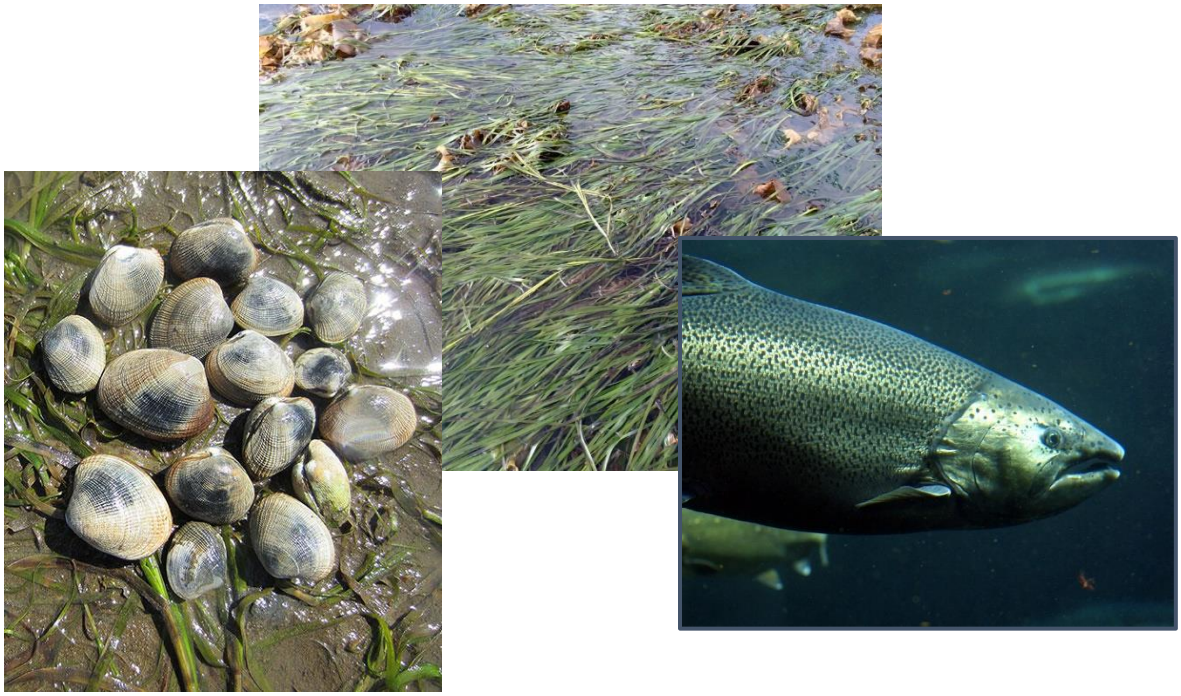
Program Schedule

PERS/CAERS
ANNUAL MEETING

Shellfish to Salmon:
Science in the Face of Climate Change

Virtual Meeting hosted by Accelevents

April 22-24, 2021



Meeting Sponsors

GeoEngineers is an integrated engineering and earth science firm with 18 offices nationwide, including offices in Washington, Oregon and California. For the last 41 years, GeoEngineers has crafted integrated environmental, geotechnical and ecological solutions for the water and natural resources, transportation, federal, energy and development markets. Our natural resource services focus on marine and aquatic environments along the Pacific Coast. Our capabilities span biological and wetlands assessments; nearshore; marine and terrestrial biology; habitat planning; mitigation and restoration; and environmental permitting and regulatory support services. Our coastal and marine ecologists specialize in everything from seagrasses and shellfish to saltwater fish and seabirds. Our scientists have completed both large- and small-scale projects, including extensive baseline studies, permitting, and long-term monitoring. As a multi-disciplinary firm, GeoEngineers takes a collaborative approach to projects blending science, engineering and regulatory considerations/priorities into optimal solutions. We are employee-owned by 215 staff members, and as owners, have a vested interest in the quality of our work and level of services that we provide on every project.

Oregon State University
Hatfield

Hatfield Marine Science Center

The Hatfield Marine Science Center (HMSC) is Oregon State University's campus for research, education, and outreach in marine and coastal sciences. Through its partnerships, HMSC improves scientific understanding of marine systems, coastal processes and resources, and applies this knowledge to social, economic, and environmental issues. As a leading marine laboratory in the Pacific Northwest, HMSC has the expertise, technology, and responsibility to address important issues of high economic, scientific, and aesthetic value in marine and coastal systems. Its locality, ready access to the ocean and richness of partners – agencies, industry, and constituencies – create a physical and intellectual campus known for multidisciplinary research, education, and outreach that is world-class and international in scope. Hands-on educational opportunities train the marine science leaders of tomorrow, and outreach transfers knowledge to the public sector using new and compelling approaches.

PERS/CAERS Joint Meeting April 22-24

Greetings from PERS and CAERS!

Welcome to the second joint PERS/CAERS annual meeting. We will make the most of this virtual opportunity to share with society members from British Columbia to Baja, and also bring colleagues from Alaska and Hawai'i into the fold. These are changing times, and atop the challenge of a global pandemic that touches us all, we create innovative ways to connect and continue our work to better understand and serve as stewards for coastal and estuarine ecosystems.

Our planet is changing. We introduce the theme of our program this year: "Shellfish to Salmon: Science in the Face of Climate Change." As scientists, stewards, educators, and managers, we recognize the multi-stressor effects that impact coastal and estuarine ecosystems and the communities and economies that depend on them. This year's program focuses on evaluating, addressing, and mitigating change across taxa, habitats, systems, and scales. Our conference coincides with "Earth Week" and runs concurrently with the Leaders Summit on Climate hosted by the Biden Administration in advance of the United Nations Climate Change Conference (COP26) this fall - we hope these and other efforts will increase awareness of the climate-ocean nexus and lead to meaningful actions.

Several things bring us together, including our passion and work. The social and political reckonings this past year also revealed the many ways we are similar more than we are different, and that we have work to do to end racism and discrimination. Both CAERS and PERS recognize and oppose the suffering and injustice inflicted by racism and discrimination. Our community is stronger when we support diversity, promote equity and inclusivity, and combat injustice. PERS and CAERS welcome everyone interested in coastal and estuarine ecosystems.

The format of the meeting is different and new for us. Take advantage of the Q&A following session talks, the poster session, and social events to foster interaction, discussion and collaboration. This spirit of engagement is meant to encourage all conference participants - from undergraduate students to seasoned veterans - to interact and address the important issues that are facing estuarine and coastal research, management, and stewardship.

Enjoy the conference!

Regards,

Liz Perotti, PERS President **Steve Litvin, CAERS President**

Conference Organizers

Elizabeth Perotti (PERS president)
Jason Stutes (PERS past-president)
Adrienne Stutes (PERS Secretary)
Jeannie Gilbert (PERS Treasurer)
Steven Litvin (CAERS President)
Jenni Schmidt (PERS Board)
Carolyn Prentice (PERS Board)
Katrina Poppe (PERS Board)

Pacific Estuarine Research Society

PERS is a non-profit organization with a wide-ranging membership from academic and research institutions, federal and state agencies, and commercial and nonprofit organizations. The purpose of the society is to bring together persons actively engaged in estuarine and coastal research and management on the Pacific Coast of North America for informal discussion and exchange of ideas for educational, research and management purposes. PERS recognizes that today's students are tomorrow's estuarine scientists and managers and seeks to support their active involvement in the annual meeting and beyond. The first PERS meeting was held in 1977 in Astoria, OR and was organized by a cadre of Pacific coast estuarine scientists who formed the group as an Affiliate Society of the Estuarine Research Federation (ERF). PERS annual meetings are held up and down the Pacific Northwest coast, and generally rotate between British Columbia, Oregon and Washington.

California Estuarine Research Society (CAERS)

The California Estuarine Research Society (CAERS) is a non-profit organization dedicated to the improvement of education and research regarding California's and Baja California's estuarine and coastal environments. The society provides a forum to enhance communication among interested scientists, engineers, and students. Formed in 2002, CAERS is the newest affiliate of the Coastal and Estuarine Research Federation (CERF). CAERS was formed to fill a geographical gap in the CERF affiliate network, thereby strengthening ties among coastal and estuarine researchers in California and Baja California, Mexico. CAERS annual meetings are held throughout California and Baja Mexico.

Invited Speakers

Dr. Francis Chan is an Associate Professor Senior Research in the Department of Integrative Biology at Oregon State University and the Director of the Cooperative Institute of Marine Resource Studies (CIMRS). Dr. Chan received his PhD in ecology from Cornell University. Dr. Chan's research is focused on understanding the ecosystem dynamics of coastal oceans. He has worked extensively on the causes and consequences of low-oxygen (hypoxia) zones along the U. S. West Coast. Dr. Chan is also working actively to understand the progression of ocean acidification in coastal waters and their implications for productive coastal oceans. He is a co-principle investigator in the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) where he works to build long-term understanding of ocean ecosystem changes through nearshore ocean acidification and hypoxia monitoring efforts. Dr. Chan lives in Eugene, Oregon.

https://science.oregonstate.edu/directory/francis-chan
https://www.researchgate.net/profile/Francis-Chan-8
https://www.cimrs.org/

Fernanda Ximena Oyarzún Dunlop. PhD in Biology, University of Washington (USA), Bachelor of Biology from the Pontificia Universidad Católica de Chile, Fulbright Scholar, also completed the Project for Interdisciplinary Pedagogy (UW Bothell), has a Certificate in Editorial Design from Universidad de Chile and is trained in Scientific Illustration (UW). She works as a researcher, scientific illustrator, and sculptor, working in both worlds — science and art — exploring the biodiversity, shapes, and evolution of marine organisms. She has taught and participated in projects of interdisciplinary pedagogy,communication and visualization of science, such as the interdisciplinary and interhemispheric program of which she was a co-founder and co-director: "ASKXXI: Art + Science Knowledge Building and Sharing in the XXI Century" which was executed in its pilot version 2018-2019 in collaboration with the US Embassy in Chile. She is also co-founder and co-director of "Bienal Concepción, Arte & Ciencia" and of "Proyecto Robsonella: creating a bridge between scientific illustration and the research of the marine diversity of Chile". Among her most recent sculptural projects are "Phylogenetic School", "Fluvial Identity", "Marine Consciousness", "Creating Realities, Adaptation to climate change", and "Cacophony of a collaboration", the last one which she created during her residency at the Artist at Sea Program of the Schmidt Ocean Institute. She is currently an associate researcher at the Coastal Socio-Ecological Millenium Institute (SECOS) where she develops a research line on art & science. She is also an associate researcher at CIBAS and the Faculty of Sciences of the Universidad Católica de la Santísima Concepción, and Centro i ~ mar of the Universidad de los Lagos, Chile. She also works independently as an artist in her studio. www.fernandaoyarzun.com

Conference Schedule

PERS/CAERS Joint Meeting

April 22-24

Virtual Meeting

Sponsored by HMSC, and GeoEngineers, Inc.

Thursday April 22 – All times in PDT

Instructions for presenters Instructions for attendees

3:00 – 4:00 pm	**Welcome and Keynote Speaker** *Francis Chan – Keynote Speaker* *Liz Perotti – PERS President* *Steve Litvin – CAERS President*
4:00 – 6:00 pm	**Virtual Social** - The social will take place within a different space. Use this link to find us: https://www.wonder.me/r?id=67c02e45-109a-4c87-830c-32e618d90837
6:00 – 9:00 pm	**Extended Social** - Come join us for some virtual games and meet new people! Use this link: https://www.wonder.me/r?id=67c02e45-109a-4c87-830c-32e618d90837

Friday April 23rd – All times in PDT

9:00 – 10 am	**Welcome/Plenary Speaker** *Steve Litvin, Liz Perotti* *Fernanda Oyarzun – Plenary Speaker*
10:00 – 10:45 am	**Breakout Session - Invertebrates –** *Tony Harbison, Summer Hendrickson, Sylvia Yamada, Jenni Schmitt (Moderator)*
10:45 – 11:00 am	**Coffee Break**
11:00 am – 12:00 pm	**Breakout Session – Contamination/Anthropogenic effects –** ***Minna Ho (Moderator)*** *Anna Bolm, Kaegan Scully-Engelmeyer, Theresa Talley, Alexandra Tissot, Robert Johnston*
12:00 – 1:00 pm	**Lunch Break**

1:00 – 2:50 pm	**Special Session: Ecosystem Level Science and Restoration – *Steve Litvin (Moderator)*** *Connie Hernandez, Ted DeWitt, Chris Janousek, Kathryn Beheshti, Melissa Ward, Denise Colombano, Chloe Jackson,*
2:50 – 3:00 pm	**Break**
3:00 – 3:45 pm	**Breakout Session – Coastal Shifts – *Liz Perotti (Moderator)*** *Steve Rumrill, Micah Rogers, Morgan Winston, Sylvia Yamada*
3:45 – 4:30 pm	**Breakout Session – Fisheries Science – *Hali Rederer (Moderator)*** *Kirsten Lomeli, Abraham Gonzalez, Shadira Gordon, Hali Rederer*
4:30 – 5:00 pm	**Breakout Session - Oysters and Aquaculture – *Steve Rumrill (Moderator)*** *Carl Hendrickson, Julio Lorda, Casey Pruitt*
5:00 – 6:00 pm	**CAERS and PERS Business Meetings** (separate rooms - see agenda on website)
6:00 – 9:00 pm	**Optional Social times -** Come hang out in the lounges for games and/or socialization.

Saturday April 24 – All times in PDT

9:00 – 9:15 am	**Welcome –** *Steve Litvin, Liz Perotti*
9:15 – 10:30 am	**Poster Session – *Jason Stutes (Moderator)*** *Main Stage: William Speiser, Samuel Winter, Joseph Brockman, Kimberly Brown, Elissa Connolly-Randazzo, Megan Considine, Karen McLauglin, Parker Richardson, Salvador Robb-Chavez, Gadwin Gan*
10:30 – 11:30 am	**Breakout Session – Eelgrass Habitat – *Jason Stutes (Moderator)*** *Morgan Eisenlord, Stuart Munsch, Aurora Ricart, Jason Stutes, Maria Jose Marin Jarrin, Cameron Sokoloski*
11:30am – 12:15 pm	**Awards and Closing Remarks –** *Katrina Poppe, Jason Stutes, Steven Litvin, Liz Perotti*

Abstracts

Alphabetical order by last name

A SNEAK PEEK AT OUR COMPREHENSIVE ASSESSMENT OF EELGRASS RESTORATION TECHNIQUES AND OUTCOMES ALONG THE U.S. WEST COAST

Drs. Kathryn Beheshti*[1,2] *and* **Melissa Ward**[1,3] [1] *Endemic Environmental Services,* [2] *University of California, Santa Cruz,* [3] *San Diego State University*

Seagrasses are in global decline. Along the US West coast, eelgrass (*Zostera marina)* is threatened by multiple stressors, from eutrophication to extreme heat events and disease. Eelgrass conservation and restoration is a high priority due in part to the suite of ecosystem services associated with these coastal habitats-- reflected in its state (e.g. the California Eelgrass Mitigation Policy) and federal (Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act) protections. Yet, successful restoration and mitigation of eelgrass remains a major challenge for practitioners. To better understand the drivers of restoration and mitigation successes and failures, we interviewed 22 practitioners and reviewed white and grey literature for over 100 eelgrass restoration and mitigation projects across California, Oregon, and Washington. We found that poor site suitability and relatedly, poor environmental conditions, rather than ill-suited methods, contributed to restoration and mitigation project failure. From these analyses we find that the most commonly applied methods include single bundle anchoring methods (e.g. garden staple), followed by TERFs, Seeding, and passive restoration (with passive restoration being the least commonly applied method). From this work we developed a recommended stepwise approach to eelgrass restoration and mitigation. Specifically, we recommend the following steps: 1) assessing site suitability, 2) conduct a pilot project testing multiple techniques, 3) transplant at scale, and 4) monitor for as long as funding allows (ideally 2 years minimum). We are hopeful that this synthesis will provide practitioners and academics with the most up to date guidance on best practices for eelgrass restoration and mitigation along the Pacific Northwest.

This work was completed in partnership with the Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) funded by Friends of South Slough and the Pew Charitable Trust.

AN UNEXPECTED SNACK: ZOOPLANKTON FEEDING ON MICROPLASTICS IN THE NORTHERN CALIFORNIA CURRENT

Anna Bolm* *(Oregon State University, bolma@oregonstate.edu),* **Elise Granek** *(Portland State University, graneke@pdx.edu),* **Jessica Miller** *(Oregon State University, Jessica.miller@oregonstate.edu),* **Susanne Brander** *(Oregon State University, susanne.brander@oregonstate.edu)*

Microplastics are ubiquitous in our oceans, yet we are still clarifying what risks they pose to marine organisms. Lab studies have more frequently used smooth, often virgin microbeads when testing the effects of microplastics on organisms, though tangled fibers and jagged fragments, are more commonly found in the ocean. This disconnect between plastics used in laboratory studies from those found in the environment is problematic. Our study quantifies and characterizes microplastics in wild-caught zooplankton to help inform future lab studies assessing risk. In 2019, we collected 39 plankton tows from 3-372 kilometers offshore between Trinidad Head, California and Cape Meares, Oregon, within the Northern California Current (NCC). The NCC is both highly productive and lacks microplastics occurrence data. These data provide a baseline for the types of microplastics internalized by NCC zooplankton genera, including amphipods, copepods, chaetognaths, larval fish, crab megalopae, and euphausiids. Of the 183 groups analyzed, potential plastics were present in 30.1%. Though we found potential plastics in each zooplankton group, our results suggest there was no difference in internalization among the groups (p-value: 0.9101). Overall, 64% of the found potential plastics were blue fibers (length: 0.11-3.74 mm). By identifying the types and quantity of microplastics zooplankton groups are ingesting in their environment, future lab studies can more accurately assess the risks associated with microplastic ingestion.

Keywords: zooplankton, marine, pollution

ARE THERE DIFFERENCES IN BURROWING BEHAVIOR BETWEEN ASCAROPHIS SPP. INFECTED AND NON-INFECTED NEOTRYPAEA CALFIORNIENSIS IN THE PRESENCE OF LEPTOCOTTUS ARMATUS?

Joseph Brockman*, Oregon State University, joseph.brockman@oregonstate.edu, **Brett Dumbauld**, United States Department of Agriculture, Brett.Dumbauld@USDA.gov, **Jessica Miller,** Oregon State University, jessica.miller@oregonstate.edu*

Pacific oyster, Crassostrea gigas, aquaculture is negatively affected by burrowing activity and bioturbation by native burrowing ghost shrimp, Neotrypaea californiensis, which bury and suffocate oysters without constant intervention. The shellfish aquaculture industry used chemicals to control burrowing shrimp populations in Washington State estuaries for about fifty years, but due to public scrutiny that practice has been discontinued and growers continue to seek alternative control methods. To inform potential biological control measures for burrowing shrimp, we investigated whether native nematode parasites and fish predators, such as Pacific staghorn sculpin, Leptocottus armatus, affect distribution and abundance of ghost shrimp populations in west coast estuaries through field surveys and lab experiments. Native nematode parasites, Ascarophis and Similascarophis spp., have been found to infect ghost shrimp and are hypothesized to alter shrimp behavior and increase host susceptibility to predation by fish predators. We conducted quarterly surveys in three estuaries (Willapa Bay, Tillamook Bay, and Yaquina Bay) to examine the seasonal distribution, population prevalence, and identity of nematode parasites infecting ghost shrimp and L. armatus. I will conduct a laboratory experiment to investigate differences in burrowing and resurfacing behaviors between infected and non-infected ghost shrimp with and without the predator L. armatus present. Results will increase understanding of parasite influence on ghost shrimp populations and advance research on the development of biological control methods for shellfish aquaculture.

EFFECTS OF EUROPEAN GREEN CRAB *(Carcinus maneas)* ACROSS EELGRASS *(Zostera marina)* DENSITIES

Kimberly Brown*, Portland State University, kibrown@pdx.edu, **Alexandra Tissot**, Portland State University, tissot@pdx.edu, **Catherine de Rivera**, Portland State University, derivera@pdx.edu*

Eelgrass (*Zostera marina*) plays a critical role in estuarine ecosystem function by sustaining a variety of marine and freshwater species, but it's increasingly threatened by the invasive European green crab *(Carcinus maenas*). *C. maenas* abundance is on the rise within the coastal environment of Oregon and it's imperative to know how these populations will affect the long-term health of eelgrass. *C. maenas* is known to pull out eelgrass when hunting for invertebrate prey underneath. Our goal is to understand to what extent the density of *Z. marina* affects its likelihood of persistence despite bioturbation by *C. maenas*. We conducted our study in Netarts Bay,OR using 0.5m2 enclosures to analyze change in eelgrass cover over the span of two weeks. We expect to find that high density *Z. marina* can withstand bioturbation due to *C. maenas*, but lower *Z. marina* densities will be more susceptible due to their sparser rhizome mats that crabs may be able to uproot more easily. Results from this study will improve understanding about the effects of invasive species on eelgrass health, which will inform future management decisions about transplanting methods, areas to prioritize restoration, as well as when and where to prioritize *C. maenas* removal.

A STATE-SPACE APPROACH TO LINKING FLOWS AND OCEAN CONDITIONS TO ESTUARINE FISH COMMUNITY STABILITY OVER FOUR DECADES

Denise Colombano* *(Department of Environmental Science, Policy, and Management, University of California, Berkeley, denise.colombano@berkeley.edu);* ***Stephanie Carlson*** *(Department of Environmental Science, Policy, and Management, University of California, Berkeley, smcarlson@berkeley.edu);* ***James Hobbs*** *(California Department of Fish and Wildlife, james.hobbs@wildlife.ca.gov);* ***Albert Ruhi*** *(Department of Environmental Science, Policy, and Management, University of California, Berkeley, albert.ruhi@berkeley.edu)*

In the San Francisco Estuary, the relative magnitude of marine vs. freshwater influences on ecosystem dynamics varies with hydroclimate patterns. Quantitatively scaling species-level responses to community-level stability remains a challenge due to variation in estuarine monitoring methodology. We applied a state-space approach to model juvenile fish community dynamics and the influence of hydroclimatic fluctuations and trends to answer the following questions: How does juvenile fish abundance vary along the estuarine gradient over time? How do watershed hydrology and ocean conditions explain interannual variation in species abundance? We examined 14 common age-0 fishes sampled at 35 core stations from 1980 to 2018. Overall, mean annual river flows and sea surface temperatures best explained community-wide abundance fluctuations. Notably, anadromous species responded similarly, with significant positive responses to flow ('freshening') in the lower estuary, whereas some marine species displayed the opposite pattern, with significant negative responses to flow ('salinity intrusion') in the upper estuary. Here we explore the life-history mechanisms that may confer response diversity--and thus temporal stability--at the community level: calculating the coefficient of variation for estimated abundances from the best supported model revealed a portfolio effect among estuarine fish communities in space and time. This work may advance the notion that directional trends, fluctuations, and extremes in environmental conditions, such as watershed hydrology and ocean conditions, will continue to reshape estuarine fish communities in the future.

Keywords: Estuaries, climate change, fish ecology

EUROPEAN GREEN CRAB, *Carcinus maenas*, HABITAT PREFERENCE IN SOUTH SLOUGH

Elissa Connolly-Randazzo*,(Portland State University, econn2pdx.edu),* ***Dr. Catherine de Rivera****, (Portland State University, derivera@pdx.edu),* ***Dr. Shon Schooler****, (South Slough National Estuarine Research Reserve, shon.schooler@state.or.us)*

European green crabs, *Carcinus maenas,* have an extensive history of negative ecological changes within estuarine habitats. While the species has been well studied, their preference in habitat selection within estuaries is not fully understood. With the use of past trapping data from South Slough National Estuarine Research Reserve, *C. maenas* abundance and distribution was correlated to mapped habitat types based on tidal regime, structure, and sediment or vegetated substrate categories. A high proportion of *C. maenas* were found in traps located within habitats of subtidal regime, tidal marsh or flat landforms and within a mixture of sand and mud sediment type. Further analysis will be conducted to determine the specific relationship between habitat-related variables and *C. maenas* presence to help predict their distributions within estuaries as conditions change due to climate change. Hence. this information can aid in current and future monitoring and removal efforts to limit *C. maenas* impact on native species.

SHELL-BORING POLYCHAETES IN PACIFIC OYSTERS OF OREGON: IDENTIFICATION, DISTRIBUTION, AND MITIGATION STRATEGIES

Megan Considine* *(Oregon State University, considim@oregonstate.edu),* ***Julieta C. Martinelli*** *(University of Washington, julimar@uw.edu),* ***Teri L. King*** *(University of Washington, guatemal@uw.edu),* ***Lorenz Hauser*** *(University of Washington, lhauser@uw.edu),* ***Jaqueline L. Padilla-Gamiño*** *(University of Washington, jpgamino@uw.edu),* ***Steven S. Rumrill*** *(Oregon Department of Fish and Wildlife, steven.s.rumrill@state.or.us),* ***Chelsea L. Wood*** *(University of Washington, chelwood@uw.edu)*

Shell-boring polychaetes burrow into the shells of cultivated and wild molluscs, creating unsightly blisters on the inside of the shell that fill with mud, detritus, and fecal material. Recently there has been a reported uptick in infested oysters on commercial farms along the west coast of the US, which may be due to a recent introduction or changes in environmental conditions. The reported increase in infestation poses economic risks for the Pacific Northwest's oyster aquaculture industry, as the reduced aesthetic quality renders the half-shell product unmarketable. Quantifying the distribution of shell-boring polychaetes and determining treatment methods is pertinent for helping the region's multimillion-dollar industry defend against this threat. The data that I will present come from the Oregon portion of a multi-state (California, Oregon, Washington, and Alaska) effort to determine infection prevalence of shell-boring polychaetes on commercial oyster farms. In 2019–2020, we obtained over 600 oysters from seven farms spanning the Oregon coast (Tillamook Bay, Netarts Bay, Yaquina Bay, and Coos Bay) and found a statewide infection rate of 11–31% over the three sampling seasons. For each season, Netarts Bay had the highest prevalence of infection. Project collaborators in Washington State tested simple experimental treatments to determine effective options that can be applied by growers to mitigate infection. Results from this study will help inform industry best practices and improve resource management actions to reduce the economic impacts of shell-boring polychaetes.

Keywords: aquatic invasive species, *Crassostrea gigas*, oyster aquaculture

A TOP-DOWN APPROACH FOR IDENTIFYING AND PRIORITIZING THE FINAL ECOSYSTEM GOODS & SERVICES FOR SITE RESTORATION

T.H. DeWitt, J. Bousquin, C. Folger, M. Harwell, T. Newcomer-Johnson, L. Sharpe, S. Yee *(US EPA),* ***C. Jackson, H. Hernandez*** *(Oak Ridge Institute for Science and Engineering),* ***A. Borde, H. Diefenderfer*** *(Pacific NW National Laboratories)*

The goals for restoration projects are often framed in terms of the benefits that will be derived from restorative actions. In many cases, the restored benefits include the direct uses of nature by people (aka, final ecosystem goods and services, or FEGS), such as enhanced recreational viewing of native wildlife, improved fishing for desired species, or increased protection of property due to wave attenuation by native vegetation. Consideration of the direct benefits that people could obtain from a restored site informs the development of monitoring plans that include FEGS-relevant metrics. These metrics can be used for adaptive management decisions and aid in communicating restoration progress toward people-centric goals to inform stakeholders and the public. We present a top-down approach to identifying the FEGS that are relevant to restoration of a site using EPA's National Ecosystem Service Classification System Plus (NESCS Plus). Using a generalized, systematic, top-down approach ensures that a full suite of potential FEGS is identified. These FEGS can then be used by restoration practitioners to identify relevant metrics to incorporate into restoration planning, monitoring, and adaptive management design. Using NESCS Plus, we identified more than 85 FEGS that may be produced by tidal wetlands (our example system). These FEGS were distributed across 29 classes of beneficiaries—defined as the roles assumed by people as they use, appreciate, or enjoy tidal wetlands—and seven classes of ecological endpoints representing a coarse categorization of the biophysical attributes that beneficiaries use. To determine which of these FEGS are of greatest interest (i.e., cited most frequently) for tidal wetland restoration, we conducted a data mining exercise using documents from organizations charged with managing, conserving, and/or restoring tidal wetlands (i.e., National Estuary Programs, National Estuarine Research Reserves, land trusts, and selected non-governmental organizations) using the results of the NESCS Plus search and other documentation. The results of this analysis will guide our prioritization of FEGS for metric development for tidal wetlands. These materials are intended for use by tidal wetland restoration practitioners

and decision makers to measure progress toward a restoration project's benefit-based goals; and, this approach is expected to be applicable to restoration of other types of ecosystems.

Keywords: Ecosystem Services, Tidal Wetlands, Restoration

WATER BORNE AND LOW DOSAGE TRANSMISSION OF EELGRASS WASTING DISEASE

Morgan E. Eisenlord[1*] *me367@cornell.edu****, M. Victoria Agnew[2], Miranda Winningham[1], Olivia Miller[1], Alex Vompe[3], Bryanda Wippel[4], Carolyn Friedman[4], C. Drew Harvell[1], Colleen A. Burge[2]***
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Eelgrass wasting disease is found in temperate seagrass beds worldwide and has the potential to devastate important coastal habitats. In this study, we explored disease transmission in eelgrass meadows through field and laboratory experiments on eelgrass wasting disease (EGWD) caused by Labyrinthula zosterae (Lz). Although transmission pathways are fundamental to understanding the epidemiology of infectious diseases, they are poorly understood in the ocean and little is known about the natural transmission of EGWD. To test in situ transmission modes, we out-planted sentinel eelgrass shoots within and up to 300 meters adjacent to a natural eelgrass bed. Infection rates and infection severity did not differ significantly among distances, providing clear evidence for transmission through the water column as well as by direct contact. The infectious dose of Lz through waterborne exposure and the temperature sensitivity of the infection process were assessed in a controlled laboratory experiment. The dose to 50% infection was only 6 cells mL-1 and was not impacted by temperatures between 7.5 C and 15 C. Warmer temperature (15 C) led to increased EGWD infection severity at high exposure doses. Our results show Lz is highly virulent and readily transmits through water without direct contact with infected plants. The complex transmission dynamics of this disease in the context of changing ocean conditions has implications for eelgrass protection and restoration in critical coastal habitats worldwide.

ARE GEESE EATING THE MARSH: EFFECTS OF CANADA GOOSE (*Branta canadensis*) AND SNOW GOOSE (*chen caerulescens*) HERBIVORY ON TIDAL MARSH RECESSION AT THE WESTHAM ISLAND MARSH

Gadwyn Gan*, (BCIT/SFU, wyngann@gmail.com)*

In the Fraser River Estuary of British Columbia, tidal marshes have been receding and converting into unvegetated mudflats since the 1980s. While there are many speculated reasons for this recession, the effect of herbivory is poorly understood. This study looked at how Canada-Goose (Branta canadensis) and Snow-Goose (Chen caerulescens) herbivory affected the percent cover of three-square bulrush (Schoenoplectus pungensI) in the Westham Island tidal marsh by using seasonal exclosure plots to reduce specific goose herbivory in a randomized block design. Based on results from July to October of 2020, I found that the percent cover of tidal-marsh vegetation was lower in plots open to Canada-Goose herbivory than those that were not by around 20%. As such, goose herbivory and potential herbivory deterrents may be an important consideration for land managers in restoring tidal marshes. I also make the case that remote sensing using drones is an effective alternative to visual estimates of percent cover of tidal-marsh vegetation.

OCEANOGRAPHIC VARIABILITY EFFECTS ON THE FISH COMMUNITY IN LOS PEÑASQUITOS LAGOON OVER A 30 YEAR PERIOD

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Estuaries are complex coastal environments at the land-ocean-atmosphere interface
threaten by extreme variability, oceanographic processes, and constant anthropogenic stress. Consequently, organisms living in these ecosystems can be considered sentinels species. Specifically, fish community assemblages in estuarine systems are ideal to study to enhance our understanding of climate change effects. In this study, we analyzed changes in the fish community at Los Peñasquitos Lagoon as a function of oceanographic variability over the last 30 years. Our results showed that the different species of fish have different responses to oceanographic processes variations and anomalies in the physical-chemical water parameters. Multivariate statistical analyses suggest that the principal causes of community changes have been strong coastal upwelling conditions, warm water temperature anomalies, strong ENSO events, and the lagoon's inlet closures. Strong coastal upwelling had a negative effect on the abundances of California halibut, *Paralichthys californicus*, and longjaw mudsucker, *Gillicthys mirabilis*. ENSO conditions and warm water temperature anomalies are favorable for invasive species like mosquitofish, *Gambusia affinis*, but negative for the lagoon's dominant species, topsmelt, *Atherinops affinis*. Furthermore, time-series statistical trend analysis results suggest a downward trend in fish densities for the longjaw mudsucker, *Gillicthys mirabilis*, and staghorn sculpin, *Leptocottus armatus*.
Long-term studies like this are important to document how oceanographic drivers shape fish communities in estuaries at different time scales. Our results provide valuable information to enhance our understanding of estuaries management under climate change challenges.

Keywords: temperature anomalies, oceanographic variability, fish community

EFFECT OF CLIMATIC FACTORS IN FISH PATHOGEN DISTRIBUTION OVER TIME AND USEFULNESS OF ENVIRONMENTAL DNA EXTRACTION AS AN EARLY DETECTION METHOD

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Recently, Northern California has been affected by fire events, such as the Camp Fire in 2018, the Walker Fire in 2019, and the North Complex Fire in 2020. Adverse climatic and environmental factors may impact water quality and the distribution of fish pathogens over time, which may increase the susceptibility of host organisms to disease outbreaks. However, current information on the effect of fires and other climatic variations in the distribution of California fish pathogens remains limited.
In collaboration with the United States Forest Service (USFS) we investigated the presence of five fish pathogens (*Ichthyophthirius multifiliis, Tetracapsuloides bryosalmonae, Ceratanova shasta, Myxobolus cerebralis, and Ranavirus*) by environmental DNA (eDNA) extraction from river sediment samples collected from 2017-2020 in areas affected by recent fire activity in Plumas County, California. We obtained 113 positive eDNA sediment samples from 56 different watersheds and used a logistic regression model to evaluate the association between fire occurrence, stream flow, water temperature, type of sediment, distance to dams,

seasonality, and pathogen detection. The results of the logistic regression analysis showed that stream flow, water temperature, and concurrent extreme fire events are significantly associated with an increase in the spatio-temporal distribution of fish pathogens across Plumas County. We believe that eDNA extraction and the modeling techniques presented here can provide a rapid and useful method to detect fish pathogens and identify important risk factors contributing to their occurrence, which could be used to improve risk-based surveillance and more cost-effective mitigation strategies.

Keywords: Environmental DNA, fish pathogen, climatic factors.

DETERMINING THE CONTRIBUTION OF FISHERY BAIT SUBSIDIES TO SPATIOTEMPORAL VARIATION IN THE FEEDING ECOLOGY OF DUNGENESS CRAB CANCER MAGISTER

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As the source of the most profitable fishery on the West Coast, Dungeness crabs undoubtedly constitute an intrinsic part of Oregon's coastal communities. Despite their cultural and economic significance, relatively little research has been done on this species' ecological role within coastal waters. This study aims to increase scientific understanding of what crabs eat and how those diet preferences vary seasonally and regionally along the Oregon coast. Within this broad context, the research also focuses on how discarded bait from the commercial Dungeness crab fishery impacts crab feeding preferences using fishermen interviews, gut contents, and stable isotopes. In terms of the chemical composition of Dungeness crab tissues, to a certain extent they "are what they eat." The amount of carbon and nitrogen in a crab's food translates to the amount of carbon and nitrogen in their bodies, allowing scientists to indirectly understand diet preferences. Looking inside crab guts provides additional evidence. The hypothesis at the root of this research is that Oregon Dungeness crabs rely heavily on discarded bait from the commercial fishery for food during the wintertime, cannibalism in the early spring, and wild benthic invertebrates and organic materials within sediments in the fall. Dozens of Oregon crabbers were interviewed to quantify how much free crab food (in the form of discarded bait) ends up in coastal waters each year. This analysis provides information about fishery impacts on feeding ecology in Oregon's coastal waters as well as a broader characterization of the Dungeness crab's role in the food web.

Keywords: stable isotope ecology, fisheries, Dungeness crab

OYSTER REEF EFFECTS ON FLOW AND SEDIMENT DYNAMICS IN LIVING SHORELINE PROJECTS IN SAN FRANCISCO BAY

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Seagrasses provide numerous ecosystem services: protecting shores via sediment stabilization, contributing to carbon storage via organic matter burial, and locally increasing pH (countering acidification) during periods of active photosynthesis. They are threatened worldwide, largely by human-mediated impacts, prompting restoration efforts. Living shorelines projects (LSPs) in the San Francisco Estuary aim to restore habitat while protecting shores. Prior work has shown that installation of LSP reef structures, designed to attract native Olympia oysters (*Ostrea lurida*), also benefits plantings of the seagrass, *Zostera marina* (eelgrass). Eelgrass planted on the shore side of these reefs became taller and denser than those planted on the bay side or those planted alone. The magnitude and spatial extent of the reef protection effects – wave attenuation, increased sedimentation, and increased water residence time – on eelgrass are not well understood. At two LSP sites, plaster dissolution blocks supported previous findings that the reefs reduce wave energy and suggest that the effect is stronger during winter than summer. Sediment cores at one site showed higher organic matter deposition leeward of the reef, but we also observed lower deposition 1m bayward of the reef. Cores at the

other site showed lower sand content 1 year after the reef was installed, indicating increased settlement of finer particles higher in organic matter. Drone footage tracking particles indicated areas of higher residence time leeward of the reef. Understanding the physical effects of LSP oyster reefs can inform future LSP designs and help optimize eelgrass plantings to enhance establishment and provision of ecosystem services.

GROWTH AND CONDITION OF THE INVASIVE ASIAN CLAM, *Corbicula fluminea,* IN THE LOWER COLUMBIA RIVER, USA

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The Asian clam, *Corbicula fluminea*, was introduced into the U.S. in the Columbia River (CR) in the 1930's and is now found in 46 states yet many aspects of its population biology are not well understood. Biweekly sampling was undertaken to investigate the growth and condition of *C. fluminea* at two location in the lower CR over three years (2017, 2018, and 2019). Previous studies informed the hypotheses that abundance, population growth rate, and individual growth rate of *C. fluminea* would increase with temperature, chlorophyll-*a*, and dissolved oxygen. Modal progression analysis revealed a lifespan of 2-3 years for *C. fluminea* in the lower CR. Generalized linear mixed modeling (GLMM) indicated that the abundance of *C. fluminea* was significantly negatively associated with chlorophyll-*a* concentration, whereas the population growth rate of *C. fluminea* was significantly positively associated with dissolved oxygen and individual growth rate was not significantly related to any individual environmental variable. The morphological condition (weight at length) of *C. fluminea* varied significantly between our two sites as well as the observed seasonal patterns in abundance. Overall, these results emphasize that the population biology of *C. fluminea* in the lower CR is similar in many aspects to populations previously studied in temperate regions, but that important spatial differences can occur between sites only 60 km apart within the same river system. This knowledge may aid in management Asian clams, as well as other invasive bivalves that are anticipated to invade the region in the near future (e.g., zebra/quagga mussels).

Keywords: Invasive species, population biology, aquatic ecology, North America

AN APPLICATION OF THE FINAL ECOSYSTEM GOODS AND SERVICES SCOPING TOOL AT RESTORATION SITES IN TILLAMOOK BAY

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Stakeholders may have different priorities regarding the purpose or goals for restoration, particularly regarding the benefits that the restoration might provide to them or the communities they represent. Early in the project process, those different priorities should be reconciled into a final set of shared goals around which the restoration project design and monitoring are developed. In many cases, those goals are expressions of final ecosystem goods and services (FEGS) which are those biophysical attributes of nature that people *directly* use, appreciate, or enjoy – such as charismatic wildlife for recreation, property protection for residents, and edible fauna for hunters and anglers. The FEGS Scoping Tool (FST) can be used by restoration practitioners for a particular restoration decision, using a structed approach, to identify what FEGS can speak directly to the values of the stakeholders involved and the beneficiaries they represent. This can help restoration practitioners focus on common interests and priorities that build toward shared restoration goals. We will demonstrate an application of the FST in Tillamook Bay, OR where we worked with restoration planners from Tillamook Bay's National Estuary Partnership. We used the tool to determine how restoration goals and monitoring metrics could be linked to FEGS most relevant to local stakeholders. This allows for an evaluation of restoration performance that can be communicated in terms of locally relevant benefits from nature. This transparent and replicable approach can be useful for restoration planners interested how FEGS can be incorporated into

restoration goals and monitoring. It is transferrable across a wide range of environmental decision contexts in which it is important to consider various, complex stakeholder interests and restoration engineering options. This flexibility also allows for the FST to be easily adaptable from small- to large-scale restoration projects both in size/extent of the project and number of stakeholders involved.

Keywords: Ecosystem Services, Tidal Wetlands, Restoration

THE VALUE OF FINAL ECOSYSTEM GOODS AND SERVICES IN RESTORATION EFFECTIVENESS MONITORING AND ASSESSMENT

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Monitoring and assessment are important aspects of restoration to establish the effectiveness of restoration efforts. Final ecosystem goods and services (FEGS) are the components of the environment directly enjoyed, consumed, or used to yield human well-being. Whereas receiving benefits from nature are often stated as complementary goals for doing ecosystem restoration (e.g., to increase benefits of recreation, flood protection, nature-based education, etc.), measuring progress toward those outcomes is not often included in post-remediation monitoring. Incorporating FEGS into restoration effectiveness monitoring and assessment (REMA)s would be useful for measuring and communicating progress towards meeting the restoration goals from a human benefits perspective. The goal of this presentation is to demonstrate how FEGS concepts and tools can be incorporated into REMA designs, with special considerations for contaminated site cleanups involving environmental components. Key to this approach is identification of the FEGS that are relevant to a given restoration project, and to find or develop metrics to include in monitoring programs. We will introduce two tools useful for this: The National Ecosystem Services Classification System Plus (NESCS Plus) and the FEGS Scoping Tool. Secondly, we will present results of a literature review to assess the extent to which REMA practices have included FEGS. Finally, we will present a generalized methodology that outlines how to incorporate FEGS endpoints and metrics into REMA designs.

Keywords: Ecosystem Services, Tidal Wetlands

A BLUE CARBON DATABASE FOR THE WEST COAST OF NORTH AMERICA

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Coastal wetlands including seagrass meadows, emergent marshes, and shrub and forested tidal wetlands sequester and store large quantities of organic carbon, also known as “blue carbon”. Most of this carbon is typically stored in soils. To help inform wetland conservation and restoration and better understand wetland contributions to estuarine ecosystem services, there is a need to collect, synthesize, and share information on blue carbon at local and regional scales. In 2018 the Pacific Northwest Blue Carbon Working Group began to compile soil carbon stock and sequestration rate data for blue carbon ecosystems along the west coast of North America. The database is a work-in-progress, incepting new data as it becomes available, with planned expansion to include greenhouse gas emission measurements. In this presentation, we briefly introduce the scope and content of the blue carbon database and provide preliminary summary information on soil blue carbon stocks from the region. Soil carbon data from over 900 cores have been added to the database covering tideflats, seagrass meadows, marshes, mangroves, shrub and forested tidal wetlands, and former tidal wetlands from Baja California to Alaska. A preliminary synthesis of stock data shows high carbon storage in soils of tidal marshes and wetlands dominated by woody vegetation, with lower values for seagrass meadows and tideflats. Data gaps highlighted by the database include smaller estuaries, scrub-shrub wetlands, and restored sites.

Keywords:carbon sequestration; tidal wetlands; restoration

INTEGRATING SEDIMENT REMEDIATION AND ECOSYSTEM RECOVERY

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Cleanup at many contaminated sediment sites can be very costly, time consuming, and ineffective if larger scale pressures and ecological processes are not adequately addressed by the remedial design. Ideally, a holistic approach is desired for remedies that brings together remediation and reuse (restoration) by exploiting synergies that minimize costs and environmental impacts and achieves whole-system sustainability benefits. Sustainable remediation strategies should be informed not only by considerations of regulatory compliance but also by stakeholder goals, values and expectations. Over the last few decades, remedies selected at contaminated sediment sites have focused on mass removal or the reduction of exposure to sediment-associated contamination to manage human health and ecological risks. At many contaminated sediment sites, assessing contaminant-focused remedy effectiveness measures has been confounded by the complexity of ecosystem processes, the lack of comprehensive monitoring data sets, and the need to align remediation objectives with ecosystem recovery goals. Additionally, sediments (whether contaminated or not) are linked to processes occurring within the watershed making them susceptible to, and potential drivers of, chemical, physical and biological stressors from larger scale social and economic pressures (land use change, hydrology perturbations, new and emerging chemicals), climate change (sea level rise, extreme events, invasive species), and other disturbances associated with the Anthropocene. Drawing on the results of case studies, key concepts and lessons learned to better integrate sediment cleanup and ecosystem recovery goals are discussed and you are cordially invited to join the discussion.

CORRELATIONS BETWEEN FISH ABUNDANCE AND PHYSICOCHEMICAL PARAMETERS IN HUMBOLDT BAY, CALIFORNIA

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The objectives of this study were to determine the extent of correlations between fish and their physical surroundings, to explore interactions between climatic and physicochemical parameters, and use geostatistical interpolation to elucidate physicochemical changes spatially and temporally. This research was conducted in Humboldt Bay, Humboldt County, California from June 2006 to August 2008. Three eelgrass sites were sampled monthly using an epibenthic otter trawl. In addition to fish populations, physicochemical and climatic parameters were assessed. These included, water temperature, salinity, dissolved oxygen, pH, turbidity, average monthly precipitation and monthly wind speed. A total of 16,261 fish, representing 40 species were captured in this study. Twelve fish species accounted for 94% of the total fish catch. Annually, species richness and diversity were significantly different; each being greatest in 2008. Fish were connected strongly to environmental parameters. Juvenile Shiner Surfperch accumulated at warmer water temperatures, greater than 16°C, while adults were found at lower water temperatures. Saddleback gunnel exhibited the highest abundances during 2007 warmer water temperatures and lower precipitation rates. Three-spined stickleback and Saddleback gunnel showed strong associations to both water temperature and precipitation. Three-spined stickleback adults appeared to prefer warmer water temperatures than juveniles, but both life stage abundances decreased with slight increases in precipitation. Black rockfish and Striped surfperch showed strong associations with turbidity. Krigged estimates of water temperature and salinity calculated using GIS showed general patterns that are useful in simplifying spatial physicochemical data.

AQUACULTURE OF THE PACIFIC OYSTER, *Crassostrea gigas,* AND LOCAL INVASIVE POPULATIONS IN COASTAL WETLANDS OF BAJA CALIFORNIA

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The Pacific oyster, *Crassostrea gigas*, is the most cultured oyster around the world, thus it is also widely distributed as invasive. Recently it has increased its distribution in the Northeastern Pacific coast, especially in Southern California and Baja California. In order to understand the effect of these invasive species on coastal habitats, we first need to understand their distribution and abundance. We examined the distribution and abundance of *C. gigas* and native oysters in estuaries along the Pacific coast of the Baja California Peninsula and found the Pacific oyster was widely distributed. We also found a correlation between the abundance of *C. gigas* and the presence of active oyster aquaculture within the wetland.

Keywords: Invasive species, Ecology, Aquaculture

TEMPERATURE VARIABILITY IN THE COOS ESTUARY AND IT'S POTENTIAL LINKS TO EELGRASS LOSS

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Estuaries are mixing zones where rivers meet the ocean, integrating terrestrial, marine, and atmospheric conditions in sometimes complicated ways. For example, in the Pacific Northwest, long-term and large spatial-scale processes, such as El Niño and marine heatwaves, induce complex interannual variations on top of typical seasonal trends. Here we present observations from the Coos Estuary, in southwestern Oregon, where both anomalously high water and air temperatures were recorded during 2014-2016. Anomalously warm waters have been previously associated with eelgrass decline, which coincidentally occurred in the estuary during the same period. However, not all areas of the estuary responded similarly, as a stronger eelgrass die-off occurred further away from the estuary mouth. At a quarterly-sampled station in the shallow southern arm of the estuary, eelgrass cover decreased starting in 2016 with very low abundance by 2018, and no evidence of recovery yet. However, at sites closer to the estuary mouth, eelgrass meadows may be showing some evidence of recovery since 2018. We explain this spatial variability in eelgrass response to temperature anomaly due to changing riverine, oceanic, and atmospheric forcing conditions, that are modulated by local water depth and relative oceanic influence. Our results highlight what may occur in estuaries under future climate change scenarios when both air and ocean temperatures are expected to increase.

THE SOUTHERN CALIFORNIA BIGHT REGIONAL MARINE MONITORING PROGRAM: A COLLABORATIVE MONITORING PROGRAM ASSESSING HUMAN IMPACTS ON COASTAL MARINE HABITATS

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Regional monitoring programs are a powerful tool for water quality scientists and coastal managers alike. Regional monitoring provides scientists the opportunity to study fundamental ecosystem mechanisms and processes over large biogeographic spatial scales, scales that are simply too difficult and costly to accomplish as a single investigator and are often too sparsely monitored for national programs. The Southern California Bight Regional Marine Monitoring Program (the Bight Program), which began in 1994 and run every five years since, is a collaborative monitoring program consisting of nearly 100 regulated, regulatory, non-governmental and academic institutions. The Bight Program has affected management actions in the region by focusing management effort on habitats most impacted by poor sediment and water quality, highlighting improvements from previous management actions, and characterizing emerging threats to the coastal zone, such as ocean acidification. Looking forward, the Bight Program is working towards characterizing shifting baselines in the Bight. Climate change is expected to have significant impacts on coastal ecosystems, altering freshwater inputs, and warming, deoxygenating, and acidifying waters. These changes will have significant impacts on the structure and function of aquatic ecosystems, as well as the fate and transport of contaminants. In an era of

shifting baselines, regional monitoring can provide managers robust data on shifting reference condition(s) as a benchmark for assessing magnitude of local anthropogenic alteration, evaluating cumulative impacts from multiple pollutant sources, and ranking changes in habitat quality and biological impacts among different types of human activities that are attributable to both global and local changes. Towards this end, the Bight Program is working to implement new indicators, metrics, and assessment frameworks to evaluate ecosystem impacts due to climate change. However, Bight monitoring is only as good as its ability to compare to other monitoring programs. Bight Program participants are looking to unify best practices to compare across monitoring programs along the US West Coast and look forward to working with other programs to establish these protocols to develop the managerially relevant monitoring datasets of the future.

INTERANNUAL SPEED AND SYNCHRONY OF EELGRASS MEADOW MOVEMENTS WITHIN SITES ALONG THE WEST COAST

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Eelgrass meadows are important, dynamic ecosystems that are often exposed to human stressors. Nearshore ecosystem management may seek to limit co-occurrence of stressful human activities where eelgrass is present, but this is challenging because eelgrass meadows move. In this talk, I will describe our ongoing work to quantify interannual dynamics of eelgrass meadows among years within sites along the west coast. Our goal is to assemble and analyze pre-existing data to quantitatively characterize distances over which eelgrass can move among years, and opportunistically examine for coherence in eelgrass dynamics among sites and in response to regional drivers (e.g., marine heat waves). At this stage of the study's development, it would be helpful to receive feedback on our analytical approach and compare our preliminary results with folks' perceptions from field experiences. We also welcome potential collaborators who would be interested in having their data included in this study and would like to work with us to develop the resulting publication. Keywords: Eelgrass, dynamics, GIS

SEA CUCUMBER - MUSSEL AQUACULTURE IN WASHINGTON STATE: ASSESSING CAGE DENSITY, FOOD TYPE, AND SIZE ON ASSIMILATION POTENTIAL AND GROWTH

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Interest in growing the native California sea cucumber *Apostichopus californicus* for both wild stock enhancement and for use in multi-trophic aquaculture has grown in Washington State*. A. californicus* is a good candidate for Integrated Multi Trophic Aquaculture (IMTA), where they are supported entirely on excess waste from existing floating aquaculture operations (e.g., bivalves or finfish). In IMTA, excess nutrients and organic materials are taken up by this secondary trophic level species, providing both environmental benefits and a marketable product. This project assesses *A. californicus* cage density (6/m^2 and 12/m^2) and size on cucumber growth and assimilation for five months underneath Mediterranean Blue Mussel, *Mytilus galloprovincialis* aquaculture in Totten Inlet, Washington. In the lab, microalgae (*Palmaria palmata*) is mixed with *M. galloprovincialis* waste and fed to *A. californicus* to compare the consumption and C:N absorption rates between waste that could be found underneath different IMTA systems. The importance of understanding the assimilation potential of *A. californicus* is considered within the aquaculture management lens. Growth potential at different *A. californicus* cage densities is considered for working practicality alongside commercial mussel aquaculture.

PACIFIC HERRING (Clupea pallasii) EGGS ACCUMULATE ON EELGRASS (Zostera marina) IN TOMALES BAY, CALIFORNIA SUGGESTING HERRING PREFERS EELGRASS FOR SPAWNING

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Pacific Herring is a lightning rod species in conflicts over what constitutes sustainable fisheries, coastal habitat restoration, and nearshore conservation. Overfishing is a global concern to the point of being considered an extinction crisis for particular fisheries. Understanding how, where, and when a particular species reproduces may be critical to understanding how a species responds to fishing pressure. The Pacific Herring is a small pelagic fish of the family *Clupeidae* found throughout the Northern Pacific Ocean.
The Pacific Herring fishery in Tomales Bay closed to commercial fishing after 2007 because of overfishing, market price decline, and low fishing effort. It has been long noted that herring tend to spawn in eelgrass meadows, but the extent of this dependency has not been thoroughly examined.
Reported are the results of a two-year field study of Pacific Herring spawning activity in Tomales Bay investigating: Do Pacific Herring eggs accumulate more on natural eelgrass compared to other natural or artificial substrates? Artificial spawning substrate research areas were built at two nearshore independent sites that included: artificial eelgrass, concrete quadrats, and existing bottom substrate quadrats (bare, sand, silt, or rock). Spawning on natural eelgrass were compared to spawning in the artificial substrate research areas at the two sites. Pacific Herring eggs accumulated magnitudes more on natural eelgrass compared to the artificial eelgrass, concrete, and existing bottom substrates.
Suggested is that herring prefers natural eelgrass for spawning, supporting natural eelgrass conservation efforts as an important component of Pacific Herring fisheries stock re-building, sustainability, and preservation.

Keywords: Pacific Herring (*Clupea pallasii*), Eelgrass (*Zostera marina*), Coastal Spawning Habitat

COAST-WIDE EVIDENCE OF LOW PH AMELIORATION BY SEAGRASS ECOSYSTEMS

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Global-scale ocean acidification has spurred interest in the capacity of seagrass ecosystems to increase seawater pH within crucial shoreline habitats through photosynthetic activity. However, the dynamic variability of the coastal carbonate system has impeded generalization into whether seagrass aerobic metabolism ameliorates low pH on physiologically and ecologically relevant timescales. Here we present results of the most extensive study to date of pH modulation by seagrasses, spanning seven meadows (*Zostera marina*) and 1000 km of California coast, US, over six years. Amelioration by seagrass ecosystems compared to non-vegetated areas occurred 65% of the time (mean increase 0.07 ± 0.008 SE). Events of continuous elevation in pH within seagrass ecosystems, indicating amelioration of low pH, were longer and of greater magnitude than opposing cases of reduced pH or exacerbation. Sustained elevations in pH of >0.1, comparable to a 30% decrease in $[H^+]$, were not restricted only to daylight hours but instead persisted for up to 21 days. Maximal pH elevations occurred in spring and summer during the seagrass growth season, with a tendency for stronger effects in higher latitude meadows. These results indicate that seagrass meadows can locally alleviate low pH conditions for extended periods of time with important implications for the conservation and management of coastal ecosystems.

THE EFFECTS OF ABIOTIC CONDITIONS AND PLANTING DESIGN ON ACTIVELY PLANTED *SPARTINA FOLIOSA* IN A SOUTHERN CALIFORNIA SALT MARSH RESTORATION SITE

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Salt marsh restoration efforts are often initiated by creating hydrologic conditions suitable for salt marsh vegetation through elevation adjustments. However, methods for altering elevation—including gradation or sediment addition—may cause unfavorable abiotic conditions for plant establishment. In such cases, actively planting salt marsh vegetation may be necessary to accelerate habitat restoration, but further research is needed to determine best planting practices in various restoration scenarios. This study analyzes several approaches to planting *Spartina foliosa* (California cordgrass) in a salt marsh restoration site in Seal Beach, CA, that received added sediment in 2016. We planted *S. foliosa* plugs in a fashion to test whether shallow ponds in the restoration site create favorable abiotic conditions for *S. foliosa* growth by installing plugs adjacent to and one meter away from these ponds. Soil salinity is slightly lower, and soil water content is higher adjacent to ponds than one meter away, but these parameters vary considerably across the site. Also, we are studying whether planting *S. foliosa* in clumps (~20 cm spacing between plants) with and without other salt marsh plant species increases growth and survivorship compared to individually planted *S. foliosa*. Seven months after planting, *S. foliosa* plugs adjacent to ponds have more and taller stems than *S. foliosa* plugs one meter away from the ponds. Stem count and height are also significantly affected by planting location within the restoration site. Neither clumped planting nor the inclusion of other species appears to impact *S. foliosa* growth.

Keywords: Restoration, Salt marsh planting, Sea-level rise

BROADSCALE DISTRIBUTION, ABUNDANCE, AND HABITAT ASSOCIATION OF THE ASIAN CLAM (*CORBICULA FLUMINEA*) IN THE LOWER COLUMBIA RIVER, USA

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The Asian clam, *Corbicula fluminea*, is an invasive freshwater bivalve that has established populations throughout the globe, including the Pacific Northwest, USA, and is known to have deleterious effects on natural and human systems. During 2017-2020 we collected adult and juvenile *C. fluminea* from 15 mid-channel and 29 shore-based sampling locations spanning 537 rkm of the Columbia River (CR) to elucidate the association of *C. fluminea* abundance and condition with habitat characteristics including dissolved O_2, pH, temperature, salinity, specific conductivity, depth, geographic location, chlorophyll *a* concentration, bank slope, and sediment composition (granulometry, TOC). *C. fluminea* abundance was greatest at the confluence of the Sandy River with the CR near Gresham, OR (avg. 342 ind. m^{-2}), with the majority of sample sites with abundances >100 ind. m^{-2} located downstream of Bonneville Dam and the majority of sample sites with abundances 0 ind. m^{-2} located upstream. Our results provide a better understanding of the basic biology and ecology of this global invader, as well as provide natural resource managers with information on where, when, and why this bivalve invades temperate river ecosystems.
Keywords: Bivalves, invasive species, Columbia River

HABS! WHAT ARE WE DOING ABOUT THEM IN OREGON?

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Coastal harmful algal blooms (HAB) have increased globally in frequency and intensity since the 1980s (IPCC Special Report on the Ocean and Cryosphere in a Changing Climate 2019). HAB events in Oregon closed shellfish harvests nearly every year since 1992, impacting industry and communities. In fall of 2020, Oregon Department of Fish and Wildlife (ODFW) closed razor clam harvesting for the entire Oregon Coast based solely on the detection of an emerging *Pseudo-nitzschia* species bloom and particulate domoic acid (DA) levels in seawater. The fall 2020 HAB event caused DA levels in razor clam tissues to rise to the highest level ever recorded in Oregon at 140 ppm, seven times the closure limit. Previous shellfish closures were based on razor clam tissue analysis, a reactive strategy. Currently, ODFW monitors surf-zone phytoplankton for HAB species as part of the Monitoring and Event Response for Harmful Algal Blooms (MERHAB) network. The MERHAB project combines surf zone data with data generated by NOAA offshore HAB monitoring, Washington HAB monitoring and University of Washington physical oceanography models to forecast nearshore HAB threats. Summary analysis are provided to fisheries managers as the Pacific Northwest HAB Bulletin. This early warning system allows shellfish managers the ability to target shellfish sampling for testing where there might be potential HAB and biotoxin impacts, resulting in less uncertainty for businesses, consumers and harvesters who rely upon these resources. The system also increases public health safety by providing more accurate testing timeframes when issues may occur.

Keywords: harmful algal blooms, climate change, and shellfish

KELP COMMUNITIES IN CRISIS: RECENT DISRUPTION OF BULL KELP BEDS AND ROCKY REEF COMMUNITIES ALONG THE SOUTHERN OREGON COAST

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Recent changes in nearshore ocean conditions contributed to broad-scale impacts to bull kelp (*Nereocystis leutkeana*) and rocky reef habitats along the southern Oregon coast. Elevated seawater temperatures associated with a marine heatwave (2015-2020) precipitated a complex cascade of impacts to the shallow-water communities, including a dramatic decline in sunflower sea stars (*Pycnopodia helianthoides*), a significant increase in purple sea urchins (*Strongylocentrotus purpuratus*), and a marked decrease in red abalone (*Haliotis rufescens*). Populations of sunflower stars were decimated coast-wide by sea star wasting disease, and plummeted to the level where they are now considered as Critically Endangered by the International Union for Conservation of Nature (2020). Purple urchin populations experienced a massive recruitment event along the southern Oregon coast (2013-2014), and it is estimated that hundreds of millions of new urchins have become established along Oregon's numerous rocky reefs. Red abalone reach the northern-most extent of their biogeographic range at Cape Arago. Recent surveys by the Oregon Department of Fish and Wildlife (ODFW) and Reef Check reveal declines in red abalone since 2015 to a level well below the threshold considered essential to ensure successful reproduction and population replenishment. California and Oregon recently suspended the recreational abalone fisheries until 2024-2026 to monitor habitat conditions, conduct new surveys of abalone populations, and generate regional forecasts for rebuilding the diminished populations. Additional management actions are needed to address widespread disruption of bull kelp communities, adopt an effective conservation strategy for sunflower stars, and slow the continued decline of red abalone populations.

Keywords: Kelp, abalone, urchins

EXPLORING BIOPHYSICAL LINKAGES BETWEEN COASTAL FORESTRY MANAGEMENT PRACTICES AND AQUATIC BIVALVE CONTAMINANT EXPOSURE

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Terrestrial land use activities present cross-ecosystem threats to riverine and marine species and processes. Specifically, pesticide runoff can disrupt hormonal, reproductive, and developmental processes in aquatic organisms, yet non-point source pollution is difficult to trace and quantify. In Oregon, U.S.A., state and federal forestry pesticide regulations, designed to meet regulatory water quality requirements, differ in buffer size and pesticide applications. We deployed passive water samplers and collected riverine and estuarine bivalves *Margaritifera falcata*, *Mya arenaria*, and *Crassostrea gigas* from Oregon Coast watersheds to examine forestry-specific pesticide contamination. We used non-metric multidimensional scaling and regression to relate concentrations and types of pesticide contamination across watersheds to ownership and management metrics. In bivalve samples collected from eight coastal watersheds, we measured twelve unique pesticides (two herbicides; three fungicides; and seven insecticides). Pesticides were detected in 38% of bivalve samples; and frequency and maximum concentrations varied by season, species, and watershed with indaziflam (herbicide) the only current-use forestry pesticide detected. Using passive water samplers, we measured four current-use herbicides corresponding with planned herbicide applications; hexazinone and atrazine were most frequently detected. Details about types and levels of exposure provide insight into effectiveness of current forest management practices in controlling transport of forest-use pesticides.

EFFECT OF PROLONGED ELEVATED SEAWATER TEMPERATURE ON *ZOSTERA MARINA* FROM THE SALISH SEA

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Seawater temperatures in the Salish Sea are predicted to increase by around 1.5-3 °C by 2095 due to climate change, and marine heat waves may become more frequent and intense. We conducted a mesocosm experiment to evaluate *Z. marina* performance in the presence of prolonged, increased seawater temperatures to emulate climate change or a marine heat wave. We transplanted *Z. marina* from four locations in Washington State into replicate tubs of sediment, placed in flow-through seawater mesocosms with ambient (n=4) or +3 °C seawater (n=4) treatments. We measured shoot density, morphological traits, and photosynthetic efficiency monthly and plastochrone interval and wasting disease index quarterly. After 2 months, we found that *Z. marina* exposed to increased temperature grew taller and had more leaves than plants exposed to ambient conditions. Conversely, *Z. marina* in ambient seawater conditions had a greater shoot density than plants in heated treatments. We found no difference in photosynthetic efficiency during this time period. Interestingly, plants from each of the 4 sites had characteristic morphology that continued to be distinct by site, regardless of temperature treatment. Similar to other studies, plants exposed to heated seawater had a lower shoot density than plants exposed to ambient conditions, and historical diebacks of *Z. marina* have been attributed to increased seawater temperature. In contrast, our study will investigate long-term implications of elevated seawater temperature whereas other studies are short-term or investigate elevated temperature in conjunction with other factors like nutrients or salinity

REMOTE SENSING OF COASTAL TURBIDITY DUE TO RUSSIAN RIVER PLUMES

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During wet California winters, the mouth of the intermittently closed Russian River estuary is open and river waters flow directly to the ocean. Buoyant, sediment-laden plumes are released during high river discharge events, increasing surface turbidity in the coastal ocean. While large-river plume systems are well studied, small/medium sized plumes like those from the Russian River are not well understood. Unlike larger plume geometries that are controlled by Coriolis, it is hypothesized that smaller plumes are primarily controlled by the interplay of river outflow, tidal currents, wind-driven currents, wind stress, and wave radiation stress. This study analyzes statistical relationships between Russian River discharge, environmental parameters, and coastal turbidity patterns from sediment plumes. About 4100 MODIS satellite images of the Russian River estuary captured over 20 years are considered against continuous historical data sets of observed/modeled river discharge, wind, and wave energy data. We infer that coastal turbidity patterns off the Russian River are well correlated with river discharge and wind patterns. Further, the offshore extent and intensity of surface sediment plumes are influenced by the momentum balance between river outflow rate and wave radiation stress.

Keywords: River plumes, sediment, remote sensing

OPPORTUNISTIC PERFORMANCE SURVEY OF A LATE 80'S RESTORATION EFFORT: AN EELGRASS RESTORATION SITE TURNS 30

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A survey team opportunistically investigated an eelgrass restoration/mitigation site in Coos Bay, OR. This transplant was performed as mitigation for the South Oregon Regional Airport (SORA) runway safety expansion. For the extension of runway into intertidal habitat, the regulatory agencies required the creation of approximately 5.0 acres of eelgrass to compensate for lost intertidal and eelgrass habitat. The site is located at a former dredge spoil island to the immediate north and west of the new runway, which was re-graded to create a new intertidal zone at optimal elevations for eelgrass. Concept sketches show that 8.1 acres was excavated and graded with 4.35 acres planted with eelgrass over four plots. The implementation occurred in 1988 and 1989, with performance monitoring occurring again in 1990. Approximately 30 years later, a survey was performed for eelgrass areal coverage and density, as well as a bathymetry, in August and September 2018. Survey results showed a relatively dense and continuous eelgrass bed is still present within the original site boundaries. The areal extent of eelgrass occupies 6.83 acres within the site at the time of the survey, with a density comparable to surrounding naturally occurring eelgrass habitat. Elevation had decreased (become shallower) nearly a foot across the site which indicates accretion (net elevation increase) is approximately +0.03 feet/year (0.91 cm/yr). This is the first quantitative documentation of eelgrass restoration performance demonstrating the viability of an eelgrass transplant site within a modified area over long time scales.

Keywords: eelgrass, restoration, performance monitoring, Coos Bay

CONTAMINANT RISKS ASSOCIATED WITH THE PACIFIC OYSTER IN THE HIGHLY URBANIZED SAN DIEGO BAY

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Contaminant loads in shellfish are of interest as indicators of the health of coastal waters and to assess potential consumption risks. Mussels have commonly been used for monitoring, but the popularity of oysters as farmed and wild-harvested food and the recent expansion of feral populations, especially the Pacific oyster (*Crassostrea gigas*) have increased interest in oyster contaminants. We analyzed Pacific oyster from San Diego Bay, California for contaminants including plastics and then compared concentrations to those in mussels from NOAA's State Mussel Watch Program (2003-2013), and human health thresholds. While some contaminants (e.g., chlorpyrifos, dieldrin) were only present in oyster from one or a few sites, many contaminants were present in all sites in both seasons, including phthalates, tributyltin, and many metals. Pacific oyster contaminant assemblages were more strongly associated with season than location, with higher concentrations of neonicotinoid pesticides and metals in the dry summer; and many sediment-bound compounds and plastics in the winter. Pacific oyster compared with mussels had generally lower concentrations of many contaminants, including some organics (PCBs, PAHs) and metals, but higher concentrations of copper and zinc. Pacific oyster exceeded consumption thresholds for PCBs. Contaminant loads across wet and dry seasons or species were not easily explained by contaminant hydrophobicity or lipid content of shellfish. Other factors such as natural history and environment need to be further explored to identify generalities across a variety of contexts (e.g., hydrologic regime, season), which can then be used in the crafting of thresholds.

THE SILENCE OF THE CLAMS: THE SUB-LETHAL EFFECTS OF ENVIRONMENTALLY RELEVANT CONCENTRATIONS OF FORESTRY USE PESTICIDES ON ADULT SOFT SHELL CLAMS

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The US forestry industry commonly applies an array of pesticides to control plant and insect pests. A recent study confirmed the presence of these pesticides in water as well as the tissues of various bivalve species in Oregon coastal watersheds. Though studies have been carried out to determine the individual effects of these compounds on organisms and the environment in which they live to establish lethal limits, environmentally relevant concentrations of these chemicals in combination have not been tested for sub-lethal effects. We conducted laboratory experiments to examine the effects of four commonly used forestry pesticides; Atrazine, Hexazinone, Indaziflam, and Bifenthrin, on the soft shell clam *Mya arenaria*, a common estuary species. Growth, feeding rates, and condition index were measured, as well as mortality. Initial results indicate effects of some combinations on condition index as well as clam mortality, even at environmentally relevant concentrations.

Keywords: pesticides, multiple stressors, bivalves

PATTERNS AND DRIVERS OF CORAL BLEACHING IN 2019 ACROSS THE HAWAIIAN ARCHIPELAGO

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The Hawaiian Archipelago experienced a moderate bleaching event in 2019—the third event over the last six years to impact the islands. We conducted coral bleaching surveys across the Hawaiian Archipelago during the 2019 bleaching event in order to 1) quantify spatial variation in bleaching extent, 2) compare 2019 results to bleaching recorded during the 2014/2015 bleaching event, 3) examine taxa-level patterns in bleaching susceptibility, and 4) determine key drivers of bleaching in 2019. While the current frequency of bleaching events is unprecedented in Hawaii, surveys showed that the 2019 bleaching across both the Main and Northwestern Hawaiian Islands was overall less severe than the last major event in 2014/2015. However, the bleaching observed was highly site and taxa-specific. This variation was driven not only by small-scale differences in acute thermal stress, but by the bleaching susceptibility of coral assemblages whose structure was shaped by past bleaching and subsequent mortality. A suite of environmental (surface light, depth) and anthropogenic (urban run-off, sewage effluent, tourism/recreation) drivers were also found to be significant drivers of bleaching in 2019. While our results do not show clear signs of overall acclimation by corals to thermal stress, certain locations may be more resilient than others. In light of the forecasted increase in severity and frequency of bleaching events, we provide specific suggestions for mitigating thermal stress and lay the groundwork for further investigations of viable management strategies in Hawaii.

AN INVESTIGATION OF THE CLOSURE REGIMES OF CALIFORNIA'S BAR-BUILT ESTUARIES

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California's bar-built estuaries (BBEs) are intermittently connected with the ocean, alternating between the tidally connected "open" and tidally disconnected "closed" inlet states. Annual closure and breaching behaviors vary between sites and years, existing on a spectrum from always open to always closed. The estuary's closure regime (the characteristic behavior of closures and breaches) is shaped by the local response to seasonal variations in waves, tides, and streamflow. It is hypothesized that latitudinal gradients in precipitation drive regional differences in closure regimes. The objective of this study was to catalog different closure behaviors across a diverse range of California BBEs and to explore how local variations in environmental forcing influence closure behaviors across sites. Twenty-one long-term records of daily estuary inlet state were analyzed at seasonal and interannual timescales. Findings include: (1) Most of the observed BBEs exhibited multiple annual closure behavior types, though the mix of behaviors varies significantly between sites; (2) While there is some north-to-south gradient in closure behavior, the observed sites exhibited strong regional diversity; (3) Multiple closure events a year (as opposed to just one) is a common occurrence in many California BBEs; (4) There are clear seasonal cycles in individual closure event lengths but they vary considerably between sites.

RANGE EXPANSION IN THE INTRODUCED EUROPEAN GREEN CRAB, *CARCINUS MAENAS* AND THE NATIVE LINED SHORE CRAB, *PACHYGRAPSUS CRASSIPES*

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Major El Nino events and oceanic heat waves are linked to the range expansion of many marine species. For the shores of the northeast Pacific, we compared range expansion in the European green crab, *Carcinus maenas*, which was introduced to San Francisco Bay prior to 1990, to that of the native lined-shore crab, *Pachygrapsus crassipes,* which has existed on the coast since the end of the last Ice Age (>10,000 years ago). The initial northern range limit of these species was central California and southern Oregon, respectively. Both species increased their northern range along the open coast to northern Oregon, Washington and Vancouver Island after strong El Niño events. However, *C. maenas* has, in just a matter of decades, successfully established populations in inlets on the west coast of Vancouver Island, and possibly also in the Salish Sea, while *P. crassipes,* in thousands of years, never has. We hypothesize that this difference in invasion success is due to the shorter larval duration of *C. maenas*, < 2 months, compared to that of *P. crassipes*, 3-4 months. Because the residency times of water in the inlets of the west coast of Vancouver Island are ~1-2 months, they can act as an incubator for the larvae of *C. maenas*, while those of *P. crassipes* are likely flushed out to the open sea before they can complete their development.

Keywords: range expansion, El Nino, invasive species

IS THE EUROPEAN GREEN CRAB IN OREGON NOW ABUNDANT ENOUGH TO BE SELF -RECRUITING?

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Annual recruitment of Young-Of-the-Year European green crabs, *Carcinus maenas*, in Oregon estuaries varies greatly with ocean conditions. Numbers were high following the 1997-1998 El Niño, decreased and remained low until they spiked again following the 2015-2016 El Niño. Among the best indicators for green crab year class strength are warm winter water temperatures, and a high abundance of southern copepods. These correlations suggest that green crabs need (1) warm winters (temperature >10°C), which enable larvae to complete their development in the near-shore, (2) strong northward flow of coastal waters during winter, which allows larvae to be transported from established populations in California and (3) coastal circulation patterns that keep larvae close to shore, where they can be carried by wind and tidal currents into estuaries to settle. Ocean indicators prior to 2016 strongly suggest that Oregon green crabs originated from California larval sources. Over the last few years, however, this relationship appears to be breaking down in that more young green crabs were observed than predicted from ocean indicators. We discuss the possible role of additional larval sources from the north and from local reproduction.

Keywords: El Niño, larval sources, temperature limitation