Towards an Estuarine Ethic: Integrating Science and Stewardship

36th Annual Meeting
April 4 – 7, 2013

Delta Town & Country Inn
Delta, B.C.

PERS
PACIFIC ESTUARINE RESEARCH SOCIETY

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36th Annual Meeting
Pacific Estuarine Research Society

Delta Town and Country Inn
Delta, B.C.

April 4–7, 2013

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SCHEDULE AT A GLANCE

Thursday, April 4th – Riverhouse Pub

6:30 - 9:00	Opening Registration & Mixer

Friday, April 5th - Delta Town & Country Inn Ballroom

7:30 – 8:30	Registration & Poster Setup
8:30 – 9:30	Welcome & Meeting Comments
9:30 – 10:15	Poster Previews
10:15 – 11:00	*Coffee Break & Poster Session 1, Reifel Room*
11:00 – 12:00	Oral Presentations 1 – Shellfish Population Dynamics
12:00 – 1:30	*Lunch*
1:30 – 2:15	Oral Presentations 2, Seagrass Dynamics
2:15 – 3:15	Oral Presentations 3, Ocean Dynamics, Health of Marine Sediments & Marine Species
3:15 – 4:15	*Coffee Break & Poster Session 2, Reifel Room*
4:15 – 5:15	Oral Presentations 4, Role of Sediments in Estuaries & Coastal Watershed Partnerships
5:15 – 6:15	PERS Business Meeting
6:30 – 9:00	Banquet, Terrace Room
	Port Sponsor Welcome – Darrell Desjardin, Port Metro Vancouver
	Keynote Speaker – John Rybczyk, Western Washington University

Saturday, April 6th - Delta Town & Country Inn Ballroom

9:00 – 10:15	Oral Presentations 5, Restoration Effects on Habitat Quality
10:15 – 11:00	*Coffee Break & Poster Session 3, Reifel Room*
11:00 – 12:00	Oral Presentations 6 – Dynamics in Estuaries & Effects of Climate Change
12:15 – 1:30	*Lunch*
1:30 – 2:00	Student Awards
2:00 – 2:30	Acknowledgements & Closing Remarks

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MEETING NOTES

Meeting Site: The conference site is the Delta Town and Country Inn, 6005 Highway 17 at Highway 19 in Delta, B.C. (Figure 1, page 3). Scientific presentations will take place in the Ballroom and posters will be shown in the Reifel Room. The Friday evening banquet will occur in the Terrace Room.

Meeting Check-in: Registration check-in desks will be set up at the Riverhouse Pub on Thursday evening and in the lobby of the Delta Town and Country Inn on Friday and Saturday mornings. All persons attending the PERS annual meeting must please check in to receive their registration materials (i.e. name badge, banquet ticket and program guide.

Social Events

Opening Mixer: In keeping with PERS tradition, an opening mixer will be held from 6:00 – 9:00 on Thursday evening (April 4) at the Riverhouse Pub, 5825 60th Avenue, Delta, located approximately 1.1 km (0.7 mi) behind the Delta Town and Country Inn (Figure 2, page 3). As part of the registration, the mixer will feature locally brewed Stanley Park beer and B.C. Sonoma Ranch wine, as well as appetizers (tea sandwiches and vegetable, cheese & Salish Sea platters). Tickets for 2 beers, glasses of wine, or soft drinks will be handed out at the door. The pub features a river rock fireplace, deck overlooking Deas Slough in the Fraser River estuary. The mixer is a great place for PERSians to reconnect and for new members to establish some professional contacts and mentors. A conference registration table will be setup at the entrance to the pub.

PERS Banquet: All registrants will receive a ticket for themselves and their paid guest to attend the PERS Banquet on Friday, April 5, from 6:30 – 9:30 in the Terrace Room, Delta Town and Country Inn. The ticket covers buffett diner and each table will have a bottle of white and red wine. As well, a no-host bar will be set up. PERS is pleased to acknowledge our major sponsor, the Port of Metro Vancouver, and Darrell Desjardin, Director, Environment and Sustainability, will provide a welcoming address.

Keynote Speaker: The banquet will feature our Keynote Speaker, Dr. John Rybczyk, presenting "**Estuarine restoration and rising sea levels: lessons from the Red Queen**". John is a professor and chair of the Department of Environmental Science, at Huxley College, Western Washington University, where, among other duties, he teaches the largest course on campus, Environmental Studies a Scientific Approach, to 450 students every quarter. Over the past twenty years, he has worked towards the development of integrated field and modeling programs designed to predict the effects of rising sea levels on coastal ecosystems. Early efforts were directed towards the wetlands of the Venice Lagoon in Italy and the Ebro Delta in Spain. Latter research in Honduran mangrove systems and in the Mississippi River Delta led eventually to his current position in the Pacific Northwest, where he has worked for the past twelve years in Willapa Bay, Padilla Bay, Skagit Bay and the Stillaguamish Delta. Versions of his models have been used by the USGS and the National Estuarine Research Reserve System to help predict the effects of rising sea levels on coastal. This past year, the State of Louisiana used his Relative Elevation Model to help guide a 50 billion dollar coastal restoration effort.

Although he spends most of his free time these days keeping a three year old son and seven year old daughter alive and fed; when the tides are neap and he can't get out to his field sites, he enjoys playing music on various stringed instruments, skiing, kayaking, fishing and all of the other typical outdoor stuff that all of us like to do in this part of the world.

PERS Silent Auction: You are invited to bid on items generously provided by PERSians and supporters that are displayed during the Friday meeting. Proceeds from the Auction go towards supporting student grants to attend and present at PERS and CERF meetings and supplement research costs. The auction winners will be announced at the banquet following the keynote address.

Meeting Information:

Oral Presentations: Each presentator has 12 minutes for their presentation and 3 minutes for questions. Session Chairs will be responsible for keeping presentations to time restrictions to ensure we keep to our meeting schedule. The meeting will be using a PC equipped with Windows 7.0 and PowerPoint for presentations. Please download your presentation to the meeting PC prior to your presentation session.

Poster Presentations: Posters will be displayed in the Reifel Room, located adjacent the lobby in the Delta Town and Country Inn. Please set up during Friday morning or during first coffee break. Pins are not to be used to attach posters to the wall and we are planning to have poster stick-ons available. Posters will be arranged alphabetically along the wall space.

Lunches: Lunches are on your own and we have tried to allow ample time for meeting participants. The nearest restaurants include Meadow's Restaurant which is actually part of the Delta Town and Country Inn, Riverhouse Restaurant, or Riverhouse Pub. Both the Inn and Riverhouse are "up-staffing" to accommodate the PERS meeting. The closest "off-site" restaurants are located in Ladner, which has a typical range of fast food and community restaurants, and Tsawwassen further down highway #17 has a range of suitable eateries.

Coffee Breaks: Coffee and tea are provided pre-meeting and at coffee breaks. The pre-meeting coffee includes a "bakery basket" with muffins and pasteries.

Optional Field Trips: There are numerous sites to explore Boundary Bay, Roberts Bank, and the Fraser River estuary from the meeting venue. Regional Parks (e.g. Deas Island, Boundary Bay, and Mud Bay) and the dike trails offer excellent walking, jogging biking, and bird watching opportunities. The Millennium Trail along the south shore of Deas Slough can be accessed from the Riverhouse Pub. The trail is 4.3 km (2.7 mi) to Ladner Village to the west or 1.6 km (1 mi) to Deas Island Regional Park to the west. The Reifel Migratory Bird Sanctuary on Westham Island is a local favourite and is lovely pastoral drive.

Depending on travel plans, there are opportunities to "get outside" on your own or conduct a PERS field trip along the sea dike along Roberts Bank to observe the intercauseway area that features tidal mudflats, eelgrass beds, Tsassawwasen salt marsh, and Port Metro Vancouver's newly constructed Deltaport Third Berth container terminal. The area is home to the Tsawwassen First Nation community, staging area for migratory birds, and great blue heronry along the Tsawwassen bluffs at the western end. It provides an excellent example to illustrate estuarine on-going development pressures, invasive plants, and ecological management efforts.

Figure 1. Regional location of PERS Annual Meeting venues.

Figure 2. Location of Delta Town & Country Inn and Riverhouse Restaurant & Pub.

ANNUAL MEETING PROGRAM SCHEDULE

Thursday, 4 April 2013

6:00 – 9:00 PM	**Opening Registration & Mixer – Riverhouse Pub**
Friday, 5 April 2013	**Science Sessions in the Ballroom, Delta Town & Country Inn**
7:30 – 8:30	**Registration & Poster Installation**
8:30 – 8:45	**PERS Welcome** – Gary Williams, President
8:45 – 9:00	**CERF Welcome** – Mark Wolf-Armstrong, Executive Director
9:00 – 9:30	**Ceremonial Welcome** – Tsawwassen First Nations (to be confirmed)
9:30 – 10:15	**Poster Previews (Authors present 2 min summary of poster)**
10:15 – 11:00	*Coffee Break & Poster Session 1, Reifel Room*
11:00 – 12:00	**Oral Presentations 1 – Shellfish Population Dynamics** Chair: Rob Russell
11:00	**O1-1. Estimating production of juvenile Dungeness crab, M*etacarcinus magister* in Pacific oyster aquaculture versus native oysters and eelgrass habitat in Willapa bay, Washington** Brett R. Dumbauld*, Lee McCoy, USDA-ARS, Hatfield Marine Science Center, Newport, OR; Jessica Ramsay, Environmental Sciences, Oregon State University, Corvallis, OR
11:15	**O1-2. Subtidal bay clam populations in Tillamook Bay, Oregon: comparison to intertidal populations and implications for shellfish management** Anthony F. D'Andrea*, Stacy Galleher, Amy Hutmacher, Natalie Amoroso, Kami Earl; Oregon Department of Fish and Wildlife, Marine Resources Program, Newport, OR
11:30	**O1-3. Overcompensation and the European Green Crab** Brian C. Turner*, Catherine de Rivera, Portland State University
11:45	O1-4. **The arrival and currents status of the European green crab in the Pacific Northwest.** Sylvia Behrens Yamada*, Zoology Department, Oregon State University, and Graham E. Gillespie, Fisheries and Oceans Canada
12:00 – 1:30 PM	*Lunch (On your own at Meadow's, or Riverhouse Restaurant & Pub)*
1:30 – 2:15 PM	**Oral Presentations 2 – Seagrass Dynamics** Chair: Tony D'Andrea
1:30 PM	**O2-1. Seasonal growth of two seagrasses with overlapping distribution in the Salish Sea: the non-native eelgrass, *Zostera japonica*, and the native eelgrass, *Z. marina*.** Douglas Bulthuis*, Heath Bohlmann, Nicole Burnett, and Suzanne Shull; Padilla Bay National Estuarine Research Reserve, Mount Vernon, WA
1:45 PM	**O2-2. Large scale changes in eelgrass (*Zostera marina* and *Z. japonica*) distribution over a large tidal flat in southern British Columbia over a 43 year period, and small scale changes over a 10 year period.** Cynthia Durance, Precision Identification, Vancouver, B.C.
2:00 PM	**O2-3. Blue carbon in the Comox Valley: the benefits of eelgrass and salt marsh restoration in coastal communities** Christine Hodgson, North Island College, Courtenay, B.C.

Friday, 5 April 2013

2:15 – 3:15 PM	**Oral Presentations 3 – Ocean Dynamics, Health of Marine Sediments & Marine Species** Chair: Adrienne Stutes
2:15 PM	**O3-1. Good news and bad news in Salish Sea sediments: wide-scale declines in benthic community health despite decreasing contaminant levels** V.A. Partridge*, M.E. Dutch, S. Weakland, K.I. Welch, E.R. Long, Washington State Department of Ecology, Olympia, WA
2:30 PM	**O3-2. Spatial and temporal trends in trophodynamics among pelagic fish and jellyfish in the Puget Sound: a stable isotope analysis** Sean Naman*, Department of Zoology, University of British Columbia; Correigh Greene[2], Casimir Rice[2], Linda Rhodes[2], Jason Hall[2], Josh Chamberlin[2], Douglas Burrows[2], Northwest Fisheries Science Center, National Marine Fisheries Service
2:45 PM	**O3-3. Spatial and temporal patterns in oxygen and nutrient dynamics in Bellingham Bay** Jude K. Apple*, David Shull, Sarah DeLand, Western Washington University; Lance Brockie, Charlotte Clausing, Joel Green; Northwest Indian College
3:00 PM	**O3-4. Predicting the success of marine species from ocean conditions**. Sylvia Behrens Yamada* Zoology Department, Oregon State University; Bill Peterson, NOAA; Bryan Black, University of Texas, Austin
3:15 – 4:15 PM	*Coffee Break & Poster Session 2*
4:15 PM	**Oral Presentations 4 – Role of Sediments in Estuaries & Coastal Watershed Partnerships** Chair: Si Simenstad
4:30 PM	**O4-1. Investigating the role of locally generated waves on sediment mobility over a sandy tidal flat in the Skagit estuary.** Alyson Day*, Stephen Henderson; Washington State University
4:45 PM	**O4-2**. **Geographic variation in Puget Sound tidal channel geometry** W. Gregory Hood, Skagit River System Cooperative, LaConner, WA
5:00 PM	**O4-3. Partnership for coastal watersheds** Craig Cornu, Coordinator of Monitoring Programs, South Slough National Estuarine Research Reserve, Coos Bay, OR
5:15 – 6:15 PM	**PERS Business Meeting**
6:30 – 9:00 PM	**Banquet at Terrace Room, Delta Town & Country Inn** **Port Sponsor Welcome** Darrell Desjardin, Port Metro Vancouver **Keynote Address: Estuarine restoration and rising sea levels: lessons from the Red Queen** John Rybczyk, Dept. of Environmental Science, Western Washington University, Bellingham, WA

ANNUAL MEETING PROGRAM SCHEDULE (continued)

Saturday, 6 April 2013

09:00 – 10:15	**Oral Presentations 5 – Restoration Effects on Habitat Quality** Chair: Scott Northrup
09:00	**O5-1. Restoring MacKay Creek estuary** Julia Alards-Tomalin*, Michael Jeffery, Courtney Lahue; B.C. Institute of Technology, Burnaby, BC
9:15	**O5-2. Salmon, seawalls, and Seattle: assessing the effects of shoreline modifications on the ecology of fish in Elliott Bay, Washington.** Stuart Munsch*, Jason Toft, Jeff Cordell, Charles Simenstad; University of Washington School of Aquatic and Fishery Sciences, Seattle, WA
9:30	**O5-3. Foraging and growth performance of juvenile chinook salmon (*Oncorhynchus tshawytscha*) in a recovering salt marsh** Aaron T. David*, University of Washington, School of Aquatic and Fishery Sciences, Seattle; Christopher Ellings, Nisqually Indian Tribe, Department of Natural Resources; Isa Woo, U.S. Geological Survey, Western Ecological Research Center, Charles Simenstad University of Washington, School of Aquatic and Fishery Sciences, Kelley Turner, Ashley Smith, U.S. Geological Survey, Western Ecological Research Center
9:45	**O5-4. Seymour River Estuary restoration** Andrew Newberry* and Amanda Turner, ; B.C. Institute of Technology, Burnaby, BC
10:00	**O5-5**. **Mosquito Creek estuary restoration** Deanna MacTavish, Michelle Holst, B.C. Institute of Technology, Burnaby, BC
10:15 – 11:00	*Coffee Break & Poster Session 3*
11:00 – 12:00	**Oral Presentations 6 – Dynamics in Estuaries and Effects of Climate Change** Chair: Cynthia Durance
11:00	**O6-1. Environmental predictors for juvenile chinook assemblages under differing management objectives: implications for resource management** P.A.L. Goertler[1]*,D.J. Teel[2], C.A. Simenstad[1], D. Bottom[2]; [1] School of Aquatic and Fishery Sciences, University of Washington, Seattle WA; [2] National Oceanic and Atmospheric Administration Northwest Fisheries Science Center Seattle, WA
11:15	**O6-2. Climate change, symbiont shuffling and life history of our most abundant intertidal anemone** B.L. Bingham*, J.L. Dimond, Western Washington University; G. Muller-Parker, National Science Foundation; Francis, L., Western Washington University, Bellingham, WA
11:30	**O6-3. From earth and ocean: The importance of upstream landscapes, salmon and cross-ecosystem subsidies to a mobile estuarine consumer** Joel Harding*, John Reynolds, Simon Fraser University, Burnaby, BC
11:45	**O6-4. Thorpe visited: how salmonids took over estuaries** Colin Levings, Fisheries and Oceans Canada
12:00	**O6-5. Portage Park beach restoration – 7 years on** Rowland Atkins, Golder Associates, Victoria, BC
12:15 – 1:30 PM	**Lunch** *(On your own at Meadow's or Riverhouse Restaurant & Pub)*

ANNUAL MEETING PROGRAM SCHEDULE (continued)

Saturday, 6 April 2013

1:30 – 2:00 PM	**Student Awards**
2:00 - 2:30 PM	**Acknowledgements & Closing Remarks**

Saturday, opportunity to visit Reifel Bird Sanctuary or Boundary Bay shoreline walk to observe shoreline flora and fauna. Shorebird and waterfowl migration is underway.

Sunday morning is a low tide for tidal flat excursion or a visit to the Wellbrook Winery in Delta, if there is interest.

POSTER SESSIONS

Friday 10:15 - 11:00 Coffee Break and Poster Session 1
Ocean Acidification and Other Oceanographic Influences on Biota

1-1. Respiration rates of benthic invertebrates show species-specific responses to ocean acidification. *L.L. Love*, Savannah State University; B. Olson, Shannon Point Marine Center, Western Washington University.*

1-2. Impacts of exposure to ocean acidification conditions on the prey of larval crabs. *Emanuel Gutierrez*, Stephen Sulkin, Anna Mai Christmas, Shannon Point Marine Center, Western Washington University.*

1-3. Effect of elevated carbon concentrations on respiration of marine microbial communities. *Amy Duarte*, Humboldt State University, Jude Apple, Shannon Point Marine Center, Western Washington University.*

1-4. Analysis of shells and swimming behavior of Olympia oyster larvae exposed to ocean acidification. *Samantha Peart*, North Carolina State University; Shawn Arellano, Shannon Point Marine Center, Western Washington University.*

1-5. Phytoplankton in Quartermaster Harbor, Puget Sound, USA. *Kyra Gagliardi*, Cheryl Greengrove, Julie Masura; University of Washington Tacoma.*

1-6. Increasing nutrients, changes in algal biomass and large *Noctiluca* blooms in Puget Sound. Is eutrophication fuelling the microbial food web? *Laura Friedenberg*, Julia Bos, Skip Albertson, Mya Keyzers, Carol Maloy, Christopher Krembs; Washington State Department of Ecology.*

1-7. Quartermaster Harbor Water Properties. Nicholas Schlafer*, Cheryl Greengrove. University of Tacoma.

Friday 3:15 - 4:15 Coffee Break and Poster Session 2
Seagrasses and Marine Vegetation

2-1. Methylation/acetylation as a derivation method for GC-MS analysis of eelgrass-produced phenolic acids. Don Valentine*, Mary Ellen Salyan, Kathy Van Alstyne, Shannon Point Marine Center, Western Washington University.

2-2. SeagrassNet: seasonal monitoring of two seagrasses, *Zostera marina* and *Zostera japonica*, at Dumas Bay, Washington. *Demetro Stowe*, J., Kreamer, K., Ferrier, L., Gaeckle, J.L., Short, F.T. Nearshore Habitat Program, Aquatic Resources Division, Washington State Department of Natural Resources, Olympia, WA.*

2-3. Marine Vegetation Atlas: An ArcGIS server application for sharing and exploring eelgrass and kelp data in Washington. *Andrew Ryan, Nearshore Habitat Program; Kate Sherman*, Nearshore Habitat Program; Helen Berry, Nearshore Habitat Program; Allison Bailey, SoundGIS; Matthew Kenny, Ridolfi Inc.*

2-4. How sediment conditions affect germination of eelgrass (*Zostera marina*) seeds from Washington State. *Victoria Monreal*, Sylvia Yang, Shannon Point Marine Center, Western Washington University.*

2-5. The assessment of nutrient, metal, and organic contaminant concentrations in eelgrass (*Zostera marina*): A project overview. *Demetro-Stowe, J., Kreamer*, K., Gaeckle, J.L. Nearshore Habitat Program, Aquatic Resources Division, Washington State Department of Natural Resources.*

2-6. Shoreline sensitivity to rising sea levels in British Columbia. *Anuradha Rao, Nikki Wright*, SeaChange Marine Conservation Society, Brentwood Bay, BC.*

POSTER SESSIONS (continued)

Saturday 10:15 - 11:00 **Coffee Break and Poster Session 3**
Effects of Climate Change on Invertebrate Population Dynamics and Tidal Wetlands

3-1. The depleted west-coast oyster, *Ostrea lurida*, is the target of several restoration efforts along the west coast. *Rose Rimler*, Cate Pritchard, Richard Emlet, Alan Shanks, Steve Rumrill, Oregon Institute of Marine Biology (UO).*

3-2. Defence mechanisms of *Synechococcus* against *Ochromonas.* *Ronneshia Jackson*, University of Alabama; Kerri Fredrickson, Suzanne Strom, Western Washington University.*

3-3. Vulnerability and adaptability of tidal wetlands to future climate change in Puget Sound: planning for strategic restoration. *Brittany R. Jones*; Charles A. Simenstad, University of Washington, Seattle, WA*.

3-4. *Alexandrium* cyst distribution and cyst viability in Puget Sound, WA USA. *Cheryl L. Greengrove*[1], Julie E. Masura[1], Stephanie K. Moore[2], Brian D. Bill[2], Levi R. Hay[2], Neil S. Banas[3], Eric P. Salathe Jr.[4], Nathan J. Mantua[4], Donald M. Anderson[5], Vera L. Trainer[2], and John E. Stein[2]; University of Washington–Tacoma, Tacoma, WA; [2]NOAA Northwest Fisheries Science Center, Seattle, WA; [3]Applied Physics Laboratory, University of Washington, Seattle; [4]Climate Impacts Group, University of Washington, Seattle, WA; [5]Woods Hole Oceanographic Institution, Woods Hole, MA*.

3-5. Life history of the red rock Crab*, Cancer productus* in Coos Bay, Oregon. *Scott Groth, Oregon Department of Fish and Wildlife and Sylvia Behrens Yamada*, Zoology Department, Oregon State Universit.y*

3-6. Initial insight on symbiont drift in an intertidal sea anemone. *M.A. Nieves-Ortiz*, Universidad de Puerto Rico in Humacao; B.L. Bingham, J. Diamond, Shannon Point Marine Center, Western Washington Universit.*

ORAL PRESENTATION ABSTRACTS

Restoring MacKay Creek Estuary. *Julia Alards-Tomalin*, Michael Jeffery, and Courtney Lahue, British Columbia Institute of Technology.*

Estuaries are highly productive, support a diverse array of flora and fauna, and perform important ecosystem services. Today, the importance of estuaries is being recognized and restoration efforts are being made to preserve and protect these valuable ecosystems including this project to restore MacKay Creek Estuary. Historic site conditions and reference sites were used to develop goals and objectives for the restoration plan. The restoration plan was divided into two portions: aquatic treatments and terrestrial treatments. The aquatic section covers the subtidal and intertidal portions of the estuary. Treatments include: sedge and eelgrass transplants, Canada goose exclosures, LWD instalment, and specific engineered treatments. The terrestrial section covers the riparian portions of the estuary. Treatments include: installation of bat houses and osprey nest platforms, removal of invasive plants, installation of beaver exclosures, and bank stabilization. Prior to restoration treatments in 2013 (pending funding), increasing awareness of the importance of MacKay Creek Estuary has been the primary project focus. Stakeholders include the City of North Vancouver, Bodwell High School, Seaspan, Squamish First Nation, Northwest Hydraulics, Squamish River Watershed Society, Seacology, North Shore Fish and Game Club, North Shore Wetland Partners, North Shore Streamkeepers, and the District of North Vancouver. Overall reception of the plan to restore MacKay Creek Estuary has been extremely positive, and both monetary and in-kind support has been generously offered. Public involvement is important in the initial phases of this project and over the long term to ensure the success of the restoration effort. Presentations on the importance of estuaries have been delivered to a wide variety of audiences including stewardship groups and high school students, which has helped create buy-in and recruit volunteers. Beginning at the end of March, volunteers will become involved in the removal of invasive species, the installation of beaver fencing, and the collection of monitoring data. Over the long term, volunteers will be critical in the monitoring and maintenance phase of this project.

Spatial and temporal patterns in oxygen and nutrient dynamics in Bellingham Bay. *Jude K. Apple*, David Shull, Sarah DeLand, Western Washington University; Lance Brockie, Charlotte Clausing, Joel Green; Northwest Indian College.*

Coastal eutrophication, anthropogenic nutrient enrichment, and bottom water hypoxia are potential stressors for many coastal and marine ecosystems, including the fjords and embayments of the Salish Sea. Recent work by researchers at Western Washington University and Northwest Indian College investigating hypoxic bottom waters in Bellingham Bay (Bellingham, WA) has identified predictable patterns in the timing and extent of hypoxia in this system, specifically an area of low dissolved oxygen in central Bellingham Bay that returns predictably each summer. Historical data indicate that bottom water hypoxia may be a natural feature of this ecosystem, although more recent data indicate that the intensity and frequency may be increasing. Nutrient models indicate that inputs of inorganic nutrients from marine sources are comparable to – if not exceeding – those from terrestrial sources. We also found close alignment between direct measurements of bottom water respiration and model-based estimates. The PNW has an impressive record of integrating science into the management of our estuarine and coastal ecosystems, whether it be habitat restoration, project mitigation, restoring sediment and water quality, and promoting process driven shoreline protection and redevelopment. This stewardship effort has included a diverse range of stakeholders, including First Nations, numerous levels of government, private developers, ports and other industrial sectors, private citizens, and non-government organizations. However, many challenges remain both human induced and natural. Challenges range from continued environmental degradation, impairment of natural processes that reduce functions and ecological services, and climate change issues such as sea level rise and ocean acidification.

Portage Park Beach Restoration – 7 years on. *Rowland Atkins, Golder Associates.*

In 2006, Golder Associates worked with the Town of View Royal to develop beach restoration/erosion protection concepts to protect an eroding culturally significant midden on the shoreline of Portage Park. The concept ultimately implemented was a beach fill design intended to maintain the beach for public use, allow public access and protect the midden. Now into its 7th year, the performance of the beach fill design for erosion protection will be discussed during this talk.

Climate change, symbiont shuffling and life history of our most abundant intertidal anemone. *B.L. Bingham*, Western Washington University; J.L. Dimond, Shannon Point Marine Center; G. Muller-Parker, National Science Foundation; L. Francis, Western Washington University.*

Along the coasts of Washington, Oregon and British Columbia, the intertidal sea anemone *Anthopleura elegantissima* hosts *Symbiodinium muscatinei* (a dinoflagellate) and *Elliptochloris marina* (a chlorophyte), and can also live largely symbiont-free (asymbiotic). The consequences of living in these remarkably different symbiotic states were examined by holding anemones in a common garden experiment under conditions of high, moderate or low irradiance. Growth, fission and gonad development were measured and related to symbiotic state after 8.5 - 11 months of treatment. Life history strategies differed fundamentally among anemones in the treatments. High irradiance and temperature reduced fitness of asymbiotic anemones and led to alternate strategies of sexual reproduction in individuals hosting *E. marina*, and asexual reproduction in individuals hosting *S. muscatinei*. This result was supported by patterns seen in *A. elegantissima* sampled from two field sites. Environmental conditions that alter the symbiotic state of *A. elegantissima* have the potential to fundamentally change the anemones' basic life history characteristics.

Seasonal growth of two seagrasses with overlapping distribution in the Salish Sea: the non-native eelgrass, *Zostera japonica*, and the native eelgrass, *Z. marina*. *Douglas Bulthuis*, Heath Bohlmann, Nicole Burnett, and Suzanne Shull; Padilla Bay National Estuarine Research Reserve.*

The native eelgrass, *Zostera marina*, grows on extensive intertidal and subtidal flats in Padilla Bay, Washington covering more than 3000 hectares. The non-native eelgrass, *Zostera japonica*, was unintentionally introduced to the Pacific Northwest in the early- to mid-1900's. *Z. japonica* initially became established in Padilla Bay on high intertidal flats that had been bare of macro-vegetation. Over time, *Z. japonica* has expanded its range and is growing increasingly intermixed with *Z. marina*. We measured vegetative characteristics monthly in more than 50 permanent plots along a 3 ½ km transect from shore to -0.4 m below MLLW. We found the two eelgrass species growing intermingled for more than 1 km along the transect. In the intermingled zones, density of *Z. japonica* was generally greater than *Z. marina* and height of *Z. marina* was greater than *Z. japonica*. Over the calendar year density of *Z. marina* was highest in January and decreased through the growing season while canopy height increased to a maximum in September/October. Density and canopy height of *Z. japonica* peaked in August. Biomass of both species peaked in July/August in all zones along the transect. Both species grew perennially with above and below ground biomass present throughout the year.

PARTNERSHIP FOR COASTAL WATERSHEDS. *Craig Cornu, Coordinator of Monitoring Programs, South Slough National Estuarine Research Reserve.*

The Partnership for Coastal Watersheds (PCW) demonstrates a stakeholder-driven community planning and decision-support process designed to address coastal issues associated with a portion of the Coos watershed defined as the South Slough estuary and "Coastal Frontal" watersheds (on the southern Oregon coast). Project facilitators (staff at the South Slough National Estuarine Research Reserve and Coos Watershed Association) convened stakeholders in a group called the Partnership Steering Committee (PSC). PSC goals were to: 1) establish a public forum that facilitates community collaboration and decision making using the best available science; and 2) effectively anticipate and respond as needed to local land use and climate-related changes in the South Slough and Coastal Frontal watersheds. Over the course of this three year project, the Partnership Steering Committee produced: 1) a Community Vision in which stakeholders describe the environmental and socioeconomic conditions they'd like to see in the project area in 20 years; 2) a comprehensive environmental and socioeconomic State of the Watersheds assessment that provides our community with an easily accessible objective source of science-based information for developing a common understanding of the current conditions in the project area; and 3) an Action Plan which describes a prioritized set of 37 actions designed to address the environmental and socioeconomic issues that impede the community's progress towards achieving its Community Vision. These products and associated stakeholder planning processes provide powerful rationale in funding proposals for implementing the projects articulated in the Action Plan. The tools developed for this project and the processes tested and evaluated provide the foundation for the second phase of the PCW project, which expands the geographic scope of the project to include the Coos estuary and associated sub-basins. Additional tools to be developed in the PCW Phase 2 include the expansion of South Slough NERR's estuarine water quality network to the Coos estuary in partnership with local tribes, the facilitation of a Coos estuary hydrodynamic model, and the development of a suite of environmental and socioeconomic indicators for the community.

Foraging and growth performance of juvenile chinook salmon (*Oncorhynchus tshawytscha*) in a recovering salt marsh. *Aaron T David*[*1], Christopher Ellings[2], Isa Woo[3], Charles Simenstad[1], Kelley Turner[3], Ashley Smith[3]; [1]School of Aquatic and Fishery Sciences, University of Washington; [2]Department of Natural Resources, Nisqually Indian Tribe; [3]U.S. Western Ecological Research Center, U.S. Geological Survey.*

The loss of estuarine wetlands in the Pacific Northwest due to human development has contributed to the decline of ocean-type Pacific salmon species (*Oncorhynchus* spp.), spurring efforts to restore and reconnect tidal wetlands. Several studies have assessed the ecological functions of restored tidal wetlands in terms of juvenile salmon; however, few have used integrative measures of salmon physiological performance, such as growth potential, to evaluate restoration. A recent dike removal in the Nisqually River estuary, the largest tidal marsh restoration to date in the Pacific Northwest (364 ha), provides an opportunity to advance our understanding of the benefits of restoring tidal wetlands to juvenile salmon. Our overall objective was to evaluate the degree with which restoring tidal flow to habitats within the Nisqually River estuary also restores the ecological functions that promote the production of juvenile Chinook salmon (*O. tshawytscha*). Specifically, we used field sampling of Chinook diet compositions and consumption rates, and water temperatures in conjunction with the Wisconsin fish bioenergetics model to compare the simulated growth potential of juvenile Chinook in two recovering and two reference marshes over three years post-restoration. We hypothesized that: (1) growth potential is initially lower in recovering habitats than reference habitats, but will approach equivalence as time since the restoration increases; and, (2) differences in growth potential between reference and recovering habitats are primarily attributable to differences in prey availability and energetic quality. Preliminary results suggest that recovering tidal marshes provided similar, though more variable, growth opportunities for juvenile Chinook salmon, and that the increased variability was due in part to greater temperature variability in the recovering marshes. These results indicate that while some attributes of recovering tidal wetland ecosystems, such as invertebrate production, rapidly reach reference levels, others such as temperature regimes take much longer to converge with reference conditions.

Investigating the role of locally generated waves on sediment mobility over a sandy tidal flat in the Skagit estuary. *Alyson Day* and Stephen Henderson, Western Washington State University.*

Tidal flats occur in low energy coastal environments where sediments are readily available, water depths are shallow, and there is an absence of breaking waves. To examine the processes responsible for transporting sediments and shaping these remarkable environments, we present field observations from a small (~30 m wide, 1.5 m deep) tidal channel and adjacent shallow, sandy tidal flats. Data collected near the north fork of the Skagit River estuary in May – August of 2009 included GPS bathymetric surveys, water velocity profiles at eight locations, salinity, temperature, and wind velocity. Between June 25 and 30, approximately 380 kg of sediment was eroded per meter across a 20m transect spanning the flats and channel. Sediment transport was estimated by combining standard models with flow velocities measured using instruments deployed along the transect. Results revealed the importance of waves to sediment mobility in this environment, despite sheltering by nearby salt marshes. When waves were accounted for, estimated bed stress was sufficient to move sediments both within the channel and on the flats. In contrast, filtering waves from measured velocity time series yielded bed stresses that were insufficient to mobilize sediments on the flats. The importance of waves persisted even during a case off moderate offshore-directed winds, when wave energy flux increased in the offshore direction over the < 30 m fetch spanning the instrument array.

Subtidal bay clam populations in Tillamook Bay, Oregon: comparison to intertidal populations and implications for shellfish management. *Anthony D'Andrea*, Stacy Galleher, Amy Hutmacher, Natalie Amoroso, and Kami Earl Oregon Department of Fish and Wildlife, Marine Resources Program.*

Tillamook Bay supports one of the most popular recreational clamming areas in Oregon. In addition, over two-thirds of the commercial bay clam harvest in Oregon comes from Tillamook Bay. The subtidal areas of the bay support a limited commercial dive bay clam fishery but, more importantly, are thought to serve as refugia for adult bay clam populations providing a brood stock to re-seed the intertidal areas. In 2012, ODFW conducted a comprehensive randomized survey of subtidal bay clams in the major tidal channels of Tillamook Bay designed to complement intertidal surveys conducted in 2010 and 2011. The results of the survey indicated that a majority of the bay clam population resides in the subtidal channels with abundances and biomass 1-2 orders of magnitude greater than those found in the intertidal areas of the bay. The biomass estimates from this study are comparable to previous subtidal surveys from the 70s, 80s, and 90s indicating a multi-decadal persistence of these populations. The presence of large subtidal populations in Tillamook Bay may be habitat-driven with the highest densities and biomass associated with the gravel-cobble habitats common in the lower bay relative to the unconsolidated sand or mud bottoms which occur in isolated channels or up-bay locations. The presence and importance of a subtidal broodstock for bay clam populations is still an open question for Oregon estuaries but, at least for Tillamook Bay, may explain the high levels of intertidal clam harvest that have been supported for more than 50 years.

Estimating production of juvenile Dungeness crab, M*etacarcinus magister,* in Pacific oyster aquaculture versus native oysters and eelgrass habitat in Willapa Bay, Washington. *Brett R. Dumbauld*, Lee McCoy, USDA-ARS, Hatfield Marine Science Center; Jessica Ramsay, Environmental Sciences, Oregon State University.*

Oysters provide several ecosystem services in estuaries including the provision of habitat for fish and other invertebrates. Native oysters, *Ostrea lurida* are no longer present in sufficient numbers in many US West Coast estuaries to quantify this service, but have been replaced with actively cultured Pacific oysters, *Crassostrea gigas*, in some of these systems. We collected information on the recruitment of juvenile Dungeness crab (*Metacarcinus magister*) to these two oyster habitats, shell, and eelgrass in order to quantify the current and historical level of this service in Willapa Bay, Washington, Pacific oysters are now actively cultured and cover approximately 20% of the intertidal area of this estuary while native oysters were estimated to have covered 17% of the intertidal area. Native oysters however, were generally distributed in low intertidal and subtidal areas and in areas located further from the mouth of the estuary than current Pacific oyster culture beds. We used the density of juvenile young of the year (YOY) crabs that settled into shell bags in Willapa Bay to model their distribution and found the greatest density of crabs in shell habitat located at lower tidal elevation close to subtidal channels. A substantial decline in crab density was observed with increasing distance from the estuary mouth. This resulted in a comparable, but lower overall contribution to YOY crab production by current aquaculture than by native oysters historically, but both of these shell habitats were estimated to produce substantially more crab than eelgrass habitat. These estuarine landscape scale tradeoffs should be considered when defining goals for both aquaculture and native oyster restoration in Willapa Bay and other estuaries along this coast.

Large scale changes in eelgrass (*Zostera marina* and *Z. japonica*) distribution over a large tidal flat in southern British Columbia over a 43 year period, and small scale changes over a 10 year period. *Cynthia Durance, Precision Identification.*

The largest eelgrass bed in southern British Columbia has been positively impacted by the construction of two causeways and perhaps the introduction of *Z. japonica*. The large scale changes that have occurred over this period will be discussed. Detailed studies of the eelgrass habitat in the area between the two causeways and at a reference site 30 kilometres away were undertaken in 2003 and annually between 2007 and 2012. There was considerable inter-annual variation in *Z. marina* productivity at both sites. Various physical parameters that may have influenced the productivity will be discussed including; the Pacific Decadal Oscillation Index, the onset of low low tides in the spring, annual mean low low water level, El Nino events, and summer air temperatures will be discussed.

Environmental predictors for juvenile Chinook assemblages under differing management objectives: implications for resource management. *P.A.L. Goertler*[1], D.J. Teel[2], C.A. Simenstad[1], D. Bottom[2]; [1] School of Aquatic and Fishery Sciences, University of Washington; [2] National Oceanic and Atmospheric Administration Northwest Fisheries Science Center.*

For many species a matrix of available habitats are necessary to ensure population stability and persistence. Access to diverse habitat promotes population diversity in Pacific salmon through the expression of life history diversity. More specifically, estuarine rearing habitat has been shown to foster dominant life history strategies, enhance within watershed biocomplexity and support smolt growth. Chinook salmon in the Columbia River have potentially undergone major population diversity losses due to anthropogenic reductions in rearing habitat. For this reason population diversity has become a target for restoration within the Columbia River estuary scientific and resource management community. In addition some management objectives especially target those populations which are listed as threatened or endangered on the Endangered Species Act (ESA) or wild origin juveniles. In many cases when fisheries data is not available or insufficient environmental data can be substituted to estimate available habitats and target areas for rehabilitation. This study validates the use of environmental data in place of costly and time consuming species specific sampling and illuminates the effect of natural resource strategies on informing future restoration in the Columbia River estuary for juvenile Chinook rearing habitat and population stability. We found that multivariate site specific variables were the best indicator of juvenile Chinook fish assemblages and demonstrate the dependence of these interpretations on the choice of several management strategies in fine-scale dynamic rearing environments in the Columbia River estuary.

From earth and ocean: The importance of upstream landscapes, salmon and cross-ecosystem subsidies to a mobile estuarine consumer. *Joel Harding* and John Reynolds, Simon Fraser University.*

A large body of research has demonstrated that resource availability is a fundamental force shaping ecological systems and that resource subsidies can alter nutrient dynamics and shape community structure in recipient habitats. The effects of subsidies can also be species-specific, and mediated by the character and connectivity of adjacent habitats. The central coast of British Columbia is a dynamic landscape where the movement of material from upstream headwaters to the coast, and the 'counter-flow' annual pulses of returning salmon, provide ample opportunity to investigate the interconnectivity between ecosystems. We used multi-model inference to investigate the effects of upstream watershed size, structure, and adult spawning Pacific salmon (*Oncorhynchus spp.*) on Dungeness crab (*Metacarcinus magister*) populations across nineteen estuaries. Crab $\delta^{15}N$ was strongly driven by watershed size, upstream salmon density, and red alder (*Alnus rubra*) predominance while $\delta^{13}C$ was explained by individual crab traits and watershed size. Relative crab abundance increased with estuary size but larger crabs inhabited estuaries below larger watersheds. These results highlight the importance of cross-ecosystem nutrient linkages within these coastal ecosystems and suggest that the magnitude of terrestrial-derived material entering estuaries is an important driver of Dungeness crab productivity.

Blue carbon in the Comox Valley: the benefits of eelgrass and salt marsh restoration in coastal communities. *Christine Hodgson, North Island College.*

The restoration of eelgrass and salt marsh beds in areas where they formerly existed is widely recognized as a valuable activity due to their importance as habitat for estuarine inhabitants and for foreshore resilience. These restoration activities can also play a role in sequestering carbon dioxide from the atmosphere and putting it into long-term storage. Blue Carbon, where aquatic plants act to store carbon in the sediments below the plants, is another benefit to eelgrass and salt marsh rehabilitation. The Blue Carbon Team, consisting of professional and volunteer members located in the Comox Valley on Vancouver Island, British Columbia, is pursuing the opportunity to develop a protocol for measuring the amount of carbon permanently sequestered by eelgrass and salt marsh, while at the same time restoring habitat that had been lost during the past 75 years due to urbanization of the area. Preliminary data suggests estuarine plant communities can remove carbon dioxide from the atmosphere and store it in sediments more efficiently than land plants. Thus, these habitat restoration efforts would additionally contribute towards mitigating climate change.

Geographic Variation in Puget Sound Tidal Channel Geometry. *W. Gregory Hood, Skagit River System Cooperative.*

Preliminary results of GIS analysis of aerial photos indicate similar scaling with marsh island area of tidal channel count, total channel surface area, total channel length, and various other geometric parameters for tidal channel networks in over 20 locations in Puget Sound. However, there is variation in scaling relationship elevations that appears to be associated with exposure to wind fetch. Tidal channels in the Nooksack and Stillaguamish Deltas have the highest fetch and the lowest tidal channel network surface area or length; tidal channels in the Skagit and Snohomish Deltas are intermediate in fetch and channel network surface area and length; tidal channels in relatively sheltered Hood Canal deltas and in lagoons have the highest amount of channel network surface area and length. Other factors likely also contribute to variation in tidal channel geometry, such as marsh elevation and tide range. The results provide guidance and standards for tidal marsh restoration design, planning, and monitoring throughout Puget Sound. For example, they illustrate non-linear cumulative effects on tidal channel network surface area and length associated with tidal marsh restoration; restoring one 100-hectare marsh produces more tidal channel area or length than does restoring ten 10-hectare marshes.

Thorpe visited: how salmonids took over estuaries. *Colin Levings, Centre for Aquaculture and Environment Research, Fisheries and Oceans Canada.*

While estuarine salmonid biologists in our region tend to concentrate on one genus (*Oncorhynchus*), there are three others (*Salmo*, *Salvelinus*, and *Hucho*) that are also valued. In an important paper published in 1994, Thorpe summarized some of the key adaptations of the four genera that enable them to use estuaries and hence complete the transition from freshwater to saltwater, the key habitat shift for anadromous species. The three most often cited adaptive processes are osmoregulation success, biotic interactions, and food supply for growth. In this talk I discuss and update some of our knowledge of these fitness components of salmonid survival, particularly the variation of estuarine habitat types, the long and short term evolution of the components to estuaries, and the relation of these processes to the natural and human-induced dispersal of salmonids. To maintain a flow of ecosystem services from salmonids in estuaries, it is likely that estuarine managers will likely have to learn to adapt to genotype x environment interactions because short term evolution can affect the long term success of habitat restoration and other conservation measures. This problem is likely to be the focus for the next golden age of salmonid research in estuaries.

Mosquito Creek Estuary Restoration. *Deanna MacTavish* and Michelle Holst, British Columbia Institute of Technology.*

Over the past 150 years, several anthropogenic factors have degraded the tidal estuary of Mosquito Creek in North Vancouver. Historically, eelgrass meadows were once abundant in the estuary and provided valuable habitat for several aquatic species. Unfortunately, due to dredging and channelization, these meadows have been completely obliterated. The estuary banks, once a vast riparian corridor, are now lined with concrete and metal debris, rebar and razor wire. Historic logging has resulted in loss of both overhead cover and coarse woody debris habitat features. Industrial development has caused point and non-point source pollution and shoreline erosion. Within the estuary, large amounts of creosote-treated pilings are leaching toxins into the water column. These and other factors have resulted in significantly reduced estuary productivity and ecosystem services.
To address these issues, we have developed a restoration plan, working collaboratively with the Squamish First Nation and City of North Vancouver, to restore estuarine habitat features. This plan will also complement works occurring on the nearby Spirit Trail overseen by the City of North Vancouver. The restoration plan will include treatments such as benching and terracing portions of the shoreline to increase the riparian buffer, anchoring cedar root wads along the banks to restore coarse woody debris habitat, transplanting eelgrass shoots within the estuary to restore meadows, wrapping or removing the creosote-treated pilings to improve water quality, and public awareness and engagement through education and outreach programs. Baseline data collection, such as water quality measurements and vegetation and wildlife surveys, is occurring presently. Benthic substrate sampling and lab analysis will take place in the coming months. Long-term monitoring will occur post-restoration to gauge project success. It is our hope that once the restoration project is complete, the Mosquito Creek Estuary will function naturally and support diverse populations of estuarine species once again.

Salmon, seawalls, and Seattle: assessing the effects of shoreline modifications on the ecology of fish in Elliott Bay, Washington. *Stuart Munsch*, Jason Toft, Jeff Cordell, and Charles Simenstad; University of Washington School of Aquatic and Fishery Sciences.*

Shoreline modifications such as armoring and overwater structures are becoming increasingly prevalent to support infrastructure aggregated on coasts worldwide. Despite the global prevalence of shoreline modifications, their effects on nearshore ecosystems are poorly understood. My research explores the effect of shoreline modifications on fish and macroinvertebrate assemblages in the urbanized estuary of Elliott Bay, Washington within Puget Sound. Among the species studied are juvenile Pacific salmon, which depend on the estuary for foraging, predator refuge, and salinity acclimation as they outmigrate along the shore. Utilizing snorkel and scuba observation methods, our research suggests shoreline modifications affect the distribution, assemblage structure, and behavior of fish and macroinvertebrates, including juvenile salmon. The Elliott Bay Seawall will be reconstructed in late 2013 and will include habitat enhancements to reduce its ecological impact. Seattle's significant and prominent investment in reducing the impact of its iconic waterfront is an opportunity to provide a broad-scale message of the importance of investing in sustainability and to reconnect people to the water.

Spatial and temporal trends in trophodynamics among pelagic fish and jellyfish in the Puget Sound: a stable isotope analy*sis.* *Sean Naman*[1], Correigh Greene[2], Casimir Rice[2], Linda Rhodes[2], Jason Hall[2], Josh Chamberlin[2], Douglas Burrows[2]; [1]Department of Zoology, University of British Columbia; [2]Northwest Fisheries Science Center, National Marine Fisheries Service.*

The pelagic zone is the largest and one of the most important components of the Puget Sound ecosystem yet many aspects of its ecology are poorly understood. Recent observations including large blooms of jellyfish coupled with the declines of middle trophic level forage fish species including Pacific herring (*Clupea pallasii*) and surf smelt (*Hypomesus pretiosus*) have led to concerns regarding the ecological health of Puget Sound's pelagic food web. Unfortunately, basic information on trophic relationships among pelagic biota including forage fish, juvenile Pacific Salmon and jellyfish is poorly characterized, limiting our ability assess the extent of degradation or stress. We address this knowledge gap using stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) to quantify trophic relationships among pelagic biota. 79 sites ranging across six oceanographic sub-basins in Puget Sound were sampled over a period of seven months in 2011. Preliminary results show strong spatial and temporal patterns of food web structure and trophic dynamics among pelagic fish and jellyfish suggesting these dynamics are heterogeneous in space and time.

Seymour River Estuary restoration . *Andrew Newberry* and Amanda Turner, British Columbia Institute of Technology.*

BCIT, in partnership with the Seymour Salmonid Society and Metro Vancouver, has begun the initial planning stages for the Seymour River Estuary Restoration Project, scheduled to begin in the spring of 2014. The project's main focus is to enhance salmonid survivorship in the watershed by restoring the valuable rearing habitat within the estuary. Currently, the Seymour Estuary is badly degraded, with little suitable habitat available. The estuary's proximity to heavy industrial development and continuous growth within the watershed has resulted in changes to the overall morphology, chemistry and function of the system. The Seymour River Estuary Restoration Project aims to address the main stressors currently impacting the estuary, by actively restoring the site to a traditional trajectory. This will be done through the implementation of three plans: The Aquatic Habitat Enhancement Plan focuses on restoring the habitat complexity within the estuary to make it a suitable rearing environment for salmonids. This plan involves eelgrass transplant initiatives, the addition of Large Woody Debris (LWD) and boulders, the addition of suitable substrate, and an overall improvement to the water quality with the estuarine environment. The Riparian Management Plan will concentrate restorative efforts within the riparian zone of the project. Restorative efforts here will focus around invasive species removal, in particular Japanese knotweed, and a re-establishment of a traditional riparian corridor. The Public Awareness and Involvement Plan will include a rehabilitation of the existing walking path along the estuary spit, the addition of interpretive signage, and the use of social media to raise awareness and educate the local community on the Seymour River Estuary Restoration Project.

Good news and bad news in Salish Sea sediments: wide-scale declines in benthic community health despite decreasing contaminant levels. *V.A. Partridge*, M.E. Dutch, S. Weakland, K.I. Welch, and E.R. Long, Washington State Department of Ecology.*

Since 1997, the Washington State Department of Ecology (Ecology) Marine Sediment Monitoring Team has been assessing sediment quality in the southern Salish Sea. Among the patterns to emerge so far are decreases in concentrations of some legacy contaminants and wide-scale deterioration of benthic community health. Sediment samples are evaluated for exposure to contaminants, toxicity to laboratory animals, and health of benthic invertebrate communities, and the results are rolled up into Ecology's respective Chemistry, Toxicity, Benthos, and combined Sediment Quality Triad Indices. The nested sampling design enables estimation of spatial extent of conditions on scales ranging from individual bays to the entire Puget Sound. Thoughts about what environmental stressors may be triggering these alarming changes will be discussed.

Overcompensation and the European green crab. *Brian C. Turner* and Catherine de Rivera, Portland State University.*

Population size can decline or, via overcompensation, increase, as mortality increases from harvest efforts targeting adults. Overcompensation increases in likelihood with high fecundity, and short juvenile stages, likely attributes of successfully invasive species. Overcompensation was documented as the result of removal efforts targeting the invasive small mouth bass, but has rarely been investigated for marine invaders. With increasing efforts of managing destructive non-indigenous marine species, such as the European green crab, *Carcinus maenas*, it is important to determine the likelihood of overcompensation to inform whether removal efforts must be intense (to outweigh the overcompensation effect) or are not even worthwhile. We examined the overcompensation potential of *C. maenas*, with experiments and surveys performed in Bodega Harbor, CA. Species that exhibit strong negative interactions between adults and juveniles are more likely to overcompensate. Therefore, these experiments examined cannibalism rates by *C. maenas* with and without alternative prey, survivorship of juvenile *C. maenas* at varying adult densities, impacts of the presence of adults on the foraging rates of juveniles, impacts of the presence of adults on juvenile growth. Adult presence does not appear to significantly affect juvenile growth or survivorship: we detected minimal cannibalism and only short-term reductions in foraging rates. Therefore it is unlikely that *C. maenas* will overcompensate in response to removal, and this conclusion is consistent with survey data on demographics in Bodega Harbor, throughout a removal effort.

Predicting the success of marine species from ocean conditions. *Sylvia Behrens Yamada*, Zoology Department, Oregon State University; Bill Peterson, NOAA; Bryan Black, University of Texas; Alan Shanks, University of Oregon.*

The California Current System off our coast cycles between warm and cold phases and these changes have profound effects on marine ecosystems. For example, during a cold phase upwelling brings cold, nutrient-rich deep water to the surface which, in turn, allows phytoplankton, zooplankton, bait fish, salmon, marine birds, Dungeness crabs and oysters to flourish. During a warm phase, upwelling ceases, ocean productivity is low and a different suite of species thrive. Some of these species are west coast natives that arrive from California such as southern copepods, Humboldt squid, Pacific whiting and leatherback turtles while others, such as the American shad and the European green crab, were introduced from the Atlantic. The native southern species contract their range soon after the ocean cools, but the introduced species persist and can increase in abundance and geographic range when warm ocean conditions return.

The arrival and currents status of the European green crab in the Pacific Northwest. Sylvia Behrens Yamada*, Zoology Department, Oregon State University, and Graham E. Gillespie, Fisheries and Oceans Canada.

European green crabs were first introduced into San Francisco Bay during the 1980's and spread northward during the 1990's via larvae carried on north-flowing ocean currents. These currents were especially strong during the unusually warm and strong El Niño event of 1997-1998, during which green crabs spread to Oregon, Washington and British Columbia. Since this initial colonizing event, green crabs in Oregon and Washington, have persisted, but only produced new cohorts after warm winters of 2003, 2005, 2006 and 2010. While green crabs are rare in Oregon and Washington, they are thriving in the inlets on the west coast of Vancouver Island. Recent range expansion into the Central Coast of British Columbia and Sooke cause concern that green crabs may soon expand their distribution to Alaska and the Salish Sea, either through larval transport in ocean currents or via movements of shellfish or culture equipment. Once a satellite population of European green crabs is established in the inland sea, the invader would spread rapidly as favorable habitats in bays and estuaries are abundant and larvae would be retained.

POSTER ABSTRACTS

Effect of elevated carbon concentrations on respiration of marine microbial communities. *Amy Duarte*, Humboldt State University; Jude Apple, Shannon Point Marine Center, Western Washington University.*

Heterotrophic bacterioplankton are the most abundant microorganism in the ocean and play a major role in global carbon cycling. Heterotrophic microbes consume most of the organic matter in the marine ecosystem and dictate the extent to which CO_2 is absorbed or released by the oceans. Despite their importance in ocean carbon cycling, we currently lack the understanding of how heterotrophic microbes will change with ocean acidification. This research aims to determine the response of microbial communities to increased carbon supply. Respiration rates of surface and deep ocean microbes from the Rosario Strait were measured. By supplementing these microbes with different carbon concentrations and comparing respiration rates of these microbes, we were able to determine the dissolved oxygen consumed and ultimately the CO_2 respired. We hypothesize that deep ocean microbes are carbon limited and predict that deep ocean microbial respiration rates will dramatically increase with the introduction of carbon sources, while respiration of surface microbes will remain relatively the same. This work will provide valuable insight on microbial response to climate change and more accurate marine food web and earth system modeling.

The assessment of nutrient, metal, and organic contaminant concentrations in eelgrass (*Zostera marina*): A project overview. *J. Demetro-Stowe, K. Kreamer*, J.L. Gaeckle, F.T. Short. Nearshore Habitat Program, Aquatic Resources Division, Washington State Department of Natural Resources.*

Outfalls that discharge residential, commercial, and industrial wastewater as well as upland stormwater are abundant throughout Puget Sound. One area with a significant data gap is the management of outfalls and, in particular, the impacts outfall infrastructure and discharge have on critical nearshore habitats (e.g., eelgrass and macroalgae). Research has demonstrated the uptake of nutrients, metals, and organic contaminants and the physiological effects on seagrass, however, little is known about the concentration of these substances in eelgrass in the Pacific Northwest and more specifically, in greater Puget Sound. Basic nutrients, nitrogen and phosphorus, are likely abundant in Puget Sound, but whether these substances are at levels that cause toxicity in eelgrass is unknown. In an effort to meet its land stewardship responsibilities and to support the Partnership's goal to increase eelgrass area by 20% by 2020, the Washington State Department of Natural Resources has identified a need to improve its understanding of key stressors in greater Puget Sound. The current project will conduct a baseline assessment of nutrients, metals, and organic contaminants in eelgrass at 15 sites throughout Puget Sound. The poster provides an overview of the project components, sample sites, methods, and preliminary results.

SeagrassNet: Seasonal monitoring of two seagrasses, *Zostera marina* and *Zostera japonica*, at Dumas Bay, Washington. *J. Demetro-Stowe*, K. Kreamer, J.L. Gaeckle, F.T. Short. Nearshore Habitat Program, Aquatic Resources Division, Washington State Department of Natural Resources.*

SeagrassNet is a global seagrass monitoring program that is now established in 32 countries with 115 monitoring sites around the world. 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, light and sediment type. A monitoring team at each site sends data via the internet to an online database and archive at www.SeagrassNet.org.

Increasing nutrients, changes in algal biomass and large *Noctiluca* blooms in Puget Sound: is eutrophication fueling the microbial food web? *Laura Friedenberg*, Julia Bos, Skip Albertson, Mya Keyzers, Carol Maloy, and Christopher Krembs; Washington State Department of Ecology.*

Because of its proximity to the cold, nutrient rich Pacific Ocean, Puget Sound is thought of as a diatom-dominated marine food web supporting higher trophic levels via a relatively short food chain. Phytoplankton species respond to nutrient availability, nutrient composition, and the physical character of the water column. Through our long-term monitoring program and aerial surveys we have found that nutrient concentrations in Puget Sound have significantly increased and nutrient ratios have steadily changed over the last 13 years. We also frequently document extensive algal blooms, *Noctiluca* blooms, and jellyfish masses at the surface. Many of the phytoplankton blooms show high abundances of autotrophic flagellates. Depth integrated algal biomass, on the other hand, shows a significant steady decline from 1999 to 2011. These seemingly opposing observations - high algal biomass and *Noctiluca* at the surface and decreasing integrated phytoplankton biomass below the surface - could be more clues to a shifting food web structure and nutrient fluxes in Puget Sound. The cause and impacts of these trends are discussed in the context of human pressures, climatic and oceanic boundary conditions, and planktonic food web structure.

Phytoplankton in Quartermaster Harbor, Puget Sound, USA. *Kyra Gagliardi*, Cheryl Greengrove, and Julie Masura; University of Washington-Tacoma.*

In 2005, a NOAA/ECOHAB survey of Puget Sound found a high abundance of *Alexandrium catenella* cysts in the surface sediments of Quartermaster Harbor (QMH). *A. catenella*, a type of phytoplankton, is a dinoflagellate which produces a suite of neurotoxins that can accumulate in filter-feeding shellfish, and if ingested by humans may cause paralytic shellfish poisoning (PSP). There is a long history of paralytic shellfish toxin (PST) presence in the Puget Sound region indicated by occurrences of paralytic shellfish poisoning (PSP) events in local Native American and First Nations lore and the logs of early European explorers. Since the 1950s, high PST events leading to shellfish bed closures in Puget Sound documented by the Washington Department of Health (WDOH) shellfish monitoring program have increased. In Puget Sound the shellfish industry is an economically important industry accounting for nearly $107 million dollars annually and employing more than 3200 people. To better understand the relationship of environmental parameters to phytoplankton communities and blooms of *A. catenella*, a research study began in 2007 to monitor the water properties and characterize the phytoplankton community in QMH. Eight discrete locations were sampled on a monthly basis from 2007 through 2012. These samples included CTD profiles of temperature, salinity, density, dissolved oxygen, fluorescence and transmissivity. Discrete water samples were also analyzed for dissolved oxygen (DO), chlorophyll, nutrients and phytoplankton. Results from the phytoplankton part of this six year study are presented here. It was observed that over the course of the study, the general water conditions in QMH have remained seasonally consistent. *A. catenella* blooms were generally seen twice yearly with a bloom occurring in late spring, and a bloom usually observed in the fall. During the study, some data suggest that the autumn bloom may be starting later in the year than has been observed in the past. It is possible that this is an emerging phenomenon which needs continued research. Protecting consumers from shellfish poisoning will require comprehensive monitoring and ongoing study.

***Alexandrium* cyst distribution and cyst viability in Puget Sound, WA, USA.** *Cheryl L. Greengrove*[1], Julie E. Masura[1], Stephanie K. Moore[2], Brian D. Bill[2], Levi R. Hay[2], Neil S. Banas[3], Eric P. Salathe Jr.[4], Nathan J. Mantua[4], Donald M. Anderson[5], Vera L. Trainer[2], and John E. Stein[2]; University of Washington–Tacoma; [2]NOAA Northwest Fisheries Science Center; [3]Applied Physics Laboratory, University of Washington; [4]Climate Impacts Group, University of Washington; [5]Woods Hole Oceanographic Institution.*

The PS-AHAB (Puget Sound *Alexandrium* Harmful Algal Bloom) program, funded by NOAA/ECOHAB, seeks to understand environmental controls on the benthic (cyst) and planktonic life stages of the toxic dinoflagellate *Alexandrium catenella*, and evaluate the effects of climate change on the timing and location of blooms. This includes detailed mapping of overwintering cysts at 99 stations throughout Puget Sound. Highest surface sediment cyst abundances in 2011 and 2012 were found in Bellingham Bay (north), in bays on the western side of the central main basin and in Quartermaster Harbor (south). While cyst distribution patterns were similar for both years, 2012 cyst abundances were a factor of 2 lower at most stations. Compared to a 2005 survey, the Bellingham Bay "seed bed" is new, whereas Quartermaster Harbor cyst concentrations have decreased by an order of magnitude. In a related study funded by Washington Sea Grant, cysts from surface sediments collected during the 2012 PS-AHAB cruise were evaluated for their germination potential. Preliminary results show that as few as 16% of cysts from the Bellingham Bay seed bed are viable (i.e., will germinate within 4 weeks at 12°C), and only 48% of cysts from Quartermaster Harbor are viable. To date, no relationship between cyst viability and cyst appearance (using image analysis software) has been detected and preliminary results from germination experiments show no evidence for an endogenous clock. These results will be used to inform a model to explore the possibility of providing seasonal *Alexandrium* bloom forecasts.

Impacts of exposure to ocean acidification conditions on the prey of larval crabs. *Emanuel Gutierrez*, University of Puerto Rico RUM; Stephen Sulkin and Anna Mai Christmas, Shannon Point Marine Center, Western Washington University.*

Global atmospheric CO_2 concentrations are increasing, causing changes in sea water chemistry and decreasing it's pH. I hypothesize that these acidic conditions may affect energy transfer among marine trophic levels. We measured growth of two types of planktonic prey exposed to sea water representing current CO_2 conditions (400 ppm) and CO_2 conditions projected for the year 2100 (1000 ppm). Length of freshly-hatched nauplii of the brine shrimp *Artemia fransiscana* and egg production of the rotifer *Brachionus plicatilis* were measured over a five day of exposure to their CO_2 conditions. In a second experiment, the impact of prior exposure to the treatments on the nutritional value of brine shrimp nauplii to stage one larval crabs was measured. We subjected a total of 72 crab larvae (zoea) of *Metacarcinus magister* to both current CO_2 conditions and the estimated conditions for the year 2100. We observed and documented both the mortality rates and duration to the first molt. The results on this ongoing research, are currently demonstrating a significant increase in the average number of deaths on the experimental acidified treatment.

Defence mechanisms of *Synechococcus* against *Ochromonas.* *Ronneshia Jackson*, University of Alabama; Kerri Fredrickson and Suzanne Strom, Western Washington University.*

Synechococcus is one of the most abundant marine picoplankton in marine ecosystems. Their genetic diversity allows for adaption to specific ecological niches. The genome of *Synechococcus* sp. strain WH8102 contains envelope-modifying genes which contribute to alterations of the cell surface, and may serve as a defence mechanism against protist grazers. Another bacterial survival strategy is morphological plasticity. Dialysis bag experiments were conducted to examine if morphological changes in WH8102 were induced when exposed to the heterotrophic flagellate *Ochromonas*. Immediately following dialysis bag incubations, grazing experiments were performed to measure grazing rates on predator-exposed prey. Preliminary results indicate that WH8102 did not undergo morphological changes when exposed to dialysis bag experimental conditions and equipment. Understanding the survival strategies of *Synechococcus* is an important step in understanding predator-prey interactions in the microbial food web.

Vulnerability and adaptability of tidal wetlands to future climate change in Puget Sound: Planning for strategic restoration. *Brittany R. Jones* and Charles A. Simenstad, University of Washington.*

Natural adaptation and restoration of ecosystems under the influence of climate change are essential for their persistence into the future. Coastal habitats, such as tidal wetlands, are particularly at risk of submergence from sea level rise and other accelerated climate change impacts. Tidal wetlands provide valuable ecological, economic, and cultural ecosystem services, such as carbon sequestration, coastal protection from storm surges and flooding, and fish and wildlife habitat. Although there are many restoration efforts attempting to revive degraded ecosystems, these efforts often fail to consider the impacts of future climate change. The overall aim of this project, therefore, is to conduct a spatially-explicit assessment of the vulnerability and adaptability of tidal wetlands to future climate change in order to plan for strategic restoration of tidal wetlands in Puget Sound. This objective will be achieved by: (1) characterizing the current distribution of tidal wetlands and adjacent upland using the existing Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) change analysis geodatabase; (2) classifying the vulnerability and adaptability of tidal wetlands to future climate change based on eustatic sea level rise, vertical land movement, sediment accretion, hydrologic alterations, and other factors; and, (3) evaluating the conservation and restoration potential of tidal wetlands based on vulnerability and adaptability criteria and benefits of ecosystem services. The results of this research are intended to aid managers and planners by identifying present and future wetland areas in which investment in conservation and restoration efforts will be most beneficial under a range of potential climate scenarios.
*Presenting author status: Master's student

Respiration rates of benthic invertebrates show species-specific responses to ocean acidification. *L.L. Love*, Savannah State University; B. Olson, Shannon Point Marine Center.*

Concentrations of atmospheric CO_2 have been increasing since the industrial revolution. In 2000, our global oceans sequestered a record 2.3×10^9 tons of anthropogenic CO_2. Dissolved CO_2 can reduce ocean pH, potentially affecting homeostasis of aquatic organisms. We hypothesized that respiration rates of organisms exposed to seawater higher in CO_2 would show higher respiration rates. To test this, respiration rates of the Purple shore crab (*Hemigrapsus nudus*) and the Olympia oyster (*Ostreola conchaphila*) were measured in control and CO_2-enriched seawater. Oxygen concentrations in the sealed experimental chambers were measured with a microx tx3 fiber optic oxygen sensor. Respiration rates of *H. nudus* did not differ across treatments, but respiration rates of *O. conchaphila* decreased under CO_2-enriched conditions. Our results suggest that marine animals show species-specific responses to altered CO_2 concentrations, responses that may reflect the CO_2 variability these organisms normally encounter.

How sediment conditions affect germination of eelgrass (*Zostera marina*) seeds from Washington State. V*ictoria Monreal* and Sylvia Yang, Shannon Point Marine Center, Western Washington University.*

Seagrasses are important because they act as habitat and food for a variety of species, provide sediment stability, filter water, decrease wave energy, and cycle nutrients and carbon. Eelgrass (*Zostera marina*), the dominant native seagrass in soft-sediment habitats of Washington State, reproduces both asexually, through rhizomes, and sexually, through flowering shoots that produce seeds. After a large-scale damaging event, eelgrass depends on sexual reproduction to speedily recolonize itself. Previous research of eelgrass in Washington has correlated the presence of eelgrass seedlings with muddy, organic-rich sediments. To test whether sediment type could have enhanced eelgrass seed germination, we planted seeds from 3 Washington sites in muddy and sandy sediments in a lab setting. To investigate mechanisms explaining how muddy sediments could affect germination, seeds were also planted in light, dark, oxic, and anoxic water treatments. Preliminary results have shown that seeds from Padilla Bay have higher germination rates in the dark treatment, while seeds from Samish Bay does not yet show a difference between light and dark treatments. In Samish Bay the greatest germination rates have been in the light-oxic and dark-anoxic treatments. Willapa Bay has had no germinated seeds. This suggests that conditions that impact seed germination are site specific.

Initial insight on symbiont drift in an intertidal sea anemone. *M.A. Nieves-Ortiz*, Universidad Puerto Rico en Humacao, B.L. Bingham and J. L. Diamond, Shannon Point Marine Center.*

With increasing rates of climate change, the relationship between corals and their symbiotic dinoflagellates (*Symbiodinium* spp.) is under threat and has become a topic of extensive research. Some corals and other cnidarian hosts are known to shift from stress-susceptible symbionts to more thermally tolerant ones, which may lead to greater resilience during warming events. The underlying physiological and cellular processes that lead to these shifts are largely unknown. The intertidal sea anemone, *Anthopleura elegantissima,* is an excellent model system to investigate these processes because it is known to undergo shifts from populations of the chlorophyte, *Elliptochloris marina,* to the dinoflagellate, *Symbiodinium Muscatinei,* under temperature and light stress. Anemones with mixed populations of the two symbionts were exposed for a 6-day period to an experimental treatment that included both high light and temperature conditions. The expelled symbionts were collected daily and examined by microscopy to determine if the anemones selectively expelled the less tolerant *E. marina*. Preliminary data shows that anemone hosts are expelling greater amounts of *Elliptochloris* than those within its tissues. This research is providing insight into the mechanisms behind symbiont shifts, demonstrating whether anemones can selectively expel less tolerant symbionts in favor for more tolerant ones under stressful conditions.

Analysis of shells and swimming behavior of Olympia oyster larvae exposed to ocean acidification. *Samantha Peart*, North Carolina State University; Shawn Arellano, Shannon Point Marine Center, Western Washington University.*

Drastic declines in native Olympia oyster populations along the west coast of the United States have led to recent intensive restoration efforts. In addition to the inherent challenges of restoration, regional and global ocean acidification poses a threat to the reestablishment of native shellfish. Studies have shown that ocean acidification can decrease shell lengths of Olympia oyster larvae. The larval shell is a significant contributor to the larval swimming behavior of Olympia oysters and changes in the larval shell may cause changes in these behaviors. Cultures of 2-day old larvae were cultured under high (1000 ppm), moderate (750 ppm), and control (350 ppm) concentrations of CO_2. After four days of exposure, larval swimming patterns were video recorded for later analysis of swimming velocity, helical length, number of helical loops, and proportions of swimmers. Larval samples were also collected from each treatment every two days to measure shell growth. Determining Olympia oyster larvae swimming behavior in response to future and regional climate changes, will contribute to determining where these larvae move through the water column in order to identify where restoration efforts should be focused.

Shoreline Sensitivity to Rising Sea Levels in British Columbia. *Anuradha Rao, University of Victoria, and Nikki Wright*, Seachange Marine Conservation Society.*

The Province of BC has developed a predictive model of shoreline sensitivity to sea level rise. The model combines sensitivity ratings from the provincial Broad Ecosystem Inventory for the backshore area and ShoreZone data for the foreshore area. The original objective was is to develop adaptation strategies for sensitive areas within protected BC Parks marine areas. The data sets and maps are now available for the entire BC coast. How these maps are (or are not) being utilized for planning purposes by provincial and local governments is the focus of this poster presentation.

Settlement and post-settlement mortality as determinants of the spatial distribution of Olympia oysters (*Ostrea lurida*) in Coos Bay, Oregon . *Rose Rimler*, Cate Pritchard, Richard Emlet, Alan Shanks, and Steven Rumrill. Oregon Institute of Marine Biology, University of Oregon.*

The depleted west-coast oyster, *Ostrea lurida*, is the target of several restoration efforts along the west coast. Large oyster populations provide a number of ecosystem services including improving water quality and providing unique habitat for other estuarine species. Often, restoration efforts focus on laying down shell to encourage spat settlement. These efforts would be aided by a better understanding of the larval dispersal patterns, settlement behavior, and post-settlement mortality of oysters in the estuary of interest. In Coos Bay, Oregon, we are investigating all three of these components of the oyster life cycle at multiple sites throughout the estuary. We used time-integrative sampling techniques-- larval tube traps and settlement plates-- to sample larvae and settlers every two weeks from late July through late November, 2012. Larval abundance and settlement varied significantly throughout the bay, and larvae are apparently absent close to the mouth of the bay. Interestingly, the relationship between larvae and settlers also changed depending on location. We are currently monitoring the growth and survival rate of two size classes of field-collected oysters at most of these same sites. We hope that our results will help inform projects intent on revitalizing this struggling native species.

Marine Vegetation Atlas: *An ArcGIS server application for sharing and exploring eelgrass and kelp data in Washington.* *Andrew Ryan, Kate Sherman*, and Helen Berry, Nearshore Habitat Program, Washington Department of Natural Resources; Allison Bailey, SoundGIS; Matthew Kenny, Ridolfi Inc.*

Eelgrass and kelp are marine vegetation with recognized ecological values, and have been identified as indicators of ecosystem recovery. The purpose of this project is to improve access to information on the distribution of eelgrass, kelp, and other marine vegetation in Puget Sound. Greater access to historical and current vegetation data is needed to guide management decision-making, support scientific research, and assess change over time. These actions will support the long-term protection of marine vegetation. This Marine Vegetation Atlas project will create a spatial database of historical and current observations of marine vegetation. Information from a broad range of sources will be integrated, including large area maps, scientific studies, and site surveys. The atlas will be available initially within DNR via ArcGIS. Ultimately, it will be accessible through an ArcGIS Server-based map on DNR's external website for use by managers, policy makers, scientists, and the general public.

Quartermaster Harbor Water Properties Abstract. *Nicholas Schlafer* and Cheryl Greengrove, University of Washington- Tacoma.*

Over the past six years researchers at the University of Washington Tacoma (UWT) have studied the hydrographic conditions in Quartermaster Harbor (QMH), a shallow, southward facing bay in central Puget Sound. Impetus for this study is twofold, in 2005 a NOAA/ECOHAB study found that the surface sediments in QMH contained the highest concentration of *Alexandrium catenella* cysts in Puget Sound and QMH has consistently been listed as a water body of concern by the Washington State Department of Ecology for its late summer high temperatures and low oxygen levels. *Alexandrium catenella* is a dinoflagellate that produces saxitoxin, a powerful neurotoxin, that through shellfish filter feeding can bioaccumulate in bivalves. Ingestion of shellfish containing saxitoxin by humans can result in Paralytic Shellfish Poisoning (PSP) and potentially death. QMH water properties and the phytoplankton community were sampled monthly 2007-2012 to determine why Quartermaster Harbor contained such favorable environmental conditions for *Alexandrium catenella*, and what parameters affected dissolved oxygen in the bay. Results indicate that oxygen in the inner harbor is a function of both physical and biological forcing conditions. The geographic configuration of the bay impedes flushing and strong stratification in late summer limits vertical mixing. Both of these mechanisms act to limit ventilation and along with biological processes lead to low oxygen levels in late summer in the inner bay. During spring phytoplankton blooms, oxygen levels in the surface water of the inner bay can be extremely high due to photosynthesis. When these organisms die and sink to the bottom, microbial activity decomposes the algae leading to decreased levels of oxygen in the lower water column. Dissolved oxygen, phytoplankton, and nutrient levels are linked in a seasonal pattern which is then intensified by the geographical configuration of the bay to create conditions optimal for high concentrations of *Alexandrium catenella* and low oxygen levels in the later summer.

Methylation/acetylation as a derivation method for GC-MS analysis of eelgrass-produced phenolic acids. *Don C. Valentine*, Western Washington University; Mary Ellen Salyan, Shannon Point Marine Center; and Kathy Van Alstyne, Western Washington University.*

Seagrasses, including eelgrass (*Zostera marina*), a species native to the Pacific Northwest, currently face a variety of threats to their survival. They have been declining at a rate of 7% yr^{-1} since 1990; greater than the rate of decline for tropical forests. Seagrasses are important economically and ecologically, providing nearly \$2 trillion yr^{-1} in nutrient recycling, and \$3,500 ha^{-1} yr^{-1} to commercial fisheries, as well as providing habitat for a variety of marine species. It is therefore important to understand how different environmental factors affect seagrass defences, and thus, their survivability. The goal of our research is to isolate, characterize and quantify phenolic acids, which are secondary metabolites that provide an important and nearly ubiquitous defence in plants. We have developed a derivation method for these phenolic acids employing the methylation of the carboxylic acid group in concert with acetylation of the hydroxyls. The end product affords a volatile compound amenable to gas chromatography-mass spectrometry (GC-MS) analyses. This method will enable us to evaluate environmental variables that may affect phenolic acid production, including future climate changes, such as ocean acidification, and to determine how these important chemical defences may respond and the implications this will have for the survival of eelgrass.

Life History of the red rock crab, *Cancer productus*, in Coos Bay, Oregon. *Scott Grote, Oregon Department of Fish and Wildlife, and Sylvia Behrens Yamada*, Zoology Department, Oregon State University.*

The red rock crab, *Cancer productus*, is an important component of nearshore and estuarine communities from Alaska to Baja, California. Red rock crabs are fished ancillary to the more directed Dungeness crab recreational fisheries of Oregon and Washington. While Dungeness fisheries are managed similarly in the Pacific Northwest, red rock management varies widely. Discrepancies in regulations reflect a knowledge gap in the life history and ecological function of this species. Dungeness crab populations are structured at broader scale (i.e. west coast wide) than red rock crabs which may occur on a more localized scale. Fisheries managers need basic life history information on red rock crabs to assure sustainable fisheries that do not adversely impact these communities. Last summer, we individually tagged 624 adult red rock crabs in Charleston, Oregon with fine fabric Floy tags (http://www.dfw.state.or.us/MRP/shellfish/crab/red_rock_tagging.asp). As a result of two sampling events and work with recreational fishers we have recaptured 147 crabs, two of which had molted (and grew), indicating that our method is working. (For example, one 85 mm female grew to 105 mm and increased in weight from 81 g to 148 g between June and September). While these initial growth and recapture data are intriguing, more data are required over time to understand growth and relative cohort strength. Recreational crab fisheries are an important part of coastal economies, approximately 120,000 boat trips are made in Oregon each year. The sustainability of these fisheries is critical to assuring the recreational opportunity and resultant economic input.

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