PERS 2024 Meeting Abstracts

Alphabetical Order by Last Name

MAPPING THE HABITAT MOSAICS OF SAANICH PENINSULA ESTUARIES HELPS DETERMINE THEIR RESILIENCY

Thomas Armitage*, SeaChange Marine Conservation Society, thomas@seachangesociety.com**, Seanie Malcolm**, SeaChange Marine Conservation Society, **Susan Anthony**, SeaChange Marine Conservation Society, **Sarah Cook**, SeaChange Marine Conservation Society

Estuarine habitats are critical coastal environments which cycle nutrients and support the productivity of fisheries by providing nursery and foraging habitats for fish and crustaceans. However, coastal development, eutrophication, habitat degradation, and climate change threaten the estuary environment. SeaChange's four-year Resilient Estuaries of the Salish Sea (RESS) project aims to determine what makes some estuaries resilient and others vulnerable and if their resiliency will continue with climate change. For the first year, we collected geographical, biological, and water quality data on six Saanich Peninsula estuaries. The goal was to identify features that could lead to their resilience. The focus of this presentation will be our seafloor mapping methods and results. For our methods, we recorded video footage from a camera towed from our vessel and synced the footage with Global Positioning System (GPS) data. We reviewed the footage and identified the seafloor habitat at each point based on their composition and predominant vegetation. We produced a point classification map for each estuary, allowing for an approximation of the habitat diversity within the estuary, including eelgrass beds. Along with abiotic factors like salinity, temperature, dissolved oxygen, percent oxygen, and turbidity, and biotic measurements like bacterial contamination and nutrient concentration, we will characterise the features of estuaries that may correlate to their level of resilience.

Keywords: Mapping, Estuary, Conservation

LONG-TERM EELGRASS MONITORING ON BC'S CENTRAL COAST: DRIVERS OF CHANGE, KEY PARAMETERS, AND DATA MOBILIZATION

Krystal Bachen*, Hakai Institute, krystal.bachen@hakai.org, **Angeleen Olson**, Hakai Institute, **Zachary Monteith**, Hakai Institute, **Carolyn Prentice**, Hakai Institute, **Derek VanMaanen**, Hakai Institute, **Gillian Sadlier-Brown**, Hakai Institute, **Tyrel Froese**, Hakai Institute, **Ondine Pontier**, Hakai Institute, **Danja Currie-Olsen**, Hakai Institute, **Heather Earle**, Hakai Institute, **Alex Schmill**, Hakai Institute, **Margot Hessing-Lewis**, Hakai Institute

Since 2014, Hakai Institute's Nearshore Program has been monitoring eelgrass (*Zostera marina*) on BC's Central Coast to investigate climate-associated changes in biodiversity, productivity, and connectivity. Six subtidal and three intertidal sites are surveyed annually by SCUBA and at low tide by foot. Surveys record density and habitat parameters of the eelgrass bed, and associated fish and invertebrate communities. Shoots are collected and processed for biometrics and mesograzer biomass. Over the last 8 years, these eelgrass meadows have been relatively healthy and stable. However, after the 2015/2016 marine heat wave, we detected a decrease in shoot density with minimal recovery across sites, suggesting persistent climate impacts of anomalous warming events. Monitoring surveys have contributed to research projects that have investigated: 1) strong seascape food web connections in seagrass beds, where kelp is supplying allochthonous food sources to seagrass consumers; 2) blue carbon work has shown that reduced wave action increases carbon storage, and that temperate seagrass stocks are lower than elsewhere in the world; and 3) working with research partners, we have identified the presence of eelgrass wasting disease, a slime mold (*Zosterae labyrinthula*) that has low disease prevalence on the Central Coast, but higher prevalence in other regions from Alaska to California. Currently our monitoring surveys are contributing to new research areas, including detection of green crabs via trapping. Lastly, we are working with the local and global community on seagrass Essential Ocean Variable (EOVs),and the emerging transboundary seagrass collective between BC and Washington.

Keywords: LTER, Zostera marina, climate change, temperature

INNOVATIVE APPROACHES TO TIDAL MARSH RESTORATION AND COASTAL FLOOD ADAPTATION IN THE FRASER RIVER DELTA

Eric Balke*, Ducks Unlimited Canada, e_balke@ducks.ca, **Daniel Stewart**, UBC Conservation Decisions Lab and Asarum Ecological Consulting, **Eric Morris**, Kerr Wood Leidal

The Fraser River Delta (FRD) has been extensively modified by historic river training, ongoing dredging, dike construction, and land conversion. Pacific salmon and other fish species rely heavily upon the FRD intertidal habitats, and fish stocks have declined as the estuary has been increasingly modified and developed over the past 150 years. Sea level is anticipated to increase over 1 metre by the year 2100, but most of the >250 km of dikes and related flood protection structures are insufficient for current flood hazards. This symposium will inspire restoration practitioners with details of new and exciting restoration tactics while highlighting the real challenges that occur during the planning and execution of past and present projects.

Presentation 1: Overview of the Fraser Delta.
Presentation 2: Marsh Creation Projects: Past, Present, Future. A comprehensive study on factors influencing the outcomes created tidal marshes in the Fraser Estuary is used as a springboard to "learn from the river" to pilot a new approach of tidal marsh creation.
Presentation 3: Sturgeon Bank Sediment Enhancement Pilot Project. Over 160 hectares of tidal marsh have died off, and a novel sediment augmentation project aims to begin restoring this significant ecological loss.
Presentation 4: Boundary Bay Living Dike Project. A local government has begun implementing a "living dike" to experiment with nature-based approaches to coastal flood protection in Boundary Bay.

Keywords: tidal marsh, coastal flood adaptation, ecological restoration, habitat creation

WILD POPULATIONS OF PACIFIC OYSTERS (MAGALLANA GIGAS) EMERGE DURING THE BLOB HEATWAVE IN SOUTH PUGET SOUND, WASHINGTON USA

Emma Beck*, University of Washington, ebeck2@uw.edu, **Jennifer Ruesink**, University of Washington, **Stena Troyer**, Harbor WildWatch, **Michael Behrens**, Pacific Lutheran University/Harbor WildWatch

Marine heatwaves have altered ecosystems globally, including changing community composition and facilitating the spread of invasive species. In south Puget Sound, Washington (USA), non-native Pacific oysters (Magallana gigas) have been farmed extensively for almost a century and grown in enhancement sites, however, they have only recently recruited in the wild. We explored how the appearance of Pacific oysters was related spatially (eight sites) and temporally (decade) to warmer summer water temperatures in south Puget Sound and compared oyster persistence across five sites where recruitment occurred. The largest recruitment event from 2012-2020 was in the summer of 2015, in the middle of the east Pacific Blob marine heatwave which led to warm water temperatures off the west coast of North America. Throughout the study period, the number of oyster recruits each year was positively correlated with warmer water temperatures. Oyster population densities differed across the five sites where recruitment occurred and generally declined after 2015, but showed no site by year interactions, which is consistent with spatially-variable recruitment and similar post-recruitment survival. Mean oyster shell heights also differed among sites, which could reflect different growth trajectories or recreational harvest patterns. Our research supports the claim that warming sea surface temperatures may interact with species introductions to change modern biogeography.

Keywords: invasive species, climate change, ecosystems

A TIME-SERIES STUDY ON THE BLOOM DYNAMICS OF HALOSPHAERA SP. (PYRAMIMONADALES, CHLOROPHYTA), A MARINE PHYTOPLANKTON, IN BELLINGHAM BAY, WASHINGTON

Jessie Bell*, Western Washington University, bellj39@wwu.edu, **Robin B. Kodner,** Western Washington University

Halosphaera, phycomate prasinophytes, are an understudied genera of marine algae found exclusively during the winter months in the Salish Sea of North America. Halosphaera exhibit a complex life cycle that alternates between a motile flagellated stage and a non-motile phycomate stage. The latter is a spherical, lipid-filled cell that ranges in size from ~120 um to ~400 um and is found in surface waters. Their life cycle raises questions about the environmental factors influencing their development. This study documented the annual bloom of Halosphaera sp. in Bellingham Bay, Bellingham, WA. A surface plankton tow was conducted daily at high slack tide from December 1, 2023, to April 1, 2024, with each tow sampling ~12.4 m^3 of water. In-situ measurements for temperature, pH, salinity, chlorophyll a, and nitrate concentration were recorded, alongside tidal range and wind speed. Phycomates were first observed on December 15, 2023, and ranged from 0 to 206 cells tow-1 across the bloom. Cell counts were generally 10 or fewer (much less than last season), but there was a significant spike from February 6 to February 11, 2024. Exploratory data analysis, Spearman's rank correlations, and generalized linear modeling (GLM) were used to reveal relationships between cell counts and abiotic factors. These findings contribute to our ecological understanding of the bloom dynamics of Halosphaera sp., and provide the first quantitative data on this taxa through daily sampling across an entire growing season.

Keywords: Halosphaera sp., green algae, bloom dynamics

EFFECTS OF TEMPERATURE ON LARVAL DEVELOPMENT AND SURVIVAL OF THE INVASIVE EUROPEAN GREEN CRAB CARCINUS MAENAS

Joyce Block*, Western Washington University, blockj3@wwu.edu

Carcinus maenas, the European Green Crab (EGC), is a successful and ubiquitous invasive species and increasing climate change sea surface temperatures are directly correlated with EGC range expansions worldwide. The critically important Zostera marina beds in Padilla Bay, Washington are threatened by EGC invasion, as are the invertebrate and vertebrate communities that rely on those beds. The purpose of this study is to investigate how survival, stage duration, and body size of EGC larvae are affected by exposure to temperatures of 12°C, 14°C, 16°C, and 18°C and to determine whether temperature responses differ for larvae produced by different individual gravid females from Padilla Bay. This summer, we will work with WDFW and Padilla Bay staff to acquire gravid EGC females that will be kept individually in a quarantine facility at WWU Shannon Point Marine Center. They will be maintained in a temperature-controlled, recirculating water bath and examined daily for the release of larvae. When that occurs, larvae will be immediately collected, and placed as single larva in 15 x 20-ml scintillation vials for each of eight temperature treatment tanks (N=120). The data collected will inform management, restoration, and conservation strategies under a regime of rising temperatures, as well as enhance biophysical models for predicting the spread of this invasive species in the Salish Sea.

Keywords: invasive species, climate change, larval development

SPATIAL AND TEMPORAL VARIABILITY OF BRACHYURAN CRAB LARVAE IN PADILLA BAY, WA.

Nicole Burnett*, Padilla Bay National Estuarine Research Reserve, nburnett@padillabay.gov, Keiley Munstermann, Padilla Bay National Estuarine Research Reserve

Located in the central Salish Sea, Padilla Bay is a small embayment in Washington with the largest eelgrass meadow in the continental United States. Numerous brachyuran crab species live in and around Padilla Bay and the adult crab community has been evaluated with monthly baited trapping efforts since 2016. In addition, the larval crab community has been explored since 2018 through monthly zooplankton sampling at three sites in order to explore the spatial and temporal variability of the zoeal crab community. We found that the larval crab community did not differ between two sites located in channels within the eelgrass meadow but did differ from a deep-water site. Additionally, the communities differed seasonally and annually. Multiple life history stages, including the larval stage, may be impacted by climate change, ocean acidification, and the introduction of invasive species such as *Carcinus maenas*. It is therefore important to understand the patterns of larval phenology and community composition to fully understand the impacts to the overall crab community.

Keywords: crab larvae, community composition, Padilla Bay, brachyuran

PSF MARINE SCIENCE'S NEARSHORE AND ESTUARY PROGRAM: DEVELOPING TOOLS AND GUIDANCE FOR SALMON HABITAT RESTORATION AND RESILIENCE

Nicole Christiansen*, Pacific Salmon Foundation, nchristiansen@psf.ca, **Isobel Pearsall,** Pacific Salmon Foundation, pearsalli@psf.ca; **Alejandra Mora-Soto** UVic, Pacific Salmon Foundation, alemoras@uvic.ca; **Kyla Sheehan**, Pacific Salmon Foundation, ksheehan@psf.ca; **Jerlyn Brutas**, UBC/Pacific Salmon Foundation, jbrutas@psf.ca; **Sarina Clay-Smith**, Pacific Salmon Foundation, sclaysmith@psf.ca; **Ben Skinner,** Pacific Salmon Foundation, bskinner@psf.ca

The Pacific Salmon Foundation's Marine Science Program, established to address key findings and recommendations of the Salish Sea Marine Survival Project, takes a multi-pronged approach to understand factors limiting the marine survival of salmon and to facilitate and support action for a sustainable and productive future for wild Pacific salmon. Estuaries and nearshore habitats – shallow shorelines, eelgrass meadows, and kelp forests – support the salmon food web and are critical places of refuge during the formative transition when juvenile salmon first enter the marine environment; but face increasing pressures from climate change and anthropogenic degradation. The Marine Science Program supports research, educational outreach, and builds capacity and resources for restoration practitioners, municipalities, citizen scientists, and the general public concerned about these critical habitats. Current projects including development of decision-based support tools and evidence-based solutions that can facilitate meaningful habitat resilience. In this panel, we will share key projects highlighting how research and collaboration can lead to solutions. The panel will commence with an introduction that will provide context, followed by a presentation of kelp resiliency research projects. Moving to a solution focus, we will share efforts promoting the adoption of nature-based solutions for shoreline communities facing climate change, and a new initiative to create a hub of information.

Keywords: salmon, estuaries, habitat

ACCESSING THE SHOREZONE COASTAL IMAGING AND HABITAT MAPPING DATASET FOR ESTUARY RESEARCH AND MANAGEMENT PLANNING

Sarah Cook*, SeaChange Marine Conservation Society, sarahcook@seachangesociety.com

The ShoreZone coastal imaging and habitat mapping dataset is a publicly accessible, transboundary resource that provides high resolution imagery and detailed physical and biological information for coastlines across the Pacific Northwest and on the East Coast of Canada. Oblique low-altitude aerial video and digital still imagery of the shoreline is collected during summer low tides from a helicopter flying at 100 m altitude. The imagery is used to divide the shoreline into relatively homogenous units with respect to physical attributes. The biological attributes classified for each unit are called biobands, which are biotic assemblages recognizable due to characteristic color, texture, exposure and tidal height. Examples of biobands are Salt Marsh, Canopy Kelps and Eelgrass. Units are digitized as shoreline segments and intertidal polygons in ArcGIS software, and then integrated with the coastal attribute data in a searchable, relational geodatabase. ShoreZone has been supported by a wide variety of partners in Canada including DFO, the Province of British Columbia, First Nations, port authorities and non-profit organizations. ShoreZone has also been supported by a wide variety of federal, state, and tribal organizations in the U.S. The data has been used for oil spill response planning, coastal management, identification of vulnerable resources, habitat and species modeling, recreational planning, scientific research, and outreach and education.

Keywords: habitat mapping, estuary research, coastal management

COMMUNITY BASED SCIENCE: MONITORING LARVAL DUNGENESS CRAB WITH LIGHT TRAPS ACROSS THE SALISH SEA

Heather Earle*, Hakai Institute, heather.earle@hakai.org, **Lauren Krzus**, Hakai Institute

Dungeness crab (*Metacarcinus magister*) are a highly valued species, playing an important role in nearshore ecosystems and local economies. They have long been harvested by coastal communities throughout their range and are among the highest value single-species fisheries in the Pacific Northwest. Despite their importance, little is known about their recruitment patterns, population structures, and life history, particularly in the Salish Sea. Since 2022, a network of community partners has been monitoring larval *M. magister* using light traps in the Northern portion of the Salish Sea working with an existing network in Puget Sound. Between our first two seasons of data collection, we have observed considerable differences in larval abundance across our network and are starting to build a picture of larval delivery patterns in the Northern Salish Sea. This work presents an opportunity to improve our understanding of larval dispersal, population and recruitment dynamics, and responses of different life stages to the impacts of climate change. These data also hold potential as a forecast tool for managers along the coast as larval delivery patterns elsewhere have been shown to strongly correlate with commercial landings four years later. Importantly, this network facilitates collaboration that spans communities, institutions, governments, and an international border, providing unique opportunities for relationship building and fostering further targeted research on this species.

Keywords: Dungeness crab, community science, larval dispersal

EMERGING ISSUES: REACHING A WIDER AUDIENCE

Cindy Elliser*, Salish Sea Institute, ellisec@wwu.edu, **Ginny Broadhurst**, Salish Sea Institute

Science communication aims to connect science to society. The Salish Sea Institute (SSI) translates science through our Emerging Issues in the Salish Sea series. SSI works to share knowledge across disciplines and borders, understanding that the international border is often a barrier to ecosystem management. This series highlights emerging issues and recent science recognizing the multinational nature of the Salish Sea. The papers are freely available and in an accessible format for policy makers, students and the public. Topics include timely management issues needing attention and condensing published scientific articles for a broader consumption. The series has been successful in reaching a large audience. Unique downloads can reach over 500/year for a single publication, totaling 1,187 downloads across 4 publications to date. The papers are reaching educational (47%), government (30%), corporate (22%) and other (1%) organizations, indicating a significantly wider audience than would be reached through traditional scientific publications. These white papers reach people that would otherwise not be accessing scientific literature, and share information in a way that can raise awareness and help shape the public perception of important issues. We find that providing free, accessible, scientific and management information through the Emerging Issues series is improving availability of information for scientists and managers driving policy decisions to protect the Salish Sea.

Keywords: Salish Sea, Science communication, Policy

TROPHIC LEVEL RESPONSES TO DIFFERENT LONGLINE DENSITIES AND CLUSTERING

Maria Garcia*, University of Washington, mariagrc@uw.edu, **Katie Houle**, Pacific Shellfish Institute, **Andy Suhrbier**, Pacific Shellfish Institute, **Jennifer Ruesink**, University of Washington

This experiment examined how longline (oyster aquaculture type) density and aisle width could be altered to mediate negative effects on eelgrass. Longlines have the potential to be detrimental to eelgrass as they can shade eelgrass, or the eelgrass can get caught on the longlines and dry out on low tides. This experiment was used to ask two questions: 1. How does altering the density of longlines and the aisle width between them affect eelgrass presence? 2. Do these effects extend to higher trophic levels? Longline density and aisle width were altered at two sites in Willapa Bay, WA. Density was altered by having reference sites with no longlines, normal density, and half density. Another set of conditions kept the density of longlines but altered the spacing between them by having sets of longlines, clusters, close together with larger aisles. This set of conditions was designed with collaboration from aquaculture farms as a solution that would be economically viable for companies to implement. The response variables spanned four trophic levels and included eelgrass, epiphyte load, epifauna load and community structure, and nekton abundance and community structure. Lower longline densities allowed for more eelgrass. However, when the overall density of longlines remained the same, effects on eelgrass were reduced when longlines were clustered (increased aisle width). Despite changes in eelgrass, neither longline density nor aisle width extended to higher trophic levels.

Keywords: Eelgrass, Z. marina, Aquaculture, Habitat Use, Multiple Trophic levels

HEALTH SURVEYS AS INDICATORS FOR EELGRASS MEADOW RESILIENCY

Olivia Graham*, Cornell University/University of Washington Friday Harbor Labs, ojg5@cornell.edu, **Baylen Ratliff**, University of Washington, **Audrey Vinton**, Cornell University, **Tina Whitman**, Friends of San Juan, **Jeff Gaeckle**, Washington State Department of Natural Resources, **Bart Christiaen**, Washington State Department of Natural Resources, **Drew Harvell**, Cornell University

Eelgrass (*Zostera marina*) forms foundational habitats in coastal regions worldwide, but is at-risk from environmental stressors, including climate warming and disease. *Labyrinthula zosterae* (Lz), the causative agent of seagrass wasting disease, threatens the many ecosystem services eelgrass meadows provide. Disease outbreaks are associated with recent, dramatic declines in eelgrass meadows throughout the San Juan Islands, Washington in the Salish Sea. Given that warmer temperatures favor many pathogens including Lz, we evaluated if levels of disease in meadows could serve as an indicator of eelgrass resiliency to climate and pathogenic stressors, since high disease levels had preceded declines in intertidal meadow density and extent. We surveyed 11 subtidal meadows throughout the San Juan Islands for disease and changes in meadow extent in summer 2023. Surveys showed disease levels varied among sites with lowest levels in deeper meadows. Previous work has also suggested that deeper eelgrass meadows might be at least partial refugia from climate stress impacting intertidal meadows. We suggest sites with the lowest disease levels will be more resilient to future warming and one-time surveys of meadow health may offer an additional metric for wider scale assessment of priority in future conservation efforts. Our approach of using disease as a barometer for resiliency to multiple stressors can be applied to other systems to inform conservation and management decisions.

Keywords: conservation, disease ecology, seagrass wasting disease

SAMPLING INVERTEBRATE ENERGY DENSITY IN THE SNOHOMISH ESTUARY, WASHINGTON STATE, USA

Sean Grealish*, Western Washington University, grealis@wwu.edu, **Joshua Chamberlin**, NOAA Fisheries, **Todd Zackey**, Tulalip Tribes Natural Resources, **Dr. Kathryn Sobocinski**, Western Washington University

Historically the Snohomish River estuary in Everett, Washington was heavily developed for industrial and agricultural uses, significantly reducing habitat available for outmigrating juvenile salmonids and their invertebrate prey. Beginning in 1994, a series of earthen dike breach restoration projects have occurred across the lower estuary aimed at reestablishing tidal connectivity to previously developed areas. Due to these projects, much of the lower estuary is now accessible to juvenile salmonids and ought to be productive rearing habitat with invertebrate prey for forage. To address prey availability at restored sites across the estuary and better understand the tidally-driven flux of invertebrates, we will sample invertebrate assemblages across the Snohomish estuary during the spring outmigration period for juvenile salmonids. Sites will include dike breach restorations, forested spruce marsh, and emergent marsh habitats. Composition of surrounding vegetation, benthic substrate, and prevalence of woody debris will be sampled at each site. Invertebrate samples will be taken using neuston nets with an attached flow meter at the water surface and just above the substrate. Water temperature, salinity, and dissolved oxygen will be measured alongside each invertebrate collection. We will use an ash-free dry weight technique to measure the amount of digestible organic matter present in each sample, which can be converted into energy density values. By leveraging the Snohomish estuary's tight patchwork of historic forested marsh and emergent marsh restoration areas we hope to better understand which factors impact the distribution and abundance of invertebrates spatially across estuary habitats and temporally throughout salmonid outmigration.

Keywords: conservation, disease ecology, seagrass wasting disease

EELGRASS/OYSTER AQUACULTURE INTERACTIONS

Katie Houle*, Pacific Shellfish Institute, katie@pacshell.org, **Dr. Jennifer Ruesink**, University of Washington, **Maria Garcia**, University of Washington, **Bob Oxborrow**, University of Washington

Oyster culture practices in the Pacific Coast region have historically overlapped with native eelgrass (*Zostera marina*) habitat and in some areas, including Washington state, continue to co-occur. Eelgrass beds are well understood to provide complex habitat for estuarine species, providing enhanced foraging and refuge for early life stages of fish and invertebrates. Further, native eelgrass is federally managed as essential fish habitat (EFH), considered Habitat Areas of Particular Concern (HAPC) for Pacific Coast groundfish and Pacific Coast salmon. A myriad of natural and anthropogenic stressors on eelgrass habitat have led to a precautionary approach to managing shellfish aquaculture activities in and around eelgrass beds. To sustainably manage the continued operation and future growth of domestic shellfish aquaculture, managers and regulators need up to date scientific information on new culture practices and environmental interactions for decision making. In response to existing data gaps in the collective knowledge of eelgrass/aquaculture interactions, Pacific Shellfish Institute convened a consortium of regional scientists in a multi-year effort to study eelgrass response to oyster aquaculture practices in WA, OR and CA estuaries. This panel highlights findings from this effort to further understand key biological responses including; eelgrass resistance and resilience traits, nekton community structure, fish behavior, fish diets and multi-trophic community response.

Keywords: eelgrass, oysters, aquaculture, nekton

NEKTON RESPONSE TO FLIP BAG CULTURE CO-LOCATED WITH EELGRASS

Katie Houle*, Pacific Shellfish Institute, katie@pacshell.org, **Kalloway Page**, Pacific Shellfish Institute, **Fiona Boardman**, University of Washington, **Jennifer Ruesink**, University of Washington

Flip bags are a dynamic suspended system that includes growing seed oysters to market size in high-density polyethylene (HDPE) mesh bags clipped to anchored lines approximately 1m above the substrate. The interactions of biological communities with mixed flip bag oyster culture, eelgrass and mudflat habitat have not been comprehensively explored. This study assessed nekton use of intertidal flip bag farms (n=6) co-located with eelgrass Zostera marina in three shellfish growing regions in Washington State. In 2020 and 2021, nekton communities were sampled in four habitat types: flip bags with eelgrass, flip bags without eelgrass, eelgrass with no culture and bare mudflat. Sampling in each habitat type occurred in both spring and summer seasons using a modified seine net and GoPro cameras set to record video for 2 minutes every 10 minutes during the diel flood tide through high slack tide. Eelgrass presence had the strongest effect in the spring on nekton abundance, taxa richness, community assemblage, and species specific associations including bay pipefish, sand shrimp, three-spine stickleback, and saddleback gunnel. Summer video indicated flip bags may increase abundances of certain species, including shiner perch, with overall more taxa present and more observed foraging activity. Both eelgrass and flip bags have seasonally different effects on nekton communities. Most nekton observed utilize the broader habitat mosaic of mudflat, eelgrass and flip bag aquaculture.

Keywords: nekton, oyster, aquaculture, eelgrass, flip bags

RECOVERY OF ELEVATION AND VEGETATION IN LEGACY WEST COAST TIDAL WETLAND RESTORATION PROJECTS

Christopher Janousek*, Oregon State University, Christopher.Janousek@oregonstate.edu, **Trevor Williams**, Oregon State University; **Jenni Schmitt**, South Slough National Estuarine Research Reserve; **Kerstin Wasson**, Elkhorn Slough National Estuarine Research Reserve; **Jeff Crooks**, Tijuana River National Estuarine Research Reserve; **Isa Woo**, U.S. Geological Survey; **Katrina Poppe**, Western Washington University; **John Rybczyk**, Western Washington University; **Stuart Siegel**, San Francisco Bay National Estuarine Research Reserve; **Jennifer Kirkland**, South Slough National Estuarine Research Reserve; **Jenna Schroeder**, Western Washington University; **Melanie Davis**, Oregon State University; **Matt Ferner**, San Francisco Bay National Estuarine Research Reserve; **Anna Kennedy**, Oregon State University; **Laura Brophy**, Institute for Applied Ecology; **Shon Schooler**, South Slough National Estuarine Research Reserve; **Sabra Comet**, South Slough National Estuarine Research Reserve; **Susan de la Cruz,** U.S. Geological Survey; **Craig Cornu**, Institute for Applied Ecology

A substantial fraction of tidal wetlands have been diked and degraded in Pacific coast estuaries. Once diked, tidal wetlands may lose elevation making them more vulnerable to sea-level rise, and they may also lose native biodiversity. Restoration through re-establishment of tidal influence is key to reversing wetland loss and restoring function. We investigated 13 of the oldest tidal marsh restoration projects along the Pacific coast of the US to evaluate how elevation and vegetation have recovered after decades of ecological succession. At sites where sediment fill was applied during restoration, restored elevation generally was similar to reference elevation. When dikes were simply breached without elevation manipulation, most restored sites had an elevation deficit relative to reference sites. Vegetation communities in almost all restoration projects had high plant cover, but sometimes had lower diversity at the plot level. Native plant species dominated most sites, but both restored and reference wetlands had some non-native taxa. Our findings suggest that even decades later, restored ecosystem structure often still differs from reference conditions in some ways. However, design features such as careful attention to elevation may help improve long-term recovery. Overall, relatively high native species cover suggests that restored sites are likely supporting many of the same key ecosystem functions as least-disturbed tidal marshes.

Keywords: restoration, ecosystem, tidal wetland

INFLUENCE OF THE JOE LEARY SLOUGH TIDE GATE AND PRECIPITATION ON SALINITY IN PADILLA BAY, WA (USA)

Alexis Jordan*, Western Washington University, jordan5@wwu.edu, Sylvia Yang, Padilla Bay National Estuarine Research Reserve

Diking and tide gates modify natural freshwater flows into estuaries, potentially affecting water quality and downstream biota. In Padilla Bay, Washington (USA), construction of dikes cut off flows from the Skagit and Samish Rivers, reducing freshwater flows that are now controlled by tide gates. It is unknown whether salinity in the downstream eelgrass meadow is altered by the tide gate. This study investigated patterns in salinity at two intertidal eelgrass meadow sites at varying distances from the Joe Leary Slough tide gate in comparison to the timing of the tide gate opening and precipitation. Salinity and water level loggers were deployed at these sites from September to December 2023 to encompass dry and rainy conditions. Salinity and depth at the tide gate and precipitation data during this period were obtained from the National Estuarine Research Reserve System-Wide Monitoring Program for comparison. Over the study period, salinity at the eelgrass site closer to the slough mouth dropped 5 ppt, whereas salinity at the eelgrass site further away was more stable. Both precipitation and the tide gate may influence daily variation in salinity at both eelgrass sites, but to varying degrees. Further study is needed to determine whether these observations are unique to the Joe Leary Slough or if freshwater flow is comparable to other tide gates in Padilla Bay and the Salish Sea. Measurable decreases in salinity have the potential to affect eelgrass seed germination and presence of eelgrass wasting disease.

Keywords: tide gate dynamics, estuarine hydrology, seagrass

DESTRUCTIVE FORAGING BY THE INVASIVE GREEN CRAB (CARCINUS MAENAS) INFLUENCES EELGRASS SURVIVAL AND BENTHIC ASSEMBLAGES

Kaitlin Macaranas*, Western Washington University, macarak@wwu.edu**, Brian Bingham,** Shannon Point Marine Center, bingham@wwu.edu

Eelgrass estuaries are invaluable coastal ecosystems (e.g., biodiversity hotspots) imperiled by the synergistic effects of climate change and invasive species. A known ecosystem engineer and voracious omnivore, invasive European green crabs (EGC; *C. maenas*) can devastate eelgrass habitats and native biota, with warming waters widening their spread and damage across coastal North America. Yet, limited knowledge exists of their ecological impact on eelgrass and benthic infauna in the Salish Sea – two key components of an eelgrass estuarine food web. The Padilla Bay National Estuarine Research Reserve (Washington, USA) is one such eelgrass estuary facing an early-stage EGC invasion. We conducted a short-term study to understand how EGC might alter eelgrass survival (*Zostera marina* and *Z. japonica*) and benthic communities in the bay. In an approved quarantine facility, replicate tanks containing sediment and eelgrass cores transplanted from Padilla Bay were divided into two treatments: with EGC and without EGC. After nine days, we measured eelgrass loss and infaunal species diversity. Preliminary findings show visible eelgrass loss with EGC exposure; this suggests trophic cascade effects are likely to occur as eelgrass and infauna respond to habitat disturbances caused by the foraging predator. We also expect direct predator impacts from EGC feeding. Establishing how EGC may affect Padilla Bay can help to improve conservation and sustainability efforts within this vital estuary.

Keywords: Invasive species, climate change, marine benthic ecology

INVESTIGATING THE EFFICACY OF OYSTER BAGS FOR THE RECRUITMENT OF INVASIVE EUROPEAN GREEN CRAB (CARCINUS MAENAS) MEGALOPAE

Erin Maher*, Hakai Institute, erin.maher@hakai.org, Heather Earle, Hakai Institute

The invasive European green crab (Carcinus maenas) has become a species of major concern for marine ecosystems around the world. Native to Europe and North Africa, and first introduced to the west coast of North America in the late 1980s, C. maenas has evolved to withstand a wide range of environmental conditions making it a remarkably successful invader. Studies have shown that gravid females can delay egg release until conditions are optimal for larval survival. Furthermore, the duration of the planktonic larval stage, and therefore the timing of settlement, can vary depending on environmental conditions. In British Columbia, efforts are being made to better understand the spread of this species through adult early-detection programs. Less is known, however, about the larval stages and settlement timing of C. maenas in BC which may have significant implications for native crab species recruiting to the same habitats, including settlement-avoidance behavior, competition, and predation. For this pilot study, we plan to deploy mesh bags containing oyster shells (a known preferred settlement substrate) at two locations (one with a known established population of C. maenas, and one without) in early May to assess their efficacy in recruiting juvenile crabs. If effective, we plan to utilize oyster bags to investigate settlement timing of C. maenas in local waters, and to better understand the impacts they may have on ecological communities during their juvenile life stages.

Keywords: Invasive European green crab, juvenile settlement timing, community interactions

COMPARING SEED PRODUCTION AND SEED BANK OF ANNUAL AND PERENNIAL FORMS OF ZOSTERA MARINA FROM PADILLA BAY, WASHINGTON (USA)

Ian McBride*, Shannon Point Marine Center/Western Washington University, mcbridi@wwu.edu, **Sylvia Yang**, Padilla Bay National Estuarine Research Reserve

Annual populations of *Zostera marina* produce near-total flowering in the first year after germination and may have the potential to produce large quantities of seeds necessary for undertaking seed-based restoration efforts. However, due to the rarity of annual forms of *Z. marina,* little research has been conducted to compare seed production and retention in the sediment between annual and perennial populations. In the present study, we investigated seed production and seed bank retention at a site in Padilla Bay, Washington (USA), where annual and perennial forms of *Z. marina* were present in adjacent areas. Seeds of both forms were collected during summer and held in 'common garden' mesocosm conditions to overwinter. The size, number, and viability of these seeds were compared to that of seeds from sediment cores collected from the field site during winter. We found that the annual meadow had the potential to produce substantially more seeds than the perennial meadow and that the annual seeds were distinctly smaller. However, sediment cores from the area dominated by annuals contained fewer hard viable seeds than those dominated by perennials. Additionally, seeds held in the mesocosms showed higher viability than those from the sediment cores, and perennials showed higher viability than annuals. This indicates that although the annual meadow produced more seeds than the perennial meadow, biological and physical factors may limit the retention of annual seeds in the sediment at this site. Further research will be necessary to understand the factors limiting annual seed retention at this site.

Keywords: Zostera marina, Seed Bank, Seed Viability

EELGRASS RESTORATION THROUGH LARGE SCALE SEEDING

Mitchel McCloskey*, San Juan Islands Conservation District, mitch@sjicd.org

We aim to develop effective methods for eelgrass restoration that can scale up efforts in the San Juan Islands archipelago. The San Juan Islands Conservation District (SJICD), in partnership with the Washington Department of Natural Resources (WDNR) and the University of Washington Friday Harbor Laboratories (FHL), has been developing the methods necessary for scalable eelgrass restoration. Our goal is to implement successful eelgrass restoration by increasing the seed stock for Z. marina, continuing the development of scalable methods, and expanding the distribution of viable seeds to restoration sites. Specifically, over the next three years, we aim to achieve the objectives of planting 500,000 eelgrass seeds and expanding the number of local restoration sites from one to a minimum of six. The strategy for enhancing eelgrass restoration involves regular site identification and assessment to identify the most effective restoration techniques. These assessments will include expert-guided selection of planting and harvest sites, in-field evaluations, and the use of data from environmental subtidal sensors managed by the WDNR near project locations. Expanding the eelgrass cultivation system is another key component of this strategy. This includes monitoring the system during seed presence, conducting effective inventories of viable seeds, and implementing overwinter storage solutions for seeds. We plan to increase seed harvest through improved techniques and expanded efforts. A range of planting strategies will be employed; these varied methods will contribute to the goal of enhancing eelgrass proliferation across multiple restoration sites.

Keywords: eelgrass restoration conservation

HABITAT SUITABILITY FOR OLYMPIA OYSTERS, OSTREA LURIDA, VARIES IN PADILLA BAY, WASHINGTON, USA

Gabriel McInnis-Hernandez*, Padilla Bay NERR, Washington Conservation Corps, gmcinnis-hernandez@padillabay.gov, Sylvia Yang, Nicole Burnett, Heath Bohlmann, Cameron Sokoloski, Roger Fuller, Angelica Lucchetto, Paul Dinnel

Olympia oysters, *Ostrea lurida*, are a species of oyster native to the West Coast of North America that has undergone drastic population declines due to overharvesting, habitat degradation, and pollution. Reintroduction and restoration of *O. lurida* has begun at several locations, but these efforts are challenged by multiple factors such as predation by non-native oyster drills, extreme air temperatures, substrate availability, and others. Therefore, it is important to evaluate habitat suitability before large-scale efforts begin. In this study, we evaluated the suitability of four sites across Padilla Bay, Washington, USA for *O. lurida*. At each site, live spat-on-shell were spread over a layer of oyster cultch in May 2023 and temperature loggers were placed in every plot. Sites were re-visited every season to record growth, presence of non-native oyster drills, and evidence of drilling. The survival and growth rates of *O. lurida* varied widely between the four sites. Drills were present at all sites, but only two sites had severe mortality due to drills. One of the other two sites experienced high mortality over winter, likely due to an intense freezing period. These results indicate that an abundance of non-native oyster drills does not make a site less suitable for *O. lurida*, and that stressors for *O. lurida* can vary within the same water body. Future work will evaluate the effects of *O. lurida* size on survival rates when exposed to a variety of different stressors.

Keywords: Native Species, Reintroduction, Site selection

SITE-SPECIFIC DEVELOPMENT AND YIELD OF ZOSTERA MARINA SEEDS IN PADILLA BAY, WASHINGTON (USA)

Benjamin Molenhouse*, Western Washington University, molenhb@wwu.edu, Sylvia Yang, Padilla Bay National Estuarine Research Reserve

Direct seeding is an increasingly acknowledged approach to large-scale seagrass restoration. In efforts of maximizing seed yield from donor sites, development of flowering shoots should be assessed to predict harvest date and theoretical seed yield. In this study, we investigated 3 locations in Padilla Bay, Washington (USA) as potential seed donor sources for eelgrass (*Zostera marina*) restoration. At each location, we assessed phenology of flowering shoot developmental stage and deployed temperature loggers. We then harvested inflorescences across a 3-week period. After collection, we ripened and processed seeds in running seawater mesocosms. Resulting seeds were counted to obtain seed yield. Flowering phenology field data was compiled from the 3 different locations then compared to theoretical and actual seed yield, inflorescence length, harvest date, and site-specific temperature variations. Our study found that seed yield varied widely amongst the sites. Sites varied in timing and maturation rates of seeds, as well as temperature conditions. Variation in these data suggest that a maximum seed yield may be achieved with an understanding of the pace of inflorescence development and site-specific conditions. Further study is needed to investigate the drivers of flowering shoot development and seed maturation rate at study sites, such as site-level differences in temperature.

Keywords: Zostera marina, seed development, seed yield

FISH DIET RESPONSE TO EELGRASS AND OYSTER AQUACULTURE

Bob Oxborrow*, University of Washington, oxborrow@uw.edu, Jason Toft, Jeff Cordell, Julia Kobelt, Alyssa Suzumura, Arielle Tonus Ellis, Katie Houle, Fiona Boardman, Jennifer Ruesink, Brooke McIntyre, Brett Dumbauld

Our main objective was to examine foraging and prey characteristics of juvenile fish species that were collected at oyster aquaculture (e.g., long-line, flip-bags) and eelgrass habitats. We processed 288 fish diets over the course of three years (2020-2022), across five estuaries in Washington and Oregon and focused on six fish species. The number of diets for analyses depended on the fish that were captured, and therefore varied across estuaries and habitats. Some fish were more transient and located in the water column (i.e., shiner perch and sticklebacks), while others were more resident and demersal (i.e., staghorn sculpin, English sole, Pacific sanddab, and starry flounder). We dissected fish stomachs in the laboratory and examined three metrics for analyses – prey mass (as instantaneous ration), prey source, and prey assemblage. Measurements of instantaneous ration were equal at eelgrass and aquaculture, signifying that fish are acquiring an equal amount of prey mass at the two habitats. We analyzed prey source by comparing the numerical proportion of grouped epifauna and infauna taxa. Fish fed more on epifauna sourced prey at eelgrass, and more on infauna sourced prey at aquaculture. Prey assemblages showed that most of the epifauna prey were harpacticoid copepods, crustaceans known to be associated with eelgrass, and most of the infauna prey were other crustaceans such as tanaids and Corophiidae amphipods, as well as bivalves. Overall, our results show that fish are feeding equally on prey mass at eelgrass and aquaculture, but feed differently on the diversity of prey and their source habitats.

Keywords: eelgrass, oysters, aquaculture fish, prey

DRIVERS OF SOIL CARBON ACCUMULATION RATES ACROSS REFERENCE, RESTORED, AND DISTURBED TIDAL WETLANDS IN THE PACIFIC NORTHWEST

Katrina Poppe*, Western Washington University, University of British Columbia, poppek@wwu.edu, **John Rybczyk**, Western Washington University, **Chris Janousek**, Oregon State University, **Scott Bridgham**, University of Oregon, **Craig Cornu**, Institute for Applied Ecology, **Sara Knox**, University of British Columbia

Despite increased interest in carbon accumulation rates (CAR) in tidal wetlands to identify natural climate solutions, few data are available from certain tidal wetland land use types such as disturbed and restored wetlands. In addition, we have a limited understanding of the environmental factors driving the large variability in CAR within and among sites. To address these knowledge gaps, we measured CAR using 210Pb, 137Cs, and surface elevation tables from a diverse set of 38 tidal wetland sites across 8 estuaries in Oregon and Washington, as part of multiple collaborative projects. Each estuary contained one or more sites that vary in wetland type (marsh, swamp, pasture), land use (reference, restored, and disturbed former wetlands), and salinity (fresh to polyhaline). Other site-level environmental variables considered as potential predictors of CAR included groundwater level, wetland elevation, vegetation type, and soil temperature. Estuary-level variables included latitude, the rate of relative sea level rise, and riverine sediment load relative to estuary area. A generalized linear mixed effects model indicated that wetland/land use type, relative sediment load, and water level were the most important drivers of CAR, explaining 58% of variability. CAR was highest in restored marshes and lowest in diked pastures, demonstrating the value of tidal wetland restoration as a natural climate solution.

Keywords: Blue carbon; Tidal wetlands; Restoration

PREVALENCE AND SEVERITY OF WASTING DISEASE VARIES IN ANNUAL AND PERENNIAL EELGRASS MEADOWS (ZOSTERA MARINA L.) IN PADILLA BAY, WA, USA

Annabelle Quinlisk*, Western Washington University, quinlia@wwu.edu , **Sylvia Yang**, Padilla Bay National Estuarine Research Reserve, **Alexis Jordan**, Western Washington University, **Ian McBride,** Western Washington University, **Ben Molenhouse**, Western Washington University

Eelgrass (Zostera marina) can exhibit one of two life history strategies, as annuals or perennials, and the effect of eelgrass wasting disease (EWD) is not fully understood with respect to the different life histories. We hypothesize that life history strategy may affect susceptibility to EWD because annuals and perennials exhibit different life spans and occupy different tidal elevations, possibly leading to variation in exposure to EWD. In this study, we surveyed eelgrass in Padilla Bay, WA at 3 sites with varying proportions of annuals and perennials in June and July 2023. We measured prevalence and severity of EWD, as well as biotic parameters such as eelgrass shoot density and canopy height, at 3 tidal elevations at each site. We found that wasting disease prevalence and severity varied amongst sites and elevations but was low overall. EWD was less prevalent in July when plants were longer, contrary to previous studies. Interestingly, the site and elevation with the lowest prevalence and severity of EWD had the highest proportion of eelgrass exhibiting an annual life history strategy. Further research should be conducted to determine if environmental factors are contributing to the low prevalence and severity in annual eelgrass meadows, as both annual life history and EWD are associated with more stressful habitat conditions.

Keywords: Eelgrass wasting disease, Labyrinthula zosterae, Life history

RESILIENCE TRAITS OF EELGRASS CHANGE ACROSS INTERTIDAL GRADIENTS AND OYSTER AQUACULTURE

Jennifer Ruesink*, University of Washington, ruesink@uw.edu, **Katie Houle**, Pacific Shellfish Institute; **Kristy Kroeker**, UC Santa Cruz; **Brett Dumbauld**, USDA Agricultural Research Service; **Fiona Boardman**, University of Washington; **Nate Lewis,** Oregon State University; **Brooke McIntyre**, USDA Agricultural Research Service; **Andy Suhrbier,** Pacific Shellfish Institute; **Bobbi Hudson**, Pacific Shellfish Institute

Species persist despite natural stressors through resistance and recovery traits, often induced by stressful conditions. Whether human activities in coastal habitats allow species to respond additively with natural stressors, or alternatively exacerbate or moderate these stressors through non-additive responses, is an open question. Across 1 m intertidal elevation range in 12 US west coast estuaries with oyster farms, eelgrass (*Zostera marina*) was measured for above-ground size, below-ground storage (resistance traits), flowering, branching, and rhizome extension (recovery traits). Shoot length, above-ground shoot mass, and below-ground mass per rhizome length declined at higher elevations, whereas declines in oyster culture occurred only in above-ground traits, not below-ground. Since flowering increased but branching declined at higher tidal elevations, these recovery traits responded in opposite directions along an intertidal stress gradient. Ground culture moderated the negative elevation effect on branching, and flowering and rhizome extension of eelgrass increased in ground culture. In off-bottom culture, eelgrass recovery traits differed by elevation, with flowering reduced at higher elevation and rhizome extension reduced at lower elevation. Relative to intertidal stress, ground culture promoted resilience and off-bottom culture had less effect.

Keywords: Seagrass-Aquaculture Interactions

VULNERABILITY TO SEA-LEVEL RISE VARIES AMONG ESTUARIES AND HABITAT TYPES: A CASE FOR A NETWORK OF SURFACE ELEVATION TABLES ACROSS THE SALISH SEA.

John Rybczyk*, Western Washington University, john.rybczyk@wwu.edu, **Melanie J. Davis**: U.S. Geological Survey, Oregon Cooperative Fish and Wildlife Research Unit, **Katrina L. Poppe**: Western Washington University, Department of Environmental Science, **Eric E. Grossman**: U.S. Geological Survey, Pacific Coastal and Marine Science Center, **Joshua W. Chamberlin**: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, **Michelle Totman** & **Todd Zackey**: Tulalip Tribes, Natural Resources Department, **Frank Leonetti**: Snohomish County, Surface Water Management, **Suzanne Shull**: Padilla Bay National Estuarine Research Reserve, **Isa Woo** & **Susan E.W. De La Cruz**: U.S. Geological Survey, Western Ecological Research Center

Coastal marshes can keep pace with rising seas levels by accreting sediments at a rate that matches relative sea level rise (RSLR). RSLR is a function of eustatic sea level rise (ESLR), deep subsidence, and shallow elevation change due to the sum of sediment accretion, compaction, and erosion. Tide gauges only record the combination of ESLR and deep subsidence. The shallow component is often ignored, even though it is the most responsive to RSLR. To this end, Surface Elevation Tables (SETs) can be used to track long-term changes in surface elevation. The SET is a leveling device that is attached to a permanent benchmark and provides a reference position from which changes in surface elevation can be measured year after year. Over the past two decades, SETs have been installed throughout five Puget Sound estuaries. We observed different rates of surface elevation change among estuaries and habitats (Nisqually = 4.64 ± 2.81 mm/year, Snohomish = 5.71 ± 5.83 mm/year, Stillaguamish = 12.82 ± 10.29 mm/year, Skagit = 16.13 ± 7.57 mm/year, Padilla = -1.25 ± 1.58 mm/year). The highest rates were found at restoring marshes with regular sediment input in the Stillaguamish

and Skagit estuaries, whereas rates were negative in sediment starved Padilla Bay. Many sites in Puget Sound appear to be keeping pace with current and projected rates of relative SLR. We propose here a coordinated effort to establish an active, transboundary network of SETs across the Salish Sea.

Keywords: Sea Level Rise, Climate Change, Coastal Marshes

USING NATIONAL ESTUARINE RESEARCH RESERVES TO UNDERSTAND HOW CLIMATE CHANGE IS IMPACTING TIDAL MARSHES IN OREGON AND ACROSS THE NATION

Jenni Schmitt*, South Slough National Estuarine Research Reserve, Jenni.Schmitt@dsl.oregon.gov, **Christopher Peter**, Christopher.R.Peter@wildlife.nh.gov, Great Bay National Estuarine Research Reserve, **David Burdick**, david.burdick@unh.edu, Jackson Estuarine Laboratory, University of New Hampshire, **Kim Cressman**, kim@catbirdstats.com, Catbird Stats, **Suzanne Shull**, sshull@padillabay.gov, Padilla Bay National Estuarine Research Reserve

Sea level rise and climate change present major threats to tidal marshes nationwide. To better track and understand these impacts, our project team has synthesized marsh plant community and sediment accretion data at 20 National Estuarine Research Reserves (NERRs) to conduct trend analyses in response to sea level rise. Three tiers of increasing complexity statistics (graphical, univariate, and multivariate) were used to analyze changes in vegetation. At Oregon's South Slough NERR, data from 2010-2021 showed significant trends in low marshes losing plant cover. An increase in typical low marsh species Sarcocornia perennis (pickleweed) and Carex lyngbyei (Lyngby's sedge) cover in higher elevation transition zones indicate upslope movement. Nine of South Slough's Surface Elevation Tables (SETs) were used for random intercept linear mixed model analysis to calculate rates of marsh elevation change. Of those, three marshes had rates of elevation change that overlapped with the confidence interval for the local long-term rate of sea level rise while the rate of elevation change at all marshes overlapped with the rate of water level change for the most recent 19-year dataset.

Keywords: Sea level rise, marsh, estuary

ESTUARINE WETLAND RESTORATION IMPACTS ON CARBON SEQUESTRATION IN THE OLDEST PROJECTS ALONG THE WEST COAST

Jenna Schroeder*, Western Washington University, schroej8@wwu.edu, **Katrina Poppe** (Western Washington University, poppek@wwu.edu), **John Rybczyk** (Western Washington University, rybczyj2@wwu.edu), **Christopher Janousek** (Oregon State University), **Trevor Williams** (Oregon State University), **Jenni Schmidt** (South Slough National Estuarine Research Reserve), **Jennifer Kirkland** (South Slough National Estuarine Research Reserve), **Kerstin Wasson** (Elkhorn Slough National Estuarine Research Reserve), **Jeff Crooks** (Tijuana River National Estuarine Research Reserve), **Shon Schooler** (South Slough National Estuarine Research Reserve), **Matt Ferner** (San Fransisco National Estuarine Research Reserve), **Stuart Siegal** (San Fransisco National Estuarine Research Reserve), **Sabra Comet** (South Slough National Estuarine Research Reserve), **Craig Cornu** (Institute for Applied Ecology), **Laura Brophy** (Institute for Applied Ecology)

Mitigating carbon dioxide's impact on our climate has become an important area of study. One such mitigation technique includes enhancing and protecting the earth's natural carbon sinks. Estuarine wetlands are recognized for their significant carbon storage capacity. This research is being conducted in tandem with a larger collaborative project that's funded by the National Estuarine Research Reserve System (NERRS). The greater project is producing comprehensive restoration assessments of various tidal wetlands throughout California, Oregon, and Washington. Sites were carefully selected based on the meeting of strict criteria and advice from personnel involved in the management of each site. This section of the larger project is assessing the impacts of restoration efforts on the carbon sequestration rates of estuarine wetlands by comparing the carbon sequestration rates of mature (20+ years) restoration sites with natural reference sites. We are looking at 12 estuarine wetlands that each contain at least one reference site and one restoration site. Carbon sequestration rates are determined by collecting and processing 2-3 soil cores from each sample site. Soil accretion rates are determined either by 210Pb profiles or sets. Carbon sequestration rates are then calculated by multiplying the percent organic carbon by the soil accretion rates. While our research is still ongoing, we will evaluate restoration efforts on a long-term scale and help inform future restoration efforts.

Keywords: Estuarine Wetland, Carbon Sequestration, Restoration

WEST COAST EELGRASS SEEDING PILOT: ENHANCING RESILIENCE TO CLIMATE CHANGE RELATED PRESSURES

Angela Spooner*, Fisheries and Oceans Canada, angela.spooner@dfo-mpo.gc.ca

Restoration of eelgrass beds has been a decades long practice. The most common method is transplanting eelgrass shoots from an established healthy donor bed to a restoration site; maximizing the plant's non-sexual reproductive growth strategy. Seeding or propagation restoration methods have had challenges yet there are important considerations to include seeding for a comprehensive restoration plan. Eelgrass seeding can be valuable in the creation and recovery of beds by providing genetic diversity. Despite low germination rates, the genetic diversity of the sexually reproduced seeds gives value to this lower density restoration method. Seeding can also be accomplished at a lower cost and effort than traditional transplanting; making it an ideal method to enhance a transplanting restoration project or on its own. In 2023, DFO's Restoration Centre of Expertise trialed eelgrass seeding at 3 sites on eastern Vancouver Island following the Buoy Deployed Seeding (BuDS) method used on the East Coast and in the San Juan Islands WA. Monitoring of these pilot sites' germination rate success has only just begun. There are plans to expand the trials to 4 funded eelgrass restoration projects in 2024 for the

Pacheedaht Nation (San Juan River), the Kyuquot First Nations in Nootka Sound, the Tsleil-Waututh Nation (Burrard Inlet), and the Haida Nation (Haida Gwaii). A webinar hosted by DFO's COE is planned for the fall of 2024 to share the BuDS methodology, outcomes and lessons learned.

Keywords: Eelgrass, Seeding, Resilience

STATUS OF THE EUROPEAN GREEN CRAB IN OREGON ESTUARIES

Sylvia Yamada*, Integrative Biology, Oregon State University, yamadas@oregonstate.edu, **Shon Schooler**, South Sough National Estuarine Research Reserve, shon.schooler@state.or.us

The abundance of the green crab (*Carcinus maenas*) in Oregon estuaries falls into two phases: before and after the 2015-2016 El Niño. Prior to 2016, recruitment of 0-Age European green crabs to Oregon estuaries was sporadic, with many years of recruitment failure. Ocean indicators of warm surface water and strong north-flowing currents were followed by good year classes of young green crabs, indicating that larvae were transported from California to Oregon in the Davidson Current during the winter. This pattern changed after the 2015-2016 El Niño, when good recruitment occurred every year, and the adult populations in estuaries increased to averages of up to 7 crabs per trap per day. The presence of greater than predicted number of 0-Age crabs after cold winters indicates the existence of additional larval sources. We present evidence for local reproduction and for larval transport from the north. Very early instar larvae were collected in Coos Bay during the 2010 mini El Niño, and crab larvae from a genetically distinct population in the Salish Sea were transported south to Washington coastal and northern Oregon estuaries in the Shelf-break current during the summer. Now that the green crab breeding populations have built up along the coast, Oregon estuaries can receive larvae from the south in the winter, from the north in the summer and from local sources. The presence of these multiple larval sources complicates the control efforts for this invader.

Keywords: invasive species, recruitment, ocean indicators

NISQUALLY RIVER EDUCATION PROJECT: TEACHING THE WONDERS OF THE NISQUALLY WATERSHED

Alex Zinck*, Nisqually River Education Project, alex@nisquallyriver.org, **Davy Clark**, Nisqually River Education Project, **Julia Fregonara**, Nisqually River Education Project, **Justin Hall**, Nisqually River Foundation, **Tristan Olson**, Nisqually River Foundation

The Nisqually watershed, beginning in Mount Rainier National Park and ending in Billy Frank Jr. Nisqually National Wildlife Refuge, faces a variety of environmental challenges such as climate change, the degradation of critical salmon habitat, and stormwater runoff carrying 6PPD-quinone. The mission of the Nisqually River Education Project (NREP) is to provide students with service learning opportunities that link Washington State learning goals and standards with local environmental issues, inspiring stewardship of the Nisqually watershed and beyond. The NREP has a history of successfully implementing watershed-based education and environmental action projects which engage students and teachers in protecting and enhancing water quality and salmon habitat. NREP supports a strong network of teachers engaged in climate education and student action. Summer Institute for Teachers, a 3 day professional development training, will be highlighted as a successful model. This professional development training brings together over 40 teachers annually and connects them with local experts and resources on a climate related theme each year. This presentation will share stories of success regarding field-based and watershed-wide outdoor education activities for students, collaboration with community partners across watersheds to support in-common conservation and education goals, and unique professional development programming for K-12 teachers.

Keywords: Environmental Education, Salmon Recovery, Stewardship