PACIFIC ESTUARINE RESEARCH SOCIETY

38th Annual Meeting
March 19-21, 2015
Talaris Conference Center,
Seattle, Washington

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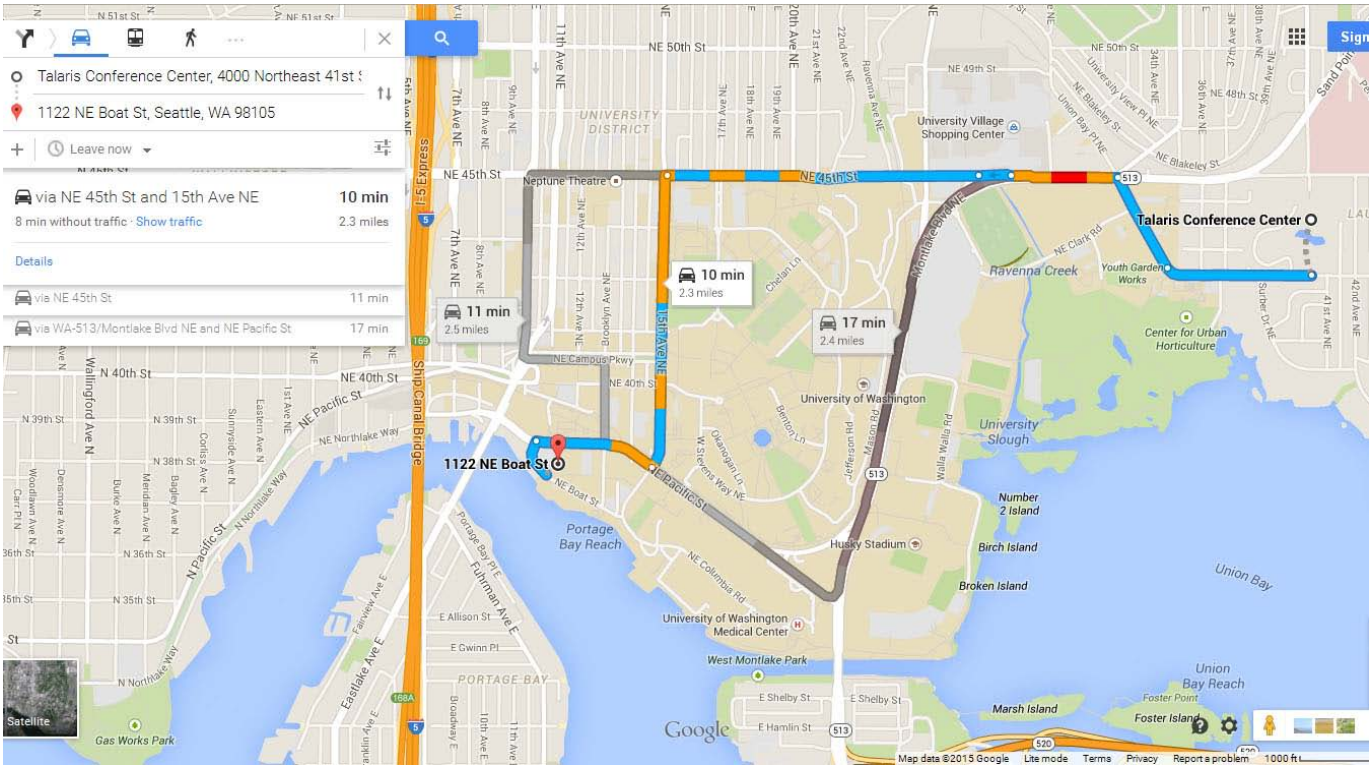
Meeting Notes

Opening mixer:	**For local seafood, libations, and convivial conversation about estuarine science, join the social event on Thursday evening, March 19, starting at 6 pm. The event takes place on the Seattle campus of the University of Washington, inside the Fishery Sciences Building at 1122 NE Boat Street, Seattle, WA 98105. Vans leave Talaris Conference Center (in front of office) for the social at 5, 6, 7, and 8 pm. Vans leave the social (from parking lot on east end of SAFS) for Talaris Conference Center at 5:30, 6:30, 7:30, 8:30, and 9:30pm.**
Meeting site:	**The conference takes place at the Talaris Conference Center, 4000 NE 41st St, Seattle, WA, 98105. Phone 206.268.7000. Come at 7:30 am on Friday and Saturday (March 20 and 21) for continental breakfast, coffee, and tea. The program begins promptly at 8 am both days and concludes with student awards after 2 pm on Saturday.**
Meeting check-in:	**You may check in at the social on Thursday evening. A registration table will also be staffed both Friday and Saturday mornings and after lunch on Friday.**
PERS banquet:	**Meeting registration includes the banquet on Friday evening, which will occur onsite at Talaris with a verdant, aquatic view. No-host bar opens at 6 pm, and buffet opens at 6:30 pm. The no-host bar will be available through dinner and for those who wish to linger until 10 pm.**
Breakfast/ Lunch:	**Meeting registration includes continental breakfast and sit-down lunch on Friday and Saturday.**
Snacks:	**Snacks are refreshed continuously throughout the conference. No official breaks are scheduled in the program, but you may find snacks and drinks at any time as you break into small groups for discussion following fast talks or gravitate to various posters.**
Fast talks:	**A fast talk consists of 10 slides advanced at 30-second intervals. Talks will be loaded from flash drives, so be sure to bring yours to load onto the conference computer at breakfast or lunch. Fast talks have been organized into sets in which each talk covers a topic quite distinct from others. Following the fast talks, at least 30 minutes are available for facilitated discussion in small groups around each presentation. Presenters may field questions, ask for feedback, hand out further data for detailed examination, or divide the group of interested participants into still smaller groups to give more people chances to speak.**
Panels:	**Panels consist of 3-5 speakers on a common theme or topic, self-organized in terms of content, delivery, and discussion.**
Posters:	**Posters should be attached with "blue tape" to walls in the two conference rooms by 8 am each morning. At the beginning of each poster session, presenters each have one minute to introduce their poster. The remainder of the hour allows participants to visit posters for further details and discussion.**

Directions

To reach Talaris from I5, take Exit 169 and go east on NE 45th Street. Just past University Village shopping center, turn right on Mary Gates Memorial Drive NE at a 5-way intersection. This road bends around and becomes NE 41st Street. Look for signs to the Talaris Conference Center on your left. Talaris is on 18 wooded acres, so the entrance drive to parking is long.



To reach the Fishery Sciences Building for the Thursday evening social, you may use the conference vans from Talaris (see Meeting Notes).

If you are driving from I5, take exit 169 and turn east on NE 45th Street. Turn right (south) on 15th Ave NE downhill until you reach a T-intersection. Turn right on Boat Street. The Fishery Sciences Building is at 1122 NE Boat Street, with on-street parking or a parking lot to the west of the building.

Metro bus route 31 runs between Talaris and the western edge of the University of Washington, close to the Fishery Sciences Building. The nearest bus stop to Talaris is at Sand Point Way NE and NE 50th Street. Departures in the evening are at 5:58, 6:14, 6:28, 6:42 etc about every 15 minutes. The closest stop to the Fishery Sciences Building is at 12th Ave NE & NE Campus Parkway. From there, walk south to Boat Street about 5 blocks. The return bus leaves the campus stop at 15 minute intervals between 7:00 and 7:45 and at 30 minute intervals thereafter.

Pacific Estuarine Research Society 2015 Annual Meeting

FRIDAY		Presenters and key words
7:30-8:00	Continental breakfast	
8:00-8:15	Welcome	
8:15-9:15	Plenary	**Dr. Colin Levings** – The Estuary as a Challenge to Salmonid Survival – A Global Overview
9:15-10:15	Posters 1	**Sepúlveda** – bacteria, sediment, eutrophication **Collins** – thermal variability, chemosynthetic communities, Phenacolepadidae **Valentin-Alvarado** – *Emiliania huxleyi*, High light, DMSP, Chemical signals, Chlorophyll, F_v/F_m **Nieto** – ocean acidification, phytoplankton, water chemistry **Ekelem** – sawmills, sulfide, eelgrass **Tomat-Kelly** – eavesdropping, marine, ecology **Lawlor** – ocean acidification, temperature, larvae **Breckenridge** – climate change, copepods, population dynamics **Sutton** – SeagrassNet, eelgrass, monitoring **Rollwagen-Bollens** – harmful cyanobacteria blooms **Szuts** – environmental monitoring, pollution, circulation **Kincaid** – invasive species, fouling community, biotic resistance
10:15-11:15	Panel 1	Puget Sound shoreline armoring: status and trends, alternative techniques, and evaluation of site specific attributes (**Dionne, Carman, Mitchell, Faulkner**)
11:15-12:30	Talks 1	**Hannach** – Puget Sound, phytoplankton, FlowCAM **Lemagie** – Oregon estuaries, river Plumes, transport **Conway-Cranos** – eelgrass, shellfish, aquaculture **Poppe** – carbon sequestration, eelgrass meadow **Selleck** – restoration, forage Fish, habitat
12:30-1:30	Lunch	
1:30-2:30	Talks 2	**Toft** – citizen science, shorelines, intertidal **Graham** – common eelgrass, water quality, restoration **Stutes** – tolerance of eelgrass to burial **Turner** – invasive Species, predator-prey Interactions, behavior
2:30-3:45	Panel 2	Principles of restoration across estuarine ecosystems (**Gaeckle, Hood, Munsch, Paine, Ruesink**)
3:45-5:00	Talks 3	**Lloyd** – salt marsh, ethnobotany, traditional management **Partridge** – benthic invertebrates, long-term, community structure **Yamada** – population, recruitment success, invasive species **Rollwagen-Bollens** – training in landscape ecology **Bos** – Puget Sound**,** monitoring**,** ecosystem**,** climate**,** network
5:00-6:00	Business meeting	
6:00-7:30	No-host bar and dinner – Plenary	**Dr. Kevin Bailey** – Of fish and men: in the wake of the Western Flyer
7:30-10:00	Discussions and no-host bar	

Pacific Estuarine Research Society 2015 Annual Meeting

SATURDAY		Presenters and key words
7:30-8:00	Continental breakfast	
8:00-9:00	Posters 2	**Drescher** – microplastics, marine debris, surface waters **McIntyre** – marine benthic community, urban bay, sediment monitoring **Emm** – regional, eelgrass, monitoring **Rodriguez-Vargas** – feeding behavior, predators, snails **Grason** – invasive species, citizen science, early detection **Sund** – invasive species, intertidal, fish, crab, seagrass **Wear** – Olympia oyster, gene expression, gonad **Hassett** – invasive species, FlowCam, molluscs **Matsubu** – salmonid behavior, halocline, estuary management **Lee** – cyanobacterial blooms, multiple stressors, aquatic invasive species **Rose** - cyanobacteria, phosphorus, trophic-cascade **Christman** – hypoxia, Puget Sound, plankton
9:00-10:00	Panel 3	Navigating ecology, culture, and resilience in the Salish Sea (**Augustine, Hatch, Emm, Hunter, Tadlock**)
10:00-11:00	Talks 4	**Johnson (Rimler)** – bacteria, volunteer, watershed **Eash-Loucks** – outfall, biodiversity, colonization **Yamada** – life history, mark-recapture, recreational fishery **Christiaen** – eelgrass, long-term trend, regional monitoring
11:00-12:00	Talks 5	**Graham** – Pacific sand lance, year class strength, condition factor **Siu** – mitigation, no-net-loss, planning **Greengrove** – HABs; *Alexandrium*; cysts in sediments **Kolb** – phytoplankton, community ecology, oceanographic forcing
12:00-1:00	Lunch	
1:00-2:00	Panel 4	Parasites, geochemistry, and estuarine conservation (**Chapman, Asson, Burton, Young**)
2:00	Awards, closing remarks	

PLENARY SPEAKERS

Friday morning, Mar. 20: Dr. Colin Levings,

Title: *The Estuary as a Challenge to Salmonid Survival – A Global Overview*

Biography: As a youth Colin Levings spent a lot of time fishing in the lower Fraser River, British Columbia (B.C). After studying at the University of B.C. and Dalhousie University in Nova Scotia he started work as a research scientist with Fisheries and Oceans Canada in West Vancouver, B.C. He was involved with some of the first studies on the estuarine ecology of salmonids on the Pacific coast. During his career he has worked in about 20 estuaries in B.C. as well as quite few overseas and on the west coast of the USA. He has published papers and reports on a wide range of estuarine topics, has mentored numerous students and colleagues, and served on advisory boards. Colin is a founding member and past President of PERS. After retiring he continues to work but makes time to teach his four grandsons about the coast.

More information: http://ires.ubc.ca/person/colin-levings/

Friday evening, Mar. 20: Dr. Kevin Bailey,

Title: *Of Fish and Men: In the Wake of the Western Flyer*

Biography: Kevin Bailey is a Seattle-based writer, renowned marine biologist and Founding Director of the Man & Sea Institute. He has published two books: *The Billion-Dollar Fish* and *The Western Flyer: Steinbeck's Boat, the Sea of Cortez and the Saga of Pacific Fisheries*. He's currently working on a new book on small-scale "green" fisheries. He's written articles for Earth Island Journal, Crosscut, and The Daily Beast. In another incarnation, Kevin worked at NOAA for too many years.

More information: http://www.manandsea.org/uploads/3/1/9/4/3194538/cv-topublish.pdf

FRIDAY PANELS

PUGET SOUND SHORELINE ARMORING: STATUS AND TRENDS, ALTERNATIVE TECHNIQUES, AND EVALUATION OF SITE SPECIFIC ATTRIBUTES (PANEL)

Panelists: Phill Dionne (WDFW, Phill.Dionne@dfw.wa.gov), Randy Carman* (WDFW, Randy.Carman@dfw.wa.gov) Theresa Mitchell (WDFW, Theresa.Mitchell@dfw.wa.gov) Hannah Faulkner (WDFW, Hannah.Faulkner@dfw.wa.gov)

Keywords: shoreline armoring, alternative techniques, site assessments

The continuing modification of Puget Sound shorelines due to installation of armoring is an issue of importance to resource agencies who manage the shorelines, scientists who study nearshore ecosystems, policy makers, homeowners and the public who recreate on the beach. To improve our understanding of the consequences of shoreline armoring including the physical and biological changes, as well as the sociopolitical climate, many agencies, scientists, and shoreline interest groups are attempting to coordinate existing information, conduct scientific investigations, and develop improved methods for addressing shoreline erosion. Our panel will address these general issues in an overview, present specific data on status and trends of armoring in Puget Sound introduce and discuss the Marine Shoreline Design Guidelines (MSDG) document of alternative armoring techniques, and report on recent evaluations of armor installations using the MSDG criteria.

The discussion following the panel presentations will be facilitated by Dr. Timothy Quinn (WDFW, Timothy.Quinn@dfw.wa.gov).

PRINCIPLES OF RESTORATION ACROSS ESTUARINE ECOSYSTEMS (PANEL)

Panelists: Stuart Munsch (smunsch@u.washington.edu), Jeff Gaeckle (jeffrey.gaeckle@dnr.wa.gov), Greg Hood (ghood@skagitcoop.org), Robert T. Paine (painert@u.washington.edu), Jennifer Ruesink (ruesink@u.washington.edu)

This panel brings together experts and practitioners who are carrying out and monitoring restoration projects in four distinct ecosystems – urban shorelines, native eelgrass, native oyster, and tidal marsh. Based on their particular case study, each panelist will address aspects of the following general questions: 1) What are the major goals of restoration in this system? (e.g., focal species, structural attributes, functional attributes)? Are these the same attributes that are monitored to assess restoration success? 2) What are the major approaches to restoration, for instance planting species vs. re-shaping abiotic conditions? 3) What are major constraints to restoration? Why does restoration fail? 4) Are there disagreements or uncertainties about "best practices"? How predictive is the science of restoration in this system? This comparative approach may (or may not) reveal similarities in terms of attention to structural or functional attributes of ecosystems, constraints on restoration due to socio-economic, biotic, or abiotic factors, and investment in post-restoration monitoring. Bob Paine will provide principles in a big-picture context for disturbance regimes and compounded perturbations in marine ecosystems.

SATURDAY PANELS

NAVIGATING ECOLOGY, CULTURE, AND RESILIENCE IN THE SALISH SEA (PANEL)

Panelists: Skye Augustine*(saugustine@nwic.edu), Marco Hatch (marcoh@nwic.edu) Rosa Hunter (rmhunter@nwic.edu), Sonni Tadlock(stadlock@students.nwic.edu), Jefferson Emm (jemm@students.nwic.edu) (Salish Sea Research Center, Northwest Indian College)

Tribal communities have an interconnected relationship with nature and long-term view of ecological change. This perspective is vital to maintaining ecosystem endurance in the face of anthropogenic impacts and climate change. As the only research center in the Pacific Northwest staffed exclusively by Native American scientists, the Salish Sea Research Center is uniquely positioned to connect marine ecology with the cultures of the Northwest Coast to grow the resilience of communities and ecosystems. Featuring these unique perspectives, this session discusses the use of marine ecology and place-based research to build the ecological and cultural resilience of the Salish Sea. Panelists will discuss the use of traditional Native American mariculture as a source of food security and spatial and temporal variability of eelgrass associated algicidal bacteria as a possible mechanism to reduce harmful algal blooms. This panel also features two Tribal College student perspectives on how the inclusion of research through education has changed their perceptions of what it means to be a marine scientist and their commitment to their undergraduate education.

PARASITES, GEOCHEMISTRY, AND ESTUARY RESTORATION (PANEL)

Panelists: John Chapman, Danielle Asson, Andrea Burton, David Young

Our four projects indicate (once again) that estuary conservation requires much more than “shovel ready” projects. Abstracts are provided separately for the four contributions.

The introduced parasite, Orthione, causes native Upogebia population collapses. Upogebia are ecosystem engineers and thus, their loss is becoming a major estuary conservation problem. Upogebia conservation will require management of Orthione. Critical information gaps that must be closed to address this management problem include what factors control Orthione. Settlement of Orthione into their new hosts is dependent on host condition. Upogebia condition appears to vary with benthic geochemistry. Upogebia conservation thus requires greater understanding of the links between Upogebia food sources, benthic geochemistry and how Orthione detects and invades these new hosts. The great benefits of estuary breaking dikes, expanding marshes and widening culverts will not be sustained unless efforts are made to resolve how or whether desired ecosystem processes will be enhanced by these changes.

Danielle Asson et al. resolved that host vulnerability to Orthione is host size and time dependent. Andrea Burton et al. found a relationship between lipid build-up in Upogebia and settlement of Orthione, which depends on the condition of Upogebia. The life history of Upogebia indicates their food sources are sediment dependent and possibly derived from sulfur fixing trophic pathways. David Young et al. have found macrophyte accumulations and consequent toxic levels of sulfide build-up that occur in the fall when maximum anaerobic food sources for Upogebia seem to occur.

ABSTRACTS

INVASIVE ISOPOD PARASITE, *ORTHIONE GRIFFENIS*, DOES NOT INDUCE SEX CHANGE IN THE MUD SHRIMP, *UPOGEBIA PUGETTENSIS* (panel)

Danielle Asson* (danielle.asson@gmail.com, Research Experience for Undergraduates, Hatfield Marine Science Center, Oregon State University), John Chapman (John.Chapman@OregonState.Edu, Dept. Fisheries and Wildlife, Oregon State University), Brett Dumbauld (Brett.Dumbauld@OregonState.edu, Agricultural Research Service, U.S. Dept. of Agriculture),

Keywords: burrowing shrimp, parasite, sex change

Effective castration of female burrowing mud shrimp, *Upogebia pugettensis*, by the recently introduced Asian parasite, *Orthione griffenis* appears to be the most important driver of its declines in western North American since the late 1990s. However, a reduced frequency of *Orthione* among *U. pugettensis* males has been attributed to parasite driven sex change and increased male mortality that could also contribute to population declines. We sampled complete size structures of *Upogebia* populations from 26 sites in 5 estuaries to test whether *Orthione* infestations are likely to feminize males or increase male mortality. Although twenty five percent of the 2,000 *Upogebia* examined were infested, we found only 3 intersex individuals, and only one of the intersexes was infested by *Orthione*. The occurrence of intersex *Upogebia* indicates possible recent or flexible evolutionary origins, but not parasite induced feminization. We found a 1:1 sex ratio within the overall population and thus again, no evidence of parasite induced feminization or sex linked mortality. The average male and female *U. pugettensis* life spans thus appear to be equal. The greater frequency of *O. griffenis* occurrences among large *Upogebia* females therefore appears to result from greater life-time female vulnerabilities to this parasite.

DETECTING AND ATTRIBUTING CHANGE IN MARINE WATER CONDITIONS IN PUGET SOUND: AN OVERVIEW OF RESULTS FROM A COORDINATED, INTERDISCIPLINARY, MULTI-AGENCY MONITORING NETWORK (POSTER)

*Julia Bos (Wash. Dept of Ecology, julia.bos@ecy.wa.gov), Stephanie K. Moore (Northwest Fisheries Science Center (NOAA), stephanie.moore@noaa.gov), Kimberle Stark (King County Dept. of Natural Resources & Parks, Kimberle.Stark@kingcounty.gov), Ken Dzinbal (Puget Sound Partnership, ken.dzinbal@psp.wa.gov), Jan Newton (UW Applied Physics Lab, newton@apl.washington.edu), and Paul Williams (Suquamish Tribe, pwilliams@suquamish.nsn.us)

Keywords: Puget Sound**,** Monitoring**,** Ecosystem**,** Climate**,** Conditions**,** Network

Since 2011, the Marine Waters Work Group (MWWG) of the Puget Sound Ecosystem Monitoring Program (PSEMP) has synthesized Puget Sound monitoring results in an annual report to identify and describe trends, anomalies, and processes. The collective view of Puget Sound marine waters conditions is presented in context of factors that drive variation and change, such as large-scale climate variability and regional weather. The MWWG is a collaboration of monitoring professionals, researchers, and data users with the common objective to foster collaboration and communication on regional monitoring and assessment activities, and to share observations and results from various Puget Sound-based monitoring efforts. These efforts employ different approaches and tools that cover various temporal and spatial scales, based on mandate, need, opportunity, funding and expertise. Collectively, the information representing various temporal and spatial scales can be used to connect status, trends, and drivers of ecological variability throughout Puget Sound marine waters. Future development of strategies to recover Puget Sound, mitigate and/or adapt to ocean acidification and climate change hinges on our ability to detect changes in water conditions. Through this coordinated publication, the MWWG is

working to build a foundation of timely integrated observations that augments individual datasets as well as contributes to the overall understanding of this complex ecosystem. It is anticipated that the scope will expand in future reports to include a synthesis of other ecosystem aspects (e.g., marine mammals and food web components).

PREDICTING THE RESPONSE OF ESTUARINE COPEPODS TO CHANGES IN THE TIMING OF THE FRASER RIVER FRESHET: FIRST STEPS (poster)

Joanne Breckenridge*(jbrecken@eos.ubc.ca), Natalie Mahara (nataliemahara17@gmail.com), Sandra Emry (s.emry07@gmail.com), and Evgeny Pakhomov (epakhomov@eos.ubc.ca) Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, 2020 – 2207 Main Mall, Vancouver, B.C., Canada V6T 1Z4

Keywords: Climate change; Copepods; Population dynamics

How estuarine zooplankton will respond to the changes in freshwater input that are occurring due to climate change is poorly understood. Snowmelt-dominated river systems are predicted to experience the greatest change to their annual hydrograph yet their estuaries are relatively unstudied. The Fraser River Estuary (FRE) is one of few such estuaries remaining in temperate regions whose flow regime has not been largely altered through damming. In 2013, we began a multi-year project to describe the zooplankton of the FRE, identify dominant taxa, and predict how their abundances will be influenced by an earlier spring freshet using population models. We found that estuarine endemic species were largely restricted to backwaters and we are focusing much of our work in these areas. Preliminary results suggest that dominant copepods may switch to diapause egg production and then largely disappear from the water column upon arrival of the spring freshet. A freshet that occurs early, when fewer adult females are present, thus has the potential to reduce that year's contribution to the egg bank. We continue to investigate this, and to gather the rate estimates necessary for population modelling, through egg production and hatching experiments, observations of vertical distribution, and weekly to bi-weekly sampling, which, in conjunction with literature estimates, will be used to estimate moulting rates. By conducting research in the largely unstudied FRE we will gain an understanding of zooplankton dynamics in estuaries of snowmelt-dominated basins and of how these systems will respond to climate change.

INVASIVE PARASITE ORTHIONE GRIFFENSIS WAITS FOR FAT UPOGEBIA PUGETTENSIS HOSTS (panel)

Andrea Burton, John Chapman, Richard Caldwell, Louise Copeman, Brett Dumbauld

Declines and extinctions of *Upogebia pugettensis* populations, a native estuary mud shrimp, are closely associated with high incidences of effective castration by the introduced blood sucking Asian parasite *Orthione griffenis*. Castration is assumed to result from nutritional costs to the host, however no relationship between *Orthione* and *Upogebia* weight or lipid stores were found in previous examinations. However, an expanded assessment over time revealed that lipid accumulation by *Upogebia* does not begin until August, and would have been difficult to detect in in previous surveys. Intense infestations by *Orthione* began after August, when maximum lipid reserves were present. The energetics of the *Orthione* and *Upogebia* interactions are therefore seasonal, with onset of *Orthione* settlement following host lipid uptake during the reproductive season of *Upogebia*.

ORTHIONE GRIFFENIS IS A PATIENT PARASITE (panel)

John Chapman* (John.Chapman@OregonState.Edu, Dept. Fisheries and Wildlife, Oregon State University), Danielle Asson (danielle.asson@gmail.com Research Experience for Undergraduates [REU], Hatfield Marine Science Center, Oregon State University [HMSC]), Ralph Breitenstein (RalphnDonelle@Charter.net, HMSC) Marie Barton (jmbarton92@gmail.com, HMSC), Andrea Burton (burton.andrear@gmail.com, HMSC), Katie Crooks (CrooksK@onid.oregonstate.edu, REU, HMSC), Brett Dumbauld (Brett.Dumbauld@OregonState.edu, Agricultural Research Service, U.S. Dept. of Agriculture), Madeline Gorchels (mgorchel@wellesley.edu, REU, HMSC), Kelsey Yates (yatesk@onid.oregonstate.edu, REU, HMSC),

The natural history of the introduced bopyrid isopod, *Orthione griffenis*, a parasite of the native North American mud shrimp, *Upogebia pugettensis*, was partially resolved by temporal comparisons of adult and larval *Orthione* and *Upogebia* populations. The larvae of both species develop in the coastal oceans and adults live only within estuaries. Cryptoniscans, the final larval stage of *Orthione*, accumulated in Yaquina Bay, Oregon over late spring and early summer, but did not settle into host *Upogebia* until fall. At the same time, previously settled *Orthione* bopyridans did not grow within their hosts. The small (0.7 mm length) cryptonsicans waited in the estuary through spring and summer before infesting hosts in the fall. These waiting cryptoniscans were possibly cueing on host condition. The timing of *Orthione* settlement is thus poorly dependent on their abundance and more likely to depend on their host's condition.

LONG-TERM MONITORING ON MULTIPLE SPATIAL SCALES: STATUS AND TRENDS OF SEAGRASS IN PUGET SOUND (talk)

Bart Christiaen* (Washington State Department of Natural Resources, Bart.christiaen@dnr.wa.gov)
Pete Dowty (Washington State Department of Natural Resources, Peter.Dowty@dnr.wa.gov)
Lisa Ferrier (Washington State Department of Natural Resources, Lisa.Ferrier@dnr.wa.gov)
Jeff Gaeckle (Washington State Department of Natural Resources, Jeffrey.Gaeckle@dnr.wa.gov)
Helen Berry (Washington State Department of Natural Resources, Helen.berry@dnr.wa.gov)

Keywords: Eelgrass, long-term trend, regional monitoring

Seagrasses provide important ecosystem services, but are sensitive to a wide range of environmental stressors. This makes them an effective indicator of habitat condition. The Department of Natural Resources monitors seagrass (predominantly *Zostera marina*) area and depth distribution in greater Puget Sound. Changes in soundwide native seagrass area are assessed in the framework of a long-term target (20% increase in soundwide seagrass area by 2020), while local patterns in seagrass distribution are examined on a shorter timeframe. There was no significant long-term trend in soundwide seagrass area in Puget Sound, and most of the 347 sample sites were stable throughout the entire monitoring record (2000-2013). However, there is some evidence that seagrass conditions improved in recent years. Several sites that were previously declining have stabilized between 2010 and 2013. At the Skokomish and the Nisqually River deltas, notable increases in eelgrass area were observed following removal of dikes and other restoration activities.

PHYSICAL AND MICROBIAL DRIVERS OF HYPOXIA IN BELLINGHAM BAY

Natasha Christman (University of Washington, nrchri10@uw.edu)*, Jude Apple (Western Washington University; Shannon Point Marine Center,judeapple@wwu.edu , Jan Newton (University of Washington,newton@apl.washington.edu)

Keywords: Hypoxia, Puget Sound, Plankton

Bottom water hypoxia is a feature of many coastal embayments and fjords in the Salish Sea. Ongoing research in Bellingham Bay (Bellingham, WA USA) by Northwest Indian College and Western Washington University has identified a seasonally recurring area of low dissolved oxygen near the center of the bay. Similar to other regions of the Salish Sea, hypoxia in Bellingham Bay may be a naturally occurring phenomenon, yet the extent of eutrophication and anthropogenic nutrient loading's influence on patterns of hypoxia is poorly understood. The present study has continued an established monitoring program documenting the range, duration and severity of hypoxia in Bellingham Bay, while adding an experimental component investigating factors that regulate respiration of heterotrophic bacterioplankton. Profiles of water column parameters and sample collection were performed on cruises in 2013 and 2014. In 2014, an array of constant-monitoring water quality sensors were additionally deployed into the center of the bay to monitor dynamics of oxygen concentrations over several weeks and found that water layer-displacement in the bay strongly correlated with spring-neap tide cycling. Manipulative experiments were conducted on collected water samples to investigate effects of temperature and organic carbon on water column respiration. These experiments revealed that temperature had a negligible effect on water column respiration, while organic carbon stimulated oxygen consumption and was thus identified as a possible limiting factor. The study's findings broaden our knowledge of factors regulating oxygen dynamics in coastal embayments of the Salish Sea and provide further insight into the potential effects of anthropogenic stressors and climate change on Salish Sea water quality.

EARLY LIFE HISTORY OF THREE MARINE SNAILS FROM CHEMOSYNTHETIC COMMUNITIES (poster)

Chelsea Collins* (Western Washington University, chelseacollins2015@gmail.com), Shawn Arellano (Shannon Point Marine Center, Shawn.Arellano@wwu.edu)

Keywords: thermal variability, chemosynthetic communities, Phenacolepadidae

Phenacolepadidae is a family of limpet-like marine snails that have been found in habitats ranging from warm shallow waters to deep-sea hydrothermal vents. We are studying three species within this family that live at different chemosynthetic habitats. *Bathynerita naticoidea* egg capsules were collected from Brine Pool NR-1 in the Gulf of Mexico from depths of 500m, where temperatures average 7°C consistently. *Shinkailepas n. sp 1&2* egg capsules were collected at two seamounts along the Mariana Arc: NW Rota (depth 500 m) and NW Eifuku (depth 1200m), respectively, where temperatures range from 2-30°C. This observational study examines early life history development at temperatures of 6°C, 15°C and 25°C over several weeks. Hatched *Shinkailepas n. sp1&2* larvae from the encapsulation experiments were continued for observations of larval survival and development. Embryos reared at 25°C developed faster, once hatched larval response was negatively associated to the high temperature. Embryos reared at 15°C developed slower than the high temperature treatment, but the larvae were more active. Embryos at 6°C had the slowest development while larval activity was similar to that of larvae at 15°C. Feeding of *Shinkailepas n. sp.* larvae on algae is still unknown. The *B. naticoidea* embryos appear to be developing at a slower rate than the *Shinkailepas n. sp1&2* and had higher embryo mortality at 25°C. However *B. naticoidea* larvae are known to tolerate temperatures up to 30°C and feed on algae. Examination of life history strategies is key to understanding colonization in these highly specialized and frequently disturbed habitats.

SYNTHESIS OF EELGRASS-SHELLFISH AQUACULTURE INTERACTIONS IN WEST COAST ESTUARIES: USING META-ANALYSIS TO QUANTIFY SOURCES OF VARIATION IN EFFECT SIZE (talk)

Letitia Conway-Cranos*(contractor for Northwest Fisheries Science Center, Tish.Conway-Cranos@noaa.gov), Beth Sanderson (Fish Ecology Division, Northwest Fisheries Science Center, Beth.Sanderson@noaa.gov)

Keywords: eelgrass, shellfish, aquaculture

A key component of effectively managing shellfish aquaculture is understanding the direct and indirect consequences of shellfish aquaculture on nearshore ecosystems. Seagrasses are highly productive ecosystem engineers in Pacific Northwest estuaries and provide habitat for a suite of fish and invertebrates including ESA listed and commercially harvested fish species. In many cases, shellfish aquaculture and eelgrass occur at similar tidal elevations and in similar environmental conditions, accentuating the need to understand the nature of the interaction between shellfish aquaculture and eelgrass in estuaries. Meta-analysis is a tool used to standardize results across different studies and compare them using a common metric of effect size. We have extensively searched the literature and compiled 16 studies on the west coast of the United States that experimentally investigated the effects of shellfish aquaculture on eelgrass and associated benthic invertebrate fauna. These studies take place across seven west coast estuaries from Northern California to British Columbia. By calculating the relative effect size for each of the experiments within each study, we intend to address the following questions: 1) What is the overall impact of shellfish aquaculture practice on eelgrass? 2) What are the relative impacts of different aquaculture practices on eelgrass? And 3) Which eelgrass response metrics (e.g., growth, density, percent cover, biomass) are the most sensitive to shellfish aquaculture? This synthesis will help to clarify the range of eelgrass responses to shellfish aquaculture as well as provide insight into the potential mechanisms driving the observed variation.

CHARACTERIZING MARINE MICROPLASTICS IN THE SURFACE WATERS OF THE GULF OF ALASKA (poster)

Madison Drescher*(University of Washington Tacoma Center for Urban Waters, maddi97@uw.edu), Julie Masura (University of Washington Tacoma Center for Urban Waters, jmasura@uw.edu), and Joel Baker (University of Washington Tacoma Center for Urban Waters, jebaker@uw.edu)

Keywords: microplastics, marine debris, surface waters

Plastic marine debris is found in coastal and marine waters worldwide. There has been an increase in the study of microplastics, synthetic polymers < 5 mm, throughout the world. Researchers at University of Washington have collaborated with NOAA to establish a baseline of the abundance and spatial and temporal variability of marine microplastics in the Gulf of Alaska, a heretofore unstudied (with respect to microplastics) region of the Pacific well known to be impacted by larger marine debris. This presentation describes the surveys sampled by NOAA from 2004 to 2013. Undergraduate student researchers from the Center for Urban Waters analyzed the environmental samples using a wet-peroxide oxidation method. The measured variable concentrations of microplastics in this region's surface water ranged from 0.0 to 67% microplastics of the dry mass with an average concentration of 6% microplastics of the dry mass.

BIOLOGICAL AND STRUCTURAL INTEGRITY ASSESSMENT AT THE BRIGHTWATER MARINE OUTFALL (TALK)

Eash-Loucks*, W., K. Stark, and J. Lundt

Keywords: outfall, biodiversity, colonization

King County's newest wastewater treatment plant, the Brightwater Treatment System, includes an outfall that discharges treated effluent to Puget Sound a mile offshore of Point Wells at 600 ft deep. The outfall, which consists of two pipes laying on the seafloor, was constructed in 2008 and began service in 2012. Underwater video showed rapid colonization by epibenthic organisms. In 2012, to test the effects of biological colonization on the pipe, nine 2x1 ft pieces of pipe-material were deployed by ROV at three depths near the pipe: 100, 300, and 600 ft, with a 600 ft reference site (total plates = 36). Three replicates of these "settlement plates" will be collected from each site after 2, 5, and 10 years. These plates will be evaluated for damages to the pipe by colonizing organisms through a series of structural integrity tests. Additionally, prior to structural integrity testing, percent coverage of epibenthic organisms will be assessed on each plate, and species present will be identified in the field to the lowest practical taxonomic unit. The first sets of plates were retrieved in September 2014. There was a lack of diversity on plates retrieved from 100 ft, which were mostly covered with barnacle scars, potentially indicating high predation rates. Coverage and diversity increased with depth, with plates from 600 ft containing several anemone, barnacle, bryozoan, polychaete, tunicate, and mollusc species. Ongoing work will determine if and how these communities change over a decade and how colonization impacts the structural integrity of the outfall pipes.

SAWMILLS, SULFIDE, AND SEEDS: THE EFFECTS OF WOOD POLLUTION ON SULFIDE LEVELS AND EELGRASS GERMINATION (poster)

Chesley Ekelem* (Harvard University, ekelem@college.harvard.edu), Sylvia Yang (Shannon Point Marine Center, Sylvia.Yang@wwu.edu)

Keywords: sawmills, sulfide, eelgrass

Historically, sawmills have released wood waste onto coastal shorelines in the Pacific Northwest, enriching marine sediments with organic material. The increase in organic carbon boosts the bacterial reduction of sulfate and results in the production of a toxic metabolite, hydrogen sulfide. Hydrogen sulfide is a phytotoxin and can decrease the growth and survival of eelgrass beds. This is a critical issue since eelgrass, *Zostera marina*, forms habitat for many species, stabilizes sediment, and plays a role in nutrient cycling and sediment chemistry. The objective of this study was to determine the effects of wood pollution on sediment pore-water hydrogen sulfide concentrations and eelgrass seed germination. To test the impact of wood inputs on sulfide production and seed germination, we conducted a laboratory mesocosm experiment with seven levels of sawdust addition into marine sediment and measured the sulfide levels biweekly. We planted seeds into the mesocosms and observed germination rates. Preliminary results suggest that higher concentrations of sawdust led to the development of higher levels of pore-water hydrogen sulfide. The results of this study could be applied to aid restoration in wood polluted areas.

QUANTITAVE ANALYSIS OF MULTIPLE EELGRASS (*Zostera marina*) MONITORING METHODS WITHIN PORTAGE BAY WASHINGTON (poster)

Jefferson Emm* (Salish Sea Research Center, Northwest Indian College, jemm@stu.nwic.edu), Marco B.A. Hatch, Ph.D. (Salish Sea Research Center, Northwest Indian College, marcoh@nwic.edu), Sandy Wyllie-Echeverria, Ph.D. (Friday Harbor Laboratories, University of Washington, zmseed@uw.com)

Keywords: regional, eelgrass, monitoring

Worldwide seagrasses are in decline. To reverse this trend seagrass monitoring programs must be able to differentiate between long-term population trends and natural variability. This includes understanding changes on the meadow and landscape scale. Given the number of seagrass monitoring methods available to resource managers it is important to decide (1) what variables are most important (2) what areas need to be monitored and (3) project budget and sustainability. To help guide resource managers in determining the appropriateness of various methods this study used four monitoring methods to quantify an eelgrass meadow (*Zostera marina)* on the Lummi Reservation in Portage Bay, Washington. A 100-meter transect and a 100 X 50m grid were placed over the Portage Bay eelgrass study site. Aerial imaging was used to quantify eelgrass meadow extent. Sixty-five aerial photos were geo-referenced and stitched together to create a single aerial photo. The fourth method tested was hydroacoustics, using a small research vessel and a Biosonics *MX-Echosounder*, eleven ~1/2 km transect paths over the eelgrass study site were completed during a slack high tide to map eelgrass. By quantitatively analyzing not only the strengths and weaknesses of these different monitoring methods, but also each method's capabilities, a framework may be provided to assist resource managers in choosing more effective and goal oriented methods of monitoring seagrasses. Based on these results a detailed monitoring plan for monitoring eelgrass in Bellingham Bay will be created with nested monitoring programs carried out by diverse stakeholders.

TIME SERIES REPORTING OF SELECTED WATER QUALITY PARAMETERS IN GARRISON BAY, SAN JUAN NATIONAL HISTORICAL PARK (talk)

Olivia Graham* (Friday Harbor Laboratories, ojgraham@mac.com), Sandy Wyllie-Echeverria (Friday Harbor Laboratories, zmseed@u.washington.edu), Jerald Weaver (National Park Service, jerald_weaver@nps.gov), Katie Harrington (Friday Harbor Laboratories), and LouAnne Wyllie (Friday Harbor Laboratories Volunteer)

Keywords: Common eelgrass, water quality, restoration Funded by the National Park Service

The San Juan Archipelago is a unique marine environment in that it is at the interface of the Salish Sea estuary and the Pacific Ocean. Several "pocket estuaries" are located within the archipelago. Common eelgrass (Zostera *marina)* populates or has recently populated these environments. One of these estuaries, Garrison Bay, is also the location of a portion of the San Juan National Historical Park and the site of a yet unexplained local extinction of *Z. marina.* Starting in 2008, we began to monitor the water quality parameters of pH, chlorophyll, turbidity, and light to 1) establish a baseline of water quality data as part of Vital Signs program with the National Park Service and 2) determine if the water column environment in Garrison Bay will support *Z. marina* colonization or restoration. Within this program our primary objectives are to understand the underlying environmental conditions within Garrison Bay in early summer, the season of patch expansion for *Z. marina* and potential seasonal changes in water quality parameters before, during, and after the boating season (June-October). We now report our cumulative findings.

SPATIOTEMPORAL VARIATION IN PACIFIC SAND LANCE (AMMODYTES *HEXAPTERUS)* ABUNDANCE AND DEMOGRAPHICS IN THE SAN JUAN CHANNEL (talk

Olivia Graham* (Friday Harbor Laboratories, ojgraham@mac.com), Matthew Baker (Friday Harbor Laboratories, mattbakr@u.washington.edu), Kailee Bynum (Friday Harbor Laboratories, bynumk@myuw.net), Emily Burke (Friday Harbor Laboratories, emilyalanaburke@gmail.com), Jan Newton (University of Washington, newton@apl.washington.edu), W. Breck Tyler (University of California Santa Cruz, ospr@ucsc.edu)

Keywords: Pacific sand lance, year class strength, condition factor

Fish feeding behavior, abundance, and population demographics depend on a number of environmental and non-environmental factors. Some fish, such as salmonids, display cyclic population structures and year class strength that are independent of their environment (Selbie 2008), whereas other fish are strongly influenced by light (Friedlaender et al. 2009), temperature (Cowx and Frear 2004) and tides (Witt 2011). Pacific sand lance (Ammodytes *hexapterus)* exhibited potential cyclic structures in previous studies, making them ideal for this abundance and population demographic study. Sand lance were collected from the San Juan archipelago and were examined to determine within-day, seasonal, and inter-annual patterns between: foraging behavior and light, time, and tides; abundance (catch per unit effort, CPUE), condition (condition factor, K), and age group structures. Together, these data suggest that sand lance foraging behavior is influenced tidal heights, although greater resolution is needed to determine the effects of other environmental conditions. Across larger temporal scales, local sand lance populations were in much lower condition that in previous years, suggesting the fall of 2014 had unusual environmental conditions. Finally, the sand lance exhibited a cyclic population structure with regards to year class strength, although not in abundance patterns. Further studies in sand lance abundance and population demographics would be useful to confirm this pattern.

OF NEEDLES AND HAYSTACKS: HABITAT MAPPING AND CITIZEN SCIENCE TO MONITOR FOR EUROPEAN GREEN CRAB IN WASHINGTON STATE (poster)

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Key Words: Invasive Species, Citizen Science, Early Detection

The European green crab (*Carcinus maenas*) was first detected in Washington waters in 1998 after warm El Niño currents spread larvae of California populations as far north as Vancouver Island. Because of perceived risks to coastal resources, the green crab was designated a deleterious species in Washington State, which among other actions, mandated monitoring and control of the species in state waters. Green crab recruiting to coast estuaries failed to establish large populations, and none were found in inland waters of Puget Sound; consequently, monitoring and control efforts were curtailed. However, in 2012, Canadian wildlife officials discovered a population of green crab in Sooke Inlet near Victoria, British Columbia, well within the Strait of Juan de Fuca. The purpose of the present study is to design and implement a habitat-specific, volunteer-based monitoring program for inland waters of Washington State. To this end, we have produced a habitat suitability map for all shorelines using coarse physical, biological, and access characteristics observable in aerial and satellite imagery. More than 100 locations along the Strait of Juan de Fuca and Puget Sound appear to be suitable for green crab establishment. Current effort focuses on developing and testing a robust yet practical protocol for high-risk habitats.

Work to date is discussed including the challenges of site prioritization and obstacles to sustaining a monitoring program for an elusive nonnative species.

EMERGENCY RESPONSE MAPPING OF *ALEXANDRIUM* CYSTS IN THE SURFACE SEDIMENTS OF QUILCENE AND DABOB BAYS (talk)

Cheryl L. Greengrove* (University of Washington–Tacoma, Tacoma, WA 98402; cgreen@uw.edu), Julie E. Masura (University of Washington–Tacoma, Tacoma, WA 98402; jmasura@uw.edu), Stephanie K. Moore (NOAA Northwest Fisheries Science Center, Seattle, WA 98112; stephanie.moore@noaa.gov)

Keywords: Harmful Algal Blooms; *Alexandrium*; Cysts in Sediments

In September and October 2014, there was an unprecedented bloom of *Alexandrium* in Dabob and Quilcene Bays in Hood Canal. The area where the bloom took place has historically been biotoxin free. At the peak of the event, the detected toxin in shellfish was up to 12,688 µg STX equiv. /100 g. Washington State Department of Health and local shellfish growers were extremely concerned that the large bloom may have resulted in a new seed bed forming that could increase bloom risk in the area during the 2015 season and beyond. *Alexandrium* species produce resting cysts that overwinter in sediments on the seafloor. The following season, the cysts germinate and can provide the inoculum for more blooms. Out of concern that this bloom may have formed a new "seed bed" that could increase bloom risk this summer, we initiated an emergency cyst mapping survey in this area from January 17-20, 2015. The work was supported by the NOAA ECOHAB Program and Penn Cove Shellfish. Our previous cyst mapping efforts in 2011, 2012 and 2013 found zero or very low concentrations of cysts in the area; the highest concentration observed was 10 cysts per cc wet sediment in Quilcene Bay in 2013. In January 2015, we found an order of magnitude greater concentration of cysts; up to 120 and 180 cysts per cc wet sediment in Quilcene Bay and Dabob Bay, respectively. These results warrant increased vigilance for monitoring cells and toxins during the 2015 season and beyond in this area.

USING FLOWCAM TECHNOLOGY TO ASSESS PHYTOPLANKTON DYNAMICS IN CENTRAL PUGET SOUND (TALK)

Hannach, Gabriela*[1], Kolb, Amelia[2] and Sandwick, Lyndsey[1]

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Keywords: Puget Sound, phytoplankton, FlowCAM

The King County Marine and Sediment Assessment Group manages a long-term monitoring program designed to assess water quality in the Central Puget Sound Basin. Since 1995, data are collected monthly for a suite of physical, chemical, and biological parameters throughout the Puget Sound Central Basin. A long-term phytoplankton component was added in 2008, and the recent acquisition of a FlowCAM imaging particle analysis system has made it possible to collect a more extensive and robust dataset for Puget Sound phytoplankton, critical in order to predict how changes in climate and other regional stressors will impact the Sound's trophic structure.

Samples from eight Central Basin locations were analyzed biweekly by FlowCAM in 2014. Our protocol allowed us to identify approximately 60 taxonomic categories using relevant descriptors of assemblage composition, such as particle size distribution, abundance and biovolume. Multivariate data analysis revealed the existence of distinct geographic clusters of Central Basin stations and characteristic species

assemblages that help interpret the dynamics of Puget Sound algal blooms. Seasonal shifts in algal abundance and biovolume were consistent with 2014's unusual climate pattern.

BROADSCALE DISTRIBUTION, ECOLOGICAL ASSOCIATIONS, AND POTENTIAL IMPACTS OF THE INVASIVE ASIAN CLAM *CORBICULA FLUMINEA* IN THE COLUMBIA RIVER BASIN (poster)

Whitney Hassett[1]*(whitney.hassett@email.wsu.edu) Stephen Bollens[1] (sbollens@vancouver.wsu.edu), Gretchen Rollwagen-Bollens[1] (rollboll@vancouver.wsu.edu), Tim Counihan[2] (tcounihan@usgs.gov), Julie Zimmerman[1] (juliezimmerman@vancouver.wsu.edu), Josh Emerson[1] (joshua.emerson@email.wsu.edu)

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Keywords: invasive species, FlowCam, molluscs

The invasive Asian clam *Corbicula fluminea* was introduced to North America in the 1930's and is now known to inhabit most regions of the contiguous United States. However, the current distribution of *C. fluminea* in the Columbia River Basin is poorly documented. We conducted a two-year field study to characterize the distribution and abundance of larval *C. fluminea* and associated environmental drivers (both biotic and abiotic) in the Columbia River Basin. Twenty-one sites in five reservoirs were sampled monthly from May through September, and 23 additional lakes and reservoirs were sampled in late summer, during both 2013 and 2014. A rapid microscopic particle imaging system, the FlowCam, was used to characterize plankton communities (60-300 micrometer size range). Preliminary data indicate *C. fluminea* are found in high abundances in Columbia River sites and are present in additional reservoirs in Oregon and Washington states. Future directions include the use of Non-Metric Multidimensional Scaling (NMDS) to determine optimal habitat conditions for larval *C. fluminea* by associations with environmental variables, and to assess ecological effects of *C. fluminea* on plankton communities by identifying assemblages that occur in the presence or absence of *C. fluminea*. Our results will be of interest to aquatic ecologists concerned with fundamental ecological processes such as population establishment and range expansion, as well as natural resource managers and policy makers interested in invasive species and conservation.

THE IMPORTANCE OF PREDICTION FOR TIDAL MARSH RESTORATION (panel)

W. Gregory Hood (Skagit River System Cooperative, LaConner, WA. ghood@skagitcoop.org)

Effective tidal marsh restoration planning, design, and monitoring require quantitative predictive models that can anticipate the results of restoration actions. Without predictions, restoration actions are simply based on faith, hunches, or trial and error. Qualitative predictions are better than nothing, but they indicate only a rudimentary understanding of a system. To further restoration science and improve our understanding of ecosystem structure and function we need to develop and apply quantitative predictive models. This talk illustrates the development and application of two approaches to quantitative prediction in tidal marsh restoration, one for vegetation and one for tidal channel geometry. For example, application of quantitative predictive models reveals that tidal marsh restoration projects in Puget Sound and the Lower Columbia River Estuary are generally deficient in tidal channel count by 4- to 5-fold compared to reference marshes. This deficiency likely impacts fish access to the restoration sites by a similar factor. Thus, the value of our restoration investments may be limited by reduced fish access resulting from poor restoration design, design that appears to be based on hunches rather than quantitative understanding.

E. COLI STATUS, TRENDS, AND SOURCE ASSESSMENT IN THE TILLAMOOK BAY WATERSHED (talk)

York Johnson (Tillamook Estuaries Partnership and Department of Environmental Quality, johnson.york@deq.state.or.us) and Rimler, Rose* (Tillamook Estuaries Partnership and Oregon Sea Grant, rose@tbnep.org)

Key words: bacteria, volunteer, watershed

Since 1997, volunteers have collected 15,000 water samples from forty-three locations in the five major river systems in the Tillamook Bay Watershed. Samples are analyzed for *E. coli* bacteria at the TEP laboratory. Through this process, TEP discovered that lower sections of four of the five rivers in the watershed routinely violate Oregon's water quality standard for recreational contact, while the Wilson River has improved and currently meets water quality standards. Bacteria concentration increases as the major land uses switch from forestry in the upper watershed to urban and agriculture in the lower lands and is also correlated with precipitation events. Additionally, a DNA marker study led by Oregon State University researchers was able to identify whether bacteria was from a human or ruminant source. This independent report concluded that "a watershed manager's best strategy for decreasing indicators of fecal pollution in this watershed is to mitigate runoff from ruminant sources".

Thanks in large part to a dedicated volunteer base, TEP can confidently state which stream reaches currently meet State bacteria standards, and which streams are in violation. At these same locations, TEP has determined whether bacteria concentrations are increasing or decreasing. With information described in the DNA study, contamination can be linked to human or ruminant (non-elk) sources. Knowledge gained though these efforts will help TEP guide the direction of management in the Tillamook Bay Watershed to minimize the impact certain practices have on water quality as it relates to bacteria.

TESTING WHETHER CHARACTERISTICS OF NON-NATIVE TUNICATES INDUCE PREDATOR AVOIDANCE ON SUSPENDED STRUCTURES BUT NOT BENTHIC SUBSTRATA (poster)

*Erin Kincaid (Portland State University, Department of Environmental Science and Management, ekincaid@pdx.edu), Catherine de Rivera (Portland State University, Department of Environmental Science and Management, derivera@pdx.edu)

Key words: invasive species, fouling community, biotic resistance

Non-native species can threaten economic and environmental health, making it crucial to understand characteristics that make non-native species successful. Identifying such characteristics allows for greater preparedness for and management of biological invasions and increases understanding of elements structuring biological communities. Many colonizing non-native tunicate species have been quite successful on, but limited to, anthropogenic structures. We conducted a quantitative observational study in Charleston Marina, OR. This study indicated that native species were depredated in the suspended environment by the nudibranch *Hermissenda crassicornis* and the flatworm *Eurylepta leoparda*,, but non-native species were not consumed. We will test the hypothesis that on artificial substrata observed predation patterns are attributable to differences in palatability of native versus non-native tunicate species. We will determine average caloric content of different species, and conduct feeding experiments to determine whether structural or chemical deterrents of the non-native *Botrylloides violaceous* affect predation rates on them relative to predation of the native *Distaplia occidentalis*. Experiments will include two benthic predators and two predators found in the suspended environment. Our experiments will compare predation rates on a) colonies of intact tunicate zooids, b) blended tunicate samples mixed with squid paste, and c) tunicate extracts in squid paste. The results will identify if non-native tunicates

escape predation in floating but not benthic environments on the Oregon coast due to their palatability characteristics, in which case predators may indirectly facilitate the invasion of docks but provide resistance to the invasion of natural benthic areas.

PUGET SOUND PHYTOPLANKTON COMMUNITY RESPONSE TO UNUSUAL OCEANOGRAPHIC CONDITIONS IN 2014 (talk)

Kolb, Amelia* (King County Science and Data Management Section, amelia.kolb@kingcounty.gov), Gabriela Hannach (King County Environmental Laboratory, gabriela.hannach@kingcounty.gov), Kimberle Stark (King County Science and Data Management Section, kimberle.stark@kingcounty.gov)

Keywords: phytoplankton, community ecology, oceanographic forcing

The King County Water and Land Resources Division sampled for community composition of marine phytoplankton semi-monthly from 2009-2014 at three sites in the Central Basin of Puget Sound. The phytoplankton dataset includes records of 126 taxa, generally identified to the genus or species level. Relative abundance was assessed semi-quantitatively using microscopy, scoring taxa as present, subdominant, or dominant by cell count. Non-metric multidimensional scaling of this dataset, analyzed alongside a suite of concurrently measured parameters (nutrients, chlorophyll a, salinity, temperature, etc.), provides a detailed synopsis of the seasonal cycle of phytoplankton community composition. Phytoplankton community composition in 2014 showed distinct patterns compared to previous years (2009-2013), including an earlier spring bloom, a more intense and persistent fall bloom (as indicated by chlorophyll a), and dominance of *Chaetoceros* (subgenus *Hyalochaete*) spp. diatoms unusually late in the fall. These phenomena are likely linked to oceanographic conditions, which included anomalously high precipitation in March and warm sea-surface temperatures persisting late into the fall.

EFFECTS OF OCEAN ACIDIFICATION AND WARMING ON OLYMPIA OYSTER LARVAL SWIMMING AND GROWTH (poster)

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Keywords: Ocean acidification, temperature, larvae

Anthropogenic influence and increased atmospheric CO_2 are creating a myriad of changing conditions for the world's oceans, including ocean acidification and warming. Multi-stress studies are imperative to the understanding of practical ocean conditions, as often times concurrent stressors exhibit synergistic rather than additive effects on organisms. We analyzed effects of temperature and acidification on Olympia oyster, *Ostrea lurida*, larval swimming behavior and growth. As the only oyster native to the northern Pacific coast of North America, this species has been in decline for the past few centuries, and has been a topic of interest for restoration in recent years. We cultured larvae at three pCO_2 treatments (400ppm, representative of current atmospheric CO_2 measurements, 800ppm, and 1200ppm, representative of possible predicted levels within the next century) and two temperatures (12°C and 25°C, values nearing the low and high temperature limits of the species). We used larval tracking and video analysis techniques to quantify swimming performance, and determined growth rate using digital image evaluating software. Knowing how swimming behaviors and the duration of the planktonic life cycle change with ocean warming and acidification will give us a better understanding of larval dispersal and inform restoration efforts.

THE EFFECTS OF CYANOBACTERIAL BLOOMS AND INVASIVE SPECIES ON ZOOPLANKTON COMMUNITY DYNAMICS IN A TIDALLY INFLUENCED SHALLOW TEMPERATE LAKE (poster)

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Keywords: cyanobacterial blooms, multiple stressors, aquatic invasive species

Cyanobacterial blooms and biological invasions are an increasingly common problem in aquatic ecosystems, yet their combined effects on zooplankton community dynamics are not well understood. Here we examined these two stressors on zooplankton community dynamics from 2005 through 2011 in a tidally influenced shallow freshwater lake (Vancouver Lake, Washington). Cluster analysis, indicator species analysis, and non-metric multidimensional scaling analyses were used to explore interactions between the zooplankton community and multiple environmental variables and stressors. Our results suggest that interannual differences in seasonal zooplankton community succession may be influenced directly by turbidity, cyanobacterial blooms, predatory zooplankton, and invasive zooplankton, and indirectly by orthophosphate availability and temperature. In particular, cyanobacterial blooms may hinder the establishment of non-native zooplankters *Bosmina coregoni* and *Pseudodiaptomus forbesi*. Based on our results, two separate management goals of reducing eutrophic conditions (cyanobacterial blooms) and managing the spread of invasive species may be in conflict. Future studies should examine competition between non-native and native species under eutrophic conditions to better understand the effects and interactions among these two stressors, and the potential long-term consequences of non-native species invasions in zooplankton community dynamics.

THE COASTAL DYNAMICS OF SMALL, DISTRIBUTED RIVER PLUMES UNDER VARIABLE WIND CONDITIONS (TALK)

Emily Lemagie* (Oregon State University, elemagie@coas.oregonstate.edu), Jim Lerczak (Oregon State University, jlerczak@coas.oregonstate.edu)

Keywords: Oregon estuaries, River Plumes, Transport

What happens to the freshwater that enters the ocean from all of Oregon's tiny estuaries? Are there conditions where a steady buoyant coastal current forms, or where outflow from one source could enter adjacent estuaries? To better understand the dynamical balances, spatial structures, and transport pathways in small, distributed, time-dependent river plumes such as these we developed an idealized three-dimensional numerical model of one- and two-river plumes over a continental shelf. During steady calm and downwelling favorable wind conditions the model results indicate a northward flowing buoyant coastal current. Under these conditions, there is evidence that water sourced from one river be transported northward and intrude into other rivers located to the north. Understanding the dynamics of plume water is fundamental for understanding the transport pathways of suspended nutrients, and larvae. The results presented here further our understanding of the coastal dynamics associated with small, distributed river plumes and provide a foundation for future work using a realistic model to investigate the outflow from the distributed rivers along the Oregon coast.

GROWING ROOTS: KWAKWAKA'WAKW CULTIVATION OF THE HIGH ESTUARINE SALT MARSH ON THE CENTRAL COAST OF BRITISH COLUMBIA. (talk)

T. Abe Lloyd, Director, Salal, the Cascadian Food Institute. abe@cascadianfood.net

Keywords: Salt Marsh, Ethnobotany, Traditional Management

Estuaries are the bread basket of every coastal First Nation's traditional territory. The Kwakwaka'wakw people, inhabiting the Central Coast of British Columbia, traditionally cultivated the edible roots of several high estuarine salt marsh species in a garden system called *taki'lakw*. My graduate research employed ethnographic methods to learn from an ancestral steward, Clan Chief Kwaxsistalla, about how the *taki'lakw* was traditional managed. Under Kwaxsistalla's guidance, I then used empirical methods to test the effects of soil cultivation and weeding on the productivity of one edible species, Pacific silverweed (*Potentilla anserina*) in the Kingcome River estuary. After one growing season, I measured a significant increase in the number of *Potentilla* roots in plots that were tilled, and plots that were tilled and weeded, relative to control plots. However, the size of the roots significantly declined and there was no change in overall root biomass. More noteworthy than the statistical results of my short term study, is the awareness that First Peoples have been actively stewarding estuaries for thousands of years, and the disruption of this legacy correlates strongly with the ecological collapse of several coastal estuaries. In essence, humans can maintain healthy coastal ecosystems while simultaneously eating them.

GOLDILOCKS EFFECT IN AN ESTUARY: FACTORS INFLUENCING THE BEHAVIOR OF JUVENILE STEELHEAD (*ONCORHYNCHUS MYKISS*) IN OPEN CONDITIONS OF AN INTERMITTANTLY CLOSED ESTUARY, CALIFORNIA, USA (poster)

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Keywords: Salmonid Behavior, Halocline, Estuary Management.

Many coastal river systems in Mediterranean and drier climates are susceptible to mouth closures due to barrier beach formation. Such closures are ecologically important because they eliminate tidal exchange and, depending duration, can convert an otherwise brackish estuary to a quiescent freshwater lagoon. These changes have profound consequences for fish and wildlife populations occupying lower riverine and estuarine habitats. Management practices affecting the number and duration of mouth closures are used to achieve conditions intended to benefit to a particular population, such as the case for juvenile steelhead (*Oncorhynchus mykiss*) in the Russian River estuary in northern California. Studies documenting steelhead habitat use in coastal estuaries are rare yet such data are critical to understanding how estuaries shape steelhead populations. The overall goal of this research is to improve understanding of ecological tradeoffs associated with estuary barrier beach management practices that manipulate lagoon formation. Objectives include comparisons of movement and habitat utilization during open- and closed-mouth conditions. Juvenile steelhead occupation and movements are estimated with acoustic telemetry. Water quality data facilitates estimates of the water quality habitats occupied. Data to date, under open estuary conditions, suggest less movement and greater site fidelity for individuals residing in areas with a persistent halocline as compared to residents in the areas with a less persistent halocline. When a halocline is present, larger individuals occupy the cooler saltwater below the halocline more often than their smaller counterparts. Sampling has yet to document a closure but is planned to continue in the spring of 2015.

THE CHANGING BENTHIC COMMUNITY IN PUGET SOUND'S COMMENCEMENT BAY FROM 1989-2014 (poster)

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Keywords: marine benthic community, urban bay, sediment monitoring

This study investigates how the benthic macroinvertebrate community in Commencement Bay, WA, has changed over time from 1989 to 2014. The biological samples were collected by Ecology's Marine Sediment Monitoring Program (MSMP) as part of a long-term effort to assess sediment quality in Puget Sound. Commencement Bay is an area of interest because it is a highly urbanized bay that is heavily influenced by anthropogenic factors, and has been part of intensive clean-up efforts since the early 1980s (U.S. EPA, 2010). This poster will include analyses of total species abundance, total species richness, major taxonomic groups, major feeding guilds, and will look more closely at some species of interest. The change between major sample years 1999 and 2008 will be presented, as well as annual data collected at one long-term station from 1989 to 2014. Lastly, relationships among benthic assemblages in the bay over time will also be explored. These data give us a well-rounded picture of the benthic macroinvertebrate community in Commencement Bay and insight into how natural and anthropogenic factors are influencing this community. It may also give us insight into larger ecosystem changes occurring in the Puget Sound.

EFFECTS OF SEAWALL ARMORING ON JUVENILE PACIFIC SALMON DIETS IN AN URBAN ESTUARINE EMBAYMENT (panel)

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Keywords: seawalls, diet, salmon

One of the most important nursery functions of estuaries is the provision of abundant prey resources to juvenile fish. Shoreline armoring compromises epibenthic and terrestrial prey resources, but it is unclear how this affects the feeding ecology of fish, particularly in urban landscapes where armoring is most common. In this study we sampled diets from three species of juvenile Pacific salmon (Oncorhynchus spp.) that fed in shallow habitats of an extensively armored urban estuary. We compared the diets of fish captured at sites armored by intertidal seawalls to those captured at small, engineered beaches without armoring. We also sampled potential prey from the environment concurrently with fish to compare prey availability and diets. The diet composition of small (< 50 mm) chum salmon (O. keta) was significantly different between seawall sites and beaches. Epibenthic copepods were significantly more abundant in these diets and the environment at beaches. At seawall sites, small chum salmon consumed significantly more planktonic copepods, which had similar environmental abundances at seawall sites and beaches. Significant armoring effects were not detected in diets of Chinook salmon (O. tshawytscha), larger chum salmon (≥ 50 mm), or pink salmon (O. gorbuscha), all of which were compositionally different than diets of small chum salmon. These findings suggest effects of armoring on fish diets depend on differences in prey selection among species and life history stages. Further research is necessary to assess effects of armoring on habitat quality because fish may opportunistically consume alternative prey when armoring compromises the prey field.

MEASURING WATER CHEMISTRY AND BIOCHEMICAL CHANGES IN *DUNALIELLA TERTIOLECTA* UNDER DIFFERENT CO_2 LEVELS (poster)

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Keywords: ocean acidification, phytoplankton, water chemistry

One event that is threatening the health of our oceans is ocean acidification. The release of CO_2 levels into the atmosphere keeps increasing every year and about half of that is absorbed into the ocean since pre-industrial times, changing the chemistry of the seawater. These changes have a direct impact on marine species. The phytoplankton is the primary producer in marine food webs, and therefor, plays an important role in the survival of species that depend on it. Their carbon to nutrient stoichiometry and fatty acid content often defines food quality in phytoplankton. With increasing CO_2 levels the effects of ocean acidification and increased carbon availability on phytoplankton need to be investigated. Here, we study the effects different CO_2 levels (400, 800, 1200 pCO_2) have on *Dunaliella tertiolecta* by monitoring the water chemistry as well as phytoplankton growth and biochemistry. By observing the chemical and biological changes, we hope to better understand how ocean acidification will impact the food quality in phytoplankton.

26 YEARS OF BENTHOS! (talk)

Valerie Partridge*, Maggie Dutch, Sandy Weakland (Washington State Department of Ecology); Kathy Welch (formerly Washington State Department of Ecology)

Keywords: Benthic Invertebrates, Long-Term, Community Structure

The Marine Sediment Monitoring Team at the Washington State Department of Ecology has a unique time-series of 26 years of benthic invertebrates collected since 1989 from 10 stations ranging from the Strait of Georgia to Budd Inlet. This long-term monitoring program is important for characterizing ambient sediment conditions and different biotic communities near the base of the food web in diverse habitats of the southern Salish Sea. Relative taxa richness (percent of taxa) by major taxonomic group and by functional feeding guild are approximately constant across these 10 different communities, but relative abundance (percent of organisms) in the same categories vary considerably from station to station. Although the time-series of the data for the individual stations indicate evidence of short-term cycles and/or changes in composition, the communities display considerable fidelity over time.

CARBON SEQUESTRATION IN PADILLA BAY'S EELGRASS MEADOWS (talk)

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Keywords: carbon sequestration, eelgrass meadow, climate change mitigation

The ability of coastal wetlands to sequester carbon in their accumulating sediments has become a topic of interest within the research and restoration communities in recent years. This natural climate change mitigation process is currently being investigated worldwide across a range of coastal wetland types, including tidal marshes, mangroves, and eelgrass meadows. Yet of these three coastal wetland types, seagrass meadows have been relatively under-studied, particularly in the Pacific Northwest, with a great deal of variation in reported carbon accumulation rates. For example, a review of seven available studies worldwide reported rates ranging from 45 to 190 g C m^{-2} yr^{-1} with a mean rate of 138 g C m^{-2} yr^{-1}. To help fill this data gap, I used field measurements of sediment bulk density, organic content, and long-term accretion rates to estimate carbon accumulation rates for the eelgrass meadows in the Padilla Bay National Estuarine Research Reserve in Puget Sound, WA. Sediment cores were obtained from seven

sites along a permanent biomonitoring transect in 2013. Carbon accumulation rates ranged from 9.5 to 51.2 g C m^{-2} yr^{-1}, with a mean of 25.4 g C m^{-2} yr^{-1}. These rates demonstrate Padilla Bay's low carbon sequestration capacity, relative to reported rates from seagrass meadows in other locations as well as other types of coastal wetlands. The low rates seen here result from both low accretion rates and low sediment organic content. Padilla Bay's carbon accumulation rates could therefore be enhanced by restoring the bay's historic sediment supply.

FEEDING BEHAVIOR OF THE MARINE SNAIL *AMPHISSA COLUMBIANA*: CHEMORECEPTION AND FEEDING PARTNERS (poster)

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Keywords: feeding behavior, predators, snails

The gastropod *A. columbiana* is common along the West Coast of the United States in sandy, muddy and rocky substrata from the low intertidal to depths of 125 m. Studies suggest these snails are scavengers, but little is known about how they actually find food. Field observations show that they are often feeding partners with asteroids, though this behavior could put them at risk of predation themselves. Our objective was to evaluate the responses of *A. columbiana* to chemicals released by feeding sea stars to see if they were attracted despite the potential risk. Fed and unfed snails were exposed to streams of 1) seawater, 2) seawater holding a damaged bivalve and 3) seawater holding a seastar feeding on a bivalve. Responses of individual snails to the streams were observed and their choices was recorded. Preliminary results suggest the snails are most strongly attracted to effluent of damaged tissue, followed by effluent from a feeding seastar. This suggests that the chemoreception abilities of *A. columbiana* are optimized to find food, despite the threat of a sea stars. This ability to feed in the presence of a predatory seastar may relate to an unusual defense behavior in this snail species.

ASSESSING THE ROLE OF BIOTIC AND ABIOTIC FACTORS ON THE DEVELOPMENT AND DECLINE OF HARMFUL CYANOBACTERIA BLOOMS IN A TIDALLY-INFLUENCED FLOOD PLAIN LAKE (POSTER)

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Vancouver Lake is a tidally-influenced shallow lake in the Columbia River flood plain. In 2008 and 2009 we conducted bi-weekly dilution and incubation experiments to concurrently measure cyanobacteria/algal growth rates, microzooplankton grazing rates, and mesozooplankton ingestion rates. From April to June of both years, algal growth rates were maximal and microzooplankton grazing rates were low, but cyanobacteria abundance was very low. Cyanobacteria increased dramatically to bloom levels in late July of both years, but for the 2-3 weeks preceding each bloom, algal growth rates and microzooplankton grazing rates were often negative, suggesting a "trophic cascade" effect may have promoted rapid cyanobacteria growth. Grazing rates increased as the bloom progressed, such that by autumn grazing rates were equal to algal growth rates. We used multivariate statistical approaches to assess the relationships between environmental factors (e.g. temperature, nutrients, pH, etc.) and cyanobacteria blooms from 2007-2010, and observed that an increased ratio of PO_4:NO_3 was consistently associated with enhanced cyanobacteria abundance. These results suggest that nutrient availability and zooplankton grazing interact to affect the development and decline of cyanobacteria blooms.

NEW NSF REU SITE AT WASHINGTON STATE UNIVERSITY VANCOUVER: LANDSCAPE ECOLOGY AND ECOSYSTEM DYNAMICS – INTEGRATING AQUATIC AND TERRESTRIAL PERSPECTIVES (TALK)

*Gretchen Rollwagen-Bollens; rollboll@vancouver.wsu.edu, Stephen Bollens; sbollens@vancouver.wsu.edu (School of the Environment, Washington State University Vancouver)

Beginning in June 2015, our NSF-funded Research Experiences for Undergraduates (REU) site at Washington State University Vancouver will provide 9-week immersive summer programs for 8 undergraduate students to gain in-depth exposure to landscape ecology and ecosystem dynamics, in a way that explicitly contrasts terrestrial and aquatic systems. We are targeting non-traditional students that are "place-bound" i.e. unable to leave home for 8-10 weeks, but want and need a challenging and accessible summer research experience to fulfill their professional goals. Our objectives are to 1) engage undergraduates in high-quality research and improve skills in scientific inquiry and communication; 2) engage undergraduates in a comparison of terrestrial and aquatic ecosystems in the Columbia River Basin (CRB); 3) promote collaboration and team-building; and 4) provide meaningful professional development and social opportunities that complement students' research experiences and prepare them for future success.

Each REU student will conduct an independent research project under the direction of a faculty Mentor from the WSU School of the Environment. Students will also attend a weekly seminar focused on landscape ecology and ecosystem dynamics, as well as topics to build inquiry skills and scientific communication. The group will participate in two field trips in the upper and lower CRB, attend weekly social events, and present their research at a poster symposium on the WSU Pullman campus. Students will be recruited from the Vancouver-Portland metro area of >2 million people, in order to select students from diverse backgrounds, including community college students and those attending 4-year institutions.

INTERACTIVE EFFECTS OF PHOSPHORUS AND ZOOPLANKTON GRAZING ON HARMFUL ALGAL BLOOMS IN A SHALLOW TEMPERATE LAKE (poster)

Vanessa Rose* (Washington State University, vanessa.rose@email.wsu.edu), Gretchen Rollwagen-Bollens (Washington State University, rollboll@vancouver.wsu.edu), Stephen Bollens (Washington State University, sbollens@vancouver.wsu.edu)

Keywords: cyanobacteria, phosphorus, trophic-cascade

Globally, harmful blooms of algae and/or cyanobacteria are occurring at increased frequencies in aquatic systems. Such blooms are considered harmful when they produce toxins, alter food webs, or deplete oxygen levels. Algal/cyanobacterial growth is moderated by grazing (top-down control) or nutrient availability (bottom-up control). Our goal was to examine the interactive effects of phosphorus and grazing on growth of algae/cyanobacteria in a shallow temperate lake (Vancouver Lake, Washington) where cyanobacteria blooms are an increasing problem. Two factorial experiments using lake water, containing natural plankton assemblages, incubated with amended phosphate, mesozooplankton (copepod) grazers, or both, were conducted every other week through July and August and once in October. Net growth rates were calculated based on concentrations of chlorophyll *a* in each treatment. For three experiments (one pre, mid, and post-bloom), cell counts were performed to calculate net growth of six microplankton groups to further assess treatment and/or interaction effects. Field data revealed bloom formation in late July and decline in September. Results indicated that algae/cyanobacteria experienced growth enhancement from phosphorus early in the pre-bloom period, growth reduction by copepod grazing in the post bloom period, but more complex interactive effects immediately prior to and at peak bloom times. Integration of data from cell counts show that selective grazing by copepods may be aiding growth limitation on algae pre-bloom but enhancing mid-bloom growth through trophic cascade events.

Our results reveal how connected and variable the effects of grazers and nutrients are on a dynamic plankton community throughout an algal bloom cycle.

SHORELINE RESTORATION DESIGN TO FACILITATE SPAWNING ACTIVITY OF FORAGE FISH (talk)

James Selleck (Hart Crowser, james.selleck@hartcrowser.com)

Keywords: Restoration, Forage Fish, Habitat

Shoreline restoration is an action agenda item for the Puget Sound Partnership, Puget Sound Initiative, and other local agencies. Projects range from small bulk head removal and shoreline modifications, to large-scale remediation and restoration funded through the Department of Ecology. Hart Crowser has conducted a variety of these projects over the past several years, and the results are beginning to describe a recipe for success. Traditional ideas of forage fish spawning habitat requirements include adequate shading, proper substrate grain size, and beach access to specific tidal ranges. Designing a beach restoration to meet these requirements is important, but does not guarantee forage fish will return to spawn there. Surveys from post-restoration monitoring have found that factors such as beach orientation, localized tidal activity, and beach slope gradient also contribute to spawning presence and successful egg development. We have found strong spawning activity even in the absence of shading, when other factors were met. Sediment size was found to be especially important for egg survival, as eggs that become buried just below the surface of the substrate, as a result of moderate wave action, experienced decreased desiccation as a result of limited exposure, even for summer spawning surf smelt. These results are important as continued efforts to restore Puget Sound shorelines are funded and researched.

BACTERIA CHARACTERIZATION OF MICROBIAL MATS FOUND IN MARINE SEDIMENTS ENRICHED WITH ORGANIC MATTER (poster)

Adriana Sepúlveda* (University of Puerto Rico at Mayagüez, adriana.sepulveda@upr.edu), Sylvia Yang, Western Washington University, sylvia.yang@wwu.edu)

Keywords: bacteria, sediment, eutrophication

Throughout past decades, there have been increases in organic matter input into bodies of water locally and globally through sources such as algal blooms as a result of eutrophication and sawmill wood waste. Sulfides are produced when bacteria consume this carbon-rich organic matter for energy and reduce sulfate molecules to obtain oxygen. These bacteria can be found in sulfidic sediments. This study wishes to characterize bacterial diversity and abundance in microorganismal mats grown on marine sediment cups treated with four different carbon sources: Sawdust, phytoplankton, sucrose, and agar. Carbon treatments consist of three levels: 1.0 g carbon, 4.5 g carbon, and 9.0 g carbon. Characterization will be done using microscopy, genetic, and molecular biology techniques. Observations prior to sampling include noting visual patterns, textures, and colors of mats that may potentially indicate the presence of sulfate-reducing bacteria. Preliminary data of percent surface coverage of different mat types show that white film-textured mats are significantly abundant in phytoplankton treatments. Control groups, which contain no additional carbon source enrichment, and sawdust treatments showed no apparent mat formation in any treatment level or replicate.

ACHIEVING "NO NET-LOSS" GOALS THROUGH MITIGATION (talk)

Nam Siu* **(**Marine Surveys & Assessments, marine.surveys.inc@gmail.com)

Keywords: Mitigation, No-Net-Loss, Planning

Most if not all shoreline development projects in the Puget Sound will have unavoidable impacts to ecosystem functions due to their location within the Critical Habitat (CH) of endangered, threaten, and sensitive species, as well as Fish and Wildlife Habitat Conservation Areas (FWHCA), and its buffers. The adaptation of newly updated Shoreline Master Programs (SMPs) in many counties throughout the sound aims to minimize and mitigate for these unavoidable impacts in accordance to new "no net-loss" (NNL) standards and guidelines. Marine Surveys and Assessments (MSA) are experienced marine environmental consultants who have worked in the Puget Sound area for over fifteen years witnessing the implementation and use of various SMPs throughout these years. Our presentation will review the interpretation of this new NNL standard and its guidelines, how MSA has incorporated NNL into our consultations and mitigation planning, provide some examples of NNL mitigation, as well as discuss problems facing NNL mitigation.

TOLERANCE OF EELGRASS TO SYSTEMATIC BURIAL: WHEN PRODUCTIVE HABITAT PRESENTS AN OBASTACLE TO REMEDIATION OF LEGACY CONTAMINATION IN PUGET SOUND (talk)

Jason Stutes (Hart Crowser, jason.stutes@hartcrowser.com), Emily Duncanson (Hart Crowser, emily.duncanson@hartcrowser.com), Hun Seak Park (WA Dept. of Ecology, HPar461@ECY.WA.GOV), Peter Adolphson (WA Dept. of Ecology, pado461@ECY.WA.GOV)

Eelgrass habitat across Puget Sound may coincide with areas of legacy contamination associated with the wood processing industry. As a consequence, the Washington Department of Ecology, Toxic Cleanup Program explored capping alternatives for remediating existing eelgrass habitat for low/intermediate levels of dioxin/furan contamination. Remediation of legacy contamination in these habitats presents a unique problem where traditional capping may adversely affect or eliminate the habitat. Such a situation exists in Fidalgo Bay at the Custom Plywood MTCA cleanup site in Anacortes. We examined the effects of various cap thicknesses and amendments on eelgrass survival and health in seven test plots. During 2013, sand caps of 4″ and 8″ (sand only and sand amended with activated carbon) were applied to these seven plots, and eelgrass metrics (density, biomass, etc.) were surveyed and compared to control and reference plots. Results suggest that eelgrass will not tolerate a sand cap thickness of 8 ″ (near 80% reduction in biomass when compared to control), but will tolerate a 4 ″ cap. When compared to control plots, the 4″ plots exhibited a distinct reduction in eelgrass density and biomass followed by a recovery phase. Eelgrass did not seem to react differently to the carbon amendment except in the 8 ″ plots which suggests the recovery phase was enhanced by the presence of activated carbon. Plots were resurveyed in 2014 which demonstrated similar long-term recovery trends to the short-term trends documented in 2013. These findings potentially provide design alternatives for remediating legacy contamination within existing productive eelgrass habitats.

CONTRASTING FISH AND CRAB ASSOCIATIONS WITH THE EXOTIC SEAGRASS *ZOSTERA JAPONICA* AND ITS NATIVE CONGENER *ZOSTERA MARINA* (poster)

Daniel Sund (College of Earth, Ocean, Atmospheric Sciences, Oregon State University); Brett Dumbauld (US Department of Agriculture, Agricultural Research Service, Hatfield Marine Science Center)

Keywords: invasive species, intertidal, fish, crab, seagrass

Introduction of non-native species often results in fundamental changes in the structure and function of perturbed environments. The introduced seagrass *Zostera japonica* is rapidly expanding in Pacific Northwest estuaries. A number of studies have compared benthic and epifaunal communities in *Z. japonica* to those of native, *Z. marina*, but to date none have examined use by larger and more mobile fish and crab. The goal of this project was to examine the community composition of a variety of intertidal estuarine habitats in Willapa Bay, Washington and Yaquina Bay, Oregon including *Z. japonica*, *Z. marina*, clam aquaculture, on-ground oyster aquaculture and bare substrate via paired deployment of cameras and small fish traps. A total of 11 species of fish and invertebrates with 10 occurring in Willapa Bay and 9 in Yaquina Bay were observed in video footage. Habitat type was a significant predictor of the most abundant species in Yaquina Bay, but not in Willapa Bay. Community composition was significantly different between habitats in each bay, but not between bays and subsequent tests suggests that community composition of the two seagrasses differed in Yaquina Bay, but not Willapa Bay. We conclude that community composition varies little at the regional scale and that local variation is highly dependent on the availability of structured habitats. Additionally, the distribution of *Z. japonica* relative to *Z. marina* likely drives differences in community composition between seagrass habitats within the two bays.

SEAGRASSNET: SEASONAL MONITORING OF TWO SEAGRASSES, ZOSTERA MARINA AND ZOSTERA JAPONICA, AT DUMAS BAY, WASHINGTON (poster)

Sutton, E, L. Ferrier, J. Gaeckle (Nearshore Habitat Program, Aquatic Resources Division, Washington State Department of Natural Resources)

SeagrassNet is a global seagrass monitoring program that is now established in 33 countries with 132 monitoring sites world-wide. Standardized protocols for scientific monitoring have been developed and are successfully implemented by trained teams of local scientists and managers. Quarterly fixed-transect sampling is carried out at sites for seagrass species composition, cover, density, biomass, canopy height, and depth distribution, as well as temperature, salinity, and light. A monitoring team at each site sends data via the internet to an online database and archive at www.SeagrassNet.org.

The Washington State Department of Natural Resources' Nearshore Habitat Program, established a SeagrassNet site at Dumas Bay in May 2008. Six years of sampling show seasonal patterns in seagrass species (*Zostera marina* and *Zostera japonica*) composition, shoot morphology and density, percent cover, and above- and below-ground biomass along transects established at +1 m, 0 m, and -1.6 m MLLW. Declines in *Z. marina* are evident at the site, and specifically at the highest and lowest tidal elevation transects (+1 m and -1.6 m, respectively). The cause of declines are currently unknown but could be related to increased environmental stressors or water clarity. Long-term assessment of seagrass resources elevates the visibility of this important nearshore habitat and provides a barometer of direct anthropogenic and global climate change impacts.

CONTINUOUS MONITORING OF SALINITY PROFILES IN ESTUARIES FROM A SEAFLOOR INSTRUMENT (POSTER)

Zoltan B Szuts* (University of Washington, Applied Physics Lab (UW/APL), zszuts@apl.washington.edu), Thomas B Sanford (UW/APL, sanford@apl.washington.edu), Andy A Ganse (UW/APL, aganse@apl.washington.edu), Nathan Lauffenburger (formerly at UW/APL, now at NOAA Alaska Fisheries Science Center, Resource Assessment and Conservation Engineering Division, Nathan.lauffenburger@noaa.gov)

Keywords: environmental monitoring, pollution, circulation

The salinity of estuarine water is a fundamental descriptor of estuarine circulation and is a critical quantity used to monitor the distribution of freshwater, nutrients, and pollutants for addressing scientific and societal concerns. A new instrument provides salinity sampling capabilities well suited for the estuarine environment: from the seafloor, it remotely measures the salinity profile in the overlying water column and provides inexpensive, robust, and long-duration sampling. The instrument, called a Sigma Profiler, uses electromagnetic fields emitted at multiple frequencies to invert for the electrical conductivity profile. We present measurements from a first deployment in the Columbia River, where continuous measurements over 2 weeks resolve the strong fortnightly modulation of the bottom salt wedge with the spring-neap tidal cycle. During spring tides, the salt wedge disappears entirely during the stronger ebb tide, while during the weaker neap tides the salt wedge is always present. From the depth of the salt wedge (seafloor to salinity interface) and its conductivity, we can constrain the amount of mixing or dilution of the salt wedge. These measurements of the evolution of salinity profiles constrain the balance between freshwater outflow and mixing (from wind stress, bottom boundary stress, or velocity shear), a balance that is hard to parameterize in numerical models. Future deployments in Puget Sound will focus on monitoring the frequency and horizontal extent of river plumes carrying high fecal coliform concentrations to shellfish beds.

VOLUNTEERS, VOLUNTEERING DATA, AND VOLUNTEER SCIENTISTS (TALK)

Jason Toft* (University of Washington, tofty@u.washington.edu), Leska Fore (Puget Sound Partnership, leska.fore@psp.wa.gov), Casey Rice (NOAA, casimir.rice@noaa.gov)

Keywords: Citizen science, shorelines, intertidal

Long-term datasets are rare, especially field-based data with a broad spatial scale. We describe a collaborative effort with the Island County Beach Watchers organization at Washington State University (*volunteers*), which has citizen scientist collected data from Whidbey and Camano Islands going back to 1994 (*volunteering data* for someone to analyze), that we (the *volunteer scientists*) are in process of analyzing. This dataset has never been adequately analyzed, and presents an opportunity to address systematic research questions, fulfill gaps in knowledge for effective management decisions, and provide feedback to the network of volunteers on what the data can be used for. The dataset was generated by volunteers going to beaches on an annual basis with the goal to collect baseline data over time at specific monitoring sites and to document changes, if any, to beach slope, substrate, and biodiversity. Data on slope and substrate were collected along transects perpendicular to shore spanning high to low tidal elevations, and biodiversity of surface epifauna and algae along transects parallel to shore at low tidal elevations. We will present our initial results, focusing on patterns of eelgrass increase/decrease over time, patterns of taxa richness with shore types (bluff-backed vs accretion) and beach slope variability (changes in profile), and patterns of algae and invertebrate community and sediment composition. Our goal is that this will help coordinate questions being asked of citizen science data, and inform the level of effort needed to properly analyze similar datasets.

EAVESDROPPING ALGAE: CHEMICAL SIGNALING, GROWTH AND HERBIVORY IN *ULVA LACTUCA* (poster)

Giovanna Tomat-Kelly* (The College of New Jersey, kellyg3@tcnj.edu), Kathy Van Alstyne (Shannon Point Marine Center, kathy.vanalstyne@wwu.edu), Suzie Gifford (Shannon Point Marine Center, suzie.gifford@wwu.edu)

Keywords: eavesdropping, marine, ecology

Dimethylsulfoniopropionate (DMSP) is an organic compound commonly found within marine algae. It occurs in especially high concentrations in algae in the genus *Ulva*. DMSP functions as an activated defense system against herbivores. Activation is initiated when DMSP-containing cells are damaged by herbivore grazing, causing DMSP cleavage. This results in two products: dimethylsulfide (DMS) and acrylic acid, both of which function as herbivore deterrents. There is now increasing evidence that DMS may also function as an airborne chemical signal in marine systems. DMS produced by herbivore-damaged macroalgae has been shown to stimulate the production of DMSP within neighboring macroalgae. Hence, there is evidence of intraspecific "eavesdropping" between macroalgae, with DMS functioning as the airborne signaling molecule. Airborne signaling is a well-studied process in terrestrial ecosystems, but is an entirely new and unexplored concept in marine systems. The purpose of this study was to better understand the role of DMS as an airborne signal in marine ecosystems by testing whether eavesdropping between macroalgae affects algal growth and the rates of herbivory on macroalgae by natural consumers. To accomplish this, eavesdropping between the macroalgae *Ulva lactuca* was simulated by exposing algae samples to DMS. DMS-exposed and control algae were then fed to *Lacuna vincta* snails to test if snails ate less of the algae exposed to DMS. We also measured differences in growth in control and treated algae. Preliminary results suggest eavesdropping between *U. lactuca* increases herbivory of *L.vincta* and increases algal growth.

EXAMINING INDUCIBLE DEFENSES TO NOVEL PREDATORS (talk)

Brian Turner* (Department of Environmental Science and Management, Portland State University, bcturner@pdx.edu), Catherine de Rivera (Department of Environmental Science and Management, Portland State University, derivera@pdx.edu)

Keywords: Invasive Species, Predator-Prey Interactions, Organism Behavior

Invasive species that can identify and respond to novel, native predators in a manner that reduces predation risk, such as the expression of inducible defenses, will be more likely to establish and spread. Few studies have examined if native predators trigger inducible defenses in invasive species, and those that have used species that have coexisted for decades rather than prey naïve to predator cues. Naïve specimens, particularly from their native range, would best represent how a species responded to predator presence and activity during the earliest stages of the invasion process. Specimens of the purple varnish clam (*Nuttallia obscurata*), a species native to Asia and introduced to the Pacific Northwest (PNW), were collected at Whalen Island, Oregon. Tethered *N. obscurata* increased their burrowing depth in the presence of risk cues (PNW crab predators with crushed *N. obscurata*), with burrowing depth varying with predator identity. When exposed to individual risk cues, clams burrowed deepest in response to the physical presence of Dungeness crabs (*Metacarcinus magister*). Our upcoming work will compare responses of clams from Japan to specimens from two locations in the PNW, Oregon and British Columbia, when exposed to *M. magister*. We hypothesize that only specimens from PNW will respond to predator cues with increased burrowing depths.

EFFECT OF HIGH LIGHT STRESS ON PHOTOSYNTHETIC EFFICIENCY AND DIMETHYLSULPHONIO-PROPIONATE (DMSP) RELEASE IN DIPLOID AND HAPLOID LIFE STAGES OF THE COCCOLITHOPHORE *EMILIANIA HUXLEYI* (poster)

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Keywords: Emiliania huxleyi, High light, DMSP, Chemical signals, Chlorophyll, F_v/F_m

The cosmopolitan marine phytoplankton species *Emiliania huxleyi* presents a digenetic heteromorphic life cycle, with the non-motile diploid phase bearing coccoliths and the flagellated haploid phase being non-calcified. *E. huxleyi* contains high concentrations of dimethylsulphoniopropionate (DMSP), the precursor of dimethylsulphide (DMS). DMSP is a multifactorial compound; it acts as a compatible solute in cell metabolism and as a chemical signal influencing bacterial and protist behavior. In the atmosphere DMS enhances cloud formation influencing climate. However, little has been documented on *E. huxleyi* chemical signal responses to high light stress, and how this relates to the heteromorphic life cycle. To this end, low light acclimated cultures of both haploid and diploid *E. huxleyi* were exposed to high light for 2 hr and allowed to recover in low light for 2 hr. During and after these treatments, growth, photosynthetic efficiency (Fv/Fm), DMSP (intracellular and released) and cell chlorophyll content were measured. Our preliminary results suggest that presence of high light decreased Fv/Fm to a greater extent in haploid than in diploid (calcified) cells, while recovery of Fv/Fm was rapid in both life stages.

DIFFERENTIAL GENE EXPRESSION IN OLYMPIA OYSTER (OSTREA LURIDA) GONADAL TISSUE (poster)

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Keywords: Olympia oyster; gene expression; gonad

Genomic tools provide useful insights to the physiology of an organism and aid in effective conservation strategies. Variations in gene expression can be used to monitor physiological responses corresponding to environmental changes. Establishment of genomic baseline data is deficient for many vulnerable aquatic species, which could benefit from the usage of such tools for conservation management and ecological monitoring. Expanding publicly available genomic databases for the Olympia oyster (*Ostrea lurida*) will enhance resources that can be used to help sustain populations. This study extends *O. lurida* baseline genomic tools through annotation of larval transcriptome data and evaluation of differential gene expression in adult male and female gonadal tissue. Larval transcriptome annotation identified over 12,000 different contiguous sequences using BLAST algorithms. Multiple protein and RNA databases available through NCBI were used for annotation of contiguous sequences for both larval and gonadal samples. Differential gene expression of male and female gonadal tissue was compared using DESeq analyses, which highlighted 1289 specific genes expressed significantly higher in male and 2284 genes in female. Differentially expressed genes were categorized by biological process using Gene Ontology Enrichment Analysis terms. Enrichment analyses showed differentially expressed genes were involved in cellular transportation of ions, the N-glycan biosynthesis pathway, and reproductive functions. Results from this study expand currently available genomic resources for *O. lurida* and provide tools that can used to develop more effective conservation strategies.

BIOLOGICAL AND PHYSIC OCEAN INDICATORS PREDICT THE SUCCESS OF THE INVASIVE EUROPEAN GREEN CRAB (talk)

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Keywords: population, recruitment success, invasive species

An introduced population of European green crabs (*Carinus maenas*) was established in San Francisco Bay sometime prior to 1989 and soon after, during the extended El Niño event of the mid 1990s, their larvae were carried northward via the coastal Davidson current. This current was especially strong during the unusually warm and strong El Niño of 1997-1998, after which a strong new cohort of green crabs appeared in Oregon, Washington and British Columbia embayments. Since this initial colonizing event, green crabs in Oregon and Washington have persisted at low densities. We show here that after the arrival of the strong founding year class of 1998, significant recruitment to the Oregon and Washington populations occurred only in 2003, 2005, 2006 and 2010. Warm winter water temperatures, high Pacific Decadal Oscillation and Multivariate ENSO (El Niño Southern Oscillation) Indices in March, weak southward shelf currents in March and April, late biological spring transition and high abundance of subtropical copepods are all strongly correlated with the establishment of strong year-classes. The opposite condition characterizes years of year class failure. These oceanographic and biological indices can be used to predict the arrival of strong year classes of green crabs and to alert managers and shellfish growers of possible increases in predation pressure from this invader.

GROWTH AND LONGEVITY OF THE RED ROCK CRAB, CANCER PRODUCTUS (talk)

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Key words: life history, mark-recapture, recreational fishery

Red rock crabs, *Cancer productus*, are an important component of Pacific Northwest nearshore ecology and its crab fisheries. While an understanding of life history parameters are critical to fisheries management, few studies have been conducted on red rock crab. We studied growth and longevity of the red rock crab at two sites representing a heavily fished saline estuary population (Coos Bay, OR) and an unfished population (Friday Harbor, WA).

Growth in crustaceans is incremental and age classes are unmixed, making these investigations difficult. We used an array of techniques including size distribution analysis, growth within confinements, and tagging in describing the life history of *C. productus*. Our ongoing field work includes tagging studies at both sites. Preliminary data shows 20-30% growth per molt increment and variability of intermolt period and timing related to size and sex. Longevity appears longer than previously described. In addition, fishing effects are clear between the populations.

IS MACROALGAL ACCUMULATION A RELIABLE INDICATOR OF INFAUNAL STRESS IN AN OREGON ESTUARY? (panel)

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Keywords: macroalgae, porewater sulfides, infauna

A frequently used indicator of estuarine condition is the accumulation of benthic macroalgae. We compared the biomass of the predominant green macroalgae *Ulva*, the development of toxic sulfides in surficial sediment pore water, and the abundances of infaunal organisms at high and low sulfide sites in Yaquina estuary, Oregon. At the high-sulfide site the median pore water sulfide concentration in the upper intertidal zone between September and November was 80 µM, three orders of magnitude above that at the low-sulfide site (0.1 µM) and four times the median LC_{50} reported for crustaceans and mollusks (~20 µM). This suggests that toxic concentrations of dissolved sulfides occurred only at the high-sulfide site, in late summer and early fall. Infaunal amphipod counts at this site were 17-fold lower than at the low-sulfide site, and substantially lower burrow densities of benthic shrimp at the high-sulfide site also were observed. In contrast, average values for macroalgal accumulation at the high- and low-sulfide sites in the peak season agreed within about a factor of two (225 and 120 gdw m^{-2}, respectively), and were not significantly different. These results suggest that macroalgal biomass alone is not a reliable indicator of benthic condition in Pacific Northwest coastal estuaries.

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