

ABSTRACTS

(in alphabetical order by last name)

INSIGHTS INTO ECOSYSTEM SERVICES, RESTORATION POTENTIAL, AND CARBON MARKETS REVEALED BY A PNW BLUE CARBON INVENTORY

Jude Apple (japple@padillabay.gov) Padilla Bay NERR/Washington Department of Ecology*

Coastal wetlands are highly productive ecosystems with tremendous potential to sequester and store atmospheric carbon, thereby acting as a sink for anthropogenic emissions of CO₂. As a result, these “blue carbon” ecosystems have gained the interest of those working to develop carbon markets. At the same time, coastal development, erosion, and other anthropogenic stressors pose a threat to the health and function of these valuable ecosystems. The Pacific Northwest Blue Carbon Working Group has recently initiated a large-scale characterization of blue carbon habitats across the PNW region and is working towards translating this information to coastal planners, restoration managers, and carbon market brokers. This presentation will provide an overview of current research efforts in blue carbon, synthesis of stock and sequestration values that are beginning to emerge – and set the stage for a discussion about the challenges we face when linking ecosystem services, restoration efforts, and financing through carbon markets.

MICROPLASTIC CONCENTRATIONS IN OREGON’S PACIFIC OYSTERS AND PACIFIC RAZOR CLAMS

Britta Baechler (baechler@pdx.edu), Elise Granek (egraneke@pdx.edu) Portland State University*

The presence of microplastics is increasingly being recognized as an ecological stressor with potential implications for marine food webs. This study aims to determine the concentrations, types, and spatial distribution of microplastic contaminants in Oregon’s estuarine Pacific oysters and open coast Pacific razor clams from 15 sites along the Oregon coast. Data on spatial, temporal, and species variability of microplastic concentrations in these commercially and recreationally- important bivalves was collected. Organic matter for each individual specimen was digested using a potassium hydroxide solution, and plastics persisted through the digestion process. The resulting liquid was then analyzed under a stereomicroscope for size, type, and concentration of microplastics per gram of organism tissue. This baseline study will enhance Oregon’s capacity to understand whether there are microplastic “hotspots” along the coast and will help shape future work to minimize plastic transmission pathways to the environment.

INVESTIGATING THE CARBON FLUX OF A COASTAL EELGRASS ECOSYSTEM, PADILLA BAY, WASHINGTON

Shauna Bjornson (sbjornson@padillabay.gov), Jude Apple (japple@padillabay.gov), Padilla Bay National Estuarine Research Reserve, Erin Murray (emcm@uw.edu) University of Washington*

Recent scientific findings have revealed the importance of coastal ecosystems in their ability to sequester and store CO₂ (i.e. blue carbon) in the face of climate change. This presentation uses Padilla Bay (the second largest eelgrass bed on the West Coast) as a model system to investigate four important aspects of carbon cycling in a coastal ecosystem; 1) net primary production (NPP), 2) microbial respiration, 3) sediment carbon content, and 4) export to the upper intertidal. To investigate NPP, we are establishing growth rates between the two species of eelgrass found in Padilla Bay (*Zostera japonica* and *Zostera marina*) and quantifying NPP on a temporal scale. Microbial respiration, a key driver of oxygen dynamics in the water column, has been monitored since 2016 and is being used to create a baseline dataset of the microbial community within the eelgrass beds. A sediment carbon content model was developed to predict accurate estimates of total organic carbon (TOC) within samples. A carbon conversion factor specific to Padilla Bay has been found by relating % loss on ignition (LOI) and TOC values. Finally, to quantify the export of carbon to the upper intertidal, we documented the carbon content of senesced eelgrass deposited along the shoreline. Our overall efforts seek to improve our understanding of the carbon cycle in Padilla Bay, and provide insight into the carbon flux of other eelgrass dominated ecosystems.

A HEALTHIER PUGET SOUND: RESTORING CRITICAL HABITAT BY TRANSPLANTING EELGRASS (*ZOSTERA MARINA*)

Jessica Blanchette (jessica.blanchette@hartcrowser.com), Jim Shannon (jim.shannon@hartcrowser.com), Hart Crowser, Jeff Gaeckle (jeff.gaeckle@dnr.wa.gov) Washington Department of Natural Resources*

In an effort to recover ecosystem health in Puget Sound, Washington, USA, the Washington State Department of Natural Resources is implementing a management plan to increase eelgrass (*Zostera marina*) area by 20% by 2020. The recovery target is equivalent to 4,400 ha; an area slightly larger than the size of the largest eelgrass meadow on the west coast of the contiguous US. Eelgrass restoration will provide a multitude of benefits, ranging from habitat for species to ameliorating climate change. Using a previously developed site selection model, we identified suitable locations and planted eelgrass at 14 test-transplant sites and 7 large-scale sites in 2016 and 2017. During the first year of the project eelgrass was transplanted using burlap strips at four test- and two large-scale transplant sites. Methodological changes in the second year added 10 test- and 5 large-scale transplant sites. Over the course of the two years, the project harvested eelgrass within 7.5% of calculated harvest objectives. Monitoring focused on the recovery of donor sites, transplant performance and effects seagrass restoration has on water chemistry. Monitoring in August 2017 found no difference in donor site shoot count, 36% of the test-transplant and 15% of the large-scale sites failed, and mixed results related to transplants moderating water chemistry. Although the project faced methodological and environmental challenges, issue-specific solutions and adaptive management allowed restoration progress and contribute valuable information towards recovering ecosystem health in the region.

EL NIÑO SOUTHERN OSCILLATION AND pH IN THE POSSESSION SOUND

Collin Chung (colchung1@gmail.com) Ocean Research College Academy (Everett Community College)*

Possession Sound is located in the northern reaches of the Puget Sound basin and exhibits a significant freshwater influence from the Snohomish River on its eastern boundary. Within an estuarine system such as this, pH levels influence the biological processes of many organisms. This study examines the effect of the El Niño weather pattern on surface pH, temperature, salinity and chlorophyll. This investigation utilizes data derived from the Ocean Research College Academy, where students collect longitudinal data as part of a long-term study on the Possession Sound. This study used data from a sample site (BUOY) since 2004. BUOY is located in Possession Sound in close proximity to the Snohomish River, thus making it directly affected by temporal variations in river discharge. Measurements of pH, salinity, and chlorophyll were taken with YSI probes. Samples were collected monthly at BUOY during the most recent neutral period (June 2012-September 2014) and El Niño period (December 2014-June 2016). It was hypothesized that salinity and surface pH would be lower during the neutral period, following seasonal trends of river discharge, but that during the El Niño period, warmer temperatures and an increase in salinity would lead to an increase in surface pH. Results show that surface pH, temperature, and chlorophyll levels were elevated during El Niño, while surface salinity was not. The results suggest that the warmer, more consistent weather observed during El Niño periods creates improved conditions for photosynthesis year-round, thus contributing to the higher, more consistent pH levels.

THE EFFECTS OF OCEAN ACIDIFICATION ON SEA ANEMONE-ALGAL SYMBIOSIS IN INTERTIDAL COMMUNITIES OF THE SALISH SEA

Natalie Coleman* (coleman4@wwu.edu) Western Washington University

Along with global climate change, ocean acidification (OA) stands as an example of the damage anthropogenic effects can have on our world. The oceans absorb one quarter of atmospheric CO₂, which decreases pH and reduces the saturation state of calcium carbonate (CaCO₃), a compound calcifying organisms need to build their shells. While most studies have focused on negative effects caused by OA, photosynthetic organisms may benefit from increased pCO₂ in their environment by increased photosynthetic efficiency. The temperate sea anemone *Anthopleura elegantissima* is a unique invertebrate that has capitalized on symbiosis by forming relationships with a chlorophyte alga and a dinoflagellate, both of which are able to utilize excess CO₂ in the ocean. This study was one of the first to investigate OA on anemones hosting both symbiont species. Anemones of all four symbiont states (chlorophyte, dinoflagellate, both, and none) were exposed to three pCO₂ levels (ambient, elevated, and high) over ten weeks. Photosynthetic efficiency, reactive oxygen species concentration, cell density, and CZAR score (the percent of anemone's organic carbon they receive from the symbiont), were measured to determine if anemones benefit differentially from OA conditions based on the identity of their symbiont. Anemones hosting dinoflagellates showed highest photosynthetic efficiency, ROS, and CZAR score at intermediate levels of OA, while those hosting chlorophytes showed declines in photosynthesis and cell density at any increased level of OA. Our results suggest anemones shifting symbionts to dinoflagellates may gain a competitive advantage, a key step in predicting the composition of intertidal ecosystems.

THE EFFECT OF ANGULAR ORIENTATION ON MORTALITY AND BURROWING BEHAVIOUR IN THE PACIFIC GEODUCK CLAM, *PANOPEA GENEROSA* (GOULD, 1850).

Rylan Command* (rcommand@uvic.ca), Talen Rimmer (rimmer_talen@gmail.com), University of Victoria

Commercial culture and harvest of Pacific geoduck clams, *Panopea generosa*, is a rapidly growing industry in the Pacific Northwest. Juvenile geoducks are typically hand-planted in sediment within PVC pipes to reduce predation. In British Columbia, Canada, mechanical planting was recently introduced as a potentially more efficient method of seeding large plots with geoducks. However, geoduck mortality associated with mechanical planting is high, and the cause is largely unknown. In this paper, the effect of planted orientation (0°, 90° and 180° with respect to the siphon angle and sediment surface) on juvenile geoduck mortality was determined across a range of shell sizes. Individuals were grouped by planting angle and buried at a depth of 15 cm for 14 days, following which mortality was assessed. We found proportionally greater survivorship of geoducks planted with siphons directly facing the sediment surface than those planted at either horizontal (0° - 90°, 17.8 ± 4.7%, (difference in mean survival ± s.e.)) or opposite (0° - 180°, 34.4 ± 5.4%) angular orientations. Survivorship of juvenile geoducks also increased with condition factor (g/cm) across all treatments. However, as condition factor approached the maximum value tested, the probability of survival converged on 100% irrespective of treatment. Our results suggest that farmers can decrease juvenile mortality by either 1) planting geoducks upright, or 2) growing geoducks to a high condition factor prior to outplanting. The implementation of these strategies may yield more geoducks at time of harvest, creating a more efficient mechanical planting mechanism.

SHELLFISH COMMUNITY PATTERNS IN THE NATIVE AND NON-NATIVE EELGRASS HABITATS OF NETARTS BAY, OREGON, USA

Anthony D'Andrea (tony.f.dandrea@state.or.us), Elizabeth Perotti (elizabeth.a.perotti@state.or.us), Cinamon Moffett (cinamon.moffett@oregonstate.edu), Stacy Strickland (stacy.a.strickland@state.or.us) Oregon Dept of Fish and Wildlife*

The non-native eelgrass *Zostera japonica* was introduced in the 1930s to the Pacific Northwest (PNW) and has since become well established in many Oregon estuaries. Several of these estuaries have expansive native *Zostera marina* beds and support communities of ecologically, recreationally, and commercially important shellfish. However, there is limited information about the effects of *Z. japonica* expansion on these communities. In 2013-2014, the Oregon Department of Fish and Wildlife conducted a comprehensive shellfish community and estuarine habitat survey of Netarts Bay. The survey used a whole estuary randomized approach stratified by region of the estuary and tide level on the intertidal. There were four major bed types identified in the bay: unvegetated (UV), *Z. marina* (ZM), *Z. japonica* (ZJ), and mixed eelgrass beds (MX). Multivariate analyses showed evidence for differences in community structure between sites with eelgrass relative to UV sites. Among the eelgrass bed types, there was a transition in community composition from ZM to MX to ZJ bed types. A canonical analysis of principle coordinates (CAP) was used to test for distinct communities between the bed types. The CAP model explained more than 75% of the variability in community structure. This variability was due to species compositional changes and characteristic species found within the different bed types. The results of this study support the assertion that the expansion of *Z. japonica* in Netarts Bay has led to shifts in shellfish communities and improve our understanding of the ecological effects of this non-native eelgrass in PNW estuaries.

SHELLFISH AND EELGRASS RESOURCES OF COOS BAY, OREGON, USA: THEN, NOW, AND IN THE FUTURE

Ylva Durland (ylva.e.durland@state.or.us), Anthony D'Andrea (tony.f.dandrea@state.or.us), Elizabeth Perotti (elizabeth.a.perotti@state.or.us), Scott Groth (scott.d.groth@state.or.us) Oregon Dept of Fish and Wildlife*

Coos Bay, on the southern Oregon coast, is one of the state's largest seaports with an economy primarily based in timber and fishery industry. The Port of Coos Bay has proposed an expansion of their shipping channel in order to enhance and diversify shipping operations from this area. This is the largest dredging project that has ever been proposed in an Oregon outer coast estuary. The main shipping channel and associated tide flats also provide excellent habitat for shellfish and is highly utilized by clammers and crabbers. The Oregon Department of Fish and Wildlife (ODFW)'s Shellfish and Estuarine Habitat Assessment of Coastal Oregon will present a summary of current (2017) and historic (1970s, 1980s) data on bivalve shellfish and eelgrass distribution together with the distribution of recreational shellfishing effort in the area. The long-term persistence of this resources, which is supported by the historical and current data, indicates consistent populations of both shellfish and eelgrass in the area. In addition, historic data has shown dense clam populations along the edge of the shipping channel that might indicate subtidal populations which may be at particularly risk due to the proposed dredging. Current shellfishing effort in the bay is concentrated along the shipping channel and any impacts from this project on shellfish resources may alter the recreational opportunities available in the bay. Combined, this dataset will be used by ODFW to assess the potential impact this project may have on estuarine resources and shellfishing opportunities.

TIPPING THE BALANCE: IMPACT OF SEAGRASS WASTING DISEASE IN A CHANGING OCEAN

Morgan Eisenlord* (me367@cornell.edu), Cornell University, Reyn Yoshioka (rmy@uoregon.edu), Oregon Institute of Marine Biology, Tyler Tran(Tyler.Tran@wwu.edu), WWU, Miranda Winningham (mcw245@cornell.edu), Phoebe Dawkins (pd298@cornell.edu) Cornell University, Clio Jensen (cliocj@gmail.com), Bryn Mawr College, Kathy Van Alstyne, (Kathy.VanAlstyne@wwu.edu), Western Washington University, Drew Harvell (cdh5@cornell.edu) Cornell University

Infectious disease has the potential to cause devastating damage to valuable marine organism and habitats. Eelgrass wasting disease (EGWD), caused by the pathogenic protist *Labyrinthula zosterae* (LZ), has caused mass die-offs in *Zostera marina* at regional and global scales. Despite this, little is known about the host-pathogen interaction or drivers of disease severity. To determine the regional impact of EGWD, we measured prevalence and severity in the San Juan Islands, Padilla Bay, Hood Canal, South Puget Sound, and Willapa Bay, Washington, and South Slough, Oregon during summer 2017. EGWD was present at all 17 sites surveyed, with prevalence ranging from <10-100% of plants infected, and four sites having >80% disease prevalence. Preliminary results from our field surveys suggest a low temperature threshold is correlated with decreased EGWD prevalence and severity. To examine the impact of LZ infection on eelgrass shoots over time, we ran a 3-week controlled experiment, exposing eelgrass shoots to LZ infection and sampling them over time. Disease severity increased through time and was correlated with decreased leaf and root growth and increased total phenols. Our results show EGWD is present in Salish Sea and coastal eelgrass beds. Furthermore, our experimental results suggest EGWD has a detrimental effect on eelgrass health, potentially contributing to decreased density and meadow declines. Monitoring of EGWD on the Pacific coast and continued research into the host-pathogen interactions is important to establish baselines of disease severity and determining the impact the disease has on eelgrass bed health and resilience.

VALUE RIGIDITY TRAPS IN ESTUARINE HABITAT COMMUNITY ECOLOGY

Steven Ferraro* (steveferraro@peak.org)

On The News Hour (PBS) there is a weekly “Brief but Spectacular” segment during which invited guests talk on a topic they are passionate about. I am passionate and very concerned about value rigidity traps and the problems they cause in estuarine habitat–community ecology. Value rigidity traps occur when people believe in the value of something so strongly that they can no longer objectively question it (Pirsig 1974: Zen and the Art of Motorcycle Maintenance). As an example, I compare and contrast Mitchell (2005: How useful is the concept of habitat?—a critique. *Oikos* 110: 634–638) and Ferraro (2013: Ecological periodic tables: in principle and practice. *Oikos* 122: 1541–1553), link their conflicting conclusions about the usefulness of the habitat concept to value rigidity traps, and explain how they have thwarted the discovery of reproducible estuarine habitat–community patterns.

BLUE CARBON: HOW MUCH IS THERE AND DOES IT HAVE ANY VALUE IN CLIMATE CHANGE MITIGATION?

Jim Fourqurean* (jim.fourqurean@fiu.edu), Jason Howard (jason.le.howard@gmail.com), Florida International University

Coastal wetlands, including tidal marshes, mangrove forests and seagrass meadows, store large amounts of carbon in their soils, as well as in biomass in the case of mangroves. Since 2012, a lot of effort has been made in estimating the sizes of existing carbon stocks in these wetlands. These habitats are also rapidly being converted by human activities, and it has been suggested that this conversion could rapidly return the often thousands of years’ worth of stored carbon to the atmosphere, exacerbating climate change. However, major questions remain before conservation of coastal wetlands can be used in climate change mitigation. These include the importance of the wetlands to the production and preservation of soil organic matter, the fate of stored carbon following conversion of coastal wetlands, and the interactions between organic and inorganic carbon cycling. The fate of disturbed soil organic matter is likely a function of the environment in which eroded material gets deposited and the lability of that organic matter. The magnitude in the uncertainty of these questions suggest that more effort should be expended on directly measuring greenhouse gas flux between healthy and disturbed coastal wetlands and the atmosphere to truly understand the potential for Blue Carbon climate mitigation strategies.

MICROPLASTICS IN SALISH SEA MARINE FOOD WEBS

Peter Hodum (peter.hodum@gmail.com) University of Puget Sound*

The pervasiveness of microplastics in marine ecosystems is increasingly well documented, but research has tended to focus on upper-trophic level species. Given its ubiquity in marine systems, its impacts may well extend throughout marine food webs. In my research lab, we are using focal species at multiple trophic levels as biological indicators to (1) monitor trends in plastic distribution and relative abundance in marine ecosystems and (2) assess impacts of plastic exposure on marine wildlife. To date, we have focused our efforts on seabirds, pelagic forage fish, benthic fish and filter-feeding mollusks. This talk will focus on recent findings from forage and benthic fish and mussels. All eight species of pelagic forage fish (Pacific herring, greenling spp., smelt spp., rockfish spp., northern anchovy, Pacific sandlance and Pacific hake) ingested microplastics, with frequency of ingestion ranging from 12%-95%. Plastic filaments comprised at least 90% of all ingested microplastics. A multi-species comparison of fish collected in 2008 and 2013 indicated a significant increase in frequency of ingestion, from 11% in 2008 to 26% in 2013. In a comparison of two benthic fish species, frequency of occurrence of ingested microplastics was significantly greater in English sole than in spotted ratfish. Of mussels collected from 63 sites in Puget Sound, all but one location contained microplastics. Amounts of plastic ingested increased with increasing mussel size, suggesting an accumulation of plastic in mussels as they age. The important next step is to determine population-level consequences of these pervasive contaminants.

MICROPLASTIC POLLUTION IN REGIONAL WATERS

Katie Houle (katie@pacshell.org) Pacific Shellfish Institute, Julie Masura (jmasura@uw.edu) UW Tacoma Center for Urban Water, Peter Hodum (phodum@pugetsound.edu) University of Puget Sound, Britta Baechler (baechler@pdx.edu) Andrew Spanjer (aspanjer@usgs.gov) USGS, Washington Water Science Center, Tacoma, WA*

Microplastic pollution is ubiquitous in all environmental compartments across the globe. A large fraction (~80%) of these contaminants found in environmental samples are microfibers, synthetic fibers sourced primarily from textiles. More than 8 million tonnes of plastic enters the ocean each year. Most plastic pollution found in marine and coastal environments comes from land-based sources, including the breakdown of local litter and daily activities of washing clothes and driving cars. Calls to address poor waste management in coastal communities is at the forefront of international discussions being led by the UN Environment and the #CleanSeas campaign launched in 2017. Regionally, Marine Debris Action Plans have been developed in HI, OR and currently WA states to prevent, research and remove debris, including microplastics. Join regional scientists during this special topics panel to learn more about the distribution and implications of microplastic pollution in our coastal, estuarine and freshwater systems. A 20-minute discussion with panelists will commence after formal presentations. Please bring questions and thoughtful points for discussion.

THE IMPACT OF WATER COLUMN MIXING IN A SALT WEDGE ESTUARY

Joshua Johnson (joshmakaha@gmail.com) Ocean Research College Academy (Everett Community College)*

The Puget Sound is a complex estuarine system within the Salish Sea, fed by both high salinity water from the Pacific Ocean and freshwater from a number of rivers. The Snohomish River is one of the largest of these freshwater inputs, transporting freshwater from the Skykomish and Snoqualmie rivers to Port Gardner Bay off the coast of Everett. At its mouth, the higher density salt water from the Puget Sound intrudes into the freshwater, forming a salt wedge that causes a highly stratified water column which rapidly changes with the tidal cycle. In this stratified water column, little mixing occurs between the different layers of the water, resulting in a lack of nutrients near the surface. This study aims to quantify the amount of mixing occurring at this location in relation to tidal patterns and season and analyze the effect varying levels of mixing have on related chemical properties. This research is being conducted at the Ocean Research College Academy (ORCA), a dual enrollment program through Everett Community College. In cooperation with Gravity Marine Consulting and the Port of Everett, ORCA has permanently moored a SeaBird CTD 3 meters below the surface in the mouth of the Snohomish River. The CTD captures temperature, salinity, chlorophyll, turbidity, and dissolved oxygen measurements at 30-minute intervals. Velocities in 3-dimensions are recorded by a Nortek Aquadopp. This study will define the characteristics of the salt wedge in relation to temperature and salinity and then analyze its influence on chlorophyll and turbidity levels.

EXPLORATION OF MICROPLASTICS IN THE LOWER PUYALLUP RIVER WATERSHED

Jessica Kelsey* (jkelsey@uw.edu), Shannon Black (black8@uw.edu), Mary Eldridge (mre6@uw.edu), Julie Masura (jmasura@uw.edu), and Jacqueline Busby (jnbusby@uw.edu) University of Washington Tacoma

Pollution Microplastics are polymers < 5mm, varying in shape, color, chemical composition, and density. Manufactured plastics are primary microplastics which include pellets, fibers, and microbeads. Secondary microplastics are plastics fragmented through photodegradation and/or mechanical weathering. Research has documented microplastics in high densities (e.g., 100,000 items per m³) in marine environments, but little work has been conducted in riverine environments. Our study is focusing on the Puyallup River Watershed, located in Washington State, and its role in microplastic transport. The Puyallup River and its two principal tributaries, the White River and the Carbon River, drain a watershed of approximately 1,040 square miles and stream from several glaciers located on Mount Rainier, including the Puyallup Glacier. During our preliminary research, samples were collected monthly, both upstream and downstream of municipal wastewater treatment plants, from five cities in the lower reaches of the Puyallup River Watershed. Fibers, fragments, and foams were identified, characterized and quantified. Only 1-foam and 5-fragments were found, with the majority being fibers. The concentration of fibers, ranged from 0 to 204 fibers/L, with an average of 22-fibers/L in each sample collected. Results were statistically inconclusive to determine if wastewater treatment plants were a point source of plastic pollution to the Puyallup River Watershed, although more fiber numbers were located upstream than downstream at most sites.

THE DIFFERING EFFECTS OF LOW SALINITY ON FEEDING RATES OF INVASIVE *CARCINUS MAENAS* AND NATIVE *CANCER PRODUCTUS*

Sophia Kontou* (sophiakontou@gmail.com), University of British Columbia

Changing climate as a result of anthropogenic impact will shift oceanic salinities; specifically, the Pacific Northwest expects freshening of its coastal waters. Abiotic environmental shifts such as this may increase an ecosystem's suitability to invasive species thereby promoting range expansion and growth. Invasive species can disrupt interspecific interactions and induce prey competition with native species. To explore this, changes in feeding rates were examined of invasive European green crabs (*Carcinus maenas*) and endemic red rock crabs (*Cancer productus*) in response to lower salinities (100, 75, and 50 percent seawater). These species exhibited opposite relationships of feeding rates in decreasing salinity. *C. productus*' feeding rate decreased with decreased salinity whereas *C. maenas*' feeding rate increased. Both species showed different trends in feeding rates when the three parameters salinity, species, and carapace width were used in a predictive model of the population average. *C. productus*' feeding rate was best described by salinity and carapace width whereas *C. maenas*' feeding rate could not be predicted by any of the variables. These results suggest that *C. maenas* has a greater adaptive ability in lower salinity conditions than *C. productus*. Their breadth of abiotic tolerance provides insight into their invasive capabilities and the likelihood that they will outcompete native crab species who share similar prey preferences in a shifting marine environment.

STUDENT RESEARCH ON THE STATE OF POSSESSION SOUND AT THE OCEAN RESEARCH COLLEGE ACADEMY

Ardi Kveven (akveven@everettcc.edu), Everett Community College Ocean Research College Academy

Connecting students to the places they live has been a cornerstone of the curriculum at the Ocean Research College Academy (ORCA) since its inception 15 years ago. By engaging students in a locally based research project in the Salish Sea, ORCA has graduated over 400 students that have direct, hands-on experiences in the Snohomish River Estuary. Through incorporating active learning strategies such as undergraduate research, students have engaged deeply in the biogeochemical processes of a salt wedge estuary. Over the course of an entire year, students collect oceanographic metrics and utilize their emerging mathematical and communication skills to analyze and interpret the longitudinal data set that includes temperature, salinity, dissolved oxygen, pH, chlorophyll concentration, turbidity, nutrient levels, fecal coliform levels and plankton presence and abundance. Additional monitoring of seabird and marine mammal abundance and distribution round out the expansive data set. As students grapple with real data that they collected, their understanding of the nature of science improves. These data represent value to not only the ORCA community, but other collaborators as well. Students present their work at conferences such as the Salish Sea Ecosystem Conference and the annual Possession Sound Student Showcase and Talks.

CARBON BLUES: BLUE CARBON STOCK AND SEQUESTRATION RATES IN CENTRAL SALISH SEA EELGRASS MEADOW SEDIMENTS

Mira Lutz (mira.lutz@wwu.edu), Katrina Poppe (katrina.poppe@wwu.edu), John Rybczyk (john.rybczyk@wwu.edu)*
Western Washington University

Seagrass meadows sequester carbon (C), reportedly at rates only surpassed worldwide by salt marsh and mangrove ecosystems. Now that their climate mitigation capacity has earned seagrass ecosystems a place in the Verified Carbon Standard voluntary greenhouse gas program, accurate ecosystem C accounting is essential to estimating restoration area. Though seagrasses vary in carbon storage and accumulation greatly across species and geography, the bulk of data included in calculating global averages involves tropical and subtropical seagrasses. We know little regarding carbon stocks nor sequestration rates for eelgrass (*Zostera marina*) meadows in the Pacific Northwest. We quantified C stocks and sequestration rates in the central Salish Sea. We gathered 20 sediment cores over three bays, as close to 1 m in depth as possible, both inter- and subtidally. We measured bulk density, carbon concentration, carbon stock, sediment grain size, and carbon accumulation rates with depth. Results show lower estimated Corg concentration (overall mean = 0.39% C by mass, SE=0.01, range=0.11%-1.75%), Corg stock to 50 cm (mean=24.46 Mg ha⁻¹, SE=2.03, range=12.16-49.99.70), and C sequestration rates (mean=53.04 g C m⁻² yr⁻¹, SE=17.84, range=11.7-132.3). Model selection from linear mixed effects models indicate sediment grain size as the main driver of C concentration. Though highly productive, *Zostera marina* growth habit is different from seagrass species in warmer climates, which may prevent it from holding its organic C stores for long. These data may prevent underestimation of eelgrass planting area required for mitigation and restoration and improve accuracy of global average seagrass blue carbon estimates.

CAPTURING AN EMERGING INVASION: STATUS OF EUROPEAN GREEN CRAB IN WASHINGTON'S SALISH SEA

Kelly Martin (kmartin8@uw.edu), Washington Sea Grant, University of Washington School of Marine and Environmental Affairs*

Originally introduced to the outer coasts of Oregon, Washington, and Vancouver Island, British Columbia, in the late 1990s, the presence of invasive European green crab, *Carcinus maenas*, has posed a threat to ecosystems of the Pacific Northwest for decades. With the recent expansion of green crab into the Salish Sea, there is increased concern over the potential ecological, economic, and cultural impacts of a full-scale invasion in Washington state. In response to this development, Washington Sea Grant launched a volunteer-based monitoring program in 2015 focused on assessing the status and impacts of a potential invasion. Today, Washington Sea Grant Crab Team manages a network of more than 200 volunteer, tribal, and agency partners monitoring 52 sites throughout Washington's Salish Sea. Since the outset of the Crab Team monitoring program, 107 European green crab have been captured at five monitoring sites along Washington's inland shorelines. Given the small size of the captured green crab, individuals are likely recent inhabitants, recruiting from the larval dispersals of nearby populations in 2015 and/or 2016. Though these populations are not yet fully established, there is potential for rapid growth without intervention. However, the low numbers and apparent isolation of current populations indicate that the invasion is still in its early stages, providing an opportunity for effective intervention. While physical oceanographic modeling and genomic research are ongoing in an attempt to determine the dispersal dynamics of green crab in the Salish Sea, continued monitoring efforts are imperative to protect ecosystems and natural resources.

SPATIAL AND TEMPORAL DISTRIBUTION OF MICROPLASTICS IN SURFACE WATERS OF PUGET SOUND

Julie Masura (jmasura@uw.edu) University of Washington Tacoma*

Plastic marine debris has been identified as a growing concern due to its durability in the ocean environment. The presence of plastics in the ocean has been persistent, but the concentrations have been highly variable. Exploration of plastic debris has been approached via size and location. Sizes are identified as macroplastics (> 5mm), microplastics (5-.330mm), and nanoplastics (<0.330mm). Plastics have been detected in surface waters, within the water column, on beaches, and among sediments on the seafloor. Scientists have contributed to understanding the impact of plastic marine debris on organisms as part of the ecosystems they occupy with the ingestion of plastics occurs with megafauna (i.e. birds) and lower trophic fauna (i.e. worms and plankton). With prior support from the NOAA Marine Debris Program, the University of Washington Tacoma, Center for Urban Waters developed sampling and analytical methods to collect, isolate, identify, and quantify microplastics in marine water samples. The design of the sampling methods for microplastics in surface waters were to be compatible with well-established ichthyoplankton survey techniques in order to efficiently and economically add microplastic quantification into existing marine field surveys. For the field portion led by faculty, undergraduate student researchers collaborated with local boat-based environmental education groups in Puget Sound, Washington, to collect environmental samples and educate participants on the impacts of marine debris on the environment, specifically microplastics. Groups were trained how to collect microplastics in the field, sending the samples to the Center for Urban Waters for analysis.

IS THE ESTUARY HALF EMPTY OR HALF FULL? JUVENILE STEELHEAD FORAGING BEHAVIOR AND PREY ASSEMBLAGE IN AN INTERMITTENT ESTUARY

William Matsubu wmatsubu@uw.edu, Si Simenstad (simenstd@uw.edu) Wetland Ecosystem Team, School of Aquatic and Fishery Sciences, University of Washington*

Benefits of estuaries are only available to organisms that can tolerate the diversity of conditions. Intermittent estuaries, estuaries that have a temporary connection to the ocean, undergo severe environmental transformations and are particularly productive. In these intermittent estuaries, management practices controlling ocean connectivity are controversial because changes to connectivity can cause deleterious conditions but also enhance the survival of juvenile steelhead. One of the main benefits of intermittent estuaries for juvenile steelhead are the foraging opportunities, yet there is considerable uncertainty about the impacts of ocean connectivity to their main prey taxa. We integrated the sampling of diet composition and availability of prey resources to evaluate the influence of inlet condition on juvenile steelhead foraging opportunities. Our results indicate that juvenile steelhead in the Russian River estuary consume a limited group of epibenthic crustaceans and aquatic insects commonly found along the bottom with a slight shift in prey composition and instantaneous ration during closed conditions. In addition, there is a rapid redistribution of prey into areas only accessible during closed conditions and a drop off in densities after breaching takes place. Therefore, foraging opportunities do not suffer during closed conditions and may decrease after a breaching event.

DIVERSE TAXA OF ZOOPLANKTON INHABIT HYPOXIC WATERS IN A TEMPERATE LAKE

Sean Nolan* (sean.nolan@wsu.edu), Stephen Bollens (sbollens@wsu.edu), Gretchen Rollwagen-Bollens (rollboll@wsu.edu) Washington State University

Zooplankton are often heterogeneously distributed in the water column and often (but not always) exhibit diel vertical migration (DVM) behaviors. Typical DVM patterns occur when the majority of a zooplankton population resides in surface waters at night and at depth during the day, although the reverse pattern is also possible. While resource availability and predation risk have been shown to influence DVM patterns, recent literature has suggested that hypoxia may also play a role in modulating DVM and vertical distribution of zooplankton. Lacamas Lake is a highly modified reservoir in Southwest Washington that exhibits seasonally variable thermal and dissolved oxygen stratification events. We hypothesized that vertical distribution and DVM behaviors of zooplankton in Lacamas Lake would vary as a response to such hypoxia events. We collected vertically discrete zooplankton samples from six depths at mid-day and mid-night during periods of varying hypoxia – spring (mild hypoxia), summer (strong hypoxia), and autumn (moderate hypoxia) – over the course of two years. Preliminary analysis of these data shows that some zooplankton taxa (copepods and cladocera) occupy the entire water column, including deep hypoxic waters, and exhibit little or no DVM behavior, whereas other taxa (rotifers) are more heterogeneously distributed during day and night, and avoid hypoxic waters. Our results indicate that vertical distribution and DVM behavior of zooplankton is highly variable – across diverse taxa and seasons – and that several interacting factors, beyond hypoxia alone, are likely responsible for this complex behavior.

THE BIG, THE MAD, AND THE TEN: FISH COMMUNITIES IN THREE NORTH CALIFORNIA ESTUARIES

Katherine Osborn* (keo6@humboldt.edu) Humboldt State University

The majority of Northern California estuaries are small, flooded, river valleys that are largely unstudied due to their small sizes and remote locations. Yet these estuaries serve as important nursery areas for many marine fish species including rockfish, flatfish, smelt, and herring, and they are vital to anadromous species such as Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*O. mykiss*). I sampled the summer and winter fish communities of the Big, Mad, and Ten Mile river estuaries. Fish were sampled via beach seine or fyke net, June 2014-June 2016. Fish abundance and diversity varied more by season (i.e. summer, winter) than by estuary. The Big River Estuary had the strongest ocean connection and the most marine fish and invertebrate species. The Mad River Estuary fish and invertebrate communities were most similar to the Ten Mile River Estuary, which had the least ocean connectivity and species diversity. The majority of Northern California estuaries are small, flooded, river valleys that are largely unstudied due to their small sizes and remote locations. Yet these estuaries serve as important nursery areas for many marine fish species including rockfish, flatfish, smelt, and herring, and they are vital to anadromous species such as Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*O. mykiss*). I sampled the summer and winter fish and invertebrate communities of the Big, Mad, and Ten Mile river estuaries. Fish were sampled via beach seine or fyke net.

ARE THINGS GETTING BETTER OR WORSE? MAYBE.

Valerie Partridge* (valerie.partridge@ecy.wa.gov), Sandra Weakland (sandra.weakland@ecy.wa.gov), Margaret Dutch (margaret.dutch@ecy.wa.gov), Dany Burgess (dany.burgess@ecy.wa.gov), Angela Eagleston (angela.eagleston@ecy.wa.gov), Carol Maloy (carol.maloy@ecy.wa.gov) Washington State Department of Ecology

The first question citizens ask about Puget Sound sediment monitoring is whether conditions are getting better or worse. To answer that question, we turn to the data we collect. Every year since 1989, the Washington State Department of Ecology has sampled sediments and benthic invertebrate communities. One element of the monitoring program has been annual sampling of 10 "sentinel" stations which span Puget Sound. These 10 stations represent different habitat and community types. This is a unique and important dataset, providing yearly insights into benthic community structure and abundance cycles of individual species. What have we learned from almost three decades at these 10 stations? First, everything is more complex than originally thought. Second, there is a remarkable resilience in some of the benthic communities. But third, some of the communities are not faring well. This presentation will highlight results from monitoring these 10 stations, place them in context with patterns seen at larger geographic scales, and describe changes to Ecology's sediment monitoring program based on lessons learned.

FROM BURROWS TO BLADES: USING UNMANNED AIRCRAFT SYSTEMS FOR ESTUARY MONITORING IN OREGON

*Elizabeth Perotti** (elizabeth.a.perotti@state.or.us), *Anthony D'Andrea* (tony.f.dandrea@state.or.us), *Timothy Lawes* (timothy.j.lawes@state.or.us), *Skyler Elmstrom* (skyler.r.elmstrom@state.or.us), *Steven Rumrill* (steven.s.rumrill@state.or.us) Oregon Dept. of Fish and Wildlife

Using unmanned aircraft systems (UAS) is more feasible for estuary monitoring and research than ever, with rapid technological advancement and recent changes in the regulatory environment. UAS can provide rapid assessment of habitats, generate data for unsafe or inaccessible areas, and provide detailed snapshots for posterity. The Oregon Department of Fish & Wildlife's Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR) Project presents an update on UAS use for shellfish and habitat monitoring in Oregon estuaries. Specifically, we highlight the importance of sensor capacity and report on observed tradeoffs between areal coverage and pixel and spatial resolution with flight altitude and duration. Using examples of pixel-based habitat categorization, UAS applications for tracking climate change effects, non-native species, and land and resource management are also discussed.

SEASONAL VARIATION IN CHLOROPHYLL AND DISSOLVED OXYGEN IN POSSESSION SOUND

*Ingrid Phillips** (iephillips@student.everettcc.edu) Ocean Research College Academy (Everett Community College)

Oxygen and organic carbon that are generated through photosynthesis in the oceans are critical for aerobic marine life. Water chemistry is influenced by primary production by organisms such as phytoplankton and eelgrass. To monitor changes in water chemistry, the students of the Ocean Research College Academy (ORCA) collected data in Possession Sound from 2012-2016. It was hypothesized that chlorophyll levels will be higher in the spring and summer because the increase of direct sunlight would cause an increase in photosynthesis, leading to increased dissolved oxygen. Three sites, Mount Baker Terminal (MBT), Buoy, and Dolphin One (DOL1), were analyzed because they lay at varying points in the estuarine system. Data were recorded at 0 meters using YSI probes (650, 85, Exo Sonde). Preliminary results demonstrated that there was a correlation between chlorophyll and DO levels. The highest average chlorophyll measurement at MBT was in the spring at 0.83 RFU, the same season in which the highest average DO level was recorded at 11.97 mg/L. Similar patterns were found at DOL1 with a mean high of 0.45 RFU and 11.26 mg/L during the spring. Levels at Buoy, contrastingly, were highest in the fall at 0.88 RFU and 11.19 mg/L, suggesting another increase in photosynthesis in the fall. The first part of our hypothesis was not proven. DO and chlorophyll levels were typically higher in the spring and fall, and not in the summer. Further studies would include analysis of phytoplankton blooms and nutrients.

REDUCED WATER MOTION ENHANCES ORGANIC CARBON STOCKS IN TEMPERATE EELGRASS MEADOWS

*Carolyn Prentice** (carolynisabella@gmail.com), *Simon Fraser & Hakai Inst.*, *Margo Hessing-Lewis* (margot@hakai.org), *Rhea Sanders-Smith* (rhea.smith@hakai.org) Hakai Institute, *Anne Salomon* (aks21@sfu.ca) Simon Fraser University

Organic carbon (OC) storage in coastal vegetated habitats (blue carbon) is increasingly being considered in carbon financing and ecosystem-based management. Seagrass meadows have potential to sequester and store significant amounts of carbon, however, existing estimates are primarily from tropical and sub-tropical regions. On the northwest coast of North America, the magnitude and variability of seagrass carbon stocks, as well as local drivers of variability remain rare. We collected sediment cores from six eelgrass (*Zostera marina*) meadows on the coast of British Columbia, Canada, to quantify sedimentary OC stocks and accumulation rates. The top 20cm of sediments exhibited a 30-fold difference in OC stocks across meadows. OC accumulation rates ranged from 13 to 50 g OC m⁻² year⁻¹, and 20 cm represented 21 to 74 years of accumulation. Isotopic analysis of sediments revealed that OC is largely derived from non-seagrass sources (terrestrial, benthic microalgae or macroalgae). Variation in surface OC stocks was best explained by a negative relationship with water motion, relative to other key biological and sedimentary factors (% fine sediments and seagrass complexity). Lower water velocities may facilitate greater OC deposition and reduce rates of erosion and resuspension. This study highlights variability in carbon stocks at local scales with profound implications for estimating variability in carbon stocks at regional and global scales, typically unaccounted for in seagrass blue carbon estimates. To help account for this variability, we demonstrate that water motion can be used as key predictor of blue carbon storage in temperate soft sediment habitats.

COMMUNITY COLLABORATION: A LOCALLY-DRIVEN APPROACH TO ESTUARINE MANAGEMENT

Jenni Schmitt* (jennie.schmitt@state.or.us) South Slough National Estuarine Research Reserve, Jill Rolfe (jrolfe@co.coos.or.us) Coos County Planning Department, Don Ivy (donaaldivy@charter.net) Partnership for Coastal Watersheds

Modern management of Oregon's estuaries and surrounding shorelands is based on the economic and social drivers of the 1970's era within which local land use plans were developed. So how do we modernize land use planning for an Oregon estuary in a way that balances responsible economic development, social interests, and the protection of natural resources? The South Slough National Estuarine Research Reserve is collaborating with a diverse group of local stakeholders and project partners to answer this question for the Coos estuary through: 1) A Map Atlas for the Coos estuary, which uses existing data to show current conditions and uses within the estuary; 2) Stakeholder input - Key issues based on the needs of the estuary were evaluated by three different focus groups (economic development; socio-cultural interests; and natural resource protection and restoration). Each focus group proposed land use and planning recommendations targeting their core area of interest; 3) Integrating map and stakeholder information to develop management options to county officials - project partners who are ultimately responsible for updating estuary management plans. This talk will highlight the results of the Map Atlas, describe the collaborative stakeholder engagement process that is driving the project, and provide a snapshot of the recommendations developed through this process.

ADVANCING MICROPLASTIC ANALYSIS AT THE U.S. GEOLOGICAL SURVEY MICROPLASTIC LABORATORY

Andrew Spanjer* (aspanjer@usgs.gov) U.S. Geological Survey

In 2017 the U.S. Geological Survey (USGS) established a microplastic laboratory in Tacoma, WA to analyze for microplastics in bed sediment, water, and tissue samples collected for studies throughout the United States. Key to this new laboratory is the refinement of methods to meet USGS standards of Quality Control and Assurance and facilitate sound environmental studies of plastic pollution in our Nation's waters. Current analysis has focused on tissue, water, and sediment samples from nearshore marine, freshwater (lakes and rivers), and stormwater infrastructure, from projects in Lake Mead, NV, Madison, WI, and streams throughout the North East United States. Locally, in cooperation with the Washington State Department of Ecology, King County, and Washington State Department of Natural Resources, we sampled 26 nearshore sediment locations in the fall of 2016 as part of the Regional Stormwater Monitoring Program. General findings for all studies confirm the ubiquitous presence of microplastics in nearly all environmental samples analyzed. This talk will cover our current analytical capabilities in the Tacoma laboratory, USGS field sampling methods, and future advancements. Additional focus will be placed on summarizing the need for methods to efficiently analyze for not only microplastic enumeration but polymer composition and plastic toxicity, whether from microplastics or associated sorbed contaminants. These advancements will be needed to understand the potential harm associated with the established microplastic presence in the environment.

MITIGATING OCEAN ACIDIFICATION: TOWARDS A MODEL RELATING PCO₂, IRRADIANCE AND LEAF AREA INDEX OF ZOSTERA MARINA L. (EELGRASS) IN PADILLA BAY, WA

Tyler Tran* (tyler.tran@wwu.edu) Western Washington University

In nearshore, soft-sediment habitats of the Salish Sea, eelgrass (*Zostera marina L.*) meadows have been identified as potential mitigators of ocean acidification (OA) because their photosynthetic activity can decrease pCO₂, increase pH and provide refuge for organisms sensitive to OA. The diurnal light cycle controls photosynthetic production of eelgrass and therefore, along with tidal cycles, exerts strong controls on variations in pCO₂ in nearshore environment. In this study, we investigate the carbon uptake rates for eelgrass under varying light, ambient pCO₂ conditions and eelgrass densities (leaf area index). The magnitude of changes predicted based on experimentally derived photosynthetic rates, measured light and water depth in Padilla Bay, WA compare well with observed variability in the field. The ambient pCO₂ conditions we tested, however, did not appear to be a major control in carbon uptake rates for eelgrass. Combining lab, model, and field results will strengthen our understanding of the variability of OA in the nearshore environment and help shellfish managers understand the drivers of that variability and inform further studies of its effects, such as potential OA refuge for shellfish and other sensitive organisms.

SMALL CLAMS MAKING A BIG DIFFERENCE: ROCHEFORTIA TUMIDA OBSCURE JUVENILE BIVALVES SURVEY RESULTS IN THE GULF ISLANDS

Alexandra Trejo (trejoa@wwu.edu), Marco Hatch (Marco.Hatch@wwu.edu) Huxley College of the Environment, Western Washington University*

Changing climate in recent years has led to a decrease in resiliency for marine species, negatively impacting Indigenous food systems and Indigenous peoples' ability to practice traditional ways of life. One way to increase the resilience of marine ecosystems can be found in ancient technologies used for millennia by Indigenous people, such as clam gardens. Clam gardens are an Indigenous form of shellfish management that allow coastal communities to maintain an interaction with nature that is resilient. Clam gardens were created by First Nation people by rolling rocks down the beach at low tide creating a rock wall. This rock wall created a terrace which expands clam habitat. As part of a joint project between Parks Canada and Coast Salish First Nations, two clam gardens are being restored in the Southern Gulf Islands, BC. The purpose of this project is to determine how clam gardens are providing a unique habitat for bivalves, specifically under five millimeters. Bivalves were separated from surface sediment core samples taken from clam garden beaches and control sites. Species composition was determined for bivalves above 1mm. Results show that 89% of bivalves assessed on clam gardens were *Rochefortia tumida*, a unique clam which reaches a maximum length of three millimeters. These results highlight the importance of species level identification to determine the impact of clam gardens on traditional food species.

COMMERCIAL CRABBING IN OREGON'S ESTUARIES: RECENT TRENDS AND CURRENT STATUS

Mitch Vance (mitch.vance@state.or.us) Oregon Dept. of Fish and Wildlife*

Oregon's estuaries support diverse and productive communities of crabs and other shellfish. The harvest of Dungeness crab from Oregon's estuaries has been pursued for several decades. The Oregon Department of Fish and Wildlife (ODFW) Shellfish Program routinely monitors and manages the activity of the commercial bay crab fishery through issuance of harvest permits, review of sales records (fish tickets), and by periodic revision of regulations. Analysis of commercial harvest records shows that effort and harvest levels can vary through time and from bay to bay. Periodic shifts in the demand, cycles in other fisheries, and changes in local interest all contribute to variability in the number of people who obtain permits, those who actively harvest bay crab, and their annual landings. I will present an historical overview of the commercial bay crab fishery in Oregon and describe recent trends in harvest activities and the management rules that are currently in place to ensure the sustainability of this natural resource. Commercial harvest of bay crab will be compared to recreational harvest, and the recent impacts of domoic acid closures will be discussed.

WORKING WITH THE SALT WEDGE DURING PIPELINE SCOUR PROTECTION PLACEMENT TO PROTECT EULACHON (*THALEICHTHYS PACIFICUS*) SPAWNING IN THE FRASER RIVER ESTUARY

Gary Williams (glwill@telus.net) GL Williams & Associates Ltd.*

Emergency repairs to Metro Vancouver's Lulu Island- Deas Island water main crossing under the South Arm of the Fraser River required scour protection to be placed in March 2017 prior to the annual Fraser freshet and during the fish sensitive period. The main concern to Fisheries and Oceans Canada, the main regulatory permitting agency, was the protection of eulachon spawning. To ensure eulachon spawning was not impacted, rock scour placement was placed at depth during maximum extent of the salt wedge when water salinity reached 25°C, well above the lethal limit of eulachon eggs (e.g. approximately 16°C). Constant water quality monitoring and side scan sonar was used to ensure works did not negatively impact fish utilizing the river. For shallow areas (e.g. <5 m depth), Ekman grab sediment samples from the work area were collected and sorted in the laboratory to confirm absence of eulachon eggs prior to rock placement. The work was successfully completed with no impacts on eulachon spawning. The project demonstrates the importance of understanding physical and biological processes to mitigate infrastructure maintenance works on important anadromous fish ecological functions.