ABSTRACTS

(In alphabetical order by last name)

LONGFIN SMELT, SPIRINCHUS THALEICHTHYS SHIFTING PARADIGMS IN THE SAN FRANCISCO ESTUARY

Shawn Acuna,Metropolitan Water District of Southern California*

Longfin smelt (Spirinchus thaleichthys) is a California listed species with the bulk of the southern subpopulation utilizing the San Francisco Estuary (SFE). Recent studies have challenged the basic conceptual model for Longfin smelt life history. The old paradigm is that Longfim smelt are an open water pelagic fish that migrate from the ocean into freshwater upstream of the SFE to spawn and the young advect downstream into the low salinity brackish water where they mature before going back out to the ocean. Larval studies indicate larval production may be predominatly brackish in origin compared to freshwater. The Longfin smelt may be more benthic in orientation as fish surveys tend to detect them near the bottom of the water column. Studies were conducted to characterize the effect of turbidity on stratification and characterize the proportional larval production in brackish water.

LOW SALINITY, OXYGEN LEVELS, AND DONOR SITE INFLUENCE GERMAINATION OF ZOSTERA MARINA SEEDS FROM

Michael Adamczyk, Western Washington University, Victoria Monreal, Daniel Woodrich, Miles Mayer, Ari Blatt, Kaitlin Ades, Sylvia Yang*

Following large-scale disturbances, rapid recovery of eelgrass meadows (Zostera marina) relies on seed dispersal and establishment of seedlings. However, the presence of seedlings varies from site to site in the southern Salish Sea (Washington State). We hypothesized that environmental factors that cue germination may not be present at all sites, populations may vary in their response to these cues, or phenological timing of seed ripening may affect germination. In this study, we investigated these hypotheses with a series of germination assays in which we exposed eelgrass seeds from Ship Harbor, Padilla Bay, Samish Bay, and Willapa Bay to a variety of environmental conditions (salinity, anoxia, light). To inform restoration practices, we also explored different methods of seed storage. We found that seeds stored in flowing ambient sea water had higher viability rates than seeds stored in the refrigerator. Salinity was the most important factor determining root emergence, with lower salinity treatments having greater emergence. Anoxia led to higher root emergence compared to oxygenated treatments, but oxygenated treatments had higher shoot emergence. Despite the importance of these cues, germination and viability were both shown to be site specific. Furthermore, seeds that were picked in late summer had higher viability and germination. We recommend that seeds for restoration should be collected from specific bays, later in the summer, to optimize viability and germination of seeds. These seeds should be stored in flowing ambient seawater to ripen, until exposed to a series of germination cues including low salinity, anoxia, and oxygen.

RECREATIONAL HARVEST OF DUNGENESS CRAB IN ALSEA BAY, OREGON: A COMPARISON BETWEEN AGENCY DATA AND CITIZEN SCIENCE INFORMATION TO ESTIMATE CATCH-PER-UNIT-EFFORT

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Crabbing is a popular recreational activity in Alsea Bay, and 8,000 to 20,000 crabbers spend time in pursuit of crab from docks and small boats each year. The Oregon Department of Fish and Wildlife (ODFW) Shellfish Program has continuously monitored recreational harvest of Dungeness crab (Cancer magister) in Alsea Bay, OR since 2007. In addition, an avid group of sport crabbers have kept records on their activities and catch beginning in 2009. This data provides an ideal opportunity to address a central question: "How accurate is the information generated by a citizen science group in comparison with data collected by the ODFW Shellfish Program?" The ODFW Shellfish Program generates quantitative data to characterize the annual harvest of Dungeness crab by conducting "creel surveys" and person-to-person interviews with boat-based recreational crabbers. Variables collected during the ODFW interviews include: dates and times, location, duration of crabbing activity, number of active crabbers, type and number of gear deployed, frequency of gear retrieval, and total number of crabs retained. Concurrently, members of the citizen science group generate a complimentary dataset by sharing information about their crabbing activity and combining the information into a common database. Side-by-side analysis of the two monitoring efforts will correlate comparable variables to evaluate the efficiency and accuracy of data collection by the citizen scientists. In the future, we will investigate the possibility to provide further training, guidance, and QA/QC steps to reduce inherent errors and help standardize the rereational crab fishery monitoring activities in Alsea Bay.

HAVE YOU SEEN THIS NEW INVADER?

Ralph Breitenstein, Oregon Dept of Fish and Wildlife, John Chapman, Michael McGowan*

We provide an annotated key and illustrations to distinguish a new invader of the eastern Pacific Upogebia major the native western North American species. Abundant, reproductive populations of the East Asian, U. major were established in San Francisco Bay, California before 2010 and have since expanded to Bodega Harbor and Drakes Estero, California. U. major were overlooked or confused with the native species, Upogebia pugettensis for many years, The present eastern Pacific range of U. major is therefore uncertain. However, U. major are likely to be spreading and could expand at least to British Columbia and to northwest Mexico. U. major are a coevolved host of the parasitic bopyrid isopod, O. griffenis that arrived on the US and Canadian west coast in the early 1980s. O. griffenis has driven many U. pugettensis populations between British Columbia and Morro Bay, California to collapse or extinction. U. major provide a secure alternative host for O. griffenis and thus increase its potential to drive native species to lower densities or extinction. We are seeking information and assistance for resolving occurrences and ranges of U. major, U. pugettensis and O. griffenis among all eastern Pacific bays and estuaries.

EFFECTS OF AIR TEMPERATURE AND DURATION OF EXPOSURE ON THE INTERTIDAL ZOSTERA MARINA FROM THE SALISH SEA

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Zostera marina is a seagrass species of the eastern Pacific that is exposed to extreme desiccation events during low tides. Air exposure and temperature stress may impact local distribution of Z. marina in terms of depth range. This 7-week study focused on the impacts of these stressors on plants from Fidalgo Bay and Cherry Point Aquatic Reserves. We investigated how air temperatures of 20 °C and 25 °C and desiccation events of one and three hours influenced eelgrass performance during a one-time air exposure event. Photosynthetic efficiency dropped notably and significantly in the longer and hotter treatments while almost all the other treatments remained similar to the control. Both shoot length and sheath length decreased over the course of the study with Fidalgo Bay having larger decreases than Cherry Point shoots. Also, Cherry Point eelgrass shoots showed less growth overall compared to Fidalgo Bay shoots. These results imply that Z. marina populations in certain areas of the Salish Sea can be more greatly impacted by desiccation events.

MAPPING OREGON'S FUTURE TIDAL WETLANDS: LANDWARD MIGRATION ZONES FOR OREGON'S 23 COASTAL ESTUARIES UNDER 6 SEA LEVEL RISE SCENARIOS

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As sea level rises, tidal wetlands will become inundated more frequently, and the influence of marine salinity will extend further upstream in our estuaries. Vegetation changes due to these altered ecosystem drivers are likely to include conversion of forested tidal wetlands to high or low marsh, high marsh to low marsh, and low marsh to mudflat. Factors that will control future tidal wetland locations and conditions include elevation/tidal inundation regime, mineral sediment accretion, organic matter accumulation, and availability of upslope land surfaces for landward migration of the wetlands. Our study focuses on the last of these (availability of upslope land surfaces). We mapped potential future tidal wetlands (also called landward migration zones or LMZs) for all of Oregon's outer coast estuaries, using extreme water level models and LIDAR elevation data. We mapped LMZs for six sea level rise scenarios (23 cm to 3.5 m) across 23 Oregon estuaries. Through a series of public meetings, we brought the resulting LMZ maps to all of Oregon's coastal watershed councils and other stakeholders; participants included resource management agency staff, nonprofit organization staff, landowners, city and county planners, and other interested groups and individuals. We also provided these groups with prioritization maps based on a series of criteria affecting importance and feasibility of conserving the mapped LMZs. The maps and underlying data will help guide action planning efforts as these groups work to ensure tidal wetlands and their many valued ecosystem services remain available in the future.

ZOOPLANKTON COMMUNITY COMPOSITION: DIEL VARIATIONS IN A SHALLOW EMBAYMENT

Nicole Burnett, Padilla Bay NERR, Jude Apple, Colleen Ebright*

Long-term investigations of zooplankton community composition at the Padilla Bay National Estuarine Research Reserve have revealed predictable seasonal and annual patters, yet the role of short-term variability (e.g. vertical migration, day/night cycles, and tidal cycles) in these patterns is poorly understood. In order to assess these short-term effects, we investigated diel variability in abundance and community composition during a spring tide in summer 2016. Zooplankton were collected using two different methods: pumping of surface and near-bottom water and horizontal plankton tows. Comparison of these methods reveals that pump and tow collections have different capture efficiencies which leads to different observations of community composition. Additionally, sampling at multiple depths using the pump method revealed small spatial scale variations in abundance and community composition. For example, zooplankton abundances were higher in the surface waters at night suggesting vertical migration despite the shallow water column and community composition appears to vary both among and within tidal stages. Our ongoing efforts to characterize long-term trends and small-scale variability of zooplankton composition in small embayments like Padilla Bay expand the scope of our understanding of zooplankton communities across coastal habitats and provide insight into their ecological contributions to broader areas like the Salish Sea.

EELGRASS, MARSH OR SANDFLAT? EVALUATING THE SEASONAL USE OF ESTUARINE HABITATS BY JUVENILE SALMON AND FISH COMMUNITIES IN THE FRASER RIVER ESTUARY.

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The Fraser River feeds the largest estuary on Canada's west coast, and its many kilometers of delta support numerous fishes, including some of the most abundant salmon runs in the world. Despite its importance, the Fraser River estuary has had few fish surveys since the 1980s, save for specific small-scale studies done for the purposes of industrial expansion. We surveyed salmon and associated fishes at 17 sites across the Fraser River estuary, which encompassed three habitat types: eelgrass, marsh, and sand flat. Sites were sampled biweekly from March - July, 2016 using beach and purse seine methods. All fish were identified to species and enumerated. All salmon were measured (forklength and depth), and hatchery markings (clipped adipose fin) were noted if present. Non-lethal fin clips were taken from juvenile Chinook for genetic stock identification, and a subsample were retained for otolith growth analysis. Seasonal shifts in fish community structure were captured by repeating the sampling once in September and October, 2016 following the same methods. Data will be used to assess the relative abundance and diversity of resident fish communities across habitats and seasons, and to quantify the use of estuarine habitats by juvenile salmon in relation to fitness measures. Results from this field study will inform habitat and fisheries management decisions via the Salish Sea Marine Survival Project, and will support a Marine Environmental Observation Prediction and Response (MEOPAR) Network visioning and management project for the Lower Fraser region.Keywords: salmon, habitat, residency

HERE COMES UPOGEBIA MAJOR

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A new invader from Asia, Upogebia major, increases the threat of extinction of the blue mud shrimp, Upogebia pugettensis, in the eastern Pacific. U. pugettensis is an ecosystem engineer of northeastern Pacific estuaries. Most U. pugettensis populations have declined to effective or actual extinction over most its range, between British Columbia and Morro Bay, California since the introduction of the East Asian isopod parasite, Orthione griffenis, that effectively castrates U. pugettensis females. O. griffenis arrived in the mid-1980s without its native Asian hosts. U. pugettensis has therefore been the only final host for O. griffenis north of Morro Bay, California. Thus, O. griffenis has been without an alternative host to maintain its populations where exceedingly low densities or extinctions of U. pugettensis occur. That condition changed with the establishment of the Asian mud shrimp, Upogebia major in San Francisco Bay, Drakes Estero and Bodega Harbor, California. U. major is a native coevolved host of O. griffenis that colonizes the same habitats where U. pugettensis previously occurred. U. major are thus likely to compete with U. pugettensis directly and to provide an alternative host for O. griffenis as they continue to extirpate U. pugettensis populations. The loss U. pugettensis will be as significant to eastern Pacific estuaries as diking or the depletion of marshes and mudflats.

NURSERY FUNCTIONS IN A MODIFIED BRACKISH MARSH

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Coastal nurseries provide essential habitat for juveniles of species that make ontogenetic shifts to adult populations. Currently, the leading hypotheses are that nurseries increase the contribution of biomass to adult populations via increases in density, growth or survival, and that connectivity along a habitat continuum facilitates recruitment success. However, we have a limited understanding of nursery functions in highly modified coastal wetlands. We asked, Do native and alien species partition juvenile rearing habitats in space and time? and, what factors contribute to juvenile habitat use in reference and modified marshes?' Using a long-term otter trawl dataset, we examined spatial and temporal patterns of juvenile fish abundance and biomass to identify and classify nurseries in a large brackish wetland that is extensively diked and managed for waterfowl (Suisun Marsh, San Francisco Estuary, California). Further, we evaluated the relative effects of structural complexity, connectivity and food resources on juvenile fish abundance using Generalized Linear Mixed Models. We found that the most abundant species had consistently higher than average annual abundance and biomass in two core habitat patches: a reference marsh (a National Estuarine Research Reserve site) and a modified marsh surrounded by diked ponds and grazed pasture. Additionally, our model results indicated that elevation, vegetation and connectivity to freshwater creeks were important predictors of juvenile abundance, but that species-specific responses varied with freshwater flow. These findings provide evidence for the prevailing nursery paradigm, and also show that reference and modified marshes can function as high-value nurseries for both native and alien species.

SPATIAL AND TEMPORAL PATTERNS OF WATER COLUMN RESPIRATION IN A SALISH SEA EMBAYMENT

Claire Cook, Padilla Bay NERR, Jude Apple

Water column respiration and carbon cycling are key drivers of ocean acidification and oxygen dynamics, yet these values and their response to carbon enrichment associated with eutrophication are poorly understood. In 2016, we began monthly monitoring of respiration rates in Padilla Bay National Estuarine Research Reserve and also developed a manipulative experiment to investigate the response of water column respiration to varying levels of carbon enrichment. Water samples were incubated at in situ temperatures and respiration rates were determined by measuring the decline of oxygen concentration over the course of a 3-day incubation period. Values of water column respiration were generally representative of other measures within the Salish Sea and also exhibited a temporal pattern of elevated rates in the warmer summer months. Variation among sites was apparent with the lowest mean respiration rate occurring at the deep-water station and higher mean respiration rates at sample stations located within the eelgrass meadows. Carbon enrichment experiments reveal dramatic differences in the response to carbon enrichment as one moves from late fall to winter, with mean rates decreasing by as much as 85% from November to December and January. Our results reveal strong seasonal variability in the microbial response to carbon enrichment. These patterns will provide insight into our understanding of climate change and the effect of eutrophication on a warmer, carbon-rich ocean. Keywords: microbial respiration, carbon enrichment, eutrophication

CMECS AND SEACOR: INCORPORATING RECENT SHELLFISH, VEGETATION, AND SUBSTRATE DATA TO IMPROVE HABITAT CLASSIFICATION MAPS FOR OREGON ESTUARIES

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The Oregon Department of Fish and Wildlife (ODFW) systematically mapped estuarine habitats in the 1970s during the development of the state's land use planning system. These maps have been used to classify estuarine habitats and resources, develop local estuary management plans, and make land use decisions. There is a pressing need to update these datasets since most of the estuary management decisions are still based on the 1970s maps. In 2010, ODFW established the Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR) as a permanent project in part to address this need within the state. Since 2010, SEACOR has conducted surveys of 5 estuaries (Tillamook Bay, Netarts Bay, Yaquina Bay, Alsea Bay, and Siletz Bay) using methods to quantify distributions of shellfish (clams, shrimp, crabs), vegetation (eelgrass, macroalgae), and substrate (sediment type). SEACOR is currently part of a collaborative team brought together by the Oregon Coastal Management Program to crosswalk and map the spatial distribution of these resources consistent with the Coastal and Marine Ecological Classification Standard (CMECS) and update the state's estuarine resource maps. Initial efforts have been focused on developing spatial interpolation techniques that can be broadly and consistently applied across a number of resource classes. We present these approaches along with some of the lessons learned in cross-walking PNW habitat data to CMECS. The final products of this mapping effort will be integrated into the Oregon Coastal Atlas (http://www.coastalatlas.net/estuarymaps/) which will serve as the long-term data portal for the current and future data from SEACOR estuary surveys.KEYWORDS: Habitat Mapping, Shellfish, Eelgrass

PREY PALATABILITY INFLUENCES PREDATION ON NATIVE VERSUS NONNATIVE ASCIDIANS ON DOCKS BUT NOT BENTHIC HABITAT

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Biotic interactions that create resistance to invasion or may facilitate it influence the establishment of species introduced to new regions. Predation can create resistance to colonizing nonnative ascidians in benthic habitats, although they are dominant on docks. Following a survey of Charleston Marina, Oregon, that revealed predators on floating docks were consuming native but not nonnative ascidians, we tested the hypothesis that benthic predators create biotic resistance to nonnative ascidians, whereas suspended predators indirectly facilitate them by depredating their competitors. We conducted surveys, feeding assays, and caloric analysis to explore if the observed predation pattern on artificial substrata is attributable to differences in palatability characteristics among ascidians and whether predation pattern changes in the benthic environment with its more diverse predator community. Feeding assays suggested tunic structure may be a key factor influencing predation rates of a nudibranch predator found on docks, which ate the native ascidian Distaplia occidentalis more than the nonnative Botrylloides violaceous. A second suspended predator, a flatworm, specialized on D. occidentalis. Benthic crabs, however, ate the nonnative ascidians. Hence, nonnative ascidians seem to be facing reduced predation in suspended but not benthic environments due to predator specialization and differences in palatability characteristics. The suspended predators may facilitate the invasion of docks while the benthic ones provide resistance to the invasion of benthic areas. Differing levels of diversity and specialization between areas of introduction and their surrounding areas may shape community susceptibility to invasion.

MAPPING THE DISTRIBUTION OF HARVESTED ESTUARINE BIVALVES WITH NATURAL HISTORY-BASED HABITAT SUITABILITY MODELS

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Maps of harvested bivalve populations are invaluable for the management of fisheries species, yet the cost to produce them typically limits their availability. Here, we demonstrate a relatively low-cost approach to generate habitat maps for five species of bivalves found in many Pacific estuaries. Using natural history information, rule-based habitat suitability models were constructed in ArcGIS for each bivalve species. Species tolerance limits, based on habitat characteristics, were determined through a literature review of four easy-to-sample parameters: salinity, depth, sediment grain size, and the presence of burrowing shrimp. Spatially-explicit habitat maps were produced for Yaquina and Tillamook estuaries (Oregon) using environmental data from multiple studies ranging from 1960 to 2012. Suitability of a given location was ranked on a scale of 1-4 (lowest to highest) depending on the number of variables that fell within a bivalve's tolerance limits. Models were tested by comparing the distribution of each suitability class with the observed distribution of bivalves reported in benthic community studies (1996-2012). Areas of highest habitat suitability within models coincided with the greatest proportion of bivalve observations and highest population densities, for each species. The principle advantage of this approach is that disparate, independent sets of existing data were sufficient to parameterize the models, and to produce and validate maps of habitat suitability. While some estuaries may not currently have those data, the model's environmental parameters are cost less to measure than bivalve population data.

COMBINED EFFECTS OF OCEAN ACIDIFICATION AND INCREASED LIGHT INTENSITY ON NATURAL PHYTOPLANKTON COMMUNITIES FROM TWO SOUTHERN OCEAN WATER MASSES

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The composition of phytoplankton communities plays a major role in the efficiency of the biological carbon pump and energy transfer to higher trophic levels. Phytoplankton community composition can be significantly affected by changes in environmental conditions. We investigated the effect of increased pCO2 and light intensity on natural communities from two Southern Ocean water masses surrounding New Zealand, the Subtropical Frontal Zone (STFZ) and Subantarctic Surface Waters (SASW). Each experiment was set up in triplicates under an ambient light (AL) treatment in combination with lower pH and a high light (HL) or combined treatment with the same decrease in pH. In the STFZ assemblage there was a positive light effect on diatom abundance and coccolithophores while solely CO2 had no effect. Species diversity decreased in the combined treatment and the ratio of pennate to centric diatoms remained similar to initial ratios. The phytoplankton community from the STFZ samples shifted to predominantly Prorocentrum-type species under low pH and higher light mostly likely due to increased grazing pressure. In the SASW assemblage there was a negative light effect on diatom abundance and solely CO2 resulted in an increase in initial diatom counts. Coccolithophores grew in the Control treatment while cryptophytes increased fastest in the high light and low pH treatment. Our results show that there are taxon-specific and locality specific differences in natural phytoplankton community responses to increased light and CO2 within low nutrient regions. KEYWORDS: phytoplankton, climate change, ocean acidification

LARVAL RECRUITMENT FROM THE NEARSHORE COASTAL OCEAN INFLUENCES BURROWING SHRIMP POPULATION ABUNDANCE AND STRUCTURE IN US WEST COAST ESTUARIES

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Burrowing shrimp are important members of estuarine intertidal communities along the US Pacific Coast. We monitored populations of these shrimp in Willapa Bay, Washington for two decades and several other estuaries along the coast from Grays Harbor, Washington to Yaquina Bay, Oregon since 2005. Ghost shrimp (Neotrypaea californiensis) density increased dramatically in the 1990's in Willapa Bay, then declined almost as precipitously through 2010. Similar, though less dramatic declines occurred in other estuaries from 2005-2010. These shrimp have pelagic larvae which develop in the coastal ocean, so we asked whether population changes were related to estuarine recruitment which we have also monitored, whether recruitment patterns were synchronous amongst estuaries, and whether patterns might also be reflected in population genetic structure. We found significant relationships between recruitment and the number of larger 1 year old shrimp present, synchronous patterns along the coast and little population genetic structure in except at even broader scales suggesting that nearshore oceanic conditions may greatly influence inter-annual recruitment success. Keywords: invertebrate, recruitment, long-term pattern

EFFECTS OF OCEAN ACIDIFICATION AND WARMING ON OLYMPIA OYSTER LARVAL SETTLEMENT AND JUVENILE MORTALITY

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Olympia oyster (Ostrea lurida) larvae can have low settlement success in both natural habitats and hatcheries. This native oyster to the West coast is culturally important and provides vital ecosystem services. In the Salish Sea, the impacts of naturally corrosive seawaters are compounded by the ocean acidification and elevated water temperatures caused by anthropogenic carbon emissions. The purpose of this study was to investigate the interactive effect of elevated seawater temperature (13, 19, and 25 °C) and pCO2 on the percent settlement of O. lurida larvae, time to larval settlement, and juvenile survival. A significantly higher percentage of individuals settled in moderate pCO2 and high temperatures, but settlement was significantly later for larvae reared under moderate pCO2 levels. Juvenile survival was not significantly impacted by either temperature or pCO2. Understanding O. lurida settlement success and post-settlement survival rates in the face of a changing ocean will be important when designing restoration efforts for the recovering native Salish Sea oyster populations.
Key words: Ocean acidification, Ostrea lurida, larval settlement

IF YOU CEASE IT, WILL THEY COME BACK? HOW EXPOSURE TO AND RELEASE FROM A POLLUTION DISTURBANCE SHAPES ROCKY INTERTIDAL COMMUNITIES IN BRITISH COLUMBIA

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Marine ecosystems in British Columbia are subject to a variety of pollution-based disturbances that restructure the composition of the vegetative and animal communities. A prime historical example of this is the effluent discharged from pulp mills across the province, which have been shown to have substantial negative impacts on coastal biodiversity. However, as environmental regulations have become more stringently enforced and the economic drivers of pulp mills have slowed down, much of this pollution has abated. The diminishment and in some cases, elimination of such disturbances provides a unique opportunity to assess the recovery of communities once affected by the mill discharge. We take this opportunity to use a long term monitoring dataset spanning three decades to study rocky intertidal communities situated around pulp mills in Prince Rupert, Powell River, and Howe Sound. Using this dataset, we demonstrate how proximity to the mill negatively influenced the intertidal community at these sites. Next we examine how the community composition shifts and recovers once the mill disturbance is alleviated. Lastly we take a specific look at which species and which life history traits are best able to survive in a disturbed environment and which species are best able to recolonize those once disturbed locations. This research provides insight into classic ecological theory, applied understanding of the impacts and implications of industrial activity in marine ecosystems, and possible methods by which to assess those industrial impacts.

MAPPING INTERTIDAL EELGRASS (ZOSTERA MARINA) HABITAT USING MULTISPECTRAL UAV IMAGERY

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Eelgrass plays a critical role in supporting and sustaining healthy nearshore marine ecosystems and has experienced site-specific changes in the Salish Sea. Because of the spatiotemporal variability in eelgrass abundance and distribution seasonally and interannually, a variety of remote sensing techniques have been employed to collect aerial imagery of eelgrass communities. UAV technology offers a relatively new approach to collect high-resolution, low altitude aerial imagery of eelgrass. UAV surveys provide solutions to many field obstacles but also presents a unique set of challenges. We conducted UAV surveys of eelgrass habitat in Fidalgo Bay, WA during the Summer of 2016 to acquire multi-spectral imagery using two different 3-band cameras; blue-green-red edge and green-red-near-IR of the electromagnetic spectrum. We are exploring unsupervised classification techniques, and parameter settings for enhancing the accuracy of mapping eelgrass habitat using multispectral imagery. We found that the near-IR imagery is more useful for delineating intertidal eelgrass habitat than the red edge imagery. Identifying and overcoming challenges for classifying UAV-eelgrass imagery will be invaluable to developing an efficient and time-effective UAV methodology for capturing aerial images for mapping eelgrass.

AN ESTUARINE BENTHIC ASSESSMENT TOOL FOR THOSE WITHOUT ONE OF THEIR OWN

David Gillett, Southern California Coastal Water Research Project*

Condition assessment tools based upon macrobenthic community structure are a central component of managing and protecting coastal and estuarine ecosystems. Changes in macrobenthic community structure can provide insight into the degree of habitat condition and the type of stressors a system is exposed to. This information is typically synthesized and communicated via condition assessment indices. However, to calibrate and validate most types of indices requires a considerable amount of biological, anthropogenic stressor, and natural forcing factor data. An exception to this truism is the Multivariate - AZTI Marine Biotic Index (M-AMBI). This index is a tolerance-based tool widely used as part of the European Union Water Framework Directive's assessment programs. The M-AMBI is relatively easy to apply and does not require an extensive amount of data for application in new ecosystems. However, M-AMBI was developed in European waters and has historically performed poorly when applied to the benthic communities of US waters. In an effort to develop a general benthic assessment index for application in the estuarine and coastal waters of the US, we have re-interpreted and re-calibrated the M-AMBI for application across the continental US. Our new assessment tool correctly classified apriori defined reference and degraded sites from around the country, was responsive to anthropogenic stressor gradients, and insensitive to natural gradients in salinity and sediment composition. This new assessment tool is the best available option for conducting benthic condition measurements along the Pacific coast of the US in situations that do not have site-specific indices associated with them.

FIELD MEASUREMENTS AND SEDIMENT TRACER MODELING AT COOS BAY INLET, OREGON

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This study compared a sediment tracer and field data collection program, with numerical modeling investigations for dredged material placed in an ocean dredged material disposal site (ODMDS) adjacent to Coos Bay, Oregon. Hydrodynamic and sediment data in Coos Bay was used to develop a coastal wave, hydrodynamic and sediment transport model, the Coastal Modeling System (CMS), and a particle tracking model, the Particle Tracking Model (PTM), and to calibrate and validate model calculations. Numerical modeling of sediment transport and fate were evaluated and pathways of placed material within and around the Coos Bay ODMDS were validated. Results from six months of simulations and the measured sediment tracer data from the same time period indicate that the sediment placed within the ODMDS primarily moves south alongshore towards the inlet entrance area at the initial stage of the release. Material arriving at the inlet channel and ebb shoal areas is jettisoned offshore by strong ebb currents. Later in the simulations and field study, the sediment tracer spreads northward alongshore due to strong southerly wind conditions. Most of the mobilized material monitored and modeled is composed of fine to medium sand-sized particles. The finer particles are transported the furthest offshore and away from the navigation channel and ODMDS area. A comparison of new sediment mapping techniques in the numerical model simulations demonstrates trajectories, speeds, and burial rates for sediments placed in the ODMDS. Both CMS and PTM results compare well with sediment tracer trajectories and speeds, however, there is room for improvement.

GROWTH AND LONGEVITY OF THE RED ROCK CRAB, CANCER PRODUCTUS

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Although the native red rock crab Cancer productus is an important component of Pacific northwest nearshore communities and recreational crab fisheries, little is known about its life history. Growth in crustaceans is incremental and age classes overlap, making these investigations difficult. An array of techniques was used to estimate growth and longevity of C. productus in a marine preserve at the University of Washington Friday Harbor Laboratories. These included size & frequency distribution analysis of young crabs in their nursery habitat, growth inside cages, and mark & recapture studies. The growth rate in C. productus varies greatly, with adult males exhibiting greater molt increments and molt frequencies than females. For crabs less than 80 mm in carapace width, males and females grow at the same rate: attaining 30 - 65 mm carapace width at age 1, and 60 €“ 95 mm at age 2. Maximum carapace widths of males and females were 171 and 150 mm, respectively, and maximum longevity is estimated to be at least 5 and probably more, much longer than previously estimated. KEY WORDS: life history, mark-recapture, recreational fishery

DEVELOPMENT OF AN AUTOMATED SYSTEM TO MEASURE GREENHOUSE GAS RESPONSE TO SALTWATER TREATMENT OF TIDAL FRESHWATER WETLAND SEDIMENTS

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Automated, high-frequency measurement systems are needed to quantify and record the dynamic evolution of greenhouse gases from tidal wetland sediments. Such methods have the potential to improve studies of biological mechanisms in sediments, increase understanding of variability among coastal ecosystems, and provide data needed for modeling the effects of sea-level change. Building on preliminary results that were based on a short-term field-deployment using a coupled gas analyzer and automated soil flux chamber system, we designed a study to evaluate the effects of oligohaline-range water on tidal freshwater sediment cores from the lower Columbia River estuary, WA. However, during the prior study, periodic chamber malfunctions had occurred that resulted in uncertainty regarding data reliability, consistency, and validity. Therefore, to ensure data quality, we have since investigated the function of the measurement system using three methods. First, we developed a €œblank €□core into which a known standard was injected to assess accuracy and precision of measurement, determine consistency among chambers, and analyze the impact of openings during chamber malfunction. We further assessed the variability between chambers and occurrence of mechanical malfunction by measuring gas fluxes with four chambers simultaneously on composite sediment. Finally, we developed R-programs to identify potential malfunction events and to estimate the most precise slopes, and thus fluxes, from the data generated. These procedures allowed us to produce and document methods to achieve accurate, precise, and reproducible high-frequency CO2, CH4, and N2O flux data from our study and will enable reliable long-term deployments in tidal wetlands.
KEYWORDS: sea-level rise, greenhouse gases, wetland soils

DISSOLVED OXYGEN VARIABILITY ON THE NORTH-CENTRAL CALIFORNIA SHELF

Kate Hewett, UC Davis, Bodega Marine Lab

The five West Coast National Marine Sanctuaries are linked by the California Current System (CCS). Wind-driven coastal upwelling plays an important role for marine resources in each sanctuary, although the effects in vary across sites. Deep waters upwelled onto the shelf are typically enriched with nutrients that fuel productivity along the CCS, but these waters are also low in dissolved oxygen (DO) concentration and can be more corrosive than surface waters (low pH and saturation state). Yet, little is known about DO variability and its response to mechanisms (e.g., wind driven advection and respiration) over the North-Central California shelf. Here we report continuous bottom measurements of temperature, salinity, and DO collected at sites in the Gulf of the Farallones (30m and 54m) and on Cordell Bank (114m and 84m). We relate T, S and DO variability to forcing mechanisms to identify the importance of physical and biological drivers of DO. This is an important step in understanding past and predicting future low-DO events on our shelf.

IMPROVED MONITORING AND UNDERSTANDING OF BIOTOXINS IN SHELLFISH AND FORAGE FISH

Mathew Hunter*, Western Washingtion University, Alexandria Marquardt

Marine biotoxins, including domoic acid, are typically produced by phytoplankton during Harmful Algal Bloom (HAB) events along the west coast. Domoic acid is a potent neurological toxin that can accumulate in shellfish, forage fish, and marine mammals. This toxin poses a significant risk to human health and fishery closures have economic impacts to coastal communities. Unlike the bordering state, Oregon only has a rudimentary program to monitor biotoxin levels in marine organisms.The overall goal for this project was to examine the scope and extent of historic and recent biotoxin testing in marine organisms along the Oregon coast and identify the need for any additional programatic development. A suite of marine organisms not typically included in standard biotoxin testing programs were collected and analyzed for domoic acid using enzyme linked immunosorbent assays to identify any relationships along trophic pathways.

INUNDATION AND SALINITY EFFECTS ON PLANT PRODUCTIVITY IN WEST COAST TIDAL MARSHES

Christopher Janousek, Oregon State University, Kevin Buffington, Karen Thorne, Bruce Dugger, Glenn Guntenspergen, John Takekawa*

Estuarine sea-level rise and salinization are two climate change impacts that may affect tidal wetlands. We conducted several field experiments to evaluate species-level differences in growth response to variable inundation, and to test how inundation combined with higher salinity might impact plant growth. We grew plant cuttings of five species in three Pacific coast marshes (Petaluma River, CA; Suisun Bay, CA; Siletz Bay, OR) across a range of flooding conditions over a single growing season to assess biomass and vegetative growth responses. Species varied in the shape of their functional response to inundation, with Juncus balticus at Suisun Bay and Salicornia pacifica showing monotonic non-linear declines in productivity with greater inundation and Carex lyngbyei, Bolboschoenus maritimus, J. balticus at Siletz Bay, and Spartina foliosa having uni-modal responses. When grown in more saline sediments, J. balticus at Suisun Bay shifted its peak production to greater inundation. Our results suggest that common Pacific coast tidal marsh species have varied sensitivity to increasing inundation, and that understanding these differences is critical for projecting potential future changes in marsh composition and wetland productivity with sea-level rise. Changing estuarine salinity may act as a second stressor on plant growth that modifies the effects of sea-level rise.

PRIORITIZING MANAGEMENT ACTIONS WHEN DATA IS SCARCE AND SYSTEMS ARE COMPLEX

Laura Kehoe, University of Victoria,BC, Julia Baum, Tara Martin*

Conservation research has predominantly focused on identifying where and why species or habitats are under threat. While this is a crucial first step, it does not tell us how to optimize the allocation of resources in order to conserve threatened biodiversity. The time is ripe to focus on identifying the key management actions needed to respond to multiple threats and emerging risks. Using state-of-the-art techniques in conservation decision science, priority threat management assessment, and expert elicitation, we seek to identify the most ecologically effective and at the same time, least costly management actions needed to ensure the long-term persistence of at risk biodiversity of the Fraser River Estuary. This estuary is the mouth of the largest salmon bearing river in the world and a stopover point for more than one million migratory birds. Many species on the estuary are at risk due to water pollution and loss of habitat resulting from industrial and urban development, exploitation of fish stocks, and climate change. This study region serves as a prime example of a complex system under siege from multiple threats but with limited scientific data. We show that such systems can be analyzed to generate management actions ranked according to estimated cost, ecological benefits, the probability of success. Importantly, this analysis can clarify what can and cannot be achieved for different levels of conservation investment, and can be used to leverage increased investment in conservation management.

TIDAL WETLAND RESTORATION AND SEA-LEVEL RISE: NATIVE AND NON-NATIVE PLANT COMMUNITY SEED BANK RESPONSE TO CHANGES IN TIDAL FLOODING AND SALINITY

Sarah Kidd,Portland State University, John Yeakley*

In the Pacific Northwest, non-native plant invasions have been found to impede recovery of wetland plant communities in the high marsh (>2.5 m, NAVD 88) of tidally reconnected oligohaline wetlands. The aim of this study was to evaluate the possible mechanisms driving these high marsh non-native plant invasions. To do this seed bank samples were collected from the dominant native, Carex lyngbyei and Schoenoplectus lacustris, and non-native, Phalaris arundinacea and Juncus effusus subsp. effusus, plant communities within two restoration sites. These seed bank samples were evaluated for composition through direct seed counts and for viability under simulated tidal flooding and salinity conditions in the greenhouse. Non-native species were the most abundant seeds identified across all plant communities. In the greenhouse, these non-native species were found to germinate at significantly greater densities under high marsh flooding and freshwater treatments as compared to mid-low marsh flooding oligohaline and all brackish treatments, mirroring their observed in-situ abundances. Dominant native species were found to germinate at similar densities across all flooding/salinity treatments. These results indicate that newly created/restored wetland salinity and flooding gradients act to suppress these non-native species' germination in the low-mid marsh but not in the high marsh, where they are likely able to outcompete with the native species in-part due to their overwhelming dominance in the seed bank. These results further indicate that sea-level rise increases in flooding and salinity may reduce the abundance of these non-native species, however, this may come at the cost of existing high marsh habitat.

TIDAL INFLUENCE ON THE COASTAL ALONGSHORE TRANSPORT OF BUOYANT RIVER PLUMES

Emily Lemagie,Oregon State University, Jim Lerczak*

What happens to the freshwater that enters the ocean from a tidal estuary such as those along the Oregon coast? Under light or downwelling-favorable winds, an alongshore current transports estuarine discharge long distances before the buoyant plume is dissipated via mixing with ambient waters. This buoyant coastal current may also transport suspended nutrients and larvae between estuarine systems. We developed an idealized three-dimensional numerical model to study the role of tides in the transport and mixing of a buoyant river plume. The total exchange flow method is applied to examine alongshore freshwater transport within different salinity classes. Although larger tides increase mixing in the estuary causing a smaller density anomaly at the mouth, larger tides lead to a greater coastal freshwater transport and at lower salinity classes in the buoyant plume away from the river. Understanding the impact of tides will improve our fundamental understanding of coastal buoyant plume transport.

SPATIAL AND VERTICAL DISTRIBUTION OF THE INVASIVE EUROPEAN GREEN CRAB IN A TEMPERATE ESTUARINE SYSTEM

Christopher Lundeberg, Oregon State University, Taylor Weldon*

The European green crab, Carcinus maenas, is a generalist predator that has established invasive populations throughout the world, including the west coast of North America. In Oregon, strong cohorts of green crabs recruit only during major El Niño events. The goals of this study are to: 1) compare the abundance and growth of the recent 2014-2015 El Niño cohort to that of the strong 1997-1998 El Niño one in Yaquina Bay, Oregon, and 2) explore the spatial and vertical distribution of C. maenas and how it relates to the that of the native red rock crab, Cancer productus. An abundance and size distribution similar to the 1997-98 cohort was observed, indicating favorable current patterns and growing conditions brought on by the strong El Niño. We did not find a correlation between the spatial distribution of C. productus and C. maenas, however there is possibility of the distribution being related to the dynamics of the bay or microhabitat preference. Our data suggests a negative correlation in the vertical tidal distribution of the two species,supporting the hypothesis that C. productus sets the vertical lower limit of C. maenas. Observations of the interactions of the two species in the same trap support this hypothesis. Future studies should follow the 2015 year class and its effects on the local ecosystems. These data could prove a valuable tool in making predictions on the indirect effects of El Niño or the establishment of a sustainable C. maenas population in Yaquina Bay.

BLUE CARBON IN CENTRAL SALISH SEA EELGRASS MEADOWS

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Seagrass meadows provide more than habitat, biodiversity support, storm surge and wave abatement, and water quality improvement; they help mitigate climate change by taking up and storing (sequestering) carbon (C), reportedly at rates only surpassed worldwide by salt marsh and mangrove ecosystems. Global average sediment C stock and sequestration rate values are currently being used in allotting carbon finance funding to restoration projects. However, little data exists for eelgrass meadows in the Pacific Northwest. The intent of our study is to quantify carbon stocks and sequestration rates over three bays in the central Salish Sea. Preliminary results from our study show lower estimated Corg concentration (mean=0.42%, range=0.098%-5.28%), Corg stock (mean=24.69 Mg ha-1, range=13.80-56.70), and C sequestration rates (means=82.17, 26.42, and 22.00 g m-2 yr-1 in Samish, Padilla, and Skagit Bays, respectively, based on preliminary analysis of 210Pb activity levels) than those reported in published studies from most other locations. KEYWORDS: Eelgrass, blue carbon, C-sequestration

EFFECTIVELY COMMUNICATING SCIENTIFIC FINDINGS TO LAY AUDIENCES

Scott Martindale, Southern California Coastal Water Research Project*

U.S. scientists overwhelmingly agree that part of their job is to lend their expertise to public policy debates surrounding science and technology. But only half of scientists report that they ever engage with the media on their research findings, and only one in four ever blog about their work. Part of the reason for the disconnect is that scientists don't know how to communicate effectively with non-scientist audiences. Unlike communicating with scientific peers, communicating with a lay audience involves transmitting very simple, straightforward messages that focus on findings and implications, not on details, caveats and methods. If you cannot fit the entirety of your message onto a Post-it note, it's probably too complicated for your audience to grasp. Effective science communication also focuses on placing findings into a broader context, enabling non-experts to appreciate how relatively narrow, incremental findings in science help to advance the field as a whole. Finally, effective science communication is synonymous with effective storytelling: Tell compelling stories, use an active voice, pose intriguing questions and then answer them, and infuse your story with examples, analogies and imagery.

JUVENILE STEELHEAD FORAGING BEHAVIOR AND PREY ASSEMBLAGE IN AN INTERMITTENTLY CLOSED ESTUARY

William Matsubu, University of Washington Wetland Ecosystem Team, Charles Simenstad*

Benefits of estuaries are only available to organisms that can tolerate the broad range of conditions. Human activities impact many estuarine processes, including those affecting the physical connection of the estuary to the ocean. Many coastal estuaries in Mediterranean and drier climates are susceptible to mouth closures due to barrier beach formations. These estuaries are subjectable to severe and often unpredictable environmental transformations. Management practices affecting the connectivity are used to achieve conditions that balance sociopolitical goals and the needs of threatened or endangered species. While closed estuaries can lead to stressful conditions, they can enhance the survival of juvenile steelhead. Although foraging opportunities are coveted as one of the main benefits of intermittently closed estuaries for juvenile steelhead, there is considerable uncertainty about the impacts of ocean connectivity on their main prey taxa. 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. Similar to other estuaries, the macroinvertebrate community varied over time and space and with the ocean connection. For example, a rapid redistribution of prey species into habitats only accessible during closed conditions. This study highlights the foraging tradeoffs for juvenile steelhead rearing in the Russian River estuary.

DEVELOPMENT OF THRESHOLD VALUES FOR A SEAGRASS EPIPHYTE INDICATOR OF NUTRIENT ENRICHMENT IN COASTAL SYSTEMS

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Epiphytes have been correlated with seagrass declines, causally related to nutrient additions in both field and mesocosm experiments, and have quantifiable impacts on light available to host plants. An extensive review of seagrass epiphyte literature was conducted to determine whether seagrass epiphyte metrics can be used as a biological indicator for nutrient impacts. Median epiphyte loads associated with 25 and 50% reduction in seagrass biomass, density and productivity are proposed as potential thresholds.

MAD FISH: FISH AND INVERTEBRATE COMMUNITIES IN THE MAD RIVER ESTUARY

Katherine Osborn, Humboldt State University, Eric LeBlanc, Tim Mulligan, Frank Shaughnessy*

The riverine estuaries of Northern California are largely unstudied, due to their small sizes and remote locations. These estuaries are highly productive ecosystems that provide habitat necessary to life-cycle completion for many fishes. The Mad River Estuary in Humboldt County serves as a migration pathway for Chinook Salmon (Oncorhynchus tshawytscha) and other salmonids, a nursery for juvenile rockfish and flounder, and a seasonal feeding ground for a diversity of marine fishes. Despite its proximity to Humboldt State University, the estuary has received relatively little attention. We established the first baseline of fish abundance, fish diversity, and prey availability in the Mad River Estuary. For the first year of the study, June 2014 - June 2015, we sampled seasonally. We increased to monthly sampling for the second year of the study, June 2015 - June 2016. Fish were sampled via beach seine and invertebrates via benthic cores. Benthic prey were also examined through the diet of two benthic fishes in the estuary: Pacific Staghorn Sculpin (Leptocottus armatus) and English Sole (Parophrys vetulus). This study investigates the seasonal dynamics of the fish and benthic invertebrate communities in the Mad River Estuary, and explores linkages between fish and their benthic prey through the diet of two focal species. Keywords: baseline assessment, fisheries,

ABOVE THE MUD: VISUALIZING SMALL FEATURES IN OREGON ESTUARIES WITH UNMANNED AIRCRAFT SYSTEMS

Elizabeth Perotti, Oregon Dept of Fish and Wildlife, Anthony D'Andrea, Skyler Elmstrom*

Unmanned Aircraft Systems (UAS) can complement scientific field research and natural resource monitoring by enabling more frequent sampling and greater aerial coverage. The Oregon Department of Fish & Wildlife's Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR) Project is tasked with assessing shellfish populations and their habitats in Oregon's estuaries. Typically, an estuary survey takes more than one year to complete on foot, includes areas that are inaccessible or unsafe, and is revisited on a decadal scale. SEACOR launched a pilot study evaluating the potential of UAS for visualizing small features requiring sub-centimeter resolution and mapping intertidal mudflats over large areas. Initial efforts produced georeferenced orthomosiacs with resolution enabling identification and quantification of bay clam and shrimp burrow holes. The boundaries of eelgrass and other vegetation can also be estimated from the imagery. We present lessons learned from these efforts and provide recommendations and common pitfalls with developing a UAS program.KEYWORDS: technology, shellfish, community

REVEALING THE SEDIMENT AND BLUE CARBON DYNAMICS OF BOTH NATURAL AND RECENTLY RESTORED TIDAL MARSHES IN THE STILLAGUAMISH RIVER ESTUARY

Katrina Poppe, Western Washington University, John Rybczyk, Logan Parr, Analissa Merrill*

Tidal marshes are typically productive and depositional environments conducive to high rates of carbon sequestration. Though they have been recognized globally for their ability to store €œblue carbon €there is still a paucity of comprehensive site-scale data from the Pacific Northwest. This study fills that gap by providing carbon stocks and sequestration rates for existing and recently restored brackish marshes in the Pacific Northwest, using the Stillaguamish River estuary in Puget Sound as the study system. We collected sediment cores from 13 sites across the estuary to measure bulk density, organic and carbon content, as well as above- and belowground plant biomass samples to determine annual productivity and biomass. Carbon stocks were partitioned into three components as recommended by the IPCC: aboveground biomass, belowground biomass, and sediment carbon. We have also been monitoring elevation change with surface elevation tables (SETs) at the coring sites since 2012. Here we present a comparison of the biomass and sediment carbon stocks from across the estuary, both within and outside the 150-acre restoration site, and relate them to environmental variables such as elevation and salinity. Sediment carbon stocks within the restoration site were similar to those in natural marshes, with an average of 6.60 versus 6.09 kgC/m2 in the upper 30 cm, respectively. We also report SET elevation change rates ranging from -0.32 to 4.73 cm/yr, and preliminary carbon accumulation rates ranging from -51 to 1080 gC/m2/yr. These results offer some insight into the marsh restoration trajectory with regard to sediment and carbon dynamics.

WHAT FACTORS DRIVE VARIATION IN TEMPERATE SEAGRASS 'BLUE CARBON' STOCKS?

Carolyn Prentice, Simon Fraser University Hakai Institute, Margot Hessing-Lewis, Rhea Smith, Anne Salomon*

Sedimentary carbon storage in marine vegetated ecosystems (blue carbon) is increasingly being considered in climate change policies and coastal ecosystem management. Seagrass meadows have been highlighted as having significantly higher carbon accumulation rates than terrestrial ecosystems, and the ability to store carbon for centuries if left undisturbed. However, current seagrass blue carbon data are sparse and regionally biased. In the Pacific Northwest, we lack information on the magnitude and variability of carbon storage, as well as drivers of variability. To help fill this data gap, I quantified sedimentary carbon stocks in Zostera marina meadows on the central coast of British Columbia, as well as potential factors influencing these carbon stocks. I collected sixty sediment cores from six seagrass meadows and analyzed organic and inorganic stocks in the top 30-80cm of sediment. Sedimentary carbon stocks appear highly variable both within and among meadows, with organic stocks in the top 20cm ranging from 315-2232 g C/m2. These values fall within the range of carbon stocks reported from other regions. Carbon stocks were generally highest in the meadow interior, and relatively lower along the meadow edge and in adjacent bare sediments. Study meadows varied in canopy height, shoot density, grain size, current speed, and depth; these parameters will be evaluated as potential drivers influencing the variation in carbon storage using generalized linear models and model selection. This research highlights the spatial variability in carbon storage capacity of Z. marina and will provide insight into factors influencing sedimentary carbon stocks in temperate seagrass

INITIAL STEPS ALONG THE PATHWAY TOWARD AN OREGON SHELLFISH INITIATIVE: RECOMMENDATIONS FROM THE OREGON SHELLFISH TASK FORCE

Steve Rumrill, Oregon Dept. of Fish and Wildlife*

In 2015, the Oregon Legislature passed HB2209 which articulated the State of Oregon policy regarding shellfish and established the Joint Interim Task Force on Oregon Shellfish. It is the policy of Oregon to enhance and expand cultivated shellfish production; conserve, protect and restore wild populations of native shellfish; and improve water quality and the health of aquatic and marine habitats. The Oregon Shellfish Task Force (OSTF) was composed of elected officials and representatives from coastal tribes, resource management, seafood safety, shellfish mariculture, commercial and sport harvests, conservation, and public education. The OSTF held seven open meetings from November 2015 through September 2016, and they identified five critical actions that could be addressed during 2017: (1) take executive action or seek legislation to formalize the Oregon Shellfish Initiative (OSI); (2) designate representatives to serve as members of the OSI €“ Oversight Committee; (3) garner support for approximately $2.9 million in additional funds in support of the OSI; (4) convene the OSI €“ Oversight Committee to adopt the priority goals and recommendations offered by the OSTF; and (5) launch the OSI. The Oregon Shellfish Initiative is envisioned as a multi-year, collaborative and cooperative effort that focuses the activities of state and federal agencies, coastal tribes, local governments, private shellfish growers, academia, non-governmental organizations and public stakeholders to achieve mutual benefits with regard to shellfish resources. Progress in Oregon toward development of a state-wide shellfish initiative falls on the shoulders of the National Shellfish Initiative (2011) and recent advancements made by WA and CA. Keywords: Oregon, Shellfish, Initiative

COMPARATIVE STUDY REPLICATING THE METHODS OF A 30-YR FISH ASSEMBLAGE SURVEY IN THE COOS ESTUARY ON A SPATIOTEMPORAL SCALE A

Carlissa Salant, Oregon Institute of Marine Biology*

Estuaries provide important habitat for many fish species and evaluation of past and current estuarine fish assemblage data is critical to understanding changes in habitat use. As part of a larger, multi-year project, we looked at seining data from 2016 for 6 different sites within the South Slough Estuary of Charleston, Oregon. Seine data was gathered monthly using methods closely aligned with historical methods used by Bottom et al. (1988) to make direct comparisons between data sets easier. The previous work analyzed seine data from 4 select months within 1987. Delving further, the current project has been conducting monthly seines since summer of 2015, capturing population patterns the past study may have missed. Here we compared the length frequency data gathered in 2016 to that gathered in 1987 for six regionally important fish species. We also compared species richness and mean densities of fish at the same sites within the slough between the two study years. The length frequency data revealed a consistent pattern of fish populations leaving sampling locations earlier in the year during 2016. Additionally, we see lower species richness and fish density in 2016. In this research, we have started to characterize temporal and spatial patterns in fish assemblages using both past and current datasets, furthering our knowledge of essential fish habitat in the estuary. Future work will include using water quality data from the System Wide Monitoring Program to look for environmental factors which may be modifying fish assemblages within the estuary.

UNDERSTANDING THE FEEDING ECOLOGY OF JUVENILE ROCKFISHES IN OREGON'S ESTUARIES

Brittany Schwartzkopf, Oregon State University, Scott Heppell*

Multiple species of rockfish (Sebastes spp.), which make up important commercial and recreational fisheries, utilize Oregon estuaries during their early life. This utilization gives rise to the hypothesis that these estuaries function as nursery habitat for rockfishes, playing a significant role in rockfish settlement and recruitment and are therefore important for population productivity. Although juvenile rockfish abundances have been found to differ between Oregon estuaries, other life history traits such as age, growth, settlement date, and feeding ecology have not been fully evaluated. With large dietary variations found for juvenile rockfishes in nearshore and offshore environments, further investigation into feeding ecology in Oregon estuaries is necessary to evaluate habitat quality of these potential nursery areas. Feeding ecology was assessed in this study using stomach content analysis and analyzed with non-metric multidimensional scaling and permutational analysis of variance. Benthic associated prey species dominated the diet, although pelagic associated prey also frequently occurred. Important prey items in all three estuaries include amphipods (specifically Americorophium sp.), copepods (specifically harpacticoids), and barnacle cyprids. Prey species presence/absence did not differ between juvenile rockfishes from eelgrass and dock habitats in Yaquina, but did vary between estuaries, with Yaquina differing from Nehalem and Alsea. This work will create baseline data on juvenile rockfish feeding ecology in different estuaries, and may help elucidate if favorable feeding conditions are present in certain estuaries, such as increased prey abundances or higher quality habitats.

Keywords: Feeding ecology, habitat quality, Sebastes

IMPACTS OF INTERTIDAL CULVERTS, BRIDGES AND TIDEGATES ON FISH ACCESS AND HABITAT CONNECTIVITY

Doris Small, Washington Dept of Fish and Wildlife, Correigh Greene, Jason Hall*

Improvement of fish passage to riverine and estuarine habitat has consistently been identified as one of the most effective investments for protection and recovery of Pacific salmon species. Several species of salmon are dependent on estuaries and marine nearshore habitats during early life history, including federally listed Chinook and chum salmon. Tidal action creates bidirectional impacts that complicate the practical application of existing protocols for fish passage assessment and current fish passage design criteria. The consequences of delaying or reducing access to estuarine habitat during portions of the tidal cycle due to man-made structures are poorly understood.Knowledge of fish movement relative to the tidal cycle and the impacts of tidal restrictions on habitat quantity and quality represent major knowledge gaps limiting the development of technical guidance for intertidal water crossing structures. Washington Department of Fish and Wildlife partnered with the NOAA Fisheries Northwest Fisheries Science Center to develop a comprehensive literature review and data gap analysis to support development of barrier assessment protocols, prioritization of removal/replacement and technical design guidelines. This presentation will summarize the findings of the literature review and identify data gaps with opportunities for collaboration with other researchers to advance this knowledge.

WETLAND RESTORATION OR MANAGEMENT? CONSERVING THE ESTUARINE ENDEMIC SALT MARSH HARVEST MOUSE

Katherine Smith, UC Davis, California Department of Fish and Wildlife*

The conservation of terrestrial mammals that inhabit coastal wetlands is often largely disregarded. This is true in the San Francisco Bay Estuary with the exception of one species, the salt marsh harvest mouse (SMHM, Reithrodontomys raviventris). Globally, only 5 species of vertebrates are entirely restricted to coastal marshes, and of those, the SMHM is the only mammal. Historically occurring in the tidal marshes of the San Francisco Bay Estuary, this species is now critically endangered due to the loss of >90% of its habitat. Some habitat that was not lost to development now exists as diked wetlands, a habitat type once considered detrimental for the SMHM. However, managers now understand that SMHM are found commonly in diked wetlands. This calls into question the value of the dominant conservation measure for this species: tidal restoration. Where wetlands are highly degraded and have little habitat value, tidal restoration is a valuable conservation measure. But when diked wetlands already have high habitat value, is tidal restoration beneficial for SMHM? I performed a three year study of populations, demographics, habitat use, and diet of this species to investigate the relative value of tidal and diked wetlands. I found that diked wetlands support similar populations of SMHM as tidal wetlands, support higher densities of reproductive females and juveniles, and provide abundant food and nesting habitat. Since tidal restoration often causes loss of terrestrial habitat, this study provides evidence that, in some areas, management of existing diked habitat may be a more efficient conservation measure for SMHM. KEYWORDS: salt marsh harvest mouse, wetland management and restoration, wildlife conservation

OCEAN ACIDIFICATION AND HYPOXIA (OAH) MONITORING AND WORKING TOWARDS AN OREGON MONITORING NETWORK

Daniel Sund, Oregon Department of Fish and Wildlife, Catherine Dayger, Caren Braby*

Ocean Acidification and Hypoxia (OAH) are environmental phenomena driving wide ranging changes in the marine environment. These changes in the marine environment are impacting natural resources and the coastal communities that rely upon them around the world. Oregon, and the West Coast, is particularly susceptible to impacts from OAH due to oceanographic processes, including basin-wide ocean currents and strong seasonal upwelling events that bring deep, acidified waters to our coast. However, the capacity to monitor OAH in the region is unknown and knowledge of the impacts of OAH in a way that is responsive to the needs of resource managers is highly variable. A regional collaboration among states and federal agencies has led to an inventory of existing monitoring assets and programs that are currently quantifying OAH and related biological-response metrics. This talk will highlight Oregon's participation in this regional effort to and organization of a community of OAH monitoring professionals to sustain future coordination and collaboration of OAH-related monitoring within Oregon and across the West Coast.

INTEGRATED MODEL OF OCEAN ACIDIFICATION AND HYPOXIA TO SUPPORT ECOSYSTEM PREDICTION AND ENVIRONMENTAL MANAGEMENT IN THE CALIFORNIA CURRENT ECOSYSTEM

Martha Sutula, Southern California Coastal Water Research Project, Simon Alin, Richard Ambrose, Nina Bednarsek, Curtis Deustch, Daniele Bianchi, Richard Feely, Faycal Kessouri, James McWilliams, Karen McLaughlin, Stephen Weisberg*

The California Current System (CCS) is among the most biologically productive regions of the world ocean, but upwelling makes it vulnerable to ocean acidification and hypoxia (OAH), which have been observed in recent decades. Three phenomena have been implicated: 1) large scale changes associated with climate warming, 2) natural variability, and 3) anthropogenic nutrient and carbon inputs. The relative importance of these drivers has not been systematically evaluated, but needed to manage coastal resources at local scales. Disentangling these stresses on OAH requires an integrated systems modeling approach. This project, in its early stages, will investigate the following questions: (1) How do the cycles of carbon, oxygen and nutrient function in the CCS in the presence of large-scale anthropogenic CO2 inputs and climate changes? (2) How much do local inputs of nutrients and CO2 contribute to altered productivity and OAH? (3) How do rates of OAH from local inputs compare to those originating from basin-scale climate change and remote transport of anthropogenic CO2? (4) What are the physiological impacts of OAH on ecologically-important pteropods, and what are valid empirical and modeled-expressed relationships between pteropod responses and OAH state variables? (5) Which areas are susceptible to OAH and how will susceptibility change between now and 2060? To address these questions, an OAH model is under development, based on the Regional Oceanic Modeling System (ROMS), comprising circulation, biogeochemical cycles, and lower-trophic ecosystem of the CCS. Sensitivities of pteropods to OAH and temperature will be measured to incorporate into the model as new ecosystem parameters. Model simulations will be validated against observational data. The model will be used to understand the relative contributions of natural climate variability, anthropogenically-induced climate change, and anthropogenic nutrient and carbon inputs on the trends of OAH in the CCS.

EVALUATION OF BATHYMETRY METHODS FOR MAPPING ELEVATION IN ESTUARIES

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Tide flat elevation within estuaries is important for structuring the spatial distribution of many intertidal organisms. Correct assessment of habitat classification and tide flat elevation relies on precise and accurate positional data, especially at small spatial scales. New advancements in Global Positioning System (GPS) improve location precision and accuracy, but it is uncertain how bathymetric data collected using different GPS systems varies. In Netarts Bay, Oregon, we compared two GPS systems with a Biosonics MX echosounder to survey bathymetry: 1) Differential GPS (DPGS); and 2) Real Time Kinematics GPS (RTK). While DGPS uses satellites to receive correct coordinates from base stations, RTK obtains more precise and accurate positioning by using satellites and a nearby base station to provide real time correction to coordinates. Bathymetry data were interpolated using inverse distance weighting with the ArcGIS 10.3 Geostatistical Analyst toolbox to determine the difference between the two methods. We found that 80% of the area surveyed differed by 30 cm or less when comparing rasters of the two methods, and a mean difference of 21.08 +/- 0.07 cm (mean +/- standard error). Thus, the choice to invest in RTK GPS or DGPS depends on the order of magnitude of acceptable error for the desired application. Keywords: Technology, Bathymetry, mudflat

FATE OF PLASTICS IN WETLAND FISH AND SEDIMENTS AT THE MOUTH OF AN URBAN COASTAL WATERSHED

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The extent to which microplastics and constituent compounds are entering coastal foodwebs is only beginning to be realized. Using wetland fish and sediment collected during June 2015 from urbanized Chollas Creek, San Diego, California, we tested the hypotheses that microplastic composition in sediments would be reflected in fish guts (non-selective consumption), and that semi-volatile organic compounds (SVOCs) would be present in all fish. Sediments contained about 10,000 microplastic pieces per m2, consisting mostly (90%) of fibers, and hard and soft pieces. Nearly 25% of fish contained microplastics, but prevalence varied with size, sex and between species. Of the 39 types of sediment microplastics, fish preferred 10 types that often resembled prey items, including filamentous algae, nematodes and fish eggs. Several phthalates were found in fish, with highest concentrations of sediment-associated compounds. We found that a species' natural history may influence contamination levels with consequences, and lessons, for all consumers.

EFFECTS OF INVERTEBRATE MESOGRAZERS AND HYDROPONIC CULTURE ON EELGRASS (ZOSTERA MARINA) FROM 4 SITES ON THE SALISH SEA

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In this study, we sought to understand factors leading to successful tank cultivation of eelgrass (Zostera marina) to be used for restoration. In the Salish Sea, eelgrass varies in morphology, and site-specific differences may dictate what cultivation conditions are best suited for individual populations. We examined how invertebrate mesograzers and hydroponic cultivation influenced both eelgrass performance and epiphytic algal biomass in a nine-week mesocosm study using 4 eelgrass populations in the southern Salish Sea. The presence of mesograzers decreased epiphytic algal biomass on eelgrass shoots and increased new aboveground eelgrass biomass. Additionally, the presence of mesograzers led to a shift in eelgrass morphology, decreasing mean sheath length and increasing the number of leaves, while total shoot length did not change. Eelgrass collected from sites where the eelgrass had previously been rooted in sediment exhibited longer shoot and sheath lengths when cultivated in sediment conditions. Eelgrass collected from the wrack (naturally uprooted and washed ashore) exhibited longer shoot and sheath lengths when grown hydroponically. Together, these results imply the importance of adding grazers and matching cultivation medium to that of source population (drifting in wrack versus rooted) for tank cultivation practices in the Salish Sea.

FROM BC TO BAJA: A MACROECOLOGICAL STUDY EXAMINING STRATEGIES AGAINST HERBIVORY IN THE SEAGRASS ZOSTERA MARINA

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Herbivory strongly influences the structure and composition of plant communities with important consequences for ecosystem functioning when consumption is upon habitat-forming species such as seagrasses. Plants are able to resist and tolerate herbivory through diverse strategies, but these capacities may change under different environmental conditions or herbivory regimes. There is increasing recognition that herbivory pressure exerted on temperate seagrasses can be strong, and it will become even more significant with the expansion of tropical herbivores into temperate regions. Through a comparative experimental approach, we examined the effects of different levels of simulated herbivory on plant vitality and defense strategies of Zostera marina across 10 sites spanning most of its distribution range (31 º to 51 ºN). Overall, eelgrass was negatively impacted by high levels of herbivory, suffering a decrease in size, abundance and growth rate, while moderate levels of herbivory did not cause obvious effects on plant vitality. In addition, high herbivory translated into higher leaf nitrogen content and higher specific leaf area, which could make plants more palatable to consumers, yet herbivores did not prefer these high-herbivory plants, suggesting a potential induction of chemical deterrents in response to high herbivory. In all, our results suggest that Z. marina is able to tolerate moderate levels of herbivory but can be severely impacted when herbivory is high, when it appears to shift towards a strategy of increasing defenses in order to reduce further grazing pressure.

MITIGATING OCEAN ACIDIFICATION: TOWARDS A MODEL RELATING PCO2, IRRADIANCE, AND DENSITY OF ZOSTERA MARINA L. (EELGRASS) FROM PADILLA BAY

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In the Salish Sea, the magnitude of ocean acidification varies greatly due to CO2 enrichment from upwelling and CO2 uptake by primary producers. Eelgrass meadows have been identified as potential mitigators of ocean acidification because eelgrass takes up dissolved CO2 and bicarbonate through photosynthesis, is carbon limited, and can increase its photosynthetic rate under elevated pCO2 conditions. However, eelgrass morphology and density varies from site to site in the Salish Sea, and photosynthesis varies diurnally. In this study, we experimentally investigated the effect of eelgrass shoot density and irradiance on eelgrass' ability to alter carbonate chemistry under conditions of moderate and high pCO2. We found no difference in carbon drawdown rate between pCO2 treatments. However, increasing shoot density led to greater increases in pH, but only up to a point. Above a threshold shoot density, the increase in pH was not as high, possibly due to self-shading. In the absence of light, eelgrass density decreased pH, most likely due to cellular respiration. These results imply that eelgrass may exacerbate ocean acidification if light is limiting. We propose further study of eelgrass density under a gradation of irradiance levels. By quantifying the changes in carbonate chemistry due to varying eelgrass densities and varying irradiances, our research will help identify characteristics of eelgrass habitats that could provide refugia for marine organisms from ocean acidification.

SHIPWORMS: CRYPTIC ECOLOGICAL ENGINEERS OF THE SEA

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Shipworms (Teredinidae) are marine borers that utilize wood for both housing and food, and are present in coastal, shelf, and pelagic habitats. Our current research includes distribution, dispersal, ocean circulation, wood degradation, phylogeny, ecology, reproductive biology, and other aspects of this bivalve group. These ˜termites of the sea' are known for their historical destruction of wooden ships and their modern destruction of piers, with significant economic costs. These costs overshadow the important ecological role shipworms play in marine ecosystems. Shipworms convert wood into molluscan biomass, larvae, and feces, all of which are a nutritional resource for other organisms. Shipworms are accompanied by a variety of specialized symbionts and commensals whose roles are largely unknown. Abandoned shipworm tunnels provide space for crevicolous fish and invertebrates. The significant shipworm biomass hidden inside woody debris often goes unnoticed, resulting in underestimates of both productivity and biodiversity. Human activities have reduced the amount of wood reaching the ocean, with unknown effects on teredinid abundance and diversity. Shipworm species found in driftwood help identify the wood's geographic origin and the role of ocean circulation in species transport and dispersal. Current project locations include the estuaries and coastlines of the Pacific coast of North America, Japan, and the Hawaiian Islands. Avenues of Teredinidae research requiring further investigation include physiology, biochemistry, reproduction, the effect of ocean acidification on burrow construction, and the contribution of shipworms to water filtration in estuaries.

THE REVENGE OF A PACIFIC NORTHWEST CLAMTASTROPHE: EXAMINING INDUCIBLE DEFENSES TO NOVEL PREDATORS

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An invading species should be more likely to establish if it can successfully identify and defend against predators in the recipient range, such as through the expression of inducible defenses. Inducible defenses are behavioral or physiological changes that reduce an organism's susceptibility to predation. Previous studies examining inducible defenses and biological invasions used introduced species that invaded years or decades before rather than newly introduced prey naive to predator cues. Therefore, we set out to examine if inducible defenses may have benefited the early stage of invasion of the purple varnish clam (Nuttallia obscurata), a species native to Asia and introduced to the Northeast Pacific. At a previous PERS meeting, we presented work showing that non-native N. obscurata increased their burrowing depth in the presence of their invaded-range predators; in particular Dungeness crabs (Metacarcinus magister). We have since compared burrowing depth in aquaria of tethered N. obscurata collected from two introduced populations, Oregon, USA and British Columbia, Canada, versus a native population in Miyagi Prefecture, Japan. Specimens of N. obscurata from the USA and Canada responded similarly to M. magister cues, while specimens from Japan did not increase their burrowing depth. This suggests that while inducible defenses may contribute to the continued success of N. obscurata in the Northeast Pacific, it is unlikely they influenced the initial survival of newly arrived N. obscurata. Nonetheless, this mechanism may influence the initial establishment of some species and population growth and expansion for other species once they learn the

COMMERCIAL CLAMMING IN OREGON'S ESTUARIES: TRENDS AND CURRENT STATUS

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Oregon's estuaries support diverse and productive communities of clams and other shellfish. Several species of clams have been harvested commercially from the intertidal and subtidal zones of estuaries along the Oregon coast for over 100 years. The Oregon Department of Fish and Wildlife (ODFW) Shellfish Program routinely monitors and manages the activity of the commercial clam fishery through issuance of harvest permits, maintenance of logbooks, review of sales records (fish tickets), and by periodic establishment and revision of harvest quotas and special harvest areas. Analysis of commercial harvest records shows that effort and harvest levels can vary dramatically through time. The variability in commercial harvest activities is dependent upon many different market factors. While cockles (*Clinocardium nuttallii*) make up the bulk of harvest, gaper clams (*Tresus capax*) and butter clams (*Saxidomus gigantea*) are also targeted. Periodic shifts in the demand for specific products, 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 clams, and their annual landings. I will present an historical overview of the commercial bay clam fishery in Oregon and describe recent trends in harvest activities and new management actions taken to ensure the sustainability of this natural resource. Commercial harvest of bay clams will be compared and contrasted with recreational harvest, and the social perceptions and political pressures associated with the different fisheries will be discussed.

TEMPORAL VARIATION IN MECHANISMS DRIVING BIODIVERSITY-PRODUCTIVITY RELATIONSHIP IN A RESTORED COASTAL WETLAND

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The loss of 90% of coastal wetlands in California over the past century has motivated questions about the effects of habitat decline on key ecosystem functions and processes, especially those linked to local species diversity. To address this, we manipulated salt marsh plant diversity in a large-scale field experiment as part of a restoration project in a southern California coastal salt marsh and lagoon. We quantified species-specific changes in plant cover one and three years post-restoration and evaluated the relative contribution of selection versus complementarity to overall diversity effects. Selection effects occur when species that perform best in monocultures also do best in mixtures, whereas complementarity effects occur when multiple species exhibit higher performance in mixtures, presumably due to resource partitioning or positive interactions between species. As expected, biodiversity enhanced primary productivity, with the magnitude of the effect increasing from the one to the three year time point. Diversity effects were initially a function of selection, with the identity of the highest performing species varying with tidal elevation. By the third year post-restoration, selection effects decreased and complementarity effects increased such that complementarity contributed most. Our results suggest that experiments of shorter duration that do not encompass the full range of environmental variability may both underestimate the strength and misidentify the mechanisms of diversity effects in natural ecosystems. In addition, these results provide information about the success of different plant traits in active planting projects and help support management decisions to restore ecosystem using higher diversity plantings instead of monocultures.

PRE-SPAWN PACIFIC HERRING POPULATION ETIMATES AND DYNAMICS ON THE CENTRAL OREGON COAST

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Pacific herring (Clupea pallasii pallasii) are an integral part of the nearshore ecosystem; however, little is known regarding their spawning population dynamics in Oregon. From 2014 - 2016, the Oregon Department of Fish and Wildlife (ODFW) Marine Resources Program conducted hydroacoustic surveys to estimate pre-spawn population size for Pacific herring in Yaquina Bay on the central Oregon coast. Acoustic surveys were conducted opportunistically from late January through mid-March in each year and a daily population estimate for Yaquina Bay was developed from each survey. Development of the population estimates from acoustic surveys explored methodological biases inherent in the collection of hydroacoustic data. Surveys indicate that herring population levels can fluctuate dramatically throughout the spawning season and among survey years. Preliminary analyses suggest that herring may prefer to stage in the lower estuary, despite spawn events occurring throughout the survey area. Population estimates are compared to those developed from annual spawn deposition surveys conducted concurrently to the acoustic surveys, by the ODFW.

ALIGNING RESTORATION GOALS AND RECOVERY TIMES AFTER INVADER ERADICATION IN CALIFORNIA SALT MARSHES

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Invasive plant ecosystem engineers can dramatically alter habitat for native communities. Following eradication of the engineer, systems may be slow to recover their pre-invasion state. Active replanting of native species can more quickly restore physical habitat for species of management concern, including birds and small mammals, and may incidentally hasten return of other pre-invasion conditions. We explored the effects of eradicating an invasive plant ecosystem engineering and subsequent impacts of active replanting on native plants and benthic invertebrate communities in salt marshes of San Francisco Bay, CA. Much of this area was invaded by non-native hybrid cordgrass (Spartina alterniflora x S. foliosa), and some locations were replanted using native S. foliosa after hybrid eradication. We sampled plants and invertebrates in three site types: 1) eradicated not replanted (eradicated), 2) eradicated with replanting (replanted), and 3) native never invaded (native). After 1.5 years, percent plant cover in eradicated sites was lower than native and replanted sites, which had equivalent plant cover. Conditions at the sediment surface in replanted areas quickly resembled those in native marshes, while eradicated sites remained distinct. Epifaunal invertebrate abundance was similar between eradicated and replanted sites and not comparable to native sites. We conclude revegetation decreases the time necessary to return aboveground habitat to the pre-invasion state. This influences invertebrate communities but with a lag time. These results may help explain why habitat restoration does not always attract target bird and mammal species, since recovery of invertebrate prey may lag behind plant recovery.

EFFECTS OF WOOD WASTE ON MARINE SEDIMENTS AND EELGRASS (ZOSTERA MARINA) IN THE SALISH SEA

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Historically in Washington State, wood waste from timber industry activities has increased porewater hydrogen sulfide (H2S) in marine sediments leaving impacted sites inhabitable, particularly for eelgrass (Zostera marina). In this study, we investigated the performance of different populations of eelgrass grown in marine sediment enriched with H2S, a known phytotoxin. Eelgrass from 8 Salish Sea locations were grown for 6 months in replicated treatments of sediment and sediment plus wood waste to generate the production of H2S. In both control and enriched sediments treatments, we measured sediment H2S concentration and a variety of eelgrass response variables. The sediment with wood waste treatment led to greater porewater H2S, reduced eelgrass shoot density, shorter shoot lengths, and reduced above ground biomass compared to sediment treatment without wood. Source location of eelgrass influenced the effect of wood treatment for shoot length. The H2S enriched sediment treatment did not affect eelgrass photosynthetic efficiency, branching, sheath length, leaf width or elongation rate, which instead depended on which location the plants were collected from. Dumas Bay and Padilla Bay plants had higher branching rates than all other sites. Nisqually Bay and Padilla Bay plants had more leaves than all other sites. Hydrogen sulfide production and eelgrass growth vary seasonally, which is the subject of an on-going study. Populations of eelgrass resilient to the effects of sediments enriched with H2S may be considered valuable donor sites for restoration in activities along historically degraded shorelines.

LIFTING BARRIERS TO RANGE EXPANSION: THE EUROPEAN GREEN CRAB, CARCINUS MAENAS, ENTERS THE SALISH SEA.

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While the European green crab, Carcinus maenas, has persisted in Oregon and Washington coastal estuaries, and thrived in the inlets of the west coast of British Columbia since 1998, populations of this species had not established themselves in the inner Salish Sea, between Southern Vancouver Island, the mainland and Puget Sound. It has been hypothesized that the Strait of Juan de Fuca acts as a semi-permeable barrier preventing C. maenas larvae from entering this inland sea. Most years, the water is too cold (<10o C) for larvae to develop and the predominately estuarine surface outflow would flush larvae out to sea. In late August and September of 2016, a total of five live C. maenas were discovered near Anacortes, Washington, suggesting that this species recently entered the inland sea as larvae. Unusually warm surface water in the northeast Pacific (>2.5o C above average) from the fall of 2013 through 2015 would have allowed larvae to survive alongshore transport off the coasts of Oregon, Washington and southern British Columbia. Reversals of the estuarine current in the Strait of Juan de Fuca forced by strong southerly winds associated with major storms along the outer coast in late October 2014 and 2015 could have transported the warm ocean water and larvae inward through the strait and, with the aid of local winds and tidal currents, into the inner Salish Sea. Preferential inward transport would have been with the Olympic Peninsula Countercurrent that forms along the US side of the channel.

KEY WORDS: invasive species, El Niño; temperature limitation; wind reversed estuarine circulation; Olympic Peninsula Countercurrent