be linked to foraging ecology. Understanding sensory variation between species is crucial for predicting their response to environmental shifts, like rising water turbidity from climate change.

76 - MICROPLASTICS PRESENT IN CALIFORNIA'S ELUSIVE SAND DOLLARS (DENDRASTER EXCENTRICUS)

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CSU Channel Islands

Microplastics (<5mm) are ubiquitous along the California nearshore environment. Walking along the shoreline you may see some of these plastics lying next to the Eccentric Sand Dollar (Dendraster excentricus) that many people like to collect and display in their homes. The Eccentric Sand dollar is a filter feeder residing in a crowded near shore environment eating crustacean larvae and plankton similar in size to the free floating microplastic debris found in our ocean. These sand dollars are predated on by California Seagulls (Larus californicus), California sheepshead (Bodianus (formerly Semicossyphus) pulcher), Starry flounders (Platichthys stellatus), and large Pink sea stars (Pisaster brevispinus) tying them into a unique position in the coastal food web. We collected sand dollars as well as environmental sand samples from ten beaches along the California coast from Morro Strand State beach in Cayucos to Silver Strand beach and discovered internalized microplastics in the Eccentric Sand dollars as well as every sand sample. This is yet another way for microplastics to enter and wreak havoc on the near shore coastal ecosystem.

77 - ICHTHYOFAUNAL UTILIZATION OF A MAN-MADE VS REMNANT NATURAL SALT MARSH CREEK IN MISSION BAY, CALIFORNIA, THREE DECADES AFTER CREATION

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1- University of San Diego 2- San Diego Audubon Society

Marsh restoration and creation are increasingly being used to mitigate Southern California's loss of wetlands due to human activities. This study used minnow traps to resample the ichthyofauna of a created marsh (Crown Point Mitigation Site; CPMS) and an adjacent natural marsh (Kendall Frost) in Mission Bay, California, 29 years following marsh creation. Data from this study were compared to data collected immediately after marsh creation from 1995-1998, and from 2021-2024. Fishes captured included *Fundulus parvipinnis*, *Gillichthys mirabilis*, *Acanthagobius flavimanus*, *Ctenogobius sagittula*, *Poecilia latipinna*, and *Mugil cephalus*. Species richness and dominance measures were higher in the natural relative to the created marsh. The size-structure of the dominant species, F. parvipinnis, were skewed towards larger sizes in the natural relative to the created marsh. These size differences in 2021-2024 were opposite of those noted in the years immediately following marsh creation, suggesting long-term changes rather than inter-annual variability. The changes in size-structure appear to arise from differences in creek morphology between the created and natural systems, with the created marsh creek having become shallower through time. The differences in ichthyofaunal communities between the created and natural systems suggest that marsh/creek geomorphology may be affecting the suitability of habitat for resident fishes and should be more carefully considered when designing marsh restoration projects.

78 - DISTRIBUTION OF COLD-SEEP MUSSEL LARVAE IN THE GULF OF MEXICO AND WESTERN ATLANTIC MARGIN

† Tarleton, I.[1*]; Van Gaest, A.L.[1]; Davis, D.J.[1]; Plowman, C.Q.[2]; Rice, L.R.[2]; Beaver, T.F.[1]; Penrose, W.[1]; Young, C.M.[2]; Arellano, S.M.[1]

1- Western Washington University 2- University of Oregon

Cold seeps in the Gulf of Mexico (GOM) and the Western Atlantic Margin (WAM) are chemosynthetically productive ecosystems that host dense communities dominated by the bathymodiolin mussels *Gigantidas childressi*, *Bathymodiolus brooksi*, or *Bathymodiolus heckerae*. The GOM and WAM seeps share these foundational bathymodiolin species, depending on site depth. We suggest the vertical distributions of bathymodiolin larvae may explain connectivity between GOM and WAM seeps. To explore distributions of bathymodiolin larvae, we collected larvae above six sites from the WAM and the GOM across three depth classifications: demersal (5 meters above bottom), thermocline (typically around 200 m depth), and mid water column (halfway between demersal and thermocline). We also collected settling larvae from tube traps deployed at two cold seep sites in the GOM and juveniles from the seafloor at three sites and identified them to species using DNA barcoding. Notably, we found one *G. childressi* larva in a demersal sample at Florida Escarpment (3300m depth) and one *B. heckerae* larva in the mid water column above Brine Pool (650m depth) and several in our tube traps at Mississippi Canyon, a site over 1000 meters above its upper depth limit, where it is not found as an adult. Juveniles collected from the seafloor at these sites, however, tended to mirror their adult ranges. These results suggest that larvae are transported far from source populations before settling, with other factors such as competitive exclusion or physiological tolerance inhibiting establishment of an adult population.

79 - SHINING A LIGHT: MEASURING LIGHT ABSORPTION AND IRRADIANCE THROUGH EELGRASS MEADOWS

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CSU, Monterey Bay

Seagrass beds account for about 10% of buried carbon found in marine sediments while making up less than 1% of oceanic surface cover. Key factors of growth in *Zostera marina* (eelgrass) such as lateral branching, rhizome development, and carbohydrate storage, are dependent on light availability and shading. Total light incident on canopies is well characterized. However, little work has focused on quantifying how light availability changes with depth inside of these meadows, especially in high turbidity environments, such as estuaries. To better quantify how light passes through eelgrass beds in the Elkhorn Slough, we will develop a sensor system capable of measuring light, temperature, and depth in areas with high sediment load throughout the water column. In order to quantify irradiance, a key value used to calculate productivity, three stages of sensors will be included: along the bottom, at the top of the meadow, and the surface of the water. The system will consist of a rigid tether that will be adjustable depending on tidal height, and a centralized control system capable of transporting and storing data collected by the sensors. The data collected from this sensor system will be inputted into a submerged canopy model, GrassLight, to estimate the productivity of eelgrass in Elkhorn Slough, CA. Additionally, we will compare these measurements to current irradiance calculations that use only two observations (top of water column and along the bottom) to estimate their overall accuracy and improve current modeling capabilities.

80 - THE RESPONSE OF FAUNAL COLONIST COMMUNITIES TO MICROBIAL BIOFILMS AT HYDROTHERMAL VENTS

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Hydrothermal vent ecosystems are highly dynamic and may be ephemeral. The persistence of vent communities depends on the ability of faunal colonists, including larvae of benthic organisms, to move among and locate suitable habitat. The unique faunal communities characteristic of hydrothermal vent ecosystems are supported by microbes that use hot, mineral-rich vent fluids to perform chemosynthesis to create biomass. With high variability in abiotic conditions making them ineffective indicators of suitable habitat, microbial biofilms may be an important signal of suitable habitat for faunal colonists. This study investigated the role of microbial biofilms on faunal colonization at hydrothermal vents on the East Pacific

Rise, 9°50’ N. We placed colonization surfaces (termed sandwiches) comprised of stacks of polycarbonate plates with either an ‘established’ biofilm or a ‘fresh’ biofilm in zones dominated by mussels at both the Tica and *Riftia* Mound hydrothermal vent sites. We investigated the differences in colonist community composition between fresh and established biofilms and between vent sites. Our results showed an impact of both site and biofilm age and suggest that established microbial biofilms support a less variable faunal colonist community than surfaces with fresh biofilms. In particular, four polychaete taxa were identified that were more abundant on established biofilms. Microbial biofilms were important for colonization in general, but also depended on faunal species. Future analyses will investigate what characteristics of the biofilms may have led to variation in faunal colonization.

81 - AN EXPLORATION OF SEEP ANIMAL LARVAL TRANSPORT: DRIVEN BY YOUR CURIOSITY

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Western Washington University

Effective communication of scientific research to the broader community is crucial, particularly in ecosystems that are not accessible, resulting in the attitude of “out of sight, out of mind.” It is important to bring these unseen ecosystems into the public eye. Story maps have emerged as a valuable tool that condenses complex scientific information into narratives centered on geography, and are suitable for various technological platforms. Over the past 40 years, exploration of deep-sea methane seeps in the Gulf of Mexico and along the US East Coast suggests these ecosystems fueled by gas support deep-sea fisheries, coral habitats, and broader oceanic food webs. Yet, most people do not know what a methane seep is. We developed an ArcGIS story map to bridge this gap, focusing on education through interactive narratives. Our project encompasses three key learning objectives: 1) understanding methane seeps and associated organisms, 2) showcasing the diverse expertise needed to study these ecosystems, 3) and highlighting the advanced technologies used in deep-sea exploration. We followed five design guidelines: integrating geography with narratives through a global map, ensuring text-map coherence, enhancing interaction, emphasizing chronological context, and maintaining visual consistency.

82 - MAPPING THE MAGNETIC FIELDS PRODUCED BY AN ELECTROMAGNET AND OBSERVING THE BEHAVIORAL EFFECTS ON SMOOTH DOGFISH SHARKS (MUSTELUS CANIS)

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1- Eastern Connecticut State University 2- University of Rhode Island 3- Texas A&M University

Sharks have an incredible sensory organ system called Ampullae of Lorenzini which allows them to sense and locate prey. This aids in survival through increase in efficiency, ability to overcome antipredatory mechanisms, and can give them a competitive edge over other predators. Understanding how sharks use their internal compass with their sensory organs is a continuous mystery for elasmobranch scientists. However, furthering the knowledge in this subject can be very beneficial for shark conservation and awareness. The main function currently known of Ampullae of Lorenzini is to respond to weak electrical signals. These faint electrical signals can come from the movements of fish and other living things in the ocean. There is minimal knowledge on the behavior and responses to different concentrations of magnetic field stimuli on smooth dogfish sharks *Mustelus canis* . In this study we recorded and quantified the behavioral reactions of smooth dogfish sharks *Mustelus canis* to different levels of magnetic fields (0 V/m, 6.00 V/m, 12.00 V/m). Dogfish sharks *Mustelus canis* were selected as the suitable species of shark for this experiment due to their abundance in New Shoreham, RI (41.1803° N, 71.5735° W). Not only is their population large in this area, but they also do well in captivity. The most avoidances were observed during the 6.00 V/m and 12.00 V/m trials. Majority of these avoidances occurred within 15 cm of the electromagnet. The results from these observations will further our understanding of how sharks interact with magnetic fields.

83 - BIOCHEMICAL INDICATORS OF GOPHER ROCKFISH (SEBASTES CARNATUS) UNDER UPWELLING STRESS IN CENTRAL CALIFORNIA

† Matthias A. Milton,[1,2*]; Dailyn E. Jones, [1,2]; Mahlon L. Rosenberg, [1]; Skye A.Cardoza, [1]; Scott L. Hamilton, [2]; Cheryl A. Logan, [1]

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Seasonal upwelling exposes nearshore organisms to periodic ocean acidification (OA) and hypoxic (H) conditions. Climate change is expected to increase the frequency and severity of these events. Nearshore rockfish in upwelling systems may already be adapted to cope with fluctuations in OAH conditions, but climate change may push them beyond their environmental thresholds. In this study, we examined the expression of protein biomarkers of physiological stress and growth (stress: Hypoxia Inducible Factor 1-alpha [HIF-1α], L-Lactate, cortisol; growth: Insulin-like Growth Factor-1 [IGF-1]) in adult gopher rockfish mothers following exposure to simulated upwelling treatments within the laboratory. We exposed rockfish to varying levels of OAH treatments during gestation and assessed protein expression in gill and muscle tissue using ELISA assays following parturition. We expected that expression of HIF-1α, L-Lactate, and cortisol would increase while IGF-1 would decrease in response to increasing OAH stress. Preliminary data indicates that HIF-1α and L- Lactate concentrations increased as OAH intensity increased. Future work will examine biomarker expression in gopher rockfish mothers exposed to upwelling conditions in the field as well as differences in the timing and duration of OAH exposure in the laboratory. Given the energetic cost of mounting a stress response, this information may be useful for predicting the impact of climate change on rockfish physiology and bioenergetics.

84 - ENERGETIC EFFICIENCY OF SIMULTANEOUS INTERSPECIFIC FORAGING OF HUMPBACK WHALES WITH CALIFORNIA SEA LIONS IN MONTEREY, CA

† Krylova, A.K.[1*]; Cade, D.E.[2]; Calambokidis, J.[3]; Goldbogen, J.A.[2]

1- Northeastern University 2- Stanford University 3- Cascadia Research Collective

Humpback whales (*Megaptera novaeangliae*) are variable, generalist feeders that switch between feeding on krill and small baitfish (primarily anchovies). Switching from krill to forage fish increases their energetic intake per lunge, but requires increased maneuvering and searching while foraging. California Sea Lions (*Zalophus californianus*) may impact this feeding event by corralling fish into further condensed states or helping to maintain school cohesion, increasing the foraging efficiency (energy in/energy out) of nearby humpbacks. Video footage from 30 temporary biologging tags deployed on humpback whales from 2014 to 2019 was used to determine sea lion presence during feeding events in Monterey Bay, CA. Fourteen tags (47%) were deployed on whales feeding in the presence of sea lions. Feeding events with and without sea lions were compared to assess changes in foraging efficiency as measured by changes in feeding rates (energy in) and required maneuvering (energy out). Preliminary results indicate a 72% increase in lunges per hour in the presence of sea lions. This interaction is potentially mutualistic, with sea lions seen hunting dispersed fish following lunges. Following increasing abundances of humpback whales and California sea lions over the last three decades, this interspecies interaction from predators of different trophic levels feeding on the same species has possible implications for foraging behavior and critical understanding of food web system stability.

85 - DETERMINING GENETIC ASSOCIATIONS WITH SEX IN THE SUNFLOWER SEA STAR

† Agrawal, S.[1*]; Schiebelhut, L.[2]; Dawson, M.N.[1]

1- School of Natural Sciences, UC Merced 2- Sunflower Star Laboratory

The sunflower sea star (*Pycnopodia helianthoides*) is a keystone species along the West Coast of North America. Sea star wasting (SSW) led to rapid mortality and a 94% decline in population density during the mid-2010s. SSW is also known to have produced a change in allele frequencies from pre-wasting to post-wasting populations of another affected species (the ochre sea star). However, it is unknown whether sex influences susceptibility to sea star wasting. Current literature regarding sex-specific single-nucleotide polymorphisms (SNPs) in sea stars is lacking, but genetic associations with sex are documented in other echinoderms. Determining these genetic associations could provide valuable insight into potential relationships between genes, sex, and sex-specific differential vulnerability to disease. Using whole genome resequencing (WGS) of 16 female and 18 male *P. helianthoides*, we tested for genetic associations with sex. Results of this study suggest a preliminary association between the homozygous SNPs in males and heterozygous SNPs in female sea stars and the potential for sex-linked loci on chromosomes 1, 15, 19, and

22 of *P. helianthoides*. We identified 28 sex-associated single nucleotide polymorphisms (SNPs), 27 of which have 100% alignment with sex while one has a 97.1% alignment with sex. We suggest it will be important to explore sex-specific loci in other sea stars, and their relationship with SSW, which might aid in restoring population density and reproduction of *P. helianthoides* through captive breeding.

86 - LONG-TERM COASTAL MONITORING BY THE MULTI-AGENCY ROCKY INTERTIDALNETWORK (MARINE)

Smith, J.R.[1]; Ambrose, R.F.[2]; Bell, C.A.[3]; Boydston, E.[4]; Burnaford, J.L.[5]; Caselle, J.[6]; Gaddam, R.[3]; Gilbane, L.[4]; Miner, C.M.[3]; Parsons-Field, A.B.[6*]; Raimondi, P.T.[3]; Sutton, S.G.[1]; Whitaker, S.G.[7]; And other MARINe partners, [8]

1- Cal Poly, Pomona 2- UC Los Angeles 3- UC Santa Cruz 4- Bureau of Ocean Energy Management 5- CSU, Fullerton 6- UC Santa Barbara 7- Channel Islands National Park 8- affiliation not listed

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. 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 management decisions. Publicly available MARINe data have been used for: performing Natural Resource Damage Assessment (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; 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 ecosystem across the US West Coast.

87 - MARINE HEAT WAVES ALTER FUNCTIONAL DIVERSITY IN ROCKY INTERTIDAL ECOSYSTEM OF THE EASTERN PACIFIC

† Streeper, I.S.[1*]; Peterson, S.[1*]; Schneider, C.L.[2]; Webb, A.[3]; Leighton, L.R.[2]; and Tyler, C.L.[1]

1- University of Nevada, Las Vegas 2- University of Alberta 3- Coconino Community College

Severe heat waves cause long-term changes in marine ecosystems and are expected to increase in intensity, magnitude, and frequency. These events induced by climate change have devastating effects including wide scale mortality from thermal shock, mass strandings, and toxic algal blooms. Here we use biological traits analysis to identify changes in the functional composition of rocky intertidal communities resulting from heat waves.Six rocky intertidal sites were surveyed near the Bamfield Marine Sciences Centre, British Columbia, Canada in the summers of 2013, 2015, 2017, and 2019, during which two heat waves occurred, one from 2014-2016, and another in 2019. To identify changes in functional diversity, we quantified 4 biological traits (tiering, feeding, motility, and size) using surveys of ~60,000 individuals from 214 species. We found that increasing species richness did not correlate to a healthy ecosystem. We observed a continued increase in functional over-redundancy, and an increase in functional vulnerability consistent with functional homogenization. We conclude that communities likely did not have sufficient time for recovery between heat waves, and were likely still undergoing a delayed recovery in the aftermath of the first heatwave when the second occurred. Furthermore, we propose that ecosystems might not recover even if conditions return to normal for several years. Even after sustained cooler intervals and respite from repeated disturbances, these changes are likely permanent.

88 - FROM URCHIN BITS TO SEA OTTER HITS: MEASURING PREY QUALITY ALONG THE SOUTHERN OREGON COAST FOR SEA OTTER REINTRODUCTION

† Jurado, G.[1*]; Rice, C.[1]; Calvanese, T.[1]; Hamilton, S.[2]

1- Oregon State University 2- Oregon Kelp Alliance

Following the maritime fur trade starting in the mid 1700s, sea otter (*Enhydra lutris*) populations were decimated along the majority of the west coast and completely eradicated in Oregon. Sea otters serve as a keystone species within their ecosystems, most notably in preserving biodiversity within kelp forest ecosystems by consuming grazer species like sea urchins, and are a culturally significant species for tribal communities along the Oregon coast. With an absence of otters along the coast, kelp forests are more prone to shifting into an urchin barren state as urchins overgraze on kelp and create large urchin filled areas with little food resources and declining biodiversity, a transition currently being seen on the southern Oregon Coast. Reintroduction of otters back into Oregon is an ongoing process that has many barriers to success to fully realize the goal; one area that still requires research is quality and availability of prey at proposed reintroduction sites. I assessed the quality of purple sea urchins at 6 sites that have been identified as potential sea otter reintroduction sites and determined whether the gonadal index (weight of gonads/total weight of urchin) of urchin populations in the subtidal is optimal for sea otter foraging. Results show an average GI of 4.95 in Brookings, OR, 4.83 in Coos Bay, OR, and 7.92 in Port Orford, OR. This experiment aims to aid in the reintroduction of sea otters back in Oregon's coast by establishing a baseline for prey quality measurements.

89 - O SEBASTES, SEBASTES, WHEREFORE ART THOU SEBASTES? A TEMPORAL ANALYSIS OF JUVENILE FISH RECRUITMENT AND SETTLEMENT ON THE SOUTHERN OREGON COAST

Bernhardt, A.*; Rice, C.; Calvanese, T.; Royer, C.; Grorud-Colvert, K.

Oregon State University

Rockfish and other ground fish, some of the most commercially important species on the Oregon Coast, undergo a recruitment process settling in the near shore environment as they transition from pelagic larval to juvenile fish. The juvenile populations tend to use complex habitats such as kelp canopy during this annual recruitment phase. On the Southern Oregon coast, we have been studying and observing these patterns and trends since 2014. This project assesses the temporal trends in settlement success and recruitment numbers from the past decade of data. In conjunction with ODFW's SUMRF program at the Redfish Rocks Marine Reserve and the Humbug Comparison Area, we have collected, processed, and analyzed over 8,000 juvenile rockfish. In this study we focus on the three most common complexes, Olive, Yellowtail, Black rockfish (OYTB), Quillback, Gopher, Black-and-Yellow rockfish (QGBC), and Cabezon (SMAR), finding that there are statistically significant differences in the settlement trends between complexes. The analysis showed that there are pulses in settlement, for example, OYTB settles primarily in May and June, much earlier than the other complexes analyzed. There are also interannual changes in complex recruitment class, these variations may be explained by favorable oceanographic conditions, to be further analyzed. Establishing knowledge of these trends allows a baseline for future assessment of juvenile rockfish success as we continue to assess our changing coastal waters.

90 - SHOULD I STAY OR SHOULD I GO: ANALYZING SEASONAL LINGCOD MOVEMENT BEHAVIOR IN REDFISH ROCKS MARINE RESERVE

Feely, B.R.*; Calvanese, T.; Rice, C.; Chapple, T.

Oregon State University

Lingcod (*Ophiodon elongatus*) is a commercially sought after predatory fish native to the Pacific Ocean and ranges from Alaska to Baja California. Kelp forests provide critical habitat for Lingcod and their prey species and is a notable feature of Redfish Rocks Marine Reserve (RRMR) located in Port Orford, Oregon. As a result of the cascading effects of the 2014 marine heatwave known as the "blob," kelp cover in RRMR and the surrounding areas has declined substantially. It is likely that this loss of kelp will alter Lingcod prey availability, abundance, and behavior in RRMR leading to more nuanced changes in Lingcod foraging behavior. The goal of this project is to improve our baseline understanding of Lingcod movements and effects of predation in RRMR. In 2021 from May to November, a passive acoustic monitoring array consisting of 32 stations was deployed in RRMR and 15 Lingcod were tagged. I created multiple 95% kernel density plots from the tagged Lingcod to assess their movement behavior and seasonal patterns. The results from this showed that Lingcod exhibit homing behavior at RRMR and seasonal shifts in homing

locations. These behaviors and patterns are likely influenced by the availability of prey and seasonal mating cycles; however, more research is needed to draw any further conclusions. Expanded passive acoustic monitoring at RRMR and surrounding areas is recommended to better analyze these movement patterns as well as assess the impacts these patterns have on local prey species.

91 - GENETIC DIFFERENTIATION OF COMMON BOTTLENOSE DOLPHINS (TURSIOPS TRUNCATUS/T. EREBENNUS) IN THE WESTERN NORTH ATLANTICGENETIC DIFFERENTIATION OF COMMON BOTTLENOSE DOLPHINS (TUSRIOPS TRUNATUC/ T. EREBENNUS) IN THE WESTERN NORTH ATLANTIC

† Leaphart, A.[1*]; Shintaku, N.[1]; Townsend, S.[1]; Merrill, G.[1]; Wisse, J.[2]; Swaim, Z.[1]; Somarelli, J.A.[2]; Quick, N.[3]; Read, A.[1]; Schultz, T.[1]

1- Duke University 2- Nicholas School of the Environment 3- University of Plymouth

Over the preceding decades, the common bottlenose dolphin (Tursiops truncatus/T. erebennus) has been acknowledged to exhibit two distinct ecotypes; the inshore ecotype (T. erebennus) and the offshore ecotype are characterized by variations in morphologies, dietary patterns, behaviors, and genetic diversity. However, the specific genetic differences that underpin these ecotypes remain to be clearly delineated. In our ongoing efforts to achieve this clarity, we have identified a third population which is genetically distinct and, to the best of our knowledge, has not been reported previously. To better understand the genetic differences underlying these ecotypes we collected 119 Tursiops samples from the western North Atlantic between Florida and North Carolina in waters ranging from intercoastal to pelagic between 2008 and 2021. We sequenced 532 base pairs of the mitochondrial Control Region in these samples to generate haplotype networks visualizing the relationships between the sequences. A haplotype network of 112 Tursiops samples showed three clusters with intermixing between the offshore and third ecotypes and distinct separation of the inshore ecotype. These findings reinforce the results of the DAPC and Structure analyses we have previously conducted as well as the genome-wide scan which revealed nuclear markers consistent with a new, third population bounded by the continental shelf. This study provides a qualitative analysis of the genomic differentiation of Tursiops populations in the western North Atlantic, with potential implications for the conservation, management, and evolution of global Tursiops populations.

92 - POTENTIALLY PATHOGENIC LESIONS ARE ASSOCIATED WITH HERBIVORY SCARS WITHIN THE TROPICAL SEAGRASS SPECIES THALASSIA HEMPRICHII

† Kumagai, J.A.[1*]; Tillman, C.N.[1]; Chapuis, M.[2]; Harvell, C.D.[3]; Micheli, F.[1]; De Leo, G.[1]

1- Stanford University 2- University of Hawai'i at Mānoa 3- Cornell University

The tropical western Pacific harbors the most diverse seagrass beds worldwide. Despite this tremendous biodiversity, the region is severely understudied. There is currently no research completed on seagrass disease within the Republic of Palau, a large ocean state in Micronesia. Yet, during recent seagrass surveys in Palau, our team quantified levels of melanized lesions on the tropical seagrass, Thalassia hemprichii, that were phenotypically similar to disease lesions caused by seagrass wasting disease in temperate waters. We investigated the possible cause of these lesions, the baseline prevalence, and the potential ecological drivers. We sampled and scanned a total of 431 second-ranked blades of T. hemprichii from six different areas around Palau. The average prevalence of lesions was 38%, and significantly correlated with prevalence of herbivory scars. We also experimentally tested whether these lesions could spread between seagrass blades. New lesions appeared on two out of six seagrass blades that were exposed to diseased seagrass blades on day 6 of a weeklong experiment, suggesting potential pathogen transmission. No new lesions appeared in the six controls. Next, we aim to determine the cause of these lesions, and further investigate the dynamics of its pathogenicity. Increasing our understanding of the basic ecology and baseline rates of these potential marine diseases is crucial if we are to shed light on disease dynamics in healthy systems and how these dynamics may change in foundational species with increasing human impacts.

93 - REMOTE CAMERA RESEARCH AND EDUCATION IN THE APPLICATION OF SEA OTTER (ENHYDRA LUTRIS) CONSERVATION AND WELLNESS IN ZOOS AND AQUARIUMS

† Reed, M.[1*]; Jensen, J.[1]; Island, H.D.[2]

1- Pacific University 2- affiliation not listed

Behavioral ecologists and biologists traditionally observe animals in their natural habitat; alternatively, trail cameras may be planted along game trails or ecotones of known wildlife runs in the hope that this less obtrusive data recording method will allow for greater access. Although health and wellness may be observed in person at zoos and aquariums, remote cameras are mainly for entertainment and advertising purposes alone. During the COVID-19 pandemic of 2020 and 2021, remote or web cameras continued to run or were added despite most zoos and aquariums closing, allowing zoo enthusiasts, students, educators, and behavioral researchers access to the animals during the shelter-in-place. Despite the utility of web cameras in research and conservation, can they be used in human-care facilities to understand wellness, engagement, and species-relevant behavior? To answer this, we conducted a comparative study of three southern sea otter communities in human-care facilities, one using in-person observational data (Oregon Zoo) and two using recordings from remote cameras (Oregon Coast Aquarium and Monterey Bay Aquarium) from September 2019 through January of 2024. We observed approximately 200 hours of in-person or Zoom-recorded web camera footage of the all-male, southern sea otter residents at the Oregon Coast Aquarium (n=3), the exclusively female sea otters at the Monterey Bay Aquarium (n=5) and the mixed-sex sea otters at the Oregon Zoo (n=5). Typically, the wellness metric, outside veterinary data, is behavioral engagement or stereotypy. The results will compare the behavioral data between the otters among the three facilities, their enrichment diversity, number, and types relative to behavioral engagement and stereotypy, and how enrichment novelty, not simply diversity and number, plays an important role in sea otter wellness.

94 - OBSERVING DIFFERENCES IN SENSORY BEHAVIOR THROUGHOUT THE FORAGING SEQUENCE OF 3 COMMON ROCKY REEF FISHES OFF SANTA CATALINA ISLAND.

Corneille G.T.,[1*]; Leon D., [2]; McElfish M.M., [1]; Mehta R.S., [1]

1- UC Santa Cruz 2- University of Southern California

Santa Catalina Island features multiple marine habitat types, including complex rocky reefs and kelp forest ecosystems, which boast high habitat complexity and species diversity. Within these ecosystems, there are many predatory fish, some of the main species being Gymnothorax mordax*Italic text*, Paralabrax clathratus*Italic text*, and Hypsypops rubicundus*Italic text*. These species differ in diet and foraging style with P. clathratus*Italic text* being a piscivore, H. rubicundus*Italic text* being an invertivore, and G. mordax*Italic text* being apex predators who eat a range of prey types. G. mordax*Italic text* are particularly interesting due to their uniqueness being the only known predator capable of foraging in rocky crevices. While all these fish are commonly observed, there is little known about the senses used to complete their foraging sequence. Our goal was to develop an understanding of how their sensory systems are used during the foraging sequence, which will broaden our understanding of predator-prey relationships within this ecosystem. We deployed underwater cameras attached to an experimental apparatus outfitted with different stimuli, which tested how prey stimulus leads to a complete foraging sequence. This allowed us to determine which senses are used for different stages of the foraging process, specifically prey detection, location, and prey capture. With the large effect these species have on their environment and the threat of rapid climate change altering the sensory landscape of marine environments, this study allows us to make predictions about how the sensory modalities of these species will shift with the effects of climate change.

95 - IMPORTANCE OF SEASONAL HYDROLOGIC PATTERNS IN ARCTIC STREAM CARBON DIOXIDE EVASION

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Arctic headwater streams play a crucial role in the carbon cycle, contributing disproportionately to carbon dioxide (CO_2) evasion relative to their size. Despite their importance, research has primarily focused on larger Arctic rivers, leaving a gap in the understanding of carbon dynamics in smaller streams. We examined how seasonal hydrologic patterns, such as spring freshet, summer baseflow, and late-season rainfall, influence CO_2 evasion in Arctic streams. During the spring freshet, rapid snowmelt results in high flow rates and increased transport of organic carbon, while the summer baseflow period is characterized by lower flow rates and higher biological activity. Late-season rainfall events further alter stream hydrology and carbon dynamics. We found that due to these various changing environmental factors, CO_2 fluxes off the stream surface exhibit distinct seasonal patterns throughout the summer period. Further, the influence of CO_2 evasion drivers, such as discharge, water temperature, CO_2 in-stream concentration and dissolved organic carbon concentration changes depending on the hydrologic period. This study improves our understanding of CO_2 evasion drivers across the entire summer period which will improve our understanding on how future emissions may change in a warming Arctic climate with longer growing seasons.

96 - UNCOVERING DRIVERS OF VARIATION IN KELP-BRYOZOAN INTERACTIONS ACROSS A BROAD LATITUDINAL GRADIENT

Hesketh, A.V.*; Allchurch, A.E.; Salomon, A.K.

Simon Fraser University

Warming can disrupt interspecific interactions, with significant ramifications for community structure and function. The bryozoan *Membranipora membranacea* is a native epiphyte of kelps in the northeast Pacific, but how kelp-bryozoan interactions will shape subtidal communities under warming is unknown. Here, we propose future work spanning from Baja California, Mexico to northern BC to address this knowledge gap. While historically present in low abundance, “blooms” of this species on giant kelp have been reported by Heiltsuk Coastal Guardian Watchmen in British Columbia (BC), Canada during recent heatwaves, where heavily encrusted fronds sank and quickly disintegrated. Substantial but variable (0–63%) bryozoan cover was observed encrusting kelp — primarily understory species — along the BC coast in summer 2024. These observations indicate that bryozoan cover may vary substantially with environmental conditions, particularly temperature. In the western Atlantic, where *M. membranacea* has invaded, bryozoan overgrowth increases kelp fragmentation and dislodgement risk, driving wide-scale kelp bed losses. Thus, ocean warming, in addition to directly impacting Pacific kelps and their associated communities, may have additional indirect effects mediated by an increase in bryozoan cover. Through future work, we will ask: 1) how bryozoan cover within understory kelp communities varies with abiotic conditions; 2) how experimental warming alters kelp-bryozoan dynamics; and 3) how bryozoan encrustation affects the structure of kelp-associated invertebrate communities.

97 - CAN GYMNOTHORAX MORDAX USE PREY ODOR TO FACILITATE PARTIALLY-EXPOSED FORAGING?

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UC Santa Cruz

Muraenid fishes (moray eels) often play an important predatory role in determining prey abundance within the communities where they reside. Some species of morays have been documented moving within intertidal areas to make use of patchy tide pools during foraging. The California Moray (*Gymnothorax mordax*) is both an active predator and an opportunistic scavenger – yet scavenging opportunities are limited in shallow marine habitats. Because the intertidal environment is inaccessible to many other predatory fishes, this area may provide morays with interesting scavenging and predation opportunities. For *G. mordax* , it is unknown what sensory information facilitates detection and location of prey, and if sensory cues can facilitate foraging across tidal contexts. Here we aimed to document if *G. mordax* ,can use chemoreception to specifically locate four different species of prey, both in a fully submerged context and in a semi-exposed intertidal context. We found that *G. mordax* can use prey chemical information alone to navigate to a specific source location, in both fully submerged and partially exposed contexts for all tested prey species. Being able to follow multiple types of prey odor into intertidal areas may allow this species to exploit foraging opportunities inaccessible to many other large predatory fishes.

98 - CHARACTERIZING CORAL REEF BIODIVERSITY IN GUINJATA BAY, MOZAMBIQUE

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Mozambique, with the third-largest coastline in the Western Indian Ocean, hosts abundant coral reef ecosystems that support the livelihoods of many coastal communities. However, like many reefs worldwide, Mozambique's reefs face stressors such as pollution, increasing fishing pressure, and rising sea temperatures. Unfortunately, Mozambique's coast remains heavily understudied, and particularly, the statuses of the southern reefs are poorly known. With the Mozambique Ministry of Fisheries publishing a national aim to conserve 95% of its current coral coverage, there is an urgent need for assessing and characterizing reefs in Southern Mozambique. This study characterizes the biodiversity and examines the temporal change of coral reefs in Guinjata Bay, Mozambique. Collaborating with Love the Oceans, a Guinjata based non-profit organization, we performed visual census surveys for benthic and fish community composition along 25x2 meter transects at 5 sites in 2017 and 2023. Compared to the few studies that have been conducted on coral reefs in Mozambique's protected reserves, we expect to see a decreasing trend in coral coverage, fish species richness, and fish species evenness from 2017 to 2023 due to the lack of protection in the face of chronic stressors. Understanding how coral reefs are shifting in Guinjata Bay is crucial for developing conservation strategies and managing local marine resources effectively. Our study will provide valuable insights on the status of coral reefs in the bay, which will be used to inform the creation of a locally managed marine protected area.

99 - INVESTIGATING THE GENETIC STRUCTURE OF BAT STARS ALONG THE NORTH PACIFIC COASTLINE

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Hopkins Marine Station

Many benthic marine species have broadly dispersing planktonic larvae. Due to their extended larval phases, these species are often presumed to exhibit high dispersal potential and significant gene flow, leading to the assumption of genetically well-mixed populations. However, numerous studies over the past few decades have revealed strong genetic and spatial patchiness in some of these broadly dispersing marine invertebrates. Historically, population genetic studies of marine invertebrates have relied on targeted, small-scale sequencing approaches, which can sometimes obscure finer details of population structure. With the advent of cost-effective methods to sequence larger portions of genomes, we are now better equipped to uncover these finer-scale patterns. Here, we use low-coverage whole-genome sequencing to explore the population genetic structure of the bat star *Patiria miniata*, a species with a long-lived planktonic larva. We examine populations across the species' broad range along the North American west coast, confirming previously reported genetic discontinuities and uncovering new evidence of subtle population structuring. Additionally, we identify putative loci under selection between populations north and south of a significant range gap.

100 - METHOD DEVELOPMENT FOR IMPLEMENTATION OF LIVER BIOPSY SAMPLING TO QUANTIFY ORGANOCHLORINES IN ELASMOBRANCHS

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Organochlorine contaminants (OCs), such as DDXs and PCBs, are prevalent in Southern California, particularly considering DDT manufacturing waste disposal in the 20th century. These contaminants can bioaccumulate in complex food webs that include benthic-associated elasmobranchs. Angel Sharks (Squatina californica) and Bat Rays (Myliobatis californica) are caught by commercial and subsistence fishers and represent affordable protein sources for low-income communities. Lipid-rich livers usually contain more OCs than muscle; however, muscle is more difficult to sample from live animals. Liver biopsies could serve as a non-lethal technique for elasmobranch OC quantification but may be limited by the small

amount of tissue that could be taken. Here, we determined if smaller tissue samples could accurately represent OC levels compared to the standard analyses of 1 g. Liver samples of varying quantities (1 g, 0.5 g, and 0.2 g) were taken from the same source sample, then solvent extracted, and a suite of OCs were quantified by GCMS. Preliminary results show that 0.2 g, 0.5 g, and 1 g samples have similar levels of sums of total OCs, DDXs, and PCBs. For total OCs, DDXs, and PCBs, 0.2g- samples reflected >85% of the 1g- samples, and 0.5g- samples were all >89% of the 1g- samples. We demonstrate that biopsy sampling is a viable option for accurate results and lethal sampling may not be necessary.

101 - ASSESSING FACTORS ASSOCIATED WITH FLOATING KELP RESILIENCE AND LOSS IN PUGET SOUND THROUGH COORDINATED MONITORING AND RESEARCH

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WA State Dept. of Natural Resources

Kelp forests form rich, underwater ecosystems that provide invaluable habitat to many marine organisms as well as a variety of ecosystem services. Declines in kelp forests have been identified on a global scale; however, the factors driving these declines are not well understood. Recent research indicates trends in kelp forest resilience and loss are highly context dependent. Within Puget Sound, a large inland sea in Washington State, long-term monitoring reveals resilient bull kelp (*Nereocystis luetkeana*) in some regions compared to sharp declines or total losses in other regions. To better understand site-specific differences, this collaborative project conducts intensive in situ monitoring at a network of 15 sites, which span a wide range of environmental conditions and bull kelp responses. Factors that are hypothesized to influence resiliency include temperature, salinity, light availability, water clarity and depth, wave exposure, nutrient concentrations, sedimentation, mechanical damage, and epiphytic load. A wide range of parameters are monitored through discrete water sampling, continuous underwater sensor deployments, canopy surveys, dive surveys, and sporophyte performance assessments. Field data analyses will begin in spring 2025.This project builds upon current regional kelp monitoring efforts by synthesizing results and establishing recommendations for future research and management plans surrounding resiliency and recovery.

102 - CRYPTIC SPECIES DELIMITATION IN THE SNAPPING SHRIMP SPECIES COMPLEX *SYNALPHEUS TUMIDOMANUS*

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Seattle University

The snapping shrimp genus *Synalpheus*, like many species-rich marine groups, presents significant taxonomic challenges due to the existence of cryptic species. Although cryptic species exhibit high morphological similarity, they differ markedly at the molecular level. To address these challenges, we sequenced members of the *Synalpheus tumidomanus* complex, primarily from the Indo-West Pacific, using samples from the Florida Museum of Natural History. Species delimitation was conducted using Poisson Tree Processes (PTP) and Assemble Species by Automatic Partitioning (ASAP), revealing at least nine distinct clades within the *S. tumidomanus* complex. These clades are dispersed across various branches of the phylogenetic tree. Notably, the most closely related clades inhabit different locations, suggesting a large degree of geographic structuring between potential cryptic species. The differentiation of cryptic species is crucial for understanding biodiversity within the taxon, guiding conservation efforts, and accurately interpreting the ecological and evolutionary processes that brought about the rapid and widespread speciation among snapping shrimp.

103 - BURIED TREASURE: COMPARING MANGROVE BLUE CARBON DATA ACROSS THE MESOAMERICAN REEF ECOREGION

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The Mesoamerican Reef (MAR) Ecoregion is an understudied hotspot for coastal biodiversity and blue carbon capture. It hosts mangroves, coastal wetlands that are highly productive at storing CO2 over long periods. However, their ecosystem services are threatened by anthropogenic disturbances. MAR countries include wetland conservation in plans for mitigating climate change, but must often refer to generalized, global data. Localized information could make these policies more comprehensive. This work evaluated differences in mangrove blue carbon across the MAR by estimating carbon stocks and comparing the extent of each country's database. Soil organic carbon (SOC) data accessible via the Coastal Carbon Atlas revealed that mangroves are the most productive in Guatemala and Honduras at storing SOC. However, total stock assessments are also influenced by mangrove cover. Integrating spatial analysis revealed that the total calculated SOC in Mexico can be up to 180 times higher than other MAR countries, influenced by the coast's extensive mangrove cover. This investigation created mangrove carbon stock summaries for the MAR, providing insight to develop restorative policy that strengthens the region's capacity for coastal conservation. This advances efforts to evaluate global coastal wetland systems and supports regional carbon inventories and decision-making processes. Monitoring blue carbon ecosystems helps preserve their potential to reduce atmospheric CO2, fortify coastlines, and support livelihoods, galvanizing their protection as nature based solutions for climate change.

104 - MAPPING SUBMARINE GROUNDWATER DISCHARGE DELIVERY ON CORAL REEF USING DRONE THERMAL INFRARED IMAGERY

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Pepperdine University

Maunalua Bay (O'ahu, HI) has experienced dramatic development and increase in population over the last 100 years, which has affected the water quality in the near shore coral reefs of the bay. The main source of land-based inorganic nutrients in Maunalua Bay is submarine groundwater discharge (SGD) which is a chronic freshwater vector. SGD at this site increases specific macroalgae's biomass, decreases biodiversity, and increases productivity of the algae that can withstand high nutrients and low salinity. We are utilizing drones equipped with infra-red thermal cameras to map the SGD, which is colder than surrounding coastal water, on two reefs at night. We have developed a method that involves creating orthomosaic maps from multiple thermal images with an 85% overlap to 85% sidelap ratio taken autonomously by our drone. To validate our thermal imagery, we collected water samples for inorganic nutrient analysis and YSI (i.e., salinity, temperature, pH, ORP, TDS) data at the surface of the water column. Using these measurements, we will determine the potential relationship between these parameters. These maps will aid us in forming a more complete model of productivity of the phytoplankton and macroalgae on these reefs.

105 - THE ECOLOGY, DIVERSITY, AND HABITAT USE OF THE NORTH-ATLANTIC DEEP-SEA SQUAT LOBSTER MUNIDOPSIS SERRICORNIS SPECIES COMPLEX (GALATHELOIDEA: MUNIDOPSIDAE)

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Individuals within the family Munidopsidae, specifically, the species *Munidopsis serricornis*, present morphological complexity; they are often found on scleractinian coral colonies (*Desmophyllum pertusum*) showing a potential symbiotic relationship. The species has a wide geographic distribution with multiple localities across the Atlantic Ocean, suggesting the existence of a species complex. Molecular phylogenetic analyses were used to discover species diversity and intraspecific variation across the species geographic range (n=99). To further differentiate this species complex, ROV video analyses were used to observe in situ colorations, assess the relationship between *M. serricornis* and deep-sea corals, and observe any species-specific pattern of coral habitat. The diversity of *Munidopsis serricornis* species complex is represented by 6 lineages with each lineage representing a specific geographic range. *M. serricornis*sensu stricto is restricted to the Northeast Atlantic including populations near the type locality (Weather Islands, Sweden) where the species was originally described. Preliminary identification suggests taxonomic confusion

among the four species described within the complex. The remaining lineages may represent different species but further ecological, morphological, and genomic nuclear data will help in deliminating these species. All of these factors will help us increase our knowledge of the diversity, ecology, and habitat use of squat lobsters, as well as coral symbioses in the deep sea.

106 - BIOFOULING AFFECTS PLASTIC CONSUMPTION BY FOOD-RESTRICTED URCHINS AND MAY CONTRIBUTE TO PRODUCTION OF MICROPLASTICS

Vea, S.M.*; Mehtani, T.*; Halim, A.B.*

MERP Santa Catalina

Sea urchins are an important benthic species along temperate coastlines and have significant impacts on kelp forest persistence as they graze or overgraze kelp understory and forests. There is increasing understanding that marine waters, including coastal kelp forests, are impacted by plastic pollution with much focus on the impact of microplastics on food webs. We are interested in interactions between urchins and plastics in kelp forests and overgrazed urchin barrens, especially in the potential for urchins in areas with low kelp availability to “graze” plastics and convert large plastics into microplastics. We held captive populations of purple sea urchins in closed-circuit aquaria and compared the rate of consumption of polyethylene sheets over 64 hours between fed and food-limited urchins. We also compared the grazing rate between clean plastics and biofouled plastic sheets to represent differing residence times in the marine environment. We did not find support for an effect of biofouling on plastic consumption rates, however, we did find increased consumption of plastics by food-limited urchins. Current efforts are focused on determining the quantity and size of microplastics produced by urchins. As plastic production in coastal environments continues to grow, we anticipate that the sea urchin’s relationship with plastic will directly impact urchin barrens and their correlation with kelp forests.

107 - USING ACOUSTICS ANALYSIS TO TEST FOR SOUND BAFFLE FUNCTION WITHIN KELP FORESTS, MONTEREY BAY, CA

Fieber, A.M.*; Ge, G.*

MERP Santa Catalina

Kelp forests play a crucial role in maintaining coastal biodiversity in temperate locations around the world. Soundscapes are frequently used to gather information about underwater species and their behavioral patterns, abundance, and location; it can also indicate human and geological activity. In our research we have used sound analysis to indicate the relative sound frequencies and power for kelp forests and nearby non-kelp forest habitats in Monterey Bay. We hypothesized (1) that the frequency and power spectra from hydrophone recordings would differ between kelp forest and non-kelp forest; (2) that the kelp forest will have lower overall power since the structure of the kelp might absorb and insulate sound. Our preliminary sound recordings were taken on two separate days with locations, “kelp forest” and “non-kelp forest” (or open water). Using Raven Pro acoustics analysis, we compared frequency spectrograms and power spectra for 30 second replicates from each recording. Our preliminary results may show differences between the “kelp forest” location and “non-kelp forest” locations through sound patterns in the frequency and power spectra, however these differences are not statistically significant. Kelp density due to the time of year as well as weather and ocean condition are likely to influence the results. We continue to collect data at each location to examine and distinguish key differences, ideally leading to a better understanding of how sound functions in kelp forests.

108 - INDIVIDUAL CHARACTERISTICS AND EXPOSURE AFFECT MICROPLASTICS LOAD IN THE SAND CRAB*EMERITA ANALOGA*

Xu, Z.*; Choi, S.*

MERP Santa Catalina

Microplastic pollution is an increasingly well appreciated issue in marine systems. Microplastics can enter food webs at the primary consumer level, and be transferred and concentrated through higher trophic levels. The sand crab *Emerita analoga* is an important infaunal filter feeder in sandy beach communities, and is a key part of the diet of coastal birds, surfperch, and otters. We are interested in the microplastic load in sandcrabs in

the Monterey Bay region and are especially concerned with how internal plastic load varies with crab characteristics (size, sex, and parasite load) and plastic exposure and load between an exposed (Carmel Beach) and protected beach (Tide Avenue) in Monterey, CA. Plastic (and parasite) load was estimated by performing dissections on crabs and examination of putative plastics using light microscopy. Plastic exposure was estimated by quantifying microplastic in a standard volume of sand collected concurrently with the crabs. Sand was mixed with hypersaline water to density separate plastic, and then vacuum filtered. Filters were then examined using light microscopy. The relationship between all the variables were determined by performing ANOVA (R/R-studio). We found that most of the factors (crab size and parasite amount) have a direct relationship with the microplastic numbers in the crab. The microplastics amount in crabs tends to be higher with larger crab size, high parasite count, and in females (which are somewhat confounded with size).

109 - THE STONY CORAL *POCILLOPORA MEANDRINA* PERSISTS IN SHALLOW REEFS WITH SUBMARINE GROUNDWATER DISCHARGE DESPITE WIDESPREAD BLEACHING EVENTS

Butler, P.*; Gong, S.*

MERP Santa Catalina

Increases in ocean temperature have led to mass bleaching events of corals all over the world. Widespread bleaching events in 2015 and 2016 caused 100% mortality of the stony coral *Pocillopora meandrina* on reefs across the Hawaiian islands. Unlike offshore locations, healthy populations of *P. meandrina* persisted through these bleaching events in some shallow nearshore locations on the western shore of the Big Island; these locations are characterized by clean, cool submarine groundwater discharge (SGD). To examine links between SGD and *P. meandrina* persistence, we documented population structure associated with SGD. Using photogrammetry, 5x5 meter plots were examined on two shallow reefs (2-3m) between 2021 and 2024 in order to analyze size structure and coral community health. *P. meandrina* sizes range from under 5 cm to over 40 cm and bleaching was only evident in under 5% of the corals with a max bleach scale of 2. Orthomosaics were processed with CoralNet to determine substrate cover. Preliminary results show that the substrate consists of 5-31% live coral cover (*P. meandrina*, *Montipora capitata*, and *Porites lobata*) and 63-94% turf. Casts with a CTD confirm that SGD is evident at all sites and is likely altering temperature, light and/or nutrient levels such that corals in these areas are better able to survive bleaching events. Future work should focus on the mechanisms behind coral survival in these locations. Sites with SGD are potential refugia for *P. meandrina* during bleaching events and should be included in Marine Protected Area designations.

110 - FEELING SHRIMPY: AN OVERVIEW OF WDFW'S LONG-TERM PANDALID SHRIMP POPULATION MONITORING EFFORTS IN THE PUGET SOUND.

Griffith, K.*; Bosley, K.

WA Dept. of Fish & Wildlife

Following a collapse of the productive and popular Hood Canal spot prawn fishery in the 1970's, the Washington Department of Fish and Wildlife began conducting an annual fishery-independent survey to monitor prawn population recovery in the Hood Canal. A few years after the WDFW initiated the survey, the new data source played an important role in the decision to re-open the fishery and was also used to develop regulations that have resulted in a sustainably managed fishery. The WDFW shrimp survey has since expanded in its spatial and temporal extent as well as in the types of data collected and species targeted. Twice a year a team of technicians and biologists collect detailed information on pandalid species composition, maturity status, size frequency, catch rates, and bycatch. In 2022, environmental monitoring was added with temperature and dissolved oxygen sensors now deployed at each site across several depth strata. In this presentation, we describe WDFW's past and current efforts to monitor shrimp populations throughout Puget Sound, highlighting the value and utility of this type of sampling program for supporting sustainable fishery management and tracking population health.

111 - DOES SIZE MATTER? EXAMINING THE COOLING EFFECT OF GREEN SPACES IN SAN DIEGO, CA.

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University of San Diego

Urban green spaces are essential in mitigating the urban heat island effect, a phenomenon where city centers are significantly warmer than surrounding areas due to increased impervious surfaces and reduced vegetation cover. This study focuses on San Diego, where lower-income residents are vulnerable to heat waves. While previous research has demonstrated the cooling effect of green spaces, more research is needed on how specific characteristics of green spaces modulate their cooling effect. To address this knowledge gap, we measured the impact of green space size and density on surface temperatures and explored the relationship between temperature and average income. We used aerial images to delineate green spaces and landscape metrics to describe their characteristics. We utilized remote sensing data to estimate surface temperatures throughout San Diego and assessed how temperatures varied with the average size, density, and extent of green spaces in each census tract. We used geographically weighted regression (GWR) to assess spatial relationships between surface temperature, green spaces, and income. Preliminary analyses suggest that the cooling effect of green spaces increases with their density and total extent. GWR indicates green spaces are particularly important in census tracts located inland and associated with lower vegetation cover. Lower-income areas, often less vegetated, experience higher surface temperatures. Our results show that cities should prioritize multiple large green spaces, reduce impervious surfaces, and increase vegetation between green spaces.

112 - EXAMINING THE EFFECTS OF GREEN SPACES AND URBAN VEGETATION ON AIR QUALITY IN SAN DIEGO, CALIFORNIA

Curran, K.*; Conway, J.; Lucich, D.; Taddeo, S.

University of San Diego

Urban green spaces (e.g., parks, forests and other vegetated areas) are known to provide ecosystem services which are benefits that nature provides to humans such as improving air quality. However, how different characteristics of green spaces influence these ecosystem services is not very well understood. To fill this knowledge gap, we compared the role of green spaces and neighborhood characteristics in impacting air quality in San Diego, California. We used remote sensing data from MODIS and Sentinel 5-P to estimate the air quality of census tracts in San Diego, based on their aerosols density and concentrations in ozone and carbon monoxide. We then used the Classification wizard tool in ARCGIS Pro to map green spaces around the city and generate landscape map to describe their size, shape, density, and connectivity. We used linear regression to assess relationships between green space size, extent, density and air quality within each census tract in San Diego. Preliminary analysis revealed that carbon monoxide concentration was most impacted by vegetation cover in the neighborhood, measured by the mean Normalized Difference Vegetation Index (NDVI), while greater green space extent is associated with lower aerosol concentrations. Our results can inform urban greening policies for increased equity in access to green spaces and good air quality.

113 - CHANGING THERMAL LANDSCAPES OF CANOPY-FORMING SEAWEEDS ALONG THE CALIFORNIA COAST

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Temperature tolerance is an important factor that determines macroecological patterns of species distribution, and its study is fundamental to understanding and predicting the responses of species to climate change. Thermotolerance, the ability of individuals to withstand a range of temperature without functional failure, is defined by an organism's survival as a function of the intensity and duration of a heating event. On rocky shores, seaweeds play crucial roles as primary producers and foundation species, understanding the responses of seaweeds to thermal stress events can help predict community-wide responses to temperature. We used temperature ramping experiments varying in intensity and duration to

evaluate photosynthetic performance and survival of the canopy-forming golden rockweed, *Silvetia compressa*. We evaluated the thermotolerance landscapes of individuals from six different populations of *Silvetia*, three in in Northern California and three in Southern California. Preliminary results suggest higher temperatures of immediate functional failure (T_{ko}) in *Silvetia* from Southern California (~56 ^{o}C) than in those from Northern California (~48 ^{o}C). Additionally, we observed greater sensitivity of photosynthetic performance to thermal change in Southern California. Our work provides insights into how warming impacts on *Silvetia* change regionally, facilitating predictions of responses to climate warming.

114 - SEX, SIZE, AND STARVATION: FACTORS INFLUENCING THE GRAZING RATES OF THE PURPLE SEA URCHIN

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Stanford University, Hopkins Marine Station

In our rapidly changing world it is more important than ever to understand the way our natural ecosystems function. Community ecologists aim to do so by uncovering the roles that each species plays in an overall system. However, in our attempts to illuminate the impact each species has on its broader community, we often overlook the variation within a given species, ignoring differences in functional role or trophic position that may exist in that population. Biological sex is one such factor that is known to influence size, behavior, distribution, nutritional demand, etc., but is often uninvestigated in the context of community ecology. This is especially true for invertebrates such as purple sea urchin (*Strongylocentrotus purpuratus*). Despite being a major factor in the state shifts of Eastern Pacific kelp forests to urchin barrens, no one has yet investigated whether biological sex influences their overall impact on the kelp forest community. In this study, I sex urchins via forced spawnings and expose them to varying levels of starvation to assess appetite changes in response to conditions that mimic barrens and forested regions. In doing so, I explore what effects starvation, size, and sex have on grazing rates of the purple sea urchin. Results from this work have the potential to help us better understand the mechanisms that lead to kelp forest state shifts and the factors that aid in recovery.

115 - DOES EPIZOOTIC SHELL DISEASE AFFECT HEMOLYMPH PROTEIN MEASUREMENTS IN *HOMARUS AMERICANUS*?

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Epizootic Shell Disease (ESD) is an opportunistic disease characterized by lesions across the shell of American lobster (Homarus americanus<//i>) and poses a significant, imminent threat to the Maine lobster fishery. ESD contributed to the catastrophic collapse of the Southern New England fishery and has recently appeared in the Gulf of Maine. The relationship between American lobster health, particularly disease severity, and hemolymph protein (a general proxy for health and nutritional status) is not well defined. However, the relationship between hemolymph protein and proximity to molting in lobster, using the Brix index, is well documented. Therefore, the objective of this study is to examine the effects of ESD on hemolymph protein, overall health and condition of the American lobster. Adult male lobster (<85 mm carapace length) from multiple populations will be sampled for biometrics (including weight and carapace length), Brix indices, molt stage (pleopod/setal development) and ESD percent coverage. Preliminary results indicate elevated Brix indices in lobster with moderate to severe ESD. This study highlights the need for further research into the relationship between Brix index, hemolymph proteins and condition (e.g. proximity to molting, overall health) in lobsters infected by ESD.

116 - ARMOR OR FASHION? DIFFERENT FINE SCALE MORPHOLOGICAL MECHANISMS ON THE ABORAL SURFACES OF NORTH AMERICAN SEA STARS

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Recent studies of Echinoderms have shown the importance of combining form, function, and behavior into our understanding of functional biology. Multiple studies have explored the biomechanical and fluid dynamics consequences of overall seastar gross morphology in driving processes such as lift and drag. But less is understood about how considerable differences in fine-scale surface morphology, such as spines, may influence performance, survival, and ultimately ecological interactions. In many of the family Asteriidae, sea stars like *Asterias*, are known for their active wreath organs, a collar of pedicellariae that surround the aboral spines. In contrast, in Asteriid *Pisaster ochraceus*, the spines are solitary, and presumably act to protect the surface from large particulates. My work comparatively examines the spine morphology of the common Asteriid keystone predators, *P. ochraceus* , *A. rubens* , and *A. forbesi* by examining both micro- and gross morphologies using field-collected specimens. Field surveys showed that *P. ochraceus* had spine patterning variation with different patterns across exposed and protected habitats, potentially correlated with wave exposure and sediment stress. Of particular interest, in *Asterias* was the variation of the wreath organ loads (number of pedicellariae), which was dissimilar to the type of spine variation I found in *Pisaster*. Laboratory studies are being conducted to analyze oxygen consumption with activated wreath organs in the two *Asterias* species.

117 - ASSESSING PATTERNS OF AN UNEXPLAINED MORTALITY EVENT OF AN INTERTIDAL FOUNDATIONAL SPECIES ON THE OREGON COAST

Jacoby, T.*; Rothman, B.; Gravem, S.; Menge, B.

Oregon State University

California blue mussels, *Mytilus californianus*, are an important foundational species along Oregon's rocky shores. They serve wide ecosystem functions that include providing habitat for a variety of invertebrates and act as a main food source for the ochre sea star, a keystone species. During the summer of 2023, an unusual and unexplained die-off of *M. californianus* occurred along the coast of Oregon. Rather than "mass" mortality where large areas of mussels are killed (e.g., by severe wave action or high temperatures), dead mussels were scattered in amongst the living. By taking measurements of shell lengths from dead individuals, we determined that larger animals were killed toward the north compared to the south. Smaller animals were overall killed less than larger ones. In conjunction with larger animals killed, mussel bed densities increased significantly between all sites in the same pattern. During the observation period (June – December 2023), there were significantly more dead mussels at Cape Perpetua than in Cape Blanco, but no clear difference between the Cape Foulweather and Cape Perpetua sites. While the exact cause of this mortality event remains unclear, our results suggest that there is a clear survival advantage for those that are smaller in size and reside within higher density beds. Further pattern assessments, such as coastal upwelling patterns and water/mussel tissue eDNA analysis, will be performed to determine what caused this event. Understanding marine disease events is important for understanding and maintaining healthy rocky intertidal habitats.

118 - THE INVASIVE EUROPEAN GREEN CRAB: REPERCUSSIONS FOR EELGRASS BEDS ON THE AMERICAN PACIFIC COAST

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Marine invasions can greatly alter ecosystems through direct and indirect interactions with foundation species. The European Green Crab (Carcinus maenas) is one of the most detrimental marine invaders worldwide due to its ability to greatly alter coastal ecosystems. On the east coast of the US, C. maeanas populations are directly correlated to declines in the foundation species, eelgrass, Zostera marina. No studies to date have attributed eelgrass loss to green crabs on the US Pacific Coast. We examined the effects of green crabs on West Coast Z. marina. We expected more damage to eelgrass when green crabs' preferred resource (clams) were present, compared to when they were absent. To test this hypothesis, we conducted an experiment with four treatments;eelgrass with and without clams crossed with eelgrass with and without crabs. We found that the green crabs damaged eelgrass significantly more than the controls. Clam presence or absence had no effect on eelgrass damage. We also determined if green crab and the ratio of native crab densities influenced eelgrass density in the field using crab trap and eelgrass density

surveys. We found a weak negative correlation between green crab abundance and eelgrass density, and a weak positive correlation between the ratio of native crabs to green crabs and eelgrass density. This finding lays important groundwork to understand how the green crab invasion influences a major foundation species (eelgrass) on the west coast of the US.

119 - DOES THE NEWLY INTRODUCED SEA ANEMONE, ANTHOPLEURA HERMAPHRODITICA, IMPACT THE SURROUNDING INFAUNAL COMMUNITY?

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UC Davis

Biological invasions of marine organisms are of growing concern with rapidly changing ocean conditions and increased ecosystem connectivity due to human activities. In 2022, an introduced sea anemone, *Anthopleura hermaphroditica*, was identified in dense aggregations on the mudflats of Tomales Bay, California. Native to Chile, Australia, and New Zealand, this is the first record of this species in the Northern hemisphere. However, the effect of its presence on the structure of the surrounding infaunal community is unknown. Therefore, we experimentally tested the potential impact of *A. hermaphroditica* in Tomales Bay, by sampling the abundance and diversity of invertebrates in plots with locally transplanted anemones, anemone mimics, and no anemones (control). Additionally, we performed observational sampling on existing patches with and without the introduced anemones. Preliminary analysis shows no significant community effects from the presence of *A. hermaphroditica* across both experimental and observational studies. This study is among the first to evaluate the community-level effects of an introduced sea anemone, and our findings will help inform resource managers working in Tomales Bay and other West Coast estuaries.

120 - DIZZY OCTOPUSES: INVESTIGATING SENSORY INTEGRATION IN OCTOPUSES THROUGH DISORIENTATION

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Walla Walla University

Octopuses, and other coleoid cephalopods, represent exciting research models for comparing disparate yet homologous tracks for sensory evolution with humans. How these sensory apparati interact and integrate helps lead to coordinated movement and orientation of the organism in its environment. This study investigated orientation in ruby octopuses (*Octopus rubescens*) through attempting to elicit disorientation. Octopuses were recorded catching crabs after either being spun at a low speed (experimental treatment), or not (control), in a circular tank for one minute. Using DEEPLABCUT, a deep-learning neural network for animal pose estimation, coordinates of the eyes and mantle tip of the octopus were labeled in the recorded data. Using this data, bearing and angle of approach were measured and used along with the style of catch, the number of jets or strikes, and the time to catch in order to estimate disorientation. These data may provide new insights into the octopus's ability to maintain orientation and coordination even after induced disorientation, shedding light on the mechanisms of their sensory and motor integration.

121 - EVALUATING WHETHER MUSSELS PROVIDE A REFUGE FOR BARNACLE PREY OF A RANGE-SHIFTING PREDATORY WHELK IN SOUTHERN CALIFORNIA

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UC Irvine

Rising global temperature is driving changes in the distribution of species worldwide. The intertidal whelk Mexacanthina lugubris has expanded its range northward and may negatively impact newly-entered habitats through predation on shellfish, including acorn barnacles. Preliminary observations suggest that the consumption of barnacles across Mexacanthina's range can vary greatly by site. One potential mechanism for this differential predation could be related to the abundance of other species at each site. In particular, mussels can serve as a recruitment substrate for barnacles and may protect barnacles from predation by making the barnacles more difficult to access. We conducted a field caging experiment at two sites in southern California to control Mexacanthina density and monitored predation on barnacles living on bare rock versus those living on

mussels over time. At the beginning of the experiment, barnacles residing on mussels had reduced mortality compared to those living on bare rock. Over the course of the experiment, Mexacanthina appeared to begin consuming barnacles living on mussels as well as the mussels themselves as the availability of barnacles on rock declined. This may be due to barnacle prey on bare rock no longer being the most optimal food source. Our findings demonstrate a potential refuge mechanism through which impacts on native, resident species from range-shifting species are reduced, particularly early in the range expansion or when prey availability is high.

122 - EXPLORING THE LIVES OF SOUPFIN SHARKS: FORAGING ECOLOGY AND MIGRATION PATTERNS

† Personius, E.M.[1*]; Nosal, A.P.[2]; Holst, M.M.[3]; Chapple, T.K.[1]

1- Oregon State University 2- Point Loma Nazarene University 3- UC Davis

The Soupfin shark (Galeorhinus galeus) is a critically endangered, highly migratory species that seasonally inhabits the coastal and offshore waters off of Oregon and Washington. Once targeted extensively for their vitamin A-rich livers in the mid-20th century, the Soupfin shark experienced a rapid population collapse, and their recovery remains uncertain. The current status and ecological role of this species in the region is poorly understood posing challenges to effective management and conservation efforts. This study investigates the trophic role, habitat use, seasonal movements, and population size of Soupfin sharks in these waters. By utilizing acoustic and satellite tracking and monitoring, along with genetic and dietary analyses, our research aims to provide vital data for improving management practices, with significant implications for regional fisheries and conservation efforts.

123 - BIG FISH, LITTLE PLASTICS: INVESTIGATING ANTHROPOGENIC MICROPARTICLE ACCUMULATION IN SALMON SHARKS OFF THE OREGON COAST

† English, M.[1*]; McInturf, A.G.[1]; Hamilton, B.M.[2]; Boisen, O.[1]; Boyt, R.[1]; Savoca, M.S.[3]; Brander, B.[1]; Taylor K., [4]; Chapple, T.K.[1]

1- Oregon State University 2- Environment and Climate Change Canada 3- Stanford University 4- affiliation not listed

Anthropogenic microparticle ingestion, including microplastics, in marine organisms—especially fish—is a growing concern. Yet, its prevalence in sharks of the Northeast Pacific remains largely unexplored. One species ideally suited to address this knowledge gap is the salmon shark (Lamna ditropis). Salmon sharks are regionally endothermic and have a high metabolic rate, and their food consumption rates and energetic requirements are higher than those of most shark species. In addition to contributing to their ecological impact as consumers, these traits may also influence how frequently they encounter plastics and other microparticles. In this study, we use a combination of methods including stomach content analysis, high-resolution microscopy, and micro-Fourier-transform infrared spectroscopy to investigate anthropogenic microparticle (natural or synthetic particles < 5 mm) quantities and types in salmon sharks off the Oregon Coast. We aim to quantify the amount of microparticles consumed by these predators along the Oregon Coast. Our preliminary findings indicate a high presence of ingested microparticles of diverse morphologies, highlighting the need for further investigation into the impact of microparticles on salmon sharks as well as other elasmobranch species.

124 - MATERNAL EFFECTS AND ENSO IMPACTS ON MULTI-BROODING IN ROSY ROCKFISH (SEBASTES ROSACEUS)

† Elias, N.D.[1*]; Perrello, S.[2]; Logan, C.[1]; Hamilton, S.[3]

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Multi-brooding frequency in viviparous fishes can influence population replenishment, and climate change may influence this reproductive trait. Rosy rockfish (*Sebastes rosaceus*) are ecologically important temperate reef fishes that often have multiple broods in the waters of southern California, but rarely in central California. Latitudinal differences in nutrient availability and other environmental drivers are thought to influence this behavior. Upwelling is stronger in central California where fish are exposed to relatively cooler, hypoxic and acidic conditions. Climate change is also influencing the intensity and frequency of upwelling events, which may alter multiple brooding. We compared multiple brooding frequency in specimens collected during La Niña (2023) and El Niño (2024) in central California, analyzing ovarian samples for evidence of secondary broods.

Upwelling intensity during the reproductive season was assessed using the NOAA CUTI index. We predicted that multiple brooding frequency would increase in the El Niño year when water temperatures are generally warmer and upwelling is weaker. We also expected that large, mature females would experience multi-brooding more often. We found that larger rosy rockfish exhibited multiple broods more frequently during La Niña conditions, but during El Niño small, mature females displayed the behavior. These shifts in reproductive trends are essential to understanding future population growth of this recreationally and commercially important species under climate change.

125 - MODELING OCEAN ACIDIFICATION AND HYPOXIA EFFECTS ON FUTURE GOPHER ROCKFISH (SEBASTES CARNATUS) POPULATION DYNAMICS

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1- CSUMB, MLML 2- NOAA 3- MLML 4- CSUMB

Understanding how abiotic and biotic factors influence reproduction is important for the conservation and management of marine populations. Fish reproduction in particular is highly dependent on oceanographic processes that are subjected to considerable seasonal and interannual variation, as well as climate change. As climate and ocean conditions change, it is crucial to understand how variation in the environment influences fish reproduction, especially in fish with economic and recreational value, such as rockfishes (*Sebastes spp.*). Rockfishes are long-lived, highly fecund, slow to mature, and found in an environment that has high seasonal and interannual variability due to both localized coastal upwelling and large scale circulation patterns within the California Current . This study investigates how ocean conditions, specifically decreases in dissolved oxygen (DO) and pH, influence the fecundity of gopher rockfish (*Sebastes carnatus*). Using a laboratory experiment, we investigated how total fecundity, and the fecundity-length relationship alters following maternal exposure to low DO and pH conditions before and during gestation, using treatment levels that are predicted to occur in the California current within the next 100 years. Preliminary results suggest that when controlling for maternal length, lower DO and pH conditions caused a decrease in total fecundity ($p = 0.051$). This decrease will be incorporated into a population dynamics model to study how future populations of gopher rockfish may shift due to changes in dissolved oxygen and pH. The population model will provide insights into how shifts in ocean conditions could impact the productivity and abundance estimates necessary for future fisheries management.

126 - USING CUTI AND BEUTI TO EXPLAIN MUSSEL AND BARNACLE RECRUITMENT ON THE OREGON COAST

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Oregon State University

Upwelling is a crucial component of the delivery of mussel and barnacle larvae from the open ocean to rocky shores and their settlement and subsequent metamorphosis to sessile forms (i.e., recruitment). Past studies have used the Bakun upwelling index (BUI) to quantify upwelling and assess its relationship with mussel and barnacle recruitment. However, the BUI has been superseded on the US West Coast by CUTI and BEUTI, which are new upwelling indices that consider additional factors. This study examines how CUTI and BEUTI are associated with mussel and barnacle recruitment over 5 years (2014-2018) on the Oregon coast. Recruitment data were gathered from 10 rocky intertidal sites using plates for barnacles and tuffies for mussels. Using generalized additive models, we evaluated the intermittent upwelling hypothesis and the influence of upwelling on recruitment using CUTI and BEUTI. Our analysis showed that barnacles and mussels both had unimodal relationships with CUTI and BEUTI, and that upwelling explained 13-14% of the variation (adjusted R^2) in barnacle and mussel recruitment. In addition, the unimodal distributions supported the intermittent upwelling hypothesis, with the most recruitment occurring during periods when there was a mix of upwelling and downwelling. This means that CUTI and BEUTI are important variables for explaining variation in recruitment and could be used to help predict recruitment, something that will be critical as climate change has the potential to change upwelling patterns around the world.

127 - BRANCHING OUT: CORAL GROWTH RESPONSE TO SHIFTING OCEAN CHEMISTRY

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Texas A&M University-Corpus Christi/Harte Research Institute

Coral skeletons are formed by the uptake of carbonate ions from seawater, creating rigid structures that protect coastlines by absorbing wave energy. These skeletons primarily grow through outward linear extension or lateral thickening, which increases bulk coral density. However, the effects of changing carbonate chemistry on coral growth mechanisms remain uncertain. Therefore, we measured linear extension and skeletal density changes under manipulated water chemistry conditions to understand drivers behind changing coral growth mechanisms. Corals were collected in Hawaii, dyed with a biological stain, and grown in separate mesocosms with varying carbonate chemistry conditions, with alterations in pH and total alkalinity to vary carbonate ion availability. Corals were grown in these conditions for 30 days to observe any changes in growth compared to the control group. Linear extension was measured from where the biological stain begins and ends on the tips of the coral, while bulk skeletal density was measured by measuring water displacement. Results revealed a positive linear relationship between linear extension and bulk skeletal density under elevated carbonate ion conditions and low pH for perforate species, Montipora capitata, but this relationship was not observed for the imperforate species, Pocillopora acuta. These results suggest a species-specific response to changes in seawater chemistries and carbonate ion availability, indicating differences in calcification and skeletal growth mechanisms.

128 - CORAL IN CRISIS: EFFECTS OF OCEAN ACIDIFICATION ON CORAL PHOTOBIOLOGY

Hailes, R.*; Armstrong, D.A.; Bahr, K.D.

Texas A&M University-Corpus Christi/Harte Research Institute

Corals rely on a symbiotic relationship with photosynthetic algae to meet their metabolic demands. But changes in the ocean's chemistry may affect the photobiology of the coral, altering the density of the symbionts and the amount of chlorophyll they contain. Therefore, this study aimed to investigate how symbiont density and chlorophyll concentration respond to ocean acidification (OA). Two species of Hawaiian coral were used throughout the experiment, Monitpora capitata and Pocillopora acuta. Corals were exposed to OA for 30 days. Small samples were taken before the experiment began and then again after the 30-day experiment for processing. We observed the greatest decrease in symbiont densities and the greatest increase in chlorophyll concentrations per symbiont cell in Montipora capitata. This suggests that the symbionts may be upregulating their chlorophyll in a response to the high CO2 conditions. Pocillopora acuta showed an increase in symbiont densities along with an increase in chlorophyll concentrations per cell, though slightly less than M. capitata. This suggests that the symbionts of P. acuta are increasing their densities in response to high CO2 conditions, rather than chlorophyll concentrations alone. Overall, our results indicate species-specific photobiological responses to ocean acidification, highlighting potential impacts on coral populations.

129 - DIET STUDY OF PACIFIC HALIBUT (HIPPOGLOSSUS STENOLEPIS) IN HOMER, ALASKA

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Fishing of Pacific Halibut, *Hippoglossus stenolepis*, has long been a source of tourism and a sustainable food source within Kachemak Bay, Alaska. Many fishermen take the opportunity to open the stomachs of halibut caught to modify lures based on what is present in the stomach contents. This has created a need within the community for diet analysis that spans multiple fishing seasons. Halibut are generally known as opportunistic feeders, feeding on a variety of benthic prey. This study seeks to determine if halibut are solely opportunistic feeders or if they have a preferred prey species. Additionally, this study investigates if fish consumption by halibut varies seasonally or annually within Kachemak Bay. Halibut stomach contents were collected at Homer Harbor fish cleaning stations from personal use and charter fishermen over peak fishing season and identified to the lowest possible taxonomic level. Halibut stomachs processed from 2022 and 2023 consumed a diet dominated by bony fish, such as sand lance and capelin, along with a low diversity of crab species. In 2024, however, halibut diets were largely composed of diverse crab

taxa and fewer bony fish compared to previous years. These results may indicate changes in environmental drivers creating favorable crab habitat where there weren't favorable conditions before, or shifting migratory patterns of halibut due to these conditions. Potential future research includes investigating the drivers of halibut population shifts and crab population dynamics in Kachemak Bay.

130 - INTERACTIVE EFFECTS OF PH AND EELGRASS WASTING DISEASE ON PHYLLAPLYSIA TAYLORI BEHAVIORAL PHYSIOLOGY

† Vaught, F.N.[1*]; Somashekar, A.N.[2*]; Tanner, R.L.[3]; Wyllie-Echeverria, S.[4]

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Zostera marina is an essential marine habitat, holding ecological importance and cultural significance among indigenous tribes. *Phyllaplysia taylori*, a sea hare endemic to the west coast, fulfills a vital role in maintaining the health of eelgrass meadows. As climate change progresses, ocean pH continues to drop and the prevalence of eelgrass wasting disease may rise due to heightened ecological stressors. We explored the effects of these environmental factors on *P. taylori* behavior with the leaves of eelgrass ramets cultured in mesocosms at the Friday Harbor Laboratories (FHL). Adult *P. taylori* of the same approximate size were selected from an eelgrass tank at FHL and starved for 1.5 hours before being placed either in a flow through table or into one of four pH treatments of 7.8, 7.7, 7.6, and 7.5. Test subjects in the flow through tables were exposed to both healthy and diseased eelgrass leaf samples visually identified from ramets while the pH treatments utilized only healthy samples. The mass of epiphytes grazed by *P. taylori* was used as a metric of behavioral impact for both ocean acidification and eelgrass wasting disease treatments. We also recorded reaction time, measured as righting behavior following placement in each pH treatment. Neither yielded statistically significant results although the flip test data displayed a weak trend of slower reaction times as pH decreased. Future testing should assess a larger sample size, control for the presence of eelgrass wasting disease by inoculating healthy samples, and afford longer acclimatization periods for *P. taylori*.

131 - HIDDEN CURRENTS: A NOVEL FLOW SENSOR FOR MEASURING WATER VELOCITIES WITHIN BIOLOGICAL ASSEMBLAGES

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In aquatic systems, water motion is an important driver of biological processes such as respiration, photosynthesis, calcification, feeding, and fertilization. Indeed, changes in water flow can have dramatic effects on mixing processes that affect the mass transfer of important gases, food particles/nutrients, and gametes between organisms and their fluid environment. However, measuring flow inside the complex shapes associated with mussel aggregations has proven difficult as many techniques require a clear line of sight, while others are inappropriate for use in the small interstitial spaces between mussels. Presently, there is need to accurately quantify flows within aggregations of benthic marine organisms. Here, we present results from our testing of a field-deployable flow sensor based on 3D-printed mussels fitted with pressure sensors. Lab testing demonstrated that the sensors are accurate over a range of ecologically-relevant velocities. We also deployed sensors in the field to characterize the natural flows present inside mussel beds. These results set the stage for more explicit investigations into the ecophysiology of aggregations associated with foundational benthic organisms (e.g., mussel beds, oyster beds, and coral reefs).

132 - IMPACTS OF VIRGIN POLYETHYLENE AND BIODEGRADABLE MICROPLASTICS ON THE GROWTH OF PSEUDO-NITZSCHIA MULTISERIES IN MONTEREY BAY

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1- Moss Landing Marine Laboratories 2- The National Marine Sanctuary Foundation Monterey Bay

Microplastics (MPs), particles smaller than 5mm, pose an increasing threat to marine ecosystems, including Monterey Bay. These MPs often originate from the inadequate disposal and recycling of plastics, particularly in coastal agricultural fields where they are used to prevent soil erosion, regulate temperature, maintain humidity, and suppress weeds. During the removal of these plastics, mechanical degradation produces MPs that persist in the soil and eventually enter nearby water bodies, contributing to marine pollution. Phytoplankton, the foundation of marine food

webs, are critical to ecosystem health, yet research on the effects of MPs on these organisms remains limited. In Monterey Bay, *Pseudo-nitzschia multiseries*, a species known for producing domoic acid and causing harmful algal blooms (HABs), serves as an ideal candidate for studying the impact of MPs on phytoplankton growth. This study evaluated the effects of virgin polyethylene and biodegradable MPs on the growth of P. *multiseries* under controlled laboratory conditions (lighting, agitation, temperature, nutrients). Agricultural plastic samples from a local farm were tested in polycarbonate bottles, with P. *multiseries* exposed to MP concentrations of 3 and 150 MPs/L. Growth responses were assessed through cell counts, pulse amplitude fluorometry, and chlorophyll analysis. The findings will enhance our understanding of how agricultural MPs influence HAB species in Monterey Bay, providing insights into the broader impacts of plastic pollution on marine ecosystems.

133 - MONITORING SUNFLOWER SEA STAR RECOVERY TRAJECTORY IN ROCKY REEF KELP FOREST ECOSYSTEMS UTILIZING SIZE AND LOCATION

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Recent evidence suggests sun stars are important meso-predators that can exhibit top-down control over sea urchin populations in rocky reef kelp forest habitats. Sea stars were negatively impacted by the sea star wasting epidemic beginning in 2013, with one particularly important sun star, the sunflower sea star *Pycnopodia helianthoides* being declared functionally extinct across much of the West Coast. Observations from coastal communities along the Oregon coast suggest new populations of sunflower sea stars may be emerging. In addition to sunflower sea stars, Stimpson sea stars *Solaster stimpsoni*, and Dawson sea stars *Solaster dawsoni*, are 2 poorly documented species of sun star with little information known about their behavior and ecological impact on rocky reef habitats. Early data suggests that while sunflower sea stars may be recovering in Oregon, Stimpson's sea stars and Dawson's sea stars are still largely absent from the state. These predatory sea stars must be observed, and their population characteristics must be documented to further the ecological preservation of these species in hopes of potentially reintroducing them into urchin barren habitats and restoring kelp forests. Using intertidal and dive surveys we acquired size and location data for these sun stars that will yield a baseline understanding of the current status of their recovering populations. These surveys showed evidence of a population of shallow-water juvenile sunflower seastars with 1 intertidal sea star at Seal Rock, OR, and 8 subtidal sea stars at Nellies Cove, OR. Supplemental data analysis using community science outlets such as iNaturlaist and public Reef Check data provided a wider range of observations for Northern Oregon on sunflower sea stars.

134 - GENOME BASED IDENTIFICATION OF PUTATIVE PREDATORY BACTERIA: DISCOVERY OF A NOVEL SPECIES FROM THE FAMILY *MICAVIBRIONACEAE*

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UC Santa Barbara

Bacterial predation, where bacteria hunt and consume other bacteria, plays a critical role in microbial ecology. Yet, the specific mechanisms enabling this behavior remain poorly understood, as our knowledge is limited to a few well defined model species. Isolation and culture-based methods often fail for studying predatory bacteria, as they rely on specific prey for survival. Thus, the ability to identify putative novel predators by their distinct genomic features is crucial for expanding our knowledge of these organisms. In microbial aggregates known as "pink berries", we discovered a putative novel bacterial predator (LS7A1) from the family *Micavibrionaceae*. This study identifies genetic mechanisms of predatory behavior within LS7A1's genome to determine whether this novel organism is a predator. Some key predatory traits targeted are receptors for chemotactic prey hunting, pilus structures for attachment, and secretion systems that deliver toxins to lyse prey cell walls. Preliminary findings include individual components of primary secretion systems types I & II, and secondary secretion systems SEC & TAT. We also searched for the absence of certain metabolic capabilities, such as amino acid biosynthesis, which indicates the need to obtain nutrients from prey. Contrary to our

expectations, most amino acid pathways were present and complete within LS7A1's genome. The results of this study will enhance our ability to identify and characterize putative novel bacterial predators from their genomes, which is crucial for expanding our knowledge of these key ecological players.

135 - SANDY BEACH HABITAT VARIABILITY OF PISMO CLAM (TIVELA STULTORUM) POPULATIONS IN MONTEREY BAY

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1- CSU Monterey Bay 2- Moss Landing Marine Labs

The Pismo clam (*Tivela stultorum*) is a valuable bioturbator and prey for many marine organisms, inhabiting the sandy intertidal and subtidal from Central California to Baja California, Mexico. Unsustainable harvesting practices of commercial and recreational fisheries led to the overexploitation and decline of their population in the 1990s. Despite ongoing sampling efforts in Southern California, where most Pismo clam populations reside, Monterey Bay lacks information on the current status of local populations. During low tide (-1.0 ft or lower), we dug along 30-meter transects, divided into 3-meter sections, where all clams were identified. Corresponding sediment samples were collected and sized using a sieve stack. The beach slope was calculated using a DGPS (Differential Global Positioning System). We produced a map showcasing the location of clams found and analyzed the relationship between sediment grain size, degree of sorting, and beach slope with a multiple logistic regression test to determine the ideal beach morphology for Pismo clams. By exploring the potential habitats in their northernmost range, we can potentially restore the decimated Pismo clam populations. Clams were present in beaches with less-sorted, fine-grain sediment, and a gentle slope.

136 - IS BLACK SPOT SHELL DISEASE RELATED TO JONAH CRAB HEALTH?

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Jonah Crab (*Cancer borealis*) is a growing fishery in New England. Despite previous studies on the related *C. pagurus*, not much information is known about the Jonah crab nor its shell disease, black spot. Due to concerns about the potential severity of black spot, our study aimed to answer the question: Is black spot disease related to Jonah crab health? Black Spot may negatively affect Jonah Crabs health, which could be observed with impaired health metrics with increased disease. Crabs (n = 71) were collected with the Maine Department of Marine Resources through the Ventless Trap Survey near Vinalhaven, Maine. Hemolymph Brix, hepatopancreas % dry weight, septicemia, and hemocyte total counts were assessed in relation to % black spot cover. These health metrics are indicative of energetic resources (Brix and dry weight) and potential secondary infection (septicemia and hemocytes). Although no significant relationship was found between black spot % cover and the health metrics, a significant relationship between Brix and hepatopancreas % dry weight suggests that Brix could serve as a non-lethal proxy for hepatopancreas % dry weight. Our results suggest black spot has no substantial negative effect on Jonah crab health by our assessed metrics, though this may be influenced by our study on mid-summer crab and does not preclude potential disease impacts concurrent with environmental stressors. This information aids fisheries management and understanding the implications of shell disease in crabs.

137 - DEVELOPING REMOTELY OPERATED VEHICLE (ROV) METHODOLOGIES FOR RECOVERING DERELICT CRAB POTS

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1- Willamette University 2- Sea Dragons ROV Team

Derelict crab pots pose a major risk to marine biodiversity and the Dungeness crab (Metacarcinus magister) fishery in Washington State. These traps continue to fish after loss, resulting in a reduction of crab population which threatens local economies and ecosystem health. The current diver-based methods for recovering these lost, discarded, or otherwise abandoned crab pots are expensive and inaccessible for many small coastal communities. This project proposes the use of Remotely Operated Vehicles (ROVs) and geospatial analysis techniques as an alternative low-cost recovery methodology enabling community-driven derelict gear location and retrieval. A comprehensive methodology is developed

inclusive of site selection, surveying, ROV-based crab pot recovery, and disposal. This methodology was tested in the coastal waters of Jefferson County, Washington State, where thirty crab pots were located and twenty approved to be removed. Additionally, the study outlines a model for community-based research that involves stakeholders, students, and invested residents in this marine resource management. It is demonstrated that the ROV-based method is an effective low-cost and community-driven way to recover derelict crab pots on a localized scale.

138 - SEAWEEDS AS MODEL ORGANISMS FOR EVALUATING TRADEOFFS BETWEEN ADAPTATIONS TO PHYSICAL STRESS AND RESOURCE ACQUISITION

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1- UC Irvine 2- Soka University of America 3- affiliation not listed

Seaweeds are model organisms for studying relationships between morphology, structural composition, and responses to stretching and peeling forces. As they are adapted to living on wave-swept shores, they must balance their structural demands with metabolic requirements. These attributes combine with seaweeds' resource acquisition strategies (e.g., surface-area-to-volume ratios) to shape diverse variation in their forms, functions, and structural development. We are investigating the relationships between seaweed blade tensile strength and internal elemental (e.g., %C, C:N) composition of several brown algae species found on California rocky shores. In addition to in-lab measurements of morphological and physiological traits including surface area, volume, and internal elemental composition, we are evaluating relationships between wave action, strength, and C:N along gradients of wave exposure and latitude. Preliminary data suggest that seaweed attachment strength is positively correlated with seaweed size and highlights variation in thallus tensile strength. Seaweeds' unique adaptations to intense flow forces make them ideal for understanding drag reduction and flexural manipulation. Macroalgal mechanics and material investigation has broader implications for not only community and physiological ecology but also for biomimetic engineering.

139 - OCEAN ACIDIFICATION MEDIATES TROPHIC CASCADES IN EELGRASS HABITAT

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Stressors such as ocean acidification (OA) pose increasing threats to marine life, including foundational species such as seagrasses that support diverse faunal communities. Positive or negative direct effects of OA on foundation species may occur via altered physiology, but OA also may indirectly affect foundation species by altering species interactions among producers, herbivores, and predators. We used a lab-based mesocosm experiment to test whether OA affects the growth and survival of eelgrass (*Zostera marina*) by interfering with trophic cascades that dictate the competitive balance between eelgrass and epiphytic algae. We also tested whether the effects of OA on trophic cascade strength are mediated by eelgrass structural complexity. Using two levels of seagrass biomass, we exposed tri-trophic experimental communities from San Diego Bay, California (fish predators, epifaunal mesograzers (prey), and eelgrass with associated epiphytic algae) to ambient flow-through seawater and to seawater with pH maintained at 0.3 units below ambient. Contrary to expectations, fish predation on mesograzers enhanced both the growth of eelgrass and (to a lesser extent) the biomass of epiphytic algae, which were not inversely correlated. However, the positive trophic cascade effect on eelgrass growth was strongly reduced by OA. Effects of shoot biomass on all processes were relatively small. Our study demonstrates that OA can mediate top-down processes that affect eelgrass growth and survival.

140 - INVESTIGATING THE SYMBIOSIS BETWEEN BATHYMODIOLIN MUSSELS AND BRANCHIPOLYNOE SCALE WORMS AT THE EAST PACIFIC RISE

Lemke, M.[1*]; Loftus, A.[1]; Hourdez, S.[2]; Arellano, S.M.[1]

1- Western Washington University 2- Observatoire Océanologique de Banyuls-sur-Mer

Deep-sea hydrothermal vent communities are highly zonated environments where many organisms rely on symbiosis to survive. Bathymodiolin mussels are key ecosystem modifiers and inhabit various chemosynthetic microhabitats. Often, these mussels host *Branchipolynoe* spp. scale worms in their mantle cavity. While typically labeled “commensal,” this relationship varies across deep-sea systems, and its ecology at the East Pacific Rise (EPR) was largely unknown. In this study, I sampled mussels and their worms from two microhabitats (“zones”) at two vent sites within the EPR with the aim to better understand this interaction. Overall, I found a 67% infestation rate, and unexpectedly, infestation rates did not differ between zones. Female worms were significantly more abundant than Male worms (X-squared = 40.89, $p<0.001$). Overall, juvenile scaleworms were the most common (n=81), followed by females (n=76), and males (n=15). Larger mussels housed larger worms, but small juvenile worms (6.76 ± 3.9 mm) were found in mussels ranging from 1.5 mm to 197 mm in length. Mussels as small as 1.5 mm had worms present, but multiple worms began to accumulate when mussels reached 32 mm long, with adult worms appearing in mussels around 43 mm long. Due to the isolation of deep-sea systems, studying each system’s specific biology is critical, as interactions may differ significantly depending on the vent system. Understanding this symbiosis at the EPR enhances our knowledge of deep-sea chemosynthetic habitats and the complexities of commensal relationships.

141 - DO PHENOLICS IMPACT EPIFAUNA SETTLEMENT ON MACROALGAE?

Barbieri-Low, J.R.*; Penn, C.; Wagstaff, M.; Miller, R.J.

Marine Science Institute, UCSB

Giant kelp is a well-researched species of macroalgae but, within their eponymous forests, many other species of macroalgae can be found. Oftentimes, fronds of these species can be found covered in epifauna which can decrease algal fitness by influencing weight and drag, increasing grazing, and lowering photosynthetic potential. While defensive chemicals in macroalgae are known to deter grazers, we investigated if they could also deter settlement of epifauna. To test this, we used 8 species of macroalgae common to the Santa Barbara Channel, along with larvae of the ascidian *Ciona robusta*, a common epifaunal organism. First, we fertilized gametes of *Ciona* in the lab, and then we added the invertebrate larvae to petri dishes containing algae, and quantified larvae survival. We also analyzed the phenolic content of algae to explore any relationship between larvae survival and defensive chemicals. We found that larvae survival did differ among algae species but that larvae survival and algae phenolics were not negatively correlated as expected, but were, in fact, positively correlated. While it is possible that this positive relationship between phenolic content and larvae survival is not causative, other roles of phenolics should be explored, as well as other factors that might influence differences in invertebrate larvae survival between algae species.

142 - HARBOR SEAL HAULOUT BEHAVIOR IN AND NEAR MORRO BAY

Savage, C.Q.*; Liwanag, H.

Cal Poly SLO

Harbor seals (*Phoca vitulina*) are coastal marine mammals that haul out close to areas of human activity, but they are notoriously reactive to human disturbance. Because their overall population is doing well, there is currently no monitoring program documenting the occurrence of 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 Morro Bay area. The goal of this project was to document the location and timing of harbor seal haulout behavior in Morro Bay and surrounding areas, to establish a baseline of haulout behavior prior to windfarm construction. To do this, we conducted regular ground surveys using binoculars at Estero Bluffs, Morro Bay, and Los Osos, documenting harbor seal abundance through a half tide cycle (i.e., from low to high tide or vice versa). We related harbor seal haulout behavior to abiotic factors such as tide level, air temperature, and wind. Our preliminary results indicate that all three abiotic factors were significantly correlated with harbor seal abundance, but the relationship differed among study sites. This information will

be used to plan standardized surveys of these populations throughout the year, generating baseline data regarding harbor seal presence on our local shores. In the future, these data will be used to understand the impacts of the increased anthropogenic activity associated with the offshore windfarm on our local harbor seals.

143 - INVESTIGATING BLUE AND OLIVE ROCKFISH PREY PREFERENCE THROUGH STOMACH CONTENT ANALYSIS

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Blue Rockfish (*Sebastes mystinus*) and Olive Rockfish (*Sebastes serranoides*) are two of the most abundant groundfish species caught in the California Central Coast and are an important part of the commercial and recreational groundfish fishery. To effectively manage this important resource, fishery managers must understand Blue and Olive Rockfish preferred prey and feeding trends to help predict the impact of environmental effects on feeding behavior and determine where they are in the trophic cascade within the context of their community. This provides a critical piece of life history information that can be used to manage fish stocks. We plan to identify, enumerate, and analyze Blue and Olive Rockfish stomach contents by creating an Index of Relative Importance (IRI). We will process the samples by dissecting each rockfish and recording body length and weight, liver and gonad weights, and sex and maturity status, as well as retaining each fish's otoliths, fin clip, and muscle tissue. For stomach content analyses, we recorded the stomach weight before and after emptying the stomach contents. We will then categorize and enumerate the dissected organisms by taxa. After collecting relevant data, we will analyze differences between sex and maturity levels. Based on past research, we expect that Blue and Olive Rockfish are relatively low on the food chain with their benthic congeners; however, we expect both species of rockfish will contain different types of prey in their stomachs. We hope to use our results to make inferences about other low-trophic level rockfishes.

144 - USING AUTONOMOUS DRONES AS A TOOL TO STUDY THE IMPACT OF SEA LEVEL RISE ON ROCKY INTERTIDAL COMMUNITIES

Bible, O.[*]; Garza, C.; Espriella, M.; Ching, J.

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. It is a critical habitat that has been the focus of environmental monitoring for decades. 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 intertidal 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 effects of sea level rise on California intertidal ecology 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 for *M. californianus* and *P. ochraceus* by using object-based classification to calculate the percent cover of photomosaics and estimating mussel extent from tidal heights. Preliminary results show no significant difference in percent cover for *M. californianus* at various sites for both MARINe and my UAV data. The results of this study suggest that UAVs, in conjunction with machine learning-based classification methods, are a valuable tool for rapidly collecting and estimating the impact of sea level rise on intertidal communities.

145 - INVESTIGATING THE CURRENT POPULATION STATUS OF THE PISMO CLAM (TIVELA STULTORUM) AROUND THE MONTEREY BAY

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1- CSU Monterey Bay 2- Moss Landing Marine Labs

The Pismo clam (*Tivela stultorum*) was an iconic species for commercial and recreational fisheries, and of the sandy intertidal and subtidal ecosystems ranging from Central California to Baja California, Mexico. Unsustainable harvesting practices and overexploitation led to an uncontrollable decline in their population in the 1990s. There is currently a gap in knowledge regarding the current status populations at several different beaches across the Monterey Bay. Burial rate trials were conducted on clams collected during tides lower than -1.0ft from both the surf zone with a clam rake and within 30-meter transects split into 3-meter sub-sections we dug using shovels. All clams were sized using calipers then placed into a pool in the sand with little disturbance. The time of initial movement and burial completion were recorded. This study yielded population counts across several beaches, building upon previous historical studies. No legal sized individuals have been found in Monterey Bay, but the strong presence of juveniles has indicated that this population is growing. Continuing to track the age classes of individuals found, identifying drivers of crucial physiological survival responses, and comparing this with their habitat conditions, Pismo clam populations can once again thrive in Monterey Bay.Note: My groupmate James (Ryan) Brady also submitted this abstract since we will be presenting the poster together.

146 - EVERY PHAGE EVERYWHERE ALL AT ONCE

Vayda, N.A.[*]; Salcido, V.; Rohwer, F.

San Diego State University

Bacteriophage, viruses that infect bacteria, are found in all environments. When the bacterial community of an environment is introduced to the viral community of another environment, viral particles are produced, meaning infection is occurring. We propose that in an ecosystem, at any given time, there are a few highly abundant viral genotypes whose hosts are dominant and numerous in that system. There are also many viral genotypes whose hosts are not present or dominant in the ecosystem, so these viruses make up a bank that can be pulled from if their host appears. To test this, we have introduced bacteria to viral communities from either the same or different environments to determine how common viral infection is within and between environments. We have collected over 100 bacterial isolates and 30 viral communities from marine, estuarine, and freshwater ecosystems around San Diego, California. These three environments were chosen because they are all aquatic, but differ in salinity, which selects for different communities. Infection tests are carried out both in 96-well plates over 24 hours in a spectrophotometer/incubator, and in plaque assays. Through these infection tests, we can determine if infection within environments is more common than between environments.

147 - ASSESSING NON-NATIVE SPECIES PRESENCE AND ABUNDANCE ACROSS MULTIPLE PROTECTION LEVELS IN CENTRAL CALIFORNIA

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Non-native species (NNS) present a major threat to global marine biodiversity. To combat the impacts of NNS and other stressors, marine protected areas have been established in many areas around the world. Yet even with enhanced protections, such areas are not immune to invasions by NNS. Although much of California's coast is contained within a network of marine protected areas with highly varied levels of protection, the presence of many strong potential vectors for NNS such as shipping, aquaculture, and recreation also makes the California coast highly vulnerable to invasions. Across these protected areas, the relationship between protection level, rate of invasions, and success of invaders is not well understood. To address this gap, I conducted intertidal surveys of fouling invertebrate and algal communities in sites of varying levels of protection ranging from minimally protected sites to fully protected marine reserves, with comparisons at some sites to two previous standardized surveys conducted 5 and 10 years previously. Preliminary results suggest range expansions of several NNS and the presence of NNS across all levels of protection, including no-take marine reserves. Further results will contribute to our long-term dataset and allow for more robust latitudinal

comparisons to detect the spread of NNS along the outer California coast. In addition, results will also contribute to developing cost-effective, accurate, and timely methods to monitor the California coast for NNS and inform management decisions to develop best practices for NNS detection and control.

148 - PREDICTING THE ECO-EVOLUTIONARY CONSEQUENCES OF THERMAL STRESS ON ROCKY INTERTIDAL MUSSELS WITH INTEGRAL PROJECTION MODELS (IPMS)

Codding, A.*; Hernández-Pacheco, R.; Allen, B.J.

CSULB

Following exposure to sublethal high temperatures, many organisms undergo physiological changes that enhance their tolerance to subsequent thermal stress. Thermal acclimation requires significant energetic resources, which could lead to reduced growth and/or reproduction due to allocation trade-offs among competing life-history traits. This raises a key question: how do fitness benefits of increased survival, coupled to costs of reduced growth and reproduction, translate into eco-evolutionary dynamics? We have formulated a novel modeling framework to investigate how links between thermally induced phenotypes and phenotype-dependent demographic rates drive the eco-evolutionary responses of populations exposed to different levels of thermal stress. Specifically, we will evaluate how performance varies with phenotype across different levels of thermal stress using integral projection models (IPMs) – demographic models that forecast life-history traits as functions of a continuous state variable. Models will be parameterized with empirical data collected from a year-long field study of California mussels (*Mytilus californianus*) in the rocky intertidal zone. A preliminary IPM built from data in the literature suggest that size-dependent life-history trade-offs, particularly in larger mussels, may influence population growth rates under thermal stress. This approach will allow us to evaluate the hypothesis that thermal stress supports the emergence of individual phenotypes driving eco-evolutionary processes within populations.

149 - TRACKING RECOVERY AND SPATIAL VARIATION OF PISASTER OCHRACEUS AND PATIRIA MINIATA ACROSS THE MONTEREY PENINSULA POST WASTING DISEASE

Staton M. E.,*; Wrinkle J., ; Siegel P., ; Haupt A.,

CSUMB

In this study, we aim to understand the relationship between spatial variation and abundance of sea stars *Pisaster orchraceus* and *Patiria miniata* post sea star wasting disease in order to understand population recovery across the Monterey Peninsula. Sea star wasting disease has heavily affected distribution patterns of *Pisaster orchraceus*, but minimally affects *Patiria miniata* . It is expected that there is high variation in spatial distribution and abundance when comparing these two species. An analysis of variation in sea star recovery will help us to understand differences and similarities between *Pisaster orchraceus* and *Patiria miniata* relationships and how this relationship may affect overall recovery in *Pisaster orchraceus* recovery.

150 - IN SITU GROWTH, MOVEMENT, AND RETENTION OF INDIVIDUAL PISMO CLAMS (TIVELA STULTORUM) IN AN INTERTIDAL BEACH HABITAT

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Concordia University Irvine

Pismo clam (*Tivela stultorum*) populations in California once supported iconic fisheries, but population declines have reduced present-day exploitation in many areas. Although this species may benefit from conservation efforts, a limited understanding of Pismo clam ecology makes it difficult to contextualize how populations might respond to conservation efforts. The objective of this study was to measure individual *in situ* growth rates and movement patterns of adult Pismo clams in an intertidal beach habitat. A total of 104 clams were tagged with radio frequency identification (RFID) tags and deployed onto their native beach on three occasions throughout the year. We used a non-invasive sensor to search

for the clams in the days, weeks, and months following deployment. Detection of tagged clams in a ca. 4,000 m^2; search area decreased over time with approximately 50% of clams lost after 44 to 117 days, depending on the season. However, many clams persisted within the search area despite large wave events and a small number were still present 355 days after the first deployment. Clams deployed for 117-325 days had a mean *in situ* growth rate of 0.053 mm d^{-1} (± 0.007 mm SE), which correlated negatively with clam size. The total distance and direction traveled by individual clams was variable over the duration of days to months, unrelated to clam size, and generally consisted of offshore or along shore movement. Ultimately, these data will help us to better understand the *in situ* ecology of individual Pismo clams and may help inform conservation efforts.

151 - MAPPING SUBMARINE GROUNDWATER DISCHARGE DELIVERY ON CORAL REEFS USING DRONE THERMAL INFRARED IMAGERY

Wang, L.[*]; Yamamoto R.,[*]; Tirgardoon, H.; Zummo, S.; La Valle, F.F.

Pepperdine University

Maunalua Bay (O‘ahu, HI) has experienced dramatic development and increase in population over the last 100 years, which has affected the water quality in the near shore coral reefs of the bay. The main source of land-based inorganic nutrients in Maunalua Bay is submarine groundwater discharge (SGD) which is a chronic freshwater vector. SGD at this site increases specific macroalgae’s biomass, decreases biodiversity, and increases productivity of the algae that can withstand high nutrients and low salinity. We are utilizing drones equipped with infra-red thermal cameras to map the SGD, which is colder than surrounding coastal water, on two reefs at night. We have developed a method that involves creating orthomosaic maps from multiple thermal images with an 85% overlap to 85% sidelap ratio taken autonomously by our drone. To validate our thermal imagery, we collected water samples for inorganic nutrient analysis and YSI (i.e., salinity, temperature, pH, ORP, TDS) data at the surface of the water column. Using these measurements, we will determine the potential relationship between these parameters. These maps will aid us in forming a more complete model of productivity of the phytoplankton and macroalgae on these reefs.

152 - GENETIC CONNECTIVITY AND SIGNALS OF SELECTION ACROSS BIOGEOGRAPHIC BARRIERS OF METACARCINUS MAGISTER IN ITS NATIVE RANGE USING WHOLE-GENOME-SEQUENCING (WGS)

† Betancourt-Sanchez, A.M.[1*]; Barber, P.H.[1]; Dawson, M.[2]; Escalona, M.[2]; Miller, C.[2]; Toffelmier, E.[2]; Shaffer, B.[2]

1- UCLA 2- affiliation not listed

Metacarcinus magister inhabits a large geographic range from Point conception California to Alaska and experiences pronounced environmental gradients (temperature, pH, and salinity) making this species particularly susceptible to ocean warming and climate shock events. To more fully understand the genetic connectivity, signals of selection selection, and epigenetic modifications in adaptation of M. magister, next-generation DNA sequencing was used to compare whole genomes of 178 M. magister samples from populations from California, Oregon, Washington, and Alaska. This study proposes to use whole genome resequencing to examine stock structure and adaptive potential in M. magister by addressing the following objectives: 1) Assess connectivity and region genetic stock structure in M. magister using whole genomes resequencing. 2) Determine if signals of selection in M. magister are influenced by biogeographic barriers and gradients along the coast of North America on northern and southern populations.3) Compare the relative importance of genomic and epigenetic variation in local adaptation of M. magister across pronounced environmental gradients.Understanding these responses is essential as larval M. magister are a critical food source for marine fishes and prey on bivalves, thus changes to these populations could have cascading ecological impacts. Results also provide insights on adaptive evolutionary potential for marine populations to respond to climate change and ocean acidification.

153 - THE ABUNDANCE OF MICROPLASTICS AT THE BOTTOM OF THE FOOD CHAIN: MYCTOPHIDS

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1- CSU San Bernardino 2- Moore Institute

Myctophids (commonly known as lanternfish) are highly abundant, planktivorous fish near the bottom of the marine food chain and are found worldwide. Although they are not popular food sources for humans, they serve as prey for a wide range of other fishes and carnivores that are consumed by humans. As a result, microplastics in their system can eventually move up the food chain, posing significant harm to both the ocean's ecosystem and human health. Our research focuses on the abundance and diversity of microplastics in myctophid (Mexican lampfish) specimens. These specimens were collected off the coast of Southern California on the Yellowfin R/V using a midwater trawl. We concentrated on identifying microplastics from the gastrointestinal (GI) tract of each fish, which was dissolved in potassium hydroxide to remove gut contents and isolate the microplastics. The remaining contents were then filtered through >250µm sieves, and all samples were analyzed at the Moore Institute (Long Beach, California) using Fourier Transform Infrared Spectroscopy to determine the density and diversity of microplastics found in the gut. We employed software tools to map, identify, and compare the different types of microplastics within the GI tracts across different species of myctophids to gain a better understanding of how plastics impact marine life.

154 - LOOKING FOR ECOLOGICAL DIFFERENCES AMONG 3 CLADES OF ROSTANGA PULCHRA - HABITAT, SPONGE PREY, BODY SIZE AND EGG SIZE

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1- Macalester College 2- University of Oregon

Rostanga pulchra, an orange nudibranch which lives along the coast from Alaska to Panama, is known to feed and lay egg masses on orange sponges in several genera. The nudibranch is cryptic because its color matches the color of the orange sponges with which it coexists. Larvae have been shown to settle on at least one orange sponge, Clathria pennata. However, recent work has shown that, R. pulchra is a species complex of at least three clades that are 12-14% divergent for nucleotides of their COI gene. Our study examined sponge prey, habitat exposure, body size, and egg size of the different clades looking for ecological divergence. We identified the nudibranchs with COI sequence barcodes and the sponges with their spicules. The sponges C. pennata, Antho lithophoenix, and Hymedesmia sp are listed as R. pulchra's main food source. We found all 3 clades of Rostanga on C. pennata, 2 clades on A. lithophoenix, and 1 clade on an unidentified sponge (Antho? sp.). We found all 3 clades in exposed and semi-exposed rocky sites, and on floating docks in a marina. The clades overlapped in body size up to 2 cm, however clade #1 had the largest individuals and most individuals had black spots. This same clade (#1) had eggs that were significantly larger than those of the other clades. These data indicate limited divergence among the traits we examined, despite considerable genetic difference. We will continue to examine individuals from the different clades to see if they show distinguishing morphological features in radulae and dorsal caryophyllidia (tubercles).

155 - HEAVY RAINFALL EFFECTS ON EELGRASS SEA HARE METABOLIC PERFORMANCE

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Chapman University

Seagrasses worldwide face threats from shifting environmental conditions, with anthropogenic impacts on climate affecting their ecosystem health. The eelgrass sea hare, *Phyllaplysia taylori*, is the most effective grazer of epiphytes that block eelgrass photosynthesis in California. CA eelgrass meadows are experiencing increased climate change-driven precipitation, leading to frequent and fast declines in seawater salinity. In this study, we set out to understand how quickly-declining salinity conditions impact the metabolic performance of *P. taylori*, and whether this differs among bays with varying levels of historic runoff. We looked at two bays with differing drainage rates in Southern and Central CA. Sea hares were acclimated in the lab for two weeks to constant exposure at 33 ppt, fast declining exposure (33-23 ppt, 2 ppt/day), and slow declining exposure (33-23 ppt, 1 ppt/day). We generated metabolic performance curves of oxygen consumption from 8-33 ppt. In Southern CA where historic runoff is low, respiration rates did not differ across measurement salinities, indicating that sea hares may engage in some osmoregulation. In Central CA

where historic runoff is high, respiration rates differed significantly across measurement salinities, indicating that sea hares are likely osmoconformers at this site, potentially impacting their persistence in future climate. Since sea hares differ in their osmoregulatory capacity depending on location, some populations will persist but not others in future precipitation conditions, unevenly impacting eelgrass health across CA.

156 - HABITAT ASSOCIATIONS OF TEMPERATE REEF FISHES IN HIGH- AND LOW-RELIEF TOPOGRAPHY AS DETERMINED BY COUPLED STEREO VIDEO PLATFORMS

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Describing fish communities in relation to two different habitats may provide insights into the relative merits of the sampling methods used to survey these fishes, as different sampling methods tend to provide different estimates of fish community metrics. In this project, we used two video collection methods, stationary stereo “minilanders” and diver operated stereo video (DOV) collected in strip transects, to compare fish communities in high- and low-relief rocky substrates in the Monterey Bay area. In each habitat type, the divers and minilanders collected data in the same area simultaneously, but were separated by at least 50 m to avoid interference between methods. Metrics such as species richness, composition, and diversity were then extracted from data generated by each video method. Both methods indicated that, on average, the high-relief sites contained significantly higher species richness, diversity, and evenness per transect or drop. However, out of 31 species identified, 4 were only seen on high-relief habitats and 8 were only seen on low-relief habitats. When the two methods were compared, stereo DOV showed a significantly higher species richness, while the minilanders showed significantly greater diversity and evenness. The minilanders also recorded more sedentary fishes, while stereo DOV recorded more mobile species. These results shed light on the ways in which habitat may drive fish communities and what aspects of the community each sampling method captures, which is important insight in the context of long term marine protected area monitoring.

157 - EXPLAINING PLANKITVORE AND PREDATOR DENSITY ON SOUTHERN CALIFORNIA ARTIFICIAL REEFS BY QUANTIFYING HABITAT CHARACTERISTICS

† Pua, C.B.[1*]; Kim, M.H.[1]; Shubin, N.P.[1]; Claisse, J.T.[2]

1- Cal Poly, Pomona 2- Cal Poly, Pomona & Vantuna Research Group, Occidental College

Southern California artificial reefs (ARs) have historically been constructed to increase recreational fishing opportunities, and more recently have also been built for reef habitat restoration and compensatory mitigation. ARs have been shown to produce similar to higher fish biomass than nearby natural reefs, with habitat characteristics influencing their fish assemblage. Habitat complexity, vertical relief, and heterogeneity have also been associated with increased AR fish density and production. My project will assess the relationship between these AR habitat characteristics and the densities of a planktivore, Blacksmith (*Chromis punctipinnis*) and one of its predators, Kelp Bass (*Paralabrax clathratus*). The planktivorous Blacksmith can play an important role in nutrient transfer, boosting primary production on reefs. Similarly, the Blacksmith can connect plankton food resources to secondary production, as they are prey to Kelp Bass, an important recreational fishery species. AR habitat data was collected with sonar and then classified and delineated in ArcGIS Pro, with habitat metrics calculated using the MultiscaleDTM package in R. These habitat metrics will then be compared with SCUBA and stereo-ROV fish survey data. The results of this project will contribute to developing AR assessment metrics, future design criteria, and informing the California Department of Fish and Wildlife’s updating of their artificial reef management plan.

158 - COMPARATIVE ANALYSIS OF FRACTION FEEDING IN MARINE MAMMALS AND ELASMOBRANCHS

Foust, P.[*]; Novak, M.

Oregon State University

Subscript text Understanding predator deeding rates is crucial for assessing their ecological impact on the environment, yet acquiring data remains challenging. Environmental factors like temperature, predator body mass, and metabolic type influence feeding dynamics. This study explores the feeding behavior of marine mammals and elasmobranchs across latitudinal zones, focusing on the fraction of predators with non-empty stomachs as an alternative for feeding rates (f*h). Data is compiled globally to encompass various species, spanning various body masses and latitudes. Endothermic marine mammals at higher latitudes are expected to exhibit different feeding patterns than ectothermic elasmobranchs at lower latitudes, reflecting their metabolic demands and ecological roles. This research contributes to understanding how metabolic processes shape predator-prey interactions and resource distribution in marine ecosystems.

159 - ON BURROWED TIME: RAZOR CLAM BURROWING BEHAVIOR BETWEEN MUDS IN THE PRESENCE OF GREEN CRABS

Lott, B.[1*]; Rawson, P.[2]; Harris, B.[2]

1- Oregon State University 2- University of Maine

Razor clam *(Ensis leei)* farming has great potential to diversify shellfish aquaculture but remains underdeveloped. With this study I hope to aid in the implementation of future razor clam farming through investigating the burrowing behavior of *E.leei* in anoxic versus oxygenated mud conditions, as well as if burrowing behaviors in these muds are altered when predators *(Carcinous Maynous)* are sensed. *C. Maynous* , the invasive green crab wreaks havoc on native ecosystems and is also a known predator to razor clams. By identifying the most optimal substrate conditions and predator prey interactions, we can enhance growth rates and reduce mortality. In turn, leading to the development of razor clam aquaculture, contributing to the diversification and sustainability of the aquaculture industry. Fourteen *E. leei* individuals were exposed to both sediment types for fifteen-minute trials in razor clam ant farms. Subsequent trials introduced green crab scents via flow-over buckets to evaluate predator presence impacts. Welch's t-tests compared burrowing times between groups, revealing no significant difference between anoxic and oxygenated conditions. However, significant differences were found when green crabs were present, indicating avoidant behavior and flexibility in burrowing in less favorable substrates when threatened. The Quinault Nation's reliance on razor clams for sustenance and income exemplifies the importance of sustainable aquaculture in the face of climate change and could help ensure traditional practices and livelihoods. Additionally, Razor clams' unique mobility and dependency on substrate for survival stress the need for suitable substrate. While only predator interactions were significant, recognizing burrowing patterns across treatments is valuable for future growers. The Rawson lab has managed *E. leei* spawning, settlement, and growth, and will distribute individuals to farms to upstart razor clam aquaculture in Maine. The lab specifically will conduct trials on feeding, density, and temperature to accelerate growth and retention, contributing to aquaculture development.

160 - ASSEMBLY AND ANALYSIS OF THE XIPHISTER MUCOSUS GENOME TO UNDERSTAND DIETARY DIVERSITY IN PRICKLEBACK FISHES

Vaskez, P.M.[*]; Heras, J.

CSU San Bernardino

Xiphister mucosus, commonly known as the Rock Prickleback (Teleostei: Stichaeidae), is an herbivorous fish that inhabits the intertidal zone from the Gulf of Alaska to Santa Cruz Island, California. Unlike most teleost species, *X. mucosus* undergoes an ontogenetic dietary shift from carnivory to herbivory, providing a unique opportunity to study dietary adaptations in pricklebacks. The objective of this study was to assemble the *X. mucosus* genome and compare digestive enzyme gene copies across prickleback species to better understand dietary diversity in this group. An individual representing the species *X. mucosus* was collected near Friday Harbor Laboratories, Washington. Genomic DNA was extracted from this individual and sequenced using Pacific Biosciences and Illumina technologies. The genome was assembled using bioinformatics tools, and we used the program Basic Local Alignment Search Tool (BLAST) to identify amylase gene copies, a key enzyme in carbohydrate digestion. Our findings will enhance our understanding of dietary adaptations in pricklebacks and contribute to the broader knowledge of evolutionary processes in herbivorous fishes.

161 - ENVIRONMENTAL DNA INFORMS MONITORING OF ARTIFICIAL REEF RESTORATION

† Catalan, E.[1*]; Waters, T.[2]; Reynolds, A.[1]; Eagle, R.[1]; Cavanaugh, K.[1]; Barber, P.[1]

1- UCLA 2- NOAA Seagrant

Currently there are over 30 known ARs off the coast of California but no formal monitoring program exists to study the biological communities they support (Hunter, 2020). In Southern California, the Palos Verdes Shelf contains a rocky reef ecosystem which has been impacted by DDT and PCB contamination and historic landslides which continue to heavily impact many of the area's low-lying reefs with chronic sedimentation and burial (Pondella et al 2013). Artificial reefs were constructed in this area in 2020 to restore fish habitats. Informal visual surveys are conducted at this site to determine its success but only once a year. Environmental DNA (eDNA) is a method that could be applied for more detailed biomonitoring of this type of restoration. eDNA is an innovative method of monitoring biodiversity based on the genetic material organisms leave behind in the environment but lacks the established methods for its application in different conservation situations. This project compares eDNA signals from a recently completed AR to nearby natural reefs as well as to traditional SCUBA surveys. Samples have been taken seasonally since before the construction of the reef in 2020 to probe for fish diversity. We also conducted concurrent kelp canopy drone-mapping, and biogeochemical sampling to compare habitat types, local ocean chemistry, seasonal dynamics, and the composition of biodiversity which we aim to uncover using eDNA. Here we present preliminary results from this project which highlight the efficacy of artificial reefs in constructing new ecologically important fish habitats and provide evidence for the feasibility in application of eDNA for monitoring these types of ecosystem restoration.

162 - SYNTHESIZED KNOWLEDGE OF ROCKY INTERTIDAL ECOSYSTEMS: COMPARING VISUAL AND MOLECULAR BIODIVERSITY SURVEY METHODS

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1- UC Santa Cruz 2- Stanford University

Rocky intertidal zones house diverse biological communities that support neighboring marine and terrestrial ecosystems, human foodways, and recreation. Yet, it is challenging to monitor the rocky intertidal at scale, and with anthropogenic stressors, it is ever more essential to monitor them consistently. Environmental DNA (eDNA) is genetic material left behind in an ecosystem, enabling the identification of organisms from an environmental sample. Recent studies have used eDNA to characterize intertidal ecosystems. However, more research is needed to understand how DNA-derived biodiversity observations in the intertidal compare to conventional visual monitoring methods. For the first time, we synthesize biodiversity data from several different survey efforts in and around the rocky intertidal at Pillar Point, Half Moon Bay, CA: iNaturalist observations (including regular Cal Academy bioblitzes), ReefCheck community science dive surveys, LiMPETS monitoring with school groups, MARINe/PISCO visual surveys at the nearby Fitzgerald Marine Reserve, and eDNA samples collected over one tidal cycle. We compare observations from these survey efforts to identify gaps and intersections detected. We find that eDNA can identify organisms that observational surveys typically do not capture, such as microscopic organisms; conversely, some organisms detected in visual surveys are missing in the eDNA data. Continued efforts to bridge visual and molecular survey methods can expand our intertidal biodiversity knowledge, enabling us to better identify ecosystem changes.

163 - FEEDING RATES OF PURPLE SEA URCHINS FED FIVE MACROALGAL DIETS

Melo, F.[*]; Galloway, A.W.E.

University of Oregon

Primary producers from diverse macroalgal groups are important food sources for intertidal invertebrate herbivores and detritivores. Recent changes in climate and predator dynamics have affected the amount of available macroalgae in the nearshore intertidal and shallow subtidal benthos of the NE Pacific. In parts of the Oregon coast, precipitous declines in nearshore macroalgae have accompanied rapid purple sea urchin (*Strongylocentrotus purpuratus*) population increases. Because purple sea urchins consume macroalgae, clarity on their feeding rates and dietary

preferences is needed to clarify their effects on the marine ecosystem. This research investigates the effects of urchin-algae trophic dynamics through feeding experiments designed to test for differences in feeding rates and gonad growth in purple urchins among some of the algal diets that are common in Southern Oregon intertidal rocky beaches. We found significant differences between the feeding rates of purple urchins that were consuming common intertidal kelp *Egregia menziesii* and those that were consuming red coralline algae *Corallina vancouveriensis* (p-value 0.0001). Urchins consumed nearly eight times more Egregia than the coralline algae. There was no significant difference between the other consumed groups (*Ulva lactuca*, *Mazzaella splendens*, *Nereocystis luetkeana*) to *Corallina vancouveriensis*(p-value 0.1675, 0.7552, 0.1218). We found a significant change in the consumption rate of macroalgae during the experimental period (p-value 0.0208).

164 - REDUCED INTENSITY OF SEAGRASS WASTING DISEASE IN POSIDONIA OCEANICA MEADOWS AT NATURAL CO2 VENTS IN ISCHIA, ITALY

† Palmisciano, M.[1*]; Graham, O.J.[2]; Teixidó, N.[3]; Chiarore, A.[4]; Mirasole, A.[4]; Colloredo-Mansfeld, Z.[5]; Harvell, D.[2]; Micheli, F.[1]

1- Hopkins Marine Station of Stanford University 2- Cornell University 3- Stazione Zoologica Anton Dohrn & Laboratoire d'Océanographie Villefranche of Sorbonne University 4- Stazione Zoologica Anton Dohrn 5- Stanford University

Seagrasses provide essential ecosystem services like carbon sequestration, coastal protection, and enriched biodiversity, but these habitat-forming species are in decline globally. Therefore, understanding the mechanisms behind seagrass resilience and vulnerability is increasingly important. The pathogenic protist *Labyrinthula zosterae* causes seagrass wasting disease (SWD), resulting in necrotic lesions, impaired photosynthesis, and reduced growth, and can cause outbreaks with mass mortality. While seagrasses may benefit from ocean acidification, or the decrease in oceanic pH from increasing atmospheric CO_2, by increasing photosynthetic rates, OA impacts on SWD infection aren't well understood. To investigate the effects of OA on SWD, we surveyed subtidal *Posidonia oceanica* meadows at three natural carbon dioxide vent sites (mean pH 7.0-7.9) in Ischia, Italy, as well as nearby ambient pH meadows (mean pH ~8.1). *P. oceanica* leaves were collected, scanned, and analyzed for SWD severity (lesion area / leaf area) and prevalence (presence/absence) using ImageJ. We also measured plant biometrics (leaf area, plant density), epiphyte load, and physical factors (pH, temperature, light, and depth). We found that mean severity and prevalence were ~5x and ~3x higher, respectively, at ambient sites compared to vents, suggesting that OA may help mitigate infection by SWD. Future investigations will include definitively identifying the disease-causing agent using histology and qPCR, as well as exploring the potential herbivory-mediated effects of OA on disease incidence.

165 - PICTURE PORE-FECT: A NOVEL METHOD TO MAP SHARK ELECTRORECEPTOR PORES WITH PHOTOGRAPH-BASED 3D MODELS

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1- Oregon State University 2- Staffordshire University

Sharks can detect weak electric fields in their environment via their Ampullae of Lorenzini, which sit at the base of individual gel-filled canals terminating in visible pores across the head. The unique pore patterns and quantities can vary greatly depending on their phylogeny, biology, and potentially life history stage, providing insights into species-specific behaviors and movements. However, the volume of data needed to uncover broad trends is difficult to achieve due to the constraints of current methods, where the skin is removed from the specimen's head and illuminated from behind to view and map the pores on a flat plane. The dissections provide essential information such as positioning and density of the pores but are tedious, time consuming, and destructive. Photographs can also be used to view the pores, but the 2D images of the round heads result in distorted mapping and density calculations. To bridge the gap between the essential data from traditional methods and non-destructive photographic methods, we developed a novel method using photograph-based 3D modeling (photogrammetry) to generate a "digital skin", a

flattened 360-degree view of the head. We compared the accuracy of our methods to traditional methods using Salmon shark (*Lamna ditropis*) and Pacific spiny dogfish (*Squalus suckleyi*) heads. Our methods can greatly reduce the time to map the pores and provide a means to map the pores non-destructively.

166 - COMPARATIVE GUT MICROPLASTICS OF MARINE ROCKFISHES (GENUS SEBASTES) LOCATED IN SOUTHERN CALIFORNIA

† Castro, V.[1*]; Lattin, W.[2]; Cowger, G.[2]; Moore, S.[2]; Heras, J.[1]

1- CSU San Bernardino 2- Moore Institute for Plastic Pollution Research

The presence of microplastics in marine environments has raised concerns about their impact on aquatic life, especially regarding species with commercial and ecological significance such as rockfishes (genus *Sebastes*). This study aims to quantify and identify the various types of microplastics that have accumulated in the guts of multiple rockfish species (*Sebastes aurora*, *Sebastes chlorostictus*, *Sebastes semicinctus*, and *Sebastes saxicola*). Specimens were collected from various locations near the Los Angeles Harbor. Following euthanization, the entire gastrointestinal tract of each fish was dissected and subjected to digestion periods in potassium hydroxide (48 hours) and Alcojet® detergent (24 hours). Microplastics were sieved after digestion to isolate particles less than 250 µm in size class. All contents were filtered using a vacuum apparatus and collected on 5-micron mesh discs. The microplastics were then identified using a Fourier Transform Infrared spectroscopy at the Moore Institute for Plastic Pollution Research in Long Beach, California. Results have shown that there is a presence of different types of microplastics in the gut contents. Hopefully, this study will bring more awareness about the health of marine life and provide an incentive to reduce plastic use.

167 - IMPACTS OF SMALL OVERWATER STRUCTURES TO NEARSHORE SEDIMENT PROCESSES

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Washington Dept. of Fish and Wildlife

The transport and deposition of sediment is a defining feature of Puget Sound, influencing shoreline erosion, nearshore habitats, and forage fish spawning. Large overwater structures, such as ferry terminals, are known to disrupt nearshore processes by adding vertical structures that interrupt sediment drift and by casting shadows to the benthos that impair vegetative growth and fish behavior. However, effects of small overwater structures (SOWS), like docks, are uncertain. Due to their smaller size, SOWS may have minimal or even positive effects to the ecosystem. A goal of this project is to increase knowledge of impacts that SOWS, a common shoreline feature throughout Puget Sound, may have on the nearshore environment. Here, we hypothesize that SOWS will alter local sediment accretion and substrate composition. We measured beach elevation and estimated sediment grain size proportions along shore-parallel transects at 16 docks across north and south regions of Puget Sound. Preliminary data suggest that SOWS may influence sediment accretion in the intertidal, thus interfering with sediment movement in drift cells. Accretion and composition around the docks varied by site, with proportions of finer-grain sediment increasing under some docks. These findings can help inform shoreline project planning and bolster nearshore restoration strategies since SOWS may influence sediment movement. Future work will incorporate SOWS design elements and build from our developing dataset by also assessing impacts of shading by SOWS on migrating juvenile salmon behavior and kelp diversity.

168 - ESTIMATING MARINE PICOPHYTOPLANKTON DAY AND NIGHT GROWTH AND GRAZING MORTALITY RATES OFF SOUTHERN CALIFORNIA

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1- CSU San Marcos 2- Scripps Institution of Oceanography UC San Diego 3- Florida State University

Marine phytoplankton are primary producers at the base of the food web. Phytoplankton are often consumed by unicellular protists. Previous work indicates picophytoplankton (0.2-2.0 µm) growth and grazing mortality rates by protistan consumers are influenced by light availability; however, research analyzing day versus night growth and grazing mortality rates, as opposed to a full 24-hour period, is limited. In this work, we analyzed the growth and grazing mortality rates of picophytoplankton during the day, night, and over 24 hours. To estimate these rates, flow cytometry samples were collected and incubated over 24 hours at four sites off the coast of southern California, three inshore and one offshore. Sample sites ranged from 30 km to 900 km from shore. Picophytoplankton growth rates were generally higher at night (0.21-1.92/day) compared to the day (0.07-0.76/day) and over 24 hours (0.2-1.10/day). Grazing mortality rates were also generally higher at night (0.07-1.76/day) compared to the day (0.06-0.20/day) and over 24 hours (0.02-0.83/day). Both growth and grazing mortality rates were the highest at the inshore sampling site closest to the coast. Studying phytoplankton growth and grazing mortality rates will give us a better understanding of the processes that determine changes in the base of the marine food web. Estimating rates at different time points gives a clearer picture of the changes in the community occurring throughout a full 24-hour period.

169 - SPATIAL AND TEMPORAL DYNAMICS OF OREGON'S KELP FORESTS WITH AN EMPHASIS ON ROCKFISHES (GENUS SEBASTES)

Moretto, W.I.*; Boisen, O.C.; Heppell, S.A.

Oregon State University

One of the most highly productive ecosystems on earth, kelp forests are prime examples of imperiled habitats that are critical to countless marine species. Kelp forests within the California Current (CC) are no exception. Multiple stressors including marine heatwaves, storms, and loss of keystone species have led to recent declines of kelp forest habitat in the CC. Despite robust monitoring efforts across much of the CC, subtidal surveys in Oregon mainly target invertebrates and algae, whereas fish surveys are rare. This is alarming considering Oregon has lost more than two-thirds of its kelp canopy (primarily composed of bull kelp, *Nereocystis leutkeana*) since 2010, an ecosystem known to provide vital habitat to many nearshore fishes, including commercially valuable rockfishes (Genus *Sebastes*). Clearly, there is an urgent need to continue to monitor canopy kelp persistence in Oregon, *and* to enhance our tracking of changes in fish communities in response to both overall declines and seasonal fluctuations in kelp canopy cover. To address this, we will compare temporal changes in fish communities using historical data collected from Oregon's Marine Reserves and via novel kelp forest community composition data collected through in-situ diver surveys (visual, eDNA, and video). In addition, we will compare juvenile rockfish habitat use across nearshore and estuarine habitats to understand which species and size classes are most reliant on kelp forests. Overall, this study will offer critical insights into the role of kelp forests in sustaining important fish species in Oregon.

170 - SEASONAL COMPARISON OF EELGRASS SHOOT DENSITY THROUGHOUT PUGET SOUND

Aga, S.J.*; Anderson, K.N.; Arensmeyer, A.V.*; Skubel, R.A.

WA Dept. of Natural Resources

Eelgrass *(Zostera marina)* is a species of sea grass native to the intertidal zone in Washington State. Considered an ecosystem engineer, it provides habitat to many species of interest and offers valuable ecosystem services. Eelgrass shoot density is notably different throughout Puget Sound and changes over the course of the growing season. Location-dependent factors, such as environmental condition and water residence time, can affect eelgrass health, making the geographic location of the meadows a factor in shoot density. The purpose of this study is to compare regional shoot densities between two areas within Puget Sound. We compared changes in shoot density over the growing season (May - September) at two sites in the South Sound and two sites in the North Sound. Eelgrass was measured intertidally from 2018-2024 between six and eleven times during the growing season. We expect to see less density in the South Sound than the North South due to differences in water quality and residence time, while both regions are expected to increase in relative density throughout the growing season. The longer water residence

time in the South Sound may have an influence on those eelgrass communities by amplifying environmental stressors such as excess nutrient input, increased pollutant concentration, and higher water temperatures that could hinder eelgrass growth and conservation efforts. Understanding differences in eelgrass density throughout Puget Sound is important for informing restoration efforts and managing species that rely on this habitat.

171 - HITCH A RIDE ON THE RAFT! TURBINARIA ORNATA RAFTS AS A NOVEL MODE OF DISPERSAL

Flores, J.A.*; Barber, P.H.

UCLA

Loss of herbivorous fish and coastal eutrophication are driving shifts from coral to algal dominated reefs in French Polynesia. In particular, the macroalga *Turbinaria ornata*, has so greatly expanded habitat usage in the South Pacific that, when dislodged by storms, they form large floating rafts. Although algal rafts are common and important in regions like the Sargasso Sea, *T. ornata* rafts are novel tropical ecosystems that form in shallow lagoons before transiting to open ocean environments, and are covered in epibionts, invertebrates and microorganisms, potentially increasing connectivity among reef ecosystems. Of particular concern are ciguatoxic dinoflagellates and coral pathogens. With climate change increasing storm intensity and frequency, *T. ornata* rafts will likely be a common feature of South Pacific reef ecosystems, but the impact on these ecosystems remains unknown. Thus, it is crucial to understand how these novel algal ecosystems may facilitate harmful epibiont dispersal. This temporal study documents how the epibiont community on *T. ornata* rafts may change over time using DNA metabarcoding, providing critical insights into the potential of algal rafts to facilitate novel ecological connectivity among tropical reef ecosystems. Given *T. ornata's* proliferation and the floating habitats they create, it is critical to understand the dynamics of their epibiont communities to elucidate how this novel dispersal pathway may transport epibionts among coral reef ecosystems, with unknown ecological consequences.

172 - RIPRAP REINFORCEMENTS: HOW DO PHOTOSYNTHESIS AND RESPIRATION AFFECT THE ABIOTIC ENVIRONMENT IN A NEW COASTAL ARMORING TECHNOLOGY?

Ghannadian, M.*; Pooni, J.; McIntire, L.C.; Miller, L.P.

San Diego State University

Organisms that reside in highly developed cities are often faced with extreme habitat loss due to urbanization. In San Diego Bay alone, roughly 75% of the shoreline habitat is composed of human-built structures. To combat habitat loss, the Port of San Diego installed new armoring technology called COASTALOCK (ECOncrete) in 2021 in two installments in the rip-rap on Harbor Island. Each installment is made up of three rows of "pools" made of an engineered concrete, designed to promote ecological communities better than the existing rip-rap. To quantify how well these units are performing, we measured the effect photosynthesis and respiration have on the dissolved oxygen in these pools, specifically at low tide, when they are isolated from the ocean. We collected temperature, dissolved oxygen, and salinity measurements at both 5 and 30 cm depths, to quantify how limited mixing at low tide and the variation in algal distribution affect the abiotic conditions at different depths. Further, to estimate how photosynthesis and community respiration contribute to the dissolved oxygen levels, we covered 6 random tide pools with tarps to stop photosynthesis for about one hour before resampling. Preliminary data suggest that abiotic conditions did not vary with depth, but photosynthesis is the driving force behind changes in dissolved oxygen levels. This is demonstrated by the significant changes in dissolved oxygen before and after the blackout treatment. This project will begin to inform the efficacy of novel coastal armoring technologies.

173 - EPIZOOTIC SHELL DISEASE, ENERGY STORAGE, AND IMMUNE FUNCTION IN AMERICAN LOBSTER

† Bell, A.R.[1*]; Stepnowski, A.R.[2]; Yoshioka, R.M.[3]; Rocker, M.M.[3]; Johnston, K.E.[3]; Groner, M.L.[3]

1- Bowdoin College 2- Colby College 3- Bigelow Laboratory for Ocean Sciences

The American lobster (*Homarus americanus*) is a key fishery with US commercial landings valued at $515 million in 2022. Epizootic shell disease (ESD), caused by microbial dysbiosis, creates lesions on the exoskeleton and can increase mortality by 70% in lobsters with moderate to severe cases. Lobster populations in the northwest Atlantic have varying levels of ESD prevalence, with prevalence highest at the southern end of their range. ESD in American lobster is enhanced with warming waters and is expected to increase as seawater temperatures continue to rise. Currently the physiological impacts of the disease are not well understood. Here we test the hypothesis that energy storage is reduced and immune responses are increased in lobster with ESD collected from three coastal populations spanning their range in the United States. From each population, lobsters with varying levels of ESD were studied for short-term (glucose from hemolymph), mid-term (glycogen from tissue) and long-term (lipids from hepatopancreas) energy storage as well as secondary infection response based on hemocyte total and differential counts. Hemocyte total counts can serve as indication for secondary infections and differential counts indicate levels of clotting, phagocytosis and encapsulation. Results will be presented and discussed in the context of fisheries management.

174 - SEDIMENT CHARACTERISTICS AND BLUE CARBON STORAGE WITHIN EELGRASS BEDS IN THE HOOD CANAL REGION

Anderson, K.N.*; Skubel, R.A.

WA Dept. of Natural Resources

Eelgrass (*Zostera marina*) is an ecosystem engineer that influences sediment characteristics via rhizome growth stabilizing adjacent sediment, and shoots slowing water movement allowing finer sediment to settle in and around the bed. It is hypothesized that sediments within eelgrass have the potential to store more carbon than surrounding mud flats, due to increased decaying biomass. The eelgrass in Puget Sound is uniquely influenced by currents and water movement, giving it more opportunity to influence sediment movement and carbon storage. In 2024, the Acidification Nearshore Monitoring Network (ANeMoNe) started a project to address whether eelgrass is influencing sediment at their monitoring sites. We performed loss on ignition carbon content and grain size analyses on samples collected inside and outside eelgrass beds at four ANeMoNe sites in the Hood Canal region, collecting samples at the start and end of the eelgrass growing season in May and August. Preliminary results for carbon content indicated lower or similar carbon storage inside the eelgrass bed compared to outside. This could be due to other benthic vegetation outside the eelgrass beds contributing to carbon cycling more than eelgrass, and future research is needed to understand the impact of other vegetation on carbon storage. These data are the first of a multiyear project to better characterize the uniqueness and changes in eelgrass beds, information we hope will increase the understanding of environmental characteristics that allow eelgrass to thrive in the region and combat climate change.

175 - THE ACIDIFICATION NEARSHORE MONITORING NETWORK (ANEMONE): PUBLIC ENGAGEMENT IN CLIMATE RESILIENCE MONITORING IN THE PUGET SOUND

Boyd, S.L.[1*]; Allen, K.S.[2*]; Anderson, K.[2]; Skubel, R.[2]

1- Washington State Dept. of Natural Resources 2- WADNR

The Acidification Nearshore Monitoring Network (ANeMoNe) is a project run by the Washington State Department of Natural Resources (WADNR) consisting of a network of 12 long-term monitoring sites in the Puget Sound and Outer Coast Estuaries that compare environmental parameters within and directly outside of native eelgrass beds (*Zostera marina*). ANeMoNe collaborates with local communities, tribes, colleges, and non-profit organizations to collect biological data and maintain sensor arrays during the spring and summer when biofouling is of greatest concern. Participants are able to learn about nearshore ecology, gain experience in fieldwork methodology, sensor calibration, and oyster larval ID. Our internship programs often offer payment or school credit for their work through various different grants awarded to ANeMoNe and our collaborators. Volunteers are recruited through a wide network of partnerships including county volunteer databases, college job boards, tribal governments, tabling at fairs, and more. During the off season, ANeMoNe staff use the data collected to create a K-12 climate change curriculum that focuses on place-based ecology including eelgrass biology, salmon ecology, and climate justice. This data is also made publicly available and is utilized by

WADNR to supplement other research and to inform policy decisions that involve the nearshore habitat. By prioritizing environmental stewardship and community engagement, WADNR can collect valuable data while educating the public and protecting Washington's invaluable nearshore ecosystems.

176 - SIPHONOUS SHOWDOWN: MECHANISMS DRIVING DIFFERENCES IN RHIZOIDAL GROWTH OF THREE COENOCYTES

Franks, J.J.*

Moss Landing Marine Laboratories

Persistent seaweed populations rely heavily on adaptive responses to disturbance. Siphonous green seaweeds, such as *Caulerpa* and *Halimeda*, are notable for exploiting disturbance for dispersal and colonization. Their coenocytic nature and rhizoidal reattachment abilities enable rapid regrowth, making them adept colonizers. In the mangrove estuary of Isla San Jose, BCS, MX, faunal disturbers like Hawksbill turtles and juvenile parrotfish contribute to fragmenting and disturbing species of *Caulerpa* and *Halimeda* through feeding behavior. Understanding their responses to these disturbances under varied conditions is vital for deciphering their dispersal and invasion strategies. I conducted experiments using seaweed from the estuary to investigate rhizoid growth and substrate preferences in *C. racemosa*, *C. sertularioides*, and *H. discoidea*. Fragment size and substrate type were experimentally manipulated in-situ to simulate disturbance scenarios. Rhizoid quantity and maximum length were measured to quantify fragment regrowth at two time points (3 and 5 days). Results suggest that species, fragment size, and substrate type all influence rhizoid growth. *H. discoidea* exhibited greater rhizoid quantity, *C. sertularioides* showed longer rhizoids, and *C. racemosa* never regrew rhizoids. Substrate preferences varied, with rock as a better substrate for *H. discoidea* and mangrove for *C. sertularioides*. Understanding the mechanisms behind disturbance and recolonization is essential for predicting and managing estuarine systems under changing climatic regimes.

177 - EXPLORING THE ROLE OF LIGHT IN THE THERMAL TOLERANCE OF THE UNDERSTORY KELP PTERYGOPHORA CALIFORNICA

Dolinar, D.P.*; Smith, J.E.

Scripps Institution of Oceanography, UCSD

Climate Change is resulting in widespread and long lasting shifts in nearshore coastal ecosystems. The negative ecological consequences from climate change are exacerbated as foundation species, such as large macroalgae, are negatively impacted and are unable to provide ecosystem services at the scale in which they had historically. Kelp forest canopy cover has dramatically decreased over the last decade in large part due to marine heat waves, resulting in the loss of habitat for many nearshore organisms as well as the loss of shade provided by their canopies. Canopy loss could be expected to either stimulate growth of understory kelp by removing light limitation or it may cause photophysiological stress due to a lack of high light acclimation. In general, little is known about how key habitat forming understory species, such as Pterygophora californica, are impacted by either thermal stress and/or this loss of canopy shading. The goals of this study were to assess the physiological response of P .calfornica to thermal stress across high and low light conditions to simulate marine heat waves in the presence and absence of kelp canopy using a laboratory experiment. This study provides evidence that higher light concentrations decrease the photosynthetic efficiency of P. californica without impacting its overall photosynthetic rate. Additionally, this study reveals that blade tissue degradation occurs under higher temperature conditions (22°C) regardless of light level. Interestingly, this study did not observe any statistically significant interactions among the light and temperature treatments with any of the response variables. These findings illustrate the importance of coupling additional factors with thermal tolerance experiments and can inform new avenues of research regarding the relationship between photobiology and thermal tolerance.

178 - TRIPLOIDS OR DIPLOIDS UNDER CLIMATE CHANGE: AN R SHINY APP FOR PUGET SOUND OYSTER FARMERS

Bajaj, K.[1*]; McElhany, P.[2]; Norrie, C.[3]; Busch, S.[2]

1- Northeastern University 2- NOAA Northwest Fisheries Science Center 3- University of Washington

As climate change worsens and marine heat waves become more frequent, Puget Sound oyster farmers struggle with widespread mortality and reduced yields. In particular, mortality has been observed in triploid oysters (individuals with 3 sets of chromosomes), valued by farmers and consumers for their fast growth and meat quality. A limited body of literature examines the impacts of temperature, salinity, hypoxia, and farm stressors on triploid mortality, but results have not been synthesized or made easily accessible to farmers. We conducted a meta-analysis of diploid-triploid experiments to evaluate the risk of triploid mortality as reported in the literature so far. We compared environmental data from long-term buoys to loggers placed directly on farms to estimate an offset in conditions. This is an important step towards mapping risk of triploid mortality in Puget Sound, where at least 75% of surveyed farmers reported growing triploids. To help farmers understand existing mortality data and receive information relevant to their farm's conditions, we built a model and decision support tool that displays results in a user-friendly format with an R Shiny application. Because the direct link between triploid mortality and the environment is currently not well parameterized, the tool will be improved to provide increasingly confident recommendations as more experimental data is reported. We are also seeking test user feedback to make the tool as accessible to the industry as possible.

179 - THE EFFECT OF MICROPLASTICS ON MARINE SNOW CONSUMPTION BY COPEPODS

Roberts, I.T.*; Prairie, J.C.

University of San Diego

One of the emerging concerns of plastic pollution are the negative effects of microplastics on marine organisms. One understudied way that zooplankton may be exposed to microplastics is through marine snow – aggregates that form in the surface ocean from phytoplankton and other organic material. Since marine snow has been shown to be an important food resource to a variety of zooplankton, our study aimed to determine how the concentration of microplastics in marine snow affected consumption of both organic material and plastic by copepods. The marine snow was made using the phytoplankton species *Thalassiosira weissflogii* added to cylindrical acrylic tanks in four separate treatments: no plastic added, and 0.05 g, 0.0125 g, and 0.005 grams of microplastics added. Cylindrical tanks were allowed to rotate for 3 days to form marine snow, and on experiment day copepods were added and allowed to forage for 45 minutes. Consumption of organic matter was measured with a fluorometer and consumption of microplastics was measured through dissection under a microscope. Here we will present results showing the effects of microplastics in marine snow on and the consumption and foraging behavior of copepods, which has important implications for the consequences of plastic pollution on the health of planktonic food webs.

180 - FORAGING BEHAVIOR OF COPEPODS IN LAYERS OF MARINE SNOW FORMED FROM DIFFERENT SPECIES OF PHYTOPLANKTON

Rauch, D.C.*; Griffin, K.; Prairie, J.C.

University of San Diego

The interactions between zooplankton and marine snow – aggregates formed from phytoplankton in surface waters – play a crucial role in the sequestration of carbon in the ocean. Little is known about how zooplankton interact with these sinking particles and what implications those interactions may have on the food web. The objective of this study was to use high-speed imaging to observe and analyze the behavior of copepods of the species *Calanus pacificus* in the presence of a layer of marine snow formed from different types of phytoplankton. The marine snow aggregates were created by adding phytoplankton cultures to cylindrical acrylic tanks and allowing them to rotate for three days in the dark. Each treatment consisted of marine snow formed from a different diatom species: *Thalassiosira wesisflogii, Chaetoceros affinis*, and *Skeletonema marinoi*. A density gradient was created to allow a marine snow layer to form in the middle of the tank. Copepods and marine snow were filmed using two cameras, which were placed facing neighboring sides of the tank; this allowed us to reconstruct 3D tracks of the swimming copepods. Here we will present results showing how different properties of the copepod foraging behavior, including swimming speed and turning frequency,

differed based on the type of marine snow they were exposed to. This study can provide further understanding the relationship between various zooplankton and marine snow formed from different sources, which has implications for how these interactions can affect the planktonic food web and carbon sequestration.

181 - THE EFFECT OF SEDIMENT ON THE FORMATION AND PROPERTIES OF MARINE SNOW AGGREGATES

Feuerborn, K.A.*; Prairie, J.C.

University of San Diego

The ocean is the largest carbon sink in the world, sequestering carbon from the atmosphere and transporting it to the sea floor where it is stored for hundreds of thousands of years. Aggregates of phytoplankton and other organic and inorganic materials, known as marine snow, are the primary vehicle through which this carbon is transported. The objective of this study was to observe how the incorporation of sediment in different concentrations impacts the formation of marine snow aggregates and their sinking velocities. We conducted a set of experiments using the phytoplankton *Thalassiosira weissflogii* and local sediment samples to create marine snow aggregates in the lab. Treatments using different sediment concentrations were allowed to rotate in cylindrical tanks to form marine snow aggregates. These aggregates were imaged to determine aggregate size and shape, and recorded in a settling tank to determine sinking velocities. We also quantified the incorporation of different sediment sizes and metals in the aggregates for each treatment. Here we present our results showing that higher concentrations of sediment formed smaller aggregates with higher comparative sinking velocities. This may have implications for how the suspension of sediment in surface waters can impact the sequestration of carbon through marine snow aggregate formation.

182 - PURPLE URCHIN MANAGEMENT IN GREATER FARALLONES NATIONAL MARINE SANCTUARY

Contolini, G.*; Hohman, R.; Gómez, J.; Mears, T.; Zepp, A.

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

Bull kelp, *Nereocystis luetkeana*, is the foundation species of kelp forest ecosystems in northern California and historically provided essential ecosystem services in Greater Farallones National Marine Sanctuary (GFNMS). Since 2014, bull kelp has declined dramatically—up to 90% in the sanctuary. Simultaneously, purple urchin densities have increased exponentially, which could prevent long-term recovery of bull kelp. Therefore, one of the first steps of kelp restoration is to reduce purple urchin densities. Greater Farallones Association and NOAA's Greater Farallones and Cordell Bank National Marine Sanctuaries are removing purple sea urchins for kelp restoration at two priority sites in GFNMS, Fort Ross Cove and Timber Cove in Sonoma County. Tapping into the experience and enthusiasm of Sonoma County's commercial red sea urchin fishing industry, we have purchased over 60,000 lbs. of purple sea urchins from five commercial divers since September 2023. The divers have worked more than 215 diver days removing urchins with a bycatch rate under 5%. Urchin densities are nearing zero in targeted areas, and gonad index is variable. Through this project, we have engaged extensively with the small fishing community in Bodega Bay and developed extremely positive relationships with commercial urchin divers, fish processors, and the company that composts the urchins. Their amazing talents and enthusiasm for kelp restoration have built a strong foundation for this work to continue and grow into the future.

183 - FOUL PLAY? DO BIO-FOULERS REDUCE THE COMPRESSIVE STRENGTH OF *OSTREA LURIDA* SHELLS IN SAN DIEGO BAY, CA, USA?

Naquin, T.E.*; Paig-Tran, E.W.; Zacherl, D.C.

CSU Fullerton

Oyster reefs are complex assemblages of live oysters, interstitial space, and dead shell. Bio-fouling organisms can increase shell degradation rate and might compromise shell compressive strength. Decreases in compressive strength, an adaptation to environmental stressors, can, by proxy, estimate reef degradation rates. We measured percent cover of bio-foulers and compressive strength as max load (i.e. maximum amount of force

(N) applied before shell failure) of *Ostrea lurida* (N = 237 live oysters) to test if more heavily fouled shells have weaker compressive strengths than less fouled shells. We sampled two seawalls in San Diego Bay, CA, USA. Grande Caribe has an east-facing seawall and is parallel to the waterline. Cesar Chavez seawall is northwest-facing, perpendicular to the waterline, and has a history of industrial pollution. Compressive strength of *O. lurida* shells increased with bio-fouler cover (p=0.0146), contradicting previous studies suggesting bio-foulers would weaken shells. Small shells (<30 mm) and shells from the lower intertidal (<0.2 m) had lower compressive strength at Cesar Chavez versus Grand Caribe (p=0.0068 and 0.0095, respectively), but this effect did not hold for larger shells (>30 mm) or in the upper intertidal. Overall, multiple factors interacted to affect shell strength, weakening shells at Cesar Chavez relative to Grand Caribe. These data illuminate how bio-fouler effects on shell budget and carbon storage within oyster reefs in the face of climate change.

184 - PHENOTYPIC AND GENETIC VARIATION ACROSS THE GULF OF MEXICO AND ATLANTIC POPULATIONS OF THE MARSH PERIWINKLE, LITTORARIA IRRORATA

Mack, C.F.*; Jiwad, W.; Browne, A.; Kelly, M.W.

Louisiana State University

The marsh periwinkle, *Littoraria irrorata*, is a keystone species in salt marsh ecosystems, playing a crucial role in trophic dynamics and the health of these habitats. These snails feed on epiphytic algae that grows on marsh grasses, which controls algal populations and promotes plant health. However, grazing can also stress marsh grasses when snail populations become too dense, leading to potential marsh degradation. When predicting ecosystem effects of climate change, it is common to use measurements made on a single population to predict species-level effects, however measurements made on a single population may not serve as an accurate proxy for the species as a whole. We investigated the phenotypic and genetic variation of *Littoraria irrorata* populations across the Gulf of Mexico and southern Atlantic coasts, aiming to understand the extent and drivers of intraspecific diversity. Morphological measurements, including shell height, width, and aperture were analyzed, along with genetic data derived from mitochondrial DNA sequencing to estimate gene flow among populations. Through comparative analysis of *Littoraria irrorata* populations along our study range, significant regional differences were observed in both forms of traits. This study highlights the limitation of using a single proxy to characterize populations across diverse coastal environments. These findings have important implications for the conservation of salt marsh ecosystems, highlighting the need to consider regional differences in resilience and adaptability of *Littoraria irrorata* populations.

185 - INTRASPECIFIC VARIATION IN DIET ACROSS POPULATIONS OF MARSH PERIWINKLES

Browne, A.A.*; Mack, S.F.; Jawad, W.A.; Kelly, M.W.

Louisiana State University

Dietary studies provide key information about partitioning of food resources across space and time. Many factors could modulate intraspecific variation in diet, such as variation in food availability and environmental conditions. Understanding and predicting the foraging activity of organisms across populations is important for analyzing food web dynamics. The marsh periwinkle snail *(Littoraria irrorata)* are a good system to test intraspecific variation in species interactions due to their abundance and large geographic range spanning from the East Coast of the United States of America as far north as Maryland, and along the Gulf of Mexico. These species are commonly known for grazing on fungi, particulate organic matter in sediments and *Spartina alterniflora* (smooth cordgrass), however due to its large distribution, variability in their dietary consumptions can arise but have not been well documented. By using Stable Isotope Analysis, which analyzes long-term assimilation of the diet, this study highlights variation in diet across the species range. Knowledge of intraspecific variation in diet will improve understanding of impacts of climate change and effects of local stressors,and make a pivotal contribution to predicting future saltmarsh ecosystem structure and functionality.

186 - THE EFFECT OF WATER FLOW ON MUSSEL BYSSAL THREAD DYNAMICS

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1- California Institute of Technology 2- Carleton College

On rocky shores, benthic organisms develop strategies to resist hydrodynamic forces that detach them from the substratum. For example, mussels deploy byssal threads whose efficacy may or may not be influenced by environmental conditions. We conducted a series of experiments testing the effects of a wide range of water velocities (e.g., 10, 15, 50, and 130 cm s^{-1}) on the quantity and quality of byssal thread production in the mussel, *Mytilus trossulus*. Under slow flow, mussels laid threads almost exclusively in the upstream direction, presumably serving as an anchor. At higher velocities, however, mussels began laying threads perpendicular to the primary direction of flow, possibly serving to stabilize against secondary flows associated with turbulent water motion. Threads from mussels exposed to different water velocities showed no statistically significant differences in mechanical strength (e.g., elastic modulus, yield force, or maximum breaking force). However, there was higher gene expression (Mfp1 and preCol-P) associated with proteins found in regions of the thread where breakage was observed to occur most frequently. Lastly, mussels laid a fewer number of threads under high flows. We will discuss the implications of these physical effects in the context of the ecology, physiology, and molecular biology of marine mussels.

187 - A STUDY ON THERMAL PERFORMANCE AND HYBRIDIZATION IN MYTILID MUSSELS

Santamaria Germani, R.*; Nishizaki, M.

Carleton College

Hybridization is a well-documented phenomenon in nature, with significant ecological and evolutionary consequences. In marine environments, where hybrid zones - regions where distinct species can interbreed - are generally less common than in terrestrial systems. Moreover, the climate change is expected to increase the frequency of species overlaps, thus creating new opportunities for hybridization. The extent to which hybrids may or may not functionally differ from either parent species is an important ecological question and remains relativly unknown for many taxa. This study examines the physiological performance of hybrids between two mytilid mussel species, *Mytilus trossulus* and *M. galloprovincialis*. Hybrid individuals were identified through genotyping, and their respiration rates were compared to those of their parent species. Molecular genotyping of each mussel used in our respiration experiments identified hybrid individuals, whose respiration rates were then measured and compared to those of their parent species. Rates measured under a range of water tmpertures (5-29C) were used to construct thermal performance curves for both species and the hybrids. Results showed that hybrids exhibit a respiration response that was intermediate of both species, but more closely resembled those of *M. trossulus* (e.g., similar thermal optima). Quantifying these differences in thermal performance for hybrids has important implications for understanding invasion biology under future climate change.

188 - A SPARROW'S TOOLKIT: ASSESSMENT AND MONITORING OF AMMOSPIZA CAUDACUTA AT THE NARRAGANSETT BAY NERR

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Salt marshes serve as vitally important ecosystems for many organisms, but accelerated sea level rise is leading to their decline. This is putting marsh-reliant species at risk, such as the threatened Saltmarsh Sparrow (*Ammospiza caudacuta*), which rely on healthy marsh habitat for nesting. Monitoring Saltmarsh Sparrow populations while developing minimally invasive monitoring methods is thus important for conservation efforts. Given this, the present study centers on the following goals: understanding Saltmarsh Sparrow distribution and relative abundance on Prudence Island, Rhode Island, using SHARP (Saltmarsh Habitat and Avian Research Program) surveys; discerning what additional information passive monitoring methods could provide about Saltmarsh Sparrows; and exploring consequences of camera traps on sparrow nest predation. Saltmarsh Sparrows were the second most recorded bird, and their abundance positively correlated with increased cover of high marsh grass (*Spartina patens*). Passive sampling methods, such as camera traps and acoustic monitoring, yielded no additional information on Saltmarsh Sparrows when compared to SHARP, but showed potential benefits for secretive marsh bird monitoring. The results also show that camera trap presence did not

make a significant difference on nest predation. This study highlights the importance of high marsh habitat restoration for Saltmarsh Sparrow conservation, and reinforces that cameras used for nest monitoring have minimal impact. Further research into more passive study methods is recommended for long-term monitoring efforts.

189 - IDENTIFYING RESILIENCE IN ZOSTERA MARINA MEADOWS IN THE SAN JUAN ISLANDS, WASHINGTON

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1- University of Washington 2- Friends of the San Juans 3- Washington Dept. of Natural Resources 4- Cornell University

Eelgrass (*Zostera marina*) is a vital ecosystem engineer in the Salish Sea and is an indicator for ecological health in Puget Sound, Washington. Eelgrass meadows around the San Juan Islands have declined significantly in recent years, limiting the many ecosystem services eelgrass meadows provide and disrupting food webs. Seagrass wasting disease (SWD), caused by the protist *Labyrinthula zosterae*, is among the modern stressors facing these meadows. Known conditions that reduce disease are cooler and deeper waters. This survey aimed to identify resilience (biotic or abiotic conditions that reduce SWD susceptibility) in San Juan Island eelgrass meadows. Here, we surveyed 11 subtidal eelgrass meadows in summer 2023 for biometric and disease analyses. We utilized the Eelgrass Lesion Image Segmentation Application (EeLISA) AI program to process collected plants. Disease prevalence (proportion of infected leaves) and disease severity (proportion of infected leaf area) varied significantly between survey sites. Sites had variable environmental conditions– such as depth, turbidity, and current – that may influence SWD susceptibility, suggesting some meadows may serve as refugia from disease and climate stressors. In the face of global and local climate change stressors, this study reinforces the importance of holistic analyses of disease and environmental conditions to better understand eelgrass resiliency and identify priority meadows for conservation.

190 - IMPACT OF DIRECT OCEAN CARBON CAPTURE EFFLUENT ON MUSSEL LARVAE AND ADULTS: IMPLICATIONS FOR MARINE ECOSYSTEMS AND SHELLFISH AQUACULTURE

Churches, N.C.[*]; Kim, D.; Jacobson, I.; Stromberg, K.; Campero, F.G.

Holdfast Aquaculture

Direct Ocean Capture (DOC) presents a promising carbon dioxide removal strategy by capturing CO2 from the ocean, the planet's largest inorganic carbon reservoir and continuous sink for atmospheric CO2. Captura Corporation, a California-based company, has developed an electrodialysis-based DOC technology that removes up to 90% of CO2 from seawater. The process produces two outputs: a measurable stream of CO2 that subsequently can be sequestered or utilized, and a stream of decarbonized seawater with slightly elevated pH, which is returned to the ocean with restored capacity to absorb CO2. To assess the environmental impact of this effluent on marine ecosystems and explore synergies with sustainable industries, Captura has partnered with Holdfast Aquaculture, which specializes in ecologically and commercially important low-trophic species (e.g. seaweeds and bivalves). Here, we present preliminary results from short-term exposure assays on the sensitive bioindicator and traditionally farmed mussel species, Mytilus galloprovincialis. Larvae and adults were exposed to increasing effluent concentrations to measure lethal and sub-lethal effects after 48 and 96 hours. Larvae exhibited no significant differences or impacts when exposed to up to 70% effluent, and all adult mussels survived and formed byssal threads across all treatments. These findings suggest the effluent may have minimal effects on marine ecosystems and may be used in shellfish hatcheries. Ongoing research will compare mussel performance in effluent versus regular seawater by assessing growth and attrition rates, including metabolic and molecular assays as additional non-lethal indicators of stress. Understanding the environmental effects of effluent and potential synergies with other sustainable industries is important for the adoption of DOC technologies.

191 - REFINING EQUITABLE PATHWAYS IN MPA MANAGEMENT FOR CALIFORNIA COASTS

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California's coastline spans over 1,100 miles with 124 Marine Protected Areas (MPAs), designed to protect biodiversity and vulnerable marine ecosystems. In theory, MPAs represent a management practice that can provide benefits to both the marine environment and to the human communities who use and/or value it. Though community co-management and ongoing communication between resource managers and diverse stakeholders have been identified as key contributors to the success of MPAs worldwide, there are ongoing concerns about who has a voice in the management of California MPAs. Here we use a cross-cultural comparative survey to investigate how coastal spaces contribute to human-wellbeing across underserved communities in central California and identify what factors function to mediate ocean access and benefits across different socioeconomic and cultural groups. More specifically, we aim to investigate how California residents' interactions with ocean spaces shape their priorities surrounding area-based coastal management. Utilizing a survey instrument (questionnaire), we engaged with residents to collect their perspectives on ocean engagement. Preliminary results have shown contrasts between priority ranking attributes between ethnic and gender groups. This information will be of critical importance to resource managers seeking to develop adaptive management strategies so that MPAs and other ocean areas may benefit all Californians, now and in the future, regardless of how environmental and socioeconomic changes may function to transform local marine environments.

192 - EVALUATING THE ROLE OF WETLAND HABITAT FEATURES IN SHAPING BIRD RESIDENCE PATTERNS FOR EFFECTIVE CONSERVATION STRATEGIES

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As climate change continues to impact ecosystems worldwide, wetlands have been disproportionately affected because they are close to human settlements. Wetland degradation is an essential focus for habitat restoration because increased connectivity of these sensitive habitats can significantly improve ecosystem function. The Los Cerritos Wetland (LCW) is an urban wetland fragment in Southern California in the pre-tidal restoration stage. Neighboring waterways are home to many animals, including sea turtles, fishes, and birds. We set out to understand the current use of LCW habitats pre-restoration to better track the impacts of tidal restoration on this wetland fragment. We focused on native birds because they utilize the habitat as part of their migration pattern. This study looked at the effects of wetland habitat features, like plant community composition, on native bird occupancy. We also looked at time of day use to determine bird residence time in the wetland. Birds were more frequently observed within salt marsh habitats containing native, shorter species like pickleweed compared with taller, invasive brush-like mustard grass. The most commonly observed species were egrets and swallows, which were more frequently observed at dawn and dusk during cooler times of day. Understanding the influence of wetland habitat features and bird residence patterns is crucial for informing conservation strategies that protect and enhance these critical ecosystems for native bird populations.

193 - HOW'S THE WEATHER IN THERE? IMPACTS OF EXTREME WEATHER EVENTS ON PARASITISM IN RIVERINE FISHES

† Whalen, C.[1*]; Boyd, D.[2]; Christner, S.[3]; Commisso, G.[1]; Jones, I.[4]; Leslie, K.[1]; Thirtyacre, J.[1]; Kuris, A.M.[5]; Mann, J.[6]; Bart, H.[7]; Díaz-Morales, D.[1]; Wood, C.L.[1]

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Extreme weather events have been increasing in frequency and magnitude as anthropogenic climate change drives increasing volatility in climatic conditions globally. These extreme weather events, including hurricanes, floods, and droughts, can cause outbreaks of parasitic disease in humans, but little is known about how these events impact rates of parasitism in wildlife populations. Our team dissected 1,188 fish collected

between 1963 and 2005 from various locations along the Pearl River in southern Louisiana and counted all the metazoan parasites within these fish. We also identified extreme weather events that affected this river system during the focal time period, including 5 major droughts, 3 major floods, and 20 hurricanes. We will assess the correlation between extreme weather events and change in parasite burden within the Pearl River ecosystem for 7 fish species. 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 have been affecting and could continue to affect wildlife populations in the southern United States.

194 - EVOLUTION OF SLOWER DEVELOPMENT IN TELEOST FISH THAT GUARD OR HIDE EGGS

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University of Washington

Published times for early cell divisions and formation of somites of embryos of teleost fish confirmed that protection of eggs is associated with slower development. Development rates were more uniformly fast for embryos of species with nonadhesive scattered eggs than for species with guarded or hidden eggs. If slower development of more protected embryos results from selection or drift, protection causes development rates to decrease over time, presumably with varied rates of evolutionary change and with changing costs and benefits of protection. Slower development can increase costs of a decrease in protection, contributing to a changing bias (hysteresis) in direction of evolutionary change in life-histories. Species with guarded or hidden eggs were similarly slower in development. Among species with adhesive eggs that are not reported to be guarded or hidden, development rates were varied and often slow, which suggests that adhesive eggs often develop at safer sites than eggs that are nonadhesive. Early cell divisions and formation of somites differ in cellular and molecular processes, but both evolved to become slower in more protected embryos. Evolution of slower development of protected embryos is not a result of an increase in egg size. Protection can increase age at hatching in disproportion to the slowing of developmental processes. Because age at hatching depends on stage of development at hatching and stimuli for hatching in addition to rate of development, age at hatching is a poor measure of rate of development.

195 - DO INVASIONS AMPLIFY OR IMPOVERISH NATIVE PARASITE COMMUNITIES? TWO CASE STUDIES IN NORTH AMERICAN FRESHWATER ECOSYSTEMS

† Commisso, G.[1*]; Boyd, D.[2]; Christner, S.[3]; Jones, I.[4]; Leslie, K.[1]; Thirtyacre, J.[1]; Whalen, C.[1]; Kuris, A.M.[5]; Mann, J.[6]; Bart, H.[7]; Díaz-Morales, D.[1]; Wood, C.L.[1]

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Invasive species can have dramatic effects on ecosystem dynamics, but how they influence the parasite community of recipient ecosystems is almost entirely unknown. According to the enemy release hypothesis, species are more heavily parasitized in their native than in their introduced ranges, which may be a factor in invasion success. **When ecosystems are flooded with parasite-free invasive hosts, what happens to native parasites and hosts?** I am planning two studies to investigate.1. Dreissenid mussels are prolific invaders of North America. Using 360 specimens from 3 fish species held at the Cornell Biological Field Station, collected from before and after invasion of Oneida Lake, I will measure how parasite diversity and abundance changes in fishes after the invasion of these low-trophic level filter feeders. I expect to see a reduction in parasites with free-living life stages post-invasion.2. Western Mosquitofish (Gambusia affinis) are native to the southeastern US, but were introduced to the southwest as a malaria control measure with unanticipated collateral impacts. Using >2000 fishes from 2 long-term collections, I'll compare the rate of change in parasite burden of mosquitofish collected in their native range (Pearl River, LA; Tulane Biodiversity Research Institute) and introduced range (Albuquerque, NM; Museum of Southwest Biology) against the rate of change in parasite burden of other fish species native to both basins. I expect to find that native parasites hosted by invasive mosquitofish are more sensitive to environmental stressors than those living on native fishes.

196 - EXAMINING TEMPORAL CHANGES OF THE MARINE PLANKTONIC COMMUNITY IN OCEANSIDE, CALIFORNIA

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CSUSM

Collecting long-term data allows for researchers to track, predict, and manage changes that occur over time. This project is the beginning of long-term seasonal monitoring research off Oceanside Pier in southern California. Our specific aim was to examine the abundance and diversity of marine plankton off Oceanside Pier. To the best of our knowledge, there are no studies examining the composition of the planktonic community in Oceanside, California. Oceanside Pier has been under construction and suffered a fire while sampling. Samples were collected once a month from February to October of 2024. Chlorophyll was sampled and measured as a proxy for phytoplankton abundances. The minimum chlorophyll was 1.36 ug/L in the winter, which eventually increased to 13.24 ug/L during summer. The abundance of plankton in the community increased from winter to summer. There was a higher abundance of diatoms in the winter months which eventually shifted to dinoflagellate dominance in summer. Temperature, dissolved oxygen, pH, turbidity, and nutrient measurements were taken to characterize the environment. pH levels increased from 7.95 to 8.4, while turbidity was variable throughout the sampling period. Dissolved oxygen levels stayed around 8 ppm, with an increase to 9.6 ppm two weeks after the fire took place at the pier. This research has provided foundational knowledge of the changes in the planktonic community and the marine environment during periods of appreciable anthropogenic impacts off southern California. This project has increased the knowledge of the temporal shifts in the planktonic community at this location and understand how changes in environmental parameters may be influencing the community.

197 - FIVE-SPINE GREEN CRAB (*CARCINUS MAENAS*) FEEDING TRIALS: A PROGRESS REPORT

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University of Oregon

There has been a consistent increase in the abundance of 5-Spine Green Crab (*Carcinus maenas*) in Coos Bay, 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 unknown and require deeper investigation. Green crabs are known to have a variable and omnivorous diet, including bivalves as the most common prey item. I conducted a feeding trial where green crabs were fed a single species diet for eight weeks. The diets included Pacific Oyster (*Crassostrea gigas*), Dungeness crabs (*Metacarcinus magister*), and shore crabs (*Hemigrapsus* sp.). Green crabs gained on average 0.69 ± 0.98g, 1.03 ± 0.91g, and 0.48 ± 0.95g per week, respectively for each diet. They consumed on average 6.77 ± 0.90g, 6.06 ± 0.88g, and 5.29 ± 1.02g per day, respectively. Tissue samples will be taken from these green crabs to create fatty acid profiles for each diet. Fatty acids are now commonly used as trophic biomarkers to infer ecological connections between species. The fatty acid profiles of the experimental green crabs will be compared to wild green crabs to determine the diets of wild green crabs in the Coos Bay estuary. This information will help characterize green crab trophic ecology and their ecosystem impacts. This research will benefit the community of Coos Bay by determining the impact of an invasive species on important local commercial and recreational fisheries.

198 - EXPLORING ENVIRONMENTAL FACTORS WHICH MAY INFLUENCE COMMUNITY ASSEMBLY IN MARINE LAKES, PALAU, MICRONESIA

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UC Merced

Marine lakes – parts of seawater surrounded by land – are island-like systems which have limnological differences that may give insights into how communities could be re-shaped in a world changed by climate. This proposition raises three questions. One, can we identify whether there are natural groupings of lakes that reflect more ocean-like versus more acidified, eutrophic, warmer lakes? Two, which environmental factors

differentiate Palauan marine lakes? And three, how might this shape their communities? To answer the first and second questions, we gathered environmental data about lakes (2006 – 2019) which we analyzed using PCA and time-series graphs. For the third question, we gathered available information about macro-invertebrate and microbial communities which we compare with the environmental data. Our analyses revealed distinct clustering of ocean, holomictic (fully mixed), and meromictic (vertically stratified) sites. Temperature is the main factor for this distinction, but other factors (oxygen, pH, and salinity) also are significant in characterizing these environments. Lake temperatures and salinity have increased through time. Thus, marine lakes may serve as a model for ocean changes and their effects. By understanding environmental change and community assembly, we can enhance our knowledge of island environments under climate change and anticipate community shifts, consequently managing and conservating these habitats.

199 - PREDICTING THE WEIGHT OF A FAMILY OF FISH USING LENGTH, HEIGHT, OR AREA

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CSU Sacramento

Body weight is a critical characteristic of a fish, though it cannot always be measured directly, particularly in the field. Other measurements such as Standard Length, Total Length, Height or Profile Area can be used to estimate Weight, but Profile Area takes much more time and effort to evaluate. The family of Cichlid fishes is one of the most diverse groups of freshwater fishes, comprising around 1800 species, and they come in many shapes and sizes. Cichlids are an ideal family of fishes to test which measurement is the best predictor of Weight: is it Total Length, Standard Length, Height, or Profile Area? I analyzed 62 species of live cichlids, one specimen per species. For each specimen, I measured Standard Length, Total Length, and Height using calipers. I photographed the specimen and Profile Area was determined using ImageJ software. These data were analyzed through regressions to determine which of the measurements best predicted Weight. This research suggests that Length is a good predictor of Weight; however, when combined with Height, this improves the predictions. Profile Area further improves these predictions; however, it requires the most time and effort to obtain. The findings from this research can help other researchers to determine which measurements they should gather while in the field when wild fish are being measured and speed is a necessity. It can also help us to estimate missing data from older publications.

200 - EFFECTS OF DIATOM-DERIVED POLYUNSATURATED ALDEHYDES ON EMBRYONIC AND LARVAL SURF SMELT (HYPOMESUS PREOTISUS) FITNESS

Kim, J.*; Cobb, J.; Clelland, G.; Cooper, J.W.; Olson, B.M.

Western Washington University

Polyunsaturated aldehydes (PUAs) are secondary oxylipins produced by some diatoms. PUAs are produced more when the diatom cells are damaged, suggesting they act as chemical grazing deterrents. Past studies showed negative effects of particulate PUAs on diatom consumers like copepods and marine invertebrates. However, very few studies have explored the potential for diatom-derived PUAs to affect marine vertebrates, such as forage fish. Forage fish are a foundational functional group in marine ecosystems whose early life stages are often sympatric with benthic diatoms due to their nearshore spawning behavior. In this study, we addressed the question of whether PUAs detrimentally affect common forage fish found in the Salish Sea, the surf smelt (Hypomesus preotisus). We investigated how PUAs affect surf smelt embryonic development and physiology by measuring survival and hatch success rates, use of endogenous energy, and embryonic heart rates. Higher concentrations of PUAs resulted in higher mortality and lower hatch success rates. Exposure to PUAs had no effects on the use of endogenous energy. Embryonic heart rates were equivalent when embryos were exposed to PUAs soon after fertilization, suggesting that surf smelt embryos can acclimate to PUAs if exposed during early development. However, higher concentrations lowered the heart rates of embryos that were exposed to PUAs days after fertilization. Our results indicate that exposure to dissolved PUAs affects forage fish early life history fitness and survival, potentially leading to cascading effects on marine ecosystems.

201 - PARASITES ACROSS TIME: THE IMPACT OF ENVIRONMENTAL CHANGE ON MONOGENEAN ABUNDANCE

† Jones, I.[1*]; Boyd, D.[2]; Christner, S.[3]; Commisso, G.[4]; Díaz-Morales, D.[4]; Leslie, K.[4]; Thirtyacre, J.[4]; Whalen, C.[4]; Kuris, A.M.[5]; Mann, J.[6]; Bart, H.[7]; Wood, C.L.[4]

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The Pearl River in Louisiana has been historically influenced by multiple stressors like warming and pulp-mill effluent, potentially impacting parasite abundance. Monogeneans are ectoparasitic on fish gills and have a direct life cycle placing them as ideal models to understand biological responses to environmental change. Thus, we aimed to address whether environmental change influences monogenean abundance over time. We expected monogenean abundance to change linearly or in a downward bell-shaped curve with time, and pollution to interact synergistically or antagonistically with time. To answer this, fish species including *Ictalurus punctatus, Pimephales vigilax,* and *Notropis atherinoides* were seined annually throughout five decades (1963-2005) and preserved at the Tulane University Biodiversity Research Institute. Fish were dissected and examined for monogeneans. Monogeneans were identified to the lowest possible taxonomic level, and their abundance was analyzed in response to time, pollution, and their interaction using generalized linear mixed models. Three different monogenean genera were identified: *Dactylogyrus* spp. infecting *Pimephales vigilax* and *Notropis atherinoides*; *Gyrodactylus* spp. infecting *P. vigilax*; and *Ligictaluridus pricei* infecting *Ictalurus punctatus*. The abundance of *Dactylogyrus* spp. infecting *P. vigilax* increased linearly with time. *L. pricei* infecting *I. punctatus* had a non-linear change in abundance over time. Pollution did not have a single or interactive effect on parasite abundance. The historical genus-specific change of monogenean abundance offers insights relevant to fish health and aquatic ecology in a changing world.

202 - HOPPING AROUND THE SALISH SEA: INVESTIGATING HOW SHORELINE MODIFICATION AND KELP AFFECT WRACK, INVERTEBRATE, AND BIRD COMMUNITIES

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Our research focuses on the effects of shoreline modification on biodiversity among sites in the Salish Sea bioregion. We compared invertebrate abundance and richness across locations, shoreline status, substrates, and kelp presence; and the relationships with wrack composition and birds. The goal of this research is to contribute to our understanding of the effects of human modification on coastal ecosystems and the potential efficacy of restoration. Investigating coastal trophic cascades and food webs, we aim to discover potential ecological indicators of modification and restoration. Invertebrate communities are particularly responsive to changes in environmental conditions and represent good candidates for this type of research. General patterns in the results suggest that the influence of shoreline modification on invertebrate and bird communities depends upon location, substrate, wrack, and kelp presence. For example, we found invertebrate richness was significantly different between shoreline modifications in combination with substrate types; natural shorelines had the highest richness in mixed and sand substrates, whereas modified shorelines had the lowest. Conversely, modified shorelines had the highest richness in pebble substrates while natural shorelines had the lowest. Our research highlights the importance of considering multiple habitat factors (e.g. substrate, wrack, kelp, etc.) that could impact how an ecosystem could be restored after shoreline modification that accounts for ecological dynamics (e.g. trophic cascades, food webs, connectivity, etc.).

203 - TEMPERATURE IMPACTS ON THE ABUNDANCE AND GROWTH RATE OF PSEUDO-NITZSCHIA SPECIES LOCAL TO MONTEREY BAY, CALIFORNIA

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Harmful Algae Blooms (HABs) are a global issue that occur when toxic phytoplankton, like species in the pennate diatom genus *Pseudo-nitzschia (PN)*, capitalize on favorable water conditions to form dense physical aggregations. Monterey Bay (MB), California has experienced severe HAB events recently in conjunction with warm sea surface temperature (SST) anomalies One of the most toxic HABs followed the 2015 Pacific Marine Heat Wave (MHW) that warmed MB to over 15°C. Natural processes like El Niño Southern Oscillation (ENSO) events and anthropogenic activities can contribute to similar warming, and models predict a 1-3°C rise in global SSTs. We seek to understand how the abundance of *PN* species local to MB respond to these temperature increases to better predict HAB threats by establishing growth rate and abundance measures at the current average MB SST, 12°C. We expected both measurements to be greater from *P. multiseries* than *P. pungens*, due to its prevalence in prior HABs. This study employed growth rate experiments to compare the two species. We measured species abundance and calculated growth rates from daily cell counts using a Sedgewick Rafter counting chamber. The results support that *P. multiseries* outperforms *P. pungens* in abundance and growth rate. Ultimately, HABs threaten to cost coastal communities millions in fisheries closures and pose a hazard to human and marine health. In comparing species at current MB average SSTs, we are establishing a comparison base for future temperature studies and improving HAB monitoring networks and models.

204 - COMPARISON OF BENTHIC FORAMINIFERA ABUNDANCE ON WESTERN PACIFIC ATOLL REEFS

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1- Santa Barbara City College 2- CSU Monterey Bay 3- One People One Reef

Coral reefs are the most biodiverse ecosystems in the oceans. However, the microfauna are under-explored. Among these are benthic foraminifera, which may play important roles in nutrient cycling on reefs. We analyze how foraminifera abundance varies between two Indo-Pacific western-facing atoll reefs in Yap State, Federated States of Micronesia. We found a stark diversity in the foraminiferan population, ranging from absent to abundant. These preliminary findings are guiding our further research regarding if/how foraminifera populations impact coral reef function and health. Such research is important due to the paucity of knowledge about the lifestyles, predators, roles, and relationships of these potentially important reef organisms. Diving into any of these parts of foraminifera will provide more insight into the factors that may impact the structure of the reefs we all know and love.

205 - ARE COMPLEX LIFE CYCLE PARASITES MORE SENSITIVE TO POLLUTANTS THAN DIRECTLY TRANSMITTED PARASITES?

† Christner, S.[1*]; Boyd, D.[2]; Commisso, G.[3]; Díaz-Morales, D.[3]; Jones, I.[4]; Leslie, K.[3]; Thirtyacre, J.[3]; Whalen, C.[3]; Kuris, A.M.[5]; Mann, J.[6]; Bart, H.[7]; Wood, C.L.[3]

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Previous studies have found that parasites have a variety of responses to pollutants which vary based on their taxonomic groupings and life histories. Pulp mill effluent in particular produces a diversity of responses among parasite taxa. But most of these past studies have been done over short time periods and at small spatial scales, which fails to account for the indirect effects of pulp mill effluent, such as impacts on host reproductive processes. Would there be the same diversity of responses in natural communities over long time spans? To investigate how parasites respond to pulp mill effluent over long time periods and at large spatial scales, we performed parasitological dissections on specimens collected from above and below the International Paper pulp mill in Bogalusa, LA, and stored in the Tulane University Biodiversity Research Institute. We selected six fish species (*Carpiodes velifer, Gambusia affinis, Ictalurus punctatus, Notropis atherinoides Percina vigil, Pimephales vigilax*) collected from the Pearl River between 1963 and 2005. We found that both direct and complex life cycle parasites decreased in response to pollution. By looking at a natural community over the span of forty years, we found more consistent results than those that were previously reported. Regardless of life history, the direct and indirect effects of pulp mill effluent decrease parasite abundance over long periods of time.

206 - EFFECTS OF PARASITE BURDEN AND PULP MILL EFFLUENT ON BODY CONDITION OF RIVER FISHES

† Thirtyacre, J.[1*]; Whalen, C.[1]; Boyd, D.[2]; Christner, S.[3]; Commisso, G.[1]; Díaz-Morales, D.[1]; Jones, I.[4]; Leslie, K.[1]; Kuris, A.M.[5]; Mann, J.[6]; Bart, H.[7]; Wood, C.L.[1]

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Specific factors in the environment, such as parasites and pollutants, can induce stress responses in fishes resulting in impacts to their physiology. Often parasites induce sublethal effects, particularly by reducing growth and degrading body condition. However, both parasites and the fish host are negatively impacted by pollutants, including pulp mill effluents. With the addition of effluent in the environment, it may increase stress responses in fishes that are also exposed to parasites. To understand these interactions, we looked at the body condition, parasite diversity and abundance, and pollutant exposure of multiple fish species collected from the Pearl River in Bogalusa, LA from 1963 to 2005. The International Paper pulp mill is stationed on this river, causing fishes downstream to be exposed to the effluent. This allows for a comparison between fish above the mill (control) to ones exposed to the pollutants below the mill (impact). We calculated common fish condition metrics to assess body condition. To evaluate the association between body condition, parasites, and pollutants, we generated linear mixed effects models. Pulp mill pollution is interacting with fish physiology, which may shed light on the complex physiological responses fishes are having to multiple stressors in their environment.

207 - HOW HAS FISH SIZE CHANGED IN THREE FISH SPECIES FROM THE SOUTHEASTERN US FROM 1963-2005?

† Boyd, D.[1*]; Commisso, G.[2]; Christner, S.[3]; Díaz-Morales, D.[2]; Jones, I.[4]; Leslie, K.[2]; Thirtyacre, J.[2]; Whalen, C.[2]; Kuris, A.M.[5]; Mann, J.[6]; Bart, H.[7]; Wood, C.L.[2]

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During a parasitological study focused on the Pearl River from the Tulane University Biodiversity Research Institute (TUBRI) collection, we noticed a decline in the size of certain fish species as time progressed. So, a subsequent study focusing on fish length and weight was run in parallel by randomly selecting other jars at TUBRI for three species (*Notropis atherinoides, Ictalurus punctatus, Hybognathus nuchalis*) to see if the same trend could be seen. Data used from the parasitological study was trimmed due to certain fish being outside the limits of dissection due to their size being too large or small. Jars from the 1963-2005 were sampled by taking standard length (mm), total length (mm), weight (mg), and state of collection (LA, MS, AL). We then ran linear mixed effects models to assess the relationship between total length and time. The models suggested that there is a significant ($p<0.05$) decline in size and weight over time for *Notropis atherinoides* and *Hybognathus nuchalis*, but no significant ($p>0.05$) change over time for *Ictalurus punctatus*. Additional sampling methods may be required to keep age class constant for all of these species in future studies.

208 - CREATURES OF HABITAT: ANALYSIS OF FISH RECRUITMENT IN NEARSHORE AREAS OF ALASKA'S INSIDE PASSAGE

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1- National Marine Fisheries Service, NOAA 2- Bowdoin College

Researchers use a variety of methods to analyze fish population recruitment in nearshore habitats around the globe, each with their own benefits and weaknesses. Originally developed by Amman (2004), the Standard Monitoring Unit for the Recruitment of Fishes (SMURF) is a device that allows for sampling of fish recruits in nearshore habitats in a way that is cost-effective and passive. Considering the recent progression of Alaska's aquaculture industry, we deployed SMURF devices on mooring lines and used nets for SMURF collection at kelp aquaculture sites, setting the groundwork for a longer study to understand how kelp farms influence fish species diversity and abundance throughout the kelp harvest cycle. We

deployed SMURFs near the surface and at depth in a kelp farm site and similar control site. After three days, we retrieved the SMURFs and identified and measured the fish species inside, while also conducting underwater visual surveys of fish and invertebrate species to collect data on biotic communities in the area before kelp is planted. This process will be repeated after kelp is planted, while kelp is growing, and again after the kelp has been harvested. In the pre-kelp phase of this study, SMURFs found small invertebrates but no fish, while visual surveys found a variety of benthic fish and invertebrate species. These early results offer a foundation from which to view the seasonal habitat provisioning impacts of kelp aquaculture, especially on species of commercial and regulatory importance, in Alaska's Inside Passage.

209 - ESTABLISHING A POST-SSWD BASELINE OF SEA STAR DENSITY IN SONOMA COUNTY

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Sonoma State University

In 2013/2014 west coast sea star populations were nearly decimated due to Sea Star Wasting Disease [SSWD]. Rapid population declines of ≥80% were seen across 20 or more species, including *Pisaster ochraceus*, which is the most conspicuous sea star species found in rocky intertidal habitats. Populations of this species seem to be on the road to recovery but very little population data has been reported post-SSWD. To begin filling this gap, we established a survey method of upper-mid intertidal habitats along the central coast of Sonoma County. Sea star density, color morphology, and size data were collected from 11 sites beginning in 2023 and repeated in 2024. We found considerable differences in disease occurrence, density and color morphology between sites, and suggestive patterns in size frequencies between sites and over time. Potentially diseased star observations overall ranged from 1.99% - 2.92%, with a potential disease occurrence high of 8.3% at one site in 2023. One striking finding is a distinct olive color morph seen only in small stars. It is unclear if this represents a juvenile coloration or if this is a newer color morph along this section of the coast. Another curiosity is the relative proportions of color morphs in the population. Historic accounts have suggested up to 25% orange while we are recording only <15%. In 2024 there was noticeable sand transport and burial of the habitat at some sites. We intend to conduct these surveys annually, as long term population observations are critical to understanding sea star population dynamics along the Sonoma coast.

210 - THERMAL STRESS AND SYMBIOSIS: EFFECTS OF RISING WATER TEMPERATURES ON ANTHOPLEURA ELEGANTISSIMA AND ITS ZOOXANTHELLAE

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University of San Diego

Marine organisms dependent on the stability of ocean conditions are particularly vulnerable to the rise in seawater temperature due to global warming. *Anthopleura elegantissima*, an aggregating anemone species known to populate the intertidal zones along the Pacific Coast of North America, shares a symbiotic relationship with photosynthetic zooxanthellae. In a phenomenon similar to coral bleaching, elevated sea temperatures can cause thermal stress within the anemone, resulting in the expulsion of zooxanthellae. The loss of zooxanthellae can be detrimental to the organism's health and reproduction while also causing the anemone to lose its color. To assess the impact of rising water temperatures on *A. elegantissima*, individuals were collected from Coronado Beach in San Diego, CA, transported to the laboratory, and placed in replicate tanks for six days at varying temperatures (25°C, 26.5°C, 28°C) and control temperature at 17°C. Tentacles from individuals were processed, and zooxanthellae density was determined using flow cytometry and protein asses to quantify the algal cell count per microgram of animal protein. Preliminary data indicates a decrease in zooxanthellae as water temperatures rise, suggesting rising water temperatures may pose a significant threat to populations of *A. elegantissima* and the ecological role they play in the intertidal zone.

211 - ASSESSMENT OF OUTPLANTED CORAL GROWTH USING PHOTOGRAMMETRY ON ISABELA ISLAND, GALÁPAGOS

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Photogrammetry is a method used to measure coral growth over time using still photographs that mesh together to create 3D photomosaic maps. This method has been used to measure individual coral colony growth and identify coral bleaching across entire reefs, but few studies have used it to evaluate growth at restoration sites. The Galápagos Islands are an ideal location to study corals due to their extensive history of coral bleaching and mortality. An existing coral nursery on Isabela Island and two nearby depth-matched outplanting sites containing 36 individual colonies of different genotypes encompassing three genera (Pocillopora, Pavona, and Porites) were used. Our objective was to track survival and growth over a six-month period. Using a GoPro, time-lapse photos were captured and inputted into Pix4D software to generate 3D photomosaics of the two outplanting sites from January 2024 and July 2024. Preliminary results illustrate that most coral colonies increased in size over time with minimal bleaching. There was approximately an 85% survival rate across all colonies, with massive corals having a significantly lower survival rate than branching corals. Future goals of this project include evaluating bleaching percentage, individual colony growth rates, and resampling six months from the last timepoints to establish a time series dataset. The Galápagos Reef Revival nursery is the first of its size and kind in the Galápagos, and this data will help inform ongoing coral restoration efforts. This project also fulfills an urgent conservation need to maximize the chance of survival of the limited number of corals in the Galápagos.

212 - APPLYING A LARGE SCALE FOOD QUALITY INDEX (FQI) OF MONTEREY BAY USING REMOTE SENSING IMAGERY

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Fish are a crucial food source across the globe, and using a bottom up approach to estimate fish stocks from phytoplankton abundance is challenging. Phytoplankton are the primary food source for grazers which include many fish and zooplankton species. The food web is dependent on these primary producers. Utilizing remote sensing to gain insight about phytoplankton productivity is the first step in understanding large scale ecology and biogeochemical cycling. The objective of this study is to use remote sensing observations to quantify phytoplankton community composition and a trophic model, the Food Quality Index (FQI), to estimate the nutritional quality of the phytoplankton pool to grazers. Each taxon fixes carbon and stores energy differently and phytoplankton taxa must be accounted for in these ecosystem models. FQIs are algorithm based indices and can be used to gain insight to the phytoplankton of Monterey Bay. Understanding the amount of energy available for consumption by grazers allows predictions and models to be built for different food webs. Future studies may use this phytoplankton FQI to understand changes in fisheries and bottom up ecology.

213 - SPATIAL VARIATION IN THE PALATABILITY OF AN INTERTIDAL SEAWEED

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Seaweed palatability can be affected by a variety of biotic and abiotic factors. In turn, variation in palatability may influence species interactions and community structure. Although previous studies have examined intraspecific variation in seaweed palatability across large-scale environmental gradients, little research on this variation has been conducted across smaller scales, particularly in the northeastern Pacific. In this study, we compared the palatability of the brown seaweed, *Fucus distichus*, between habitats and within sites that differ in biotic and abiotic conditions. We collected specimens from 6 rocky intertidal sites in Humboldt County, CA: 3 within Humboldt Bay and 3 on the outer coast. We tested for differences in palatability to herbivores using lab-based, paired-choice feeding assays. We found that bay specimens were significantly more palatable than coast specimens, to both isopods (*Idotea wosnesenskii*) and turban snails (*Tegula funebralis*). We also found differences in *Fucus* palatability from sites within each habitat. These findings suggest that *Fucus* palatability is affected both by differences between bay and open coast sites, as well as variability within each habitat. Future studies will examine the possible mechanisms that are affecting palatability, such as

nutritional quality, morphology, and grazing pressure. Our project may provide insight into how environmental changes may affect seaweed palatability and herbivore behavior. Studying seaweed palatability can improve our understanding of differences across natural environmental gradients and their importance to community dynamics.

214 - TROPHIC MODELING OF OREGON'S NEARSHORE REEFS AND ITS IMPLICATIONS FOR KELP FOREST MANAGEMENT

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This project explores the intricate dynamics of Oregon's nearshore reefs, focusing on the trophic interactions within kelp forest ecosystems. Kelp forests are vital to Oregon's marine environment, providing habitat and food sources for various species, including commercially important fish and shellfish. However, recent disturbances, such as the 2014-2016 marine heatwave and increased sea urchin grazing, have led to significant declines in kelp populations. Through the development of a multi-species mathematical model, this study aims to forecast the outcomes of various management strategies, including urchin culling and the reintroduction of sea otters, which prey on urchins. The model will also consider secondary impacts, such as otter predation on Dungeness crab, a highly profitable species for Oregon's fisheries. This research will provide valuable insights for stakeholders, including the Oregon Kelp Alliance, Dungeness Crab Commission, and local urchin fishers, among others, by offering a decision support tool to evaluate potential trade-offs in kelp forest management. The findings will contribute to the broader understanding of kelp ecosystem resilience and inform future conservation efforts. *By engaging with experts and local communities, we aim to refine our model and identify knowledge gaps, ensuring a comprehensive approach to ecosystem management*.

215 - DETECTING THE ENDANGERED SAN JOAQUIN KIT FOX (VULPES MACROTIS MUTICA) IN KERN COUNTY, CA, USING A NON-INVASIVE PCR-BASED METHOD

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CSUB

The San Joaquin kit fox (SJKF) (Vulpes macrotis mutica) is endemic to the San Joaquin Valley in California. Ongoing urban sprawl and change in land use over time have resulted in dramatic habitat loss and led to its listing as federally and state endangered under the Endangered Species Act and California Endangered Species Act. Many studies and efforts have been conducted to restore and protect remaining habitat from further loss and degradation. An essential part to these efforts involve presence/absence surveys prior to urban construction processes using camera monitoring, tracking dogs, tracking plates, spotlighting, and trapping. While these traditional methods are known to work well, they typically come with a large price tag and require many hours of labor to be reliable. In our study, we used a non-invasive method based on DNA extraction from fecal samples collected in the environment followed by a diagnostic Polymerase Chain Reaction (PCR) based on the mitochondrial gene. We applied this method to several case studies in Kern County, CA and this method to be highly reliable in confirming the presence of San Joaquin Kit foxes and other canine species in the field. Communicating this non-invasive method to local environmental consulting companies and promoting it as an acceptable survey method to the Department of Fish and Wildlife will help to improve future environmental assessments for SJKF populations in a cost and time effective way.

216 - ROCK WRASSE CLEANING BEHAVIOR: SEX-DEPENDENT ACTIVITY AND CLIENT SPECIFICITY

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Rock wrasse are common on Southern California reefs and may act as a cleaner species that eats the ectoparasites found on other species of fish. However, little is known about the factors governing their cleaning behavior and their preference for client species. We conducted 57 focal observations of rock wrasse cleaning behavior at several locations near Santa Catalina Island. We observed each focal individual for 5 minutes

and recorded sex, total length, and number of cleaning events. Immediately after these behavioral observations, we quantified the local density of client species on 2m by 50m transects. One noteworthy result was that larger males allocated less time to cleaning behavior compared to females. Such differences may be due to the tendency of larger males to hold territories. Another important result concerned selectivity for various client species. We observed rock wrasse cleaning six client species. Comparisons of the proportion of time each species was cleaned relative to the local abundance of client species, rock wrasse exhibited a significant preference for halfmoon (5.46), opaleye (3.87), and garibaldi (1.79; values statistically indistinguishable from 1 indicate neutrality). Rock wrasse showed no preference for blacksmith (1.73) and giant kelpfish (0.16) and exhibited a significant avoidance of other rock wrasse (0.015). Finally, the average cleaning activity of rock wrasse (5.47 interactions min-1) was comparable to values reported for other facultative cleaners in temperate and tropical reefs. These results suggest that rock wrasse perform an important cleaning service for the fish communities on Southern California reefs.

217 - DEMYSTIFYING STRESS: A MODEL TO IDENTIFY AND QUANTIFY STRESS IN CAPTIVE SOUTHERN SEA OTTERS, ENHYDRA LUTRIS NEREIS

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1- CSU Monterey Bay 2- Monterey Bay Aquarium

The southern sea otter *(Enhydra lutris nereis)* is a keystone species crucial to maintaining kelp forest health and biodiversity but was nearly driven to extinction by past hunting practices. The Monterey Bay Aquarium captures, rehabilitates, and releases this threatened population to re-establish this once-thriving population. Animal welfare assessments are used to assess the overall well-being of individuals, though these fail to account for an underrepresented signifier of animal health: stress. This project developed a methodology for staff to noninvasively identify and quantify stress in captive sea otters. 72 hours of recorded footage was reviewed to identify an otter's time allotment of daily activities at low, medium, and high stress levels determined by the frequency of pacing behavior. A Stress Identification and Quantification (SIQ) Model was established, and statistically backed definitions eliminated room for subjective error among staff when ranking stress. The SIQ Model presents nine behaviors, four indicating physical stress and five indicating psychological stress. These behaviors are scored from zero to three, and the gathered rankings become one cumulative "stress score." Observed morning activity differed greatly from evening activity, resulting in a protocol to perform SIQ analyses twice daily. Scores recorded over time allow caretakers to identify patterns in stress frequency. With the implementation of this model, threatened southern sea otters will now be provided with an increased quality of care, benefiting the conservation of this species.