Program Schedule

PACIFIC ESTUARINE RESEARCH SOCIETY

39TH ANNUAL MEETING

Cheakamus Centre
Brackendale, B.C.

March 10-12, 2016

Meeting Sponsors

GL Williams & Associates Ltd.

Squamish River Watershed Society

Fortis BC

Moffatt & Nichol

Squamish Terminals

Quest University

Squamish First Nation

30
Years
1986–2016

GL Williams
& Associates Ltd.
Coastal and Estuarine Habitat

2907 Silver Lake Place
Coquitlam BC V3C 6A2
T 604.941.7541
C 604.377.7089
E glwill@telus.net

moffatt & nichol

QUEST UNIVERSITY CANADA

Program

39th Annual Meeting

Pacific Estuarine Research Society

Cheakamus Centre

Brackendale, B.C.

March 10-12, 2016

PERS 2016 Conference Organizing Committee

Gary Williams
Jeannie Gilbert
Edith Tobe
Colin Levings
Cynthia Durance
Jude Apple
Jason Stutes

PERS Board of Directors

Tony D'Andrea - President
Gary Williams - Past-President
Jude Apple - President-Elect
Jeanie Gilbert - Treasurer
Adrienne Stutes - Secretary
Cynthia Durance, Jim Brennan, Jason Stutes - Members-at-Large
Emily LeMagie - Student-at-Large

REMEMBERING BOB EMMETT, FORMER PERS PRESIDENT & FRIEND…
(1955-2015)

The Emmett Memorial fund was created in 2015 by PERS in Bob's memory. We would like to present here the 2015 donors to this fund. More information on how to donate can be found on our website.

George and Susan Boehlert
Daniel Bottom
Amy Emmett
Kurt Fresh
Sean Hayes
Anna Kagley
Jessica Miller
Alec Maule
William Pearcy
Erik Robinson
Todd Sandell
Charles Simenstad
Pew Trust
Laurie Weitkamp
Boone and Nancy White
Gary Williams

MEETING NOTES

Meeting Site	The 39th PERS conference takes place at the Cheakamus Centre, 1600 Paradise Valley Road, Brackendale, B.C. The conference oral and poster presentations take place at the Spakwus House Presentation Room and Poser Room, respectively. Meals and opening mixer occur at the ELC. See Program Schedule for times and locations.
Opening mixer	The traditional PERS opening mixer will occur at the Cheakamus Centre Environmental Learning Centre (ELC), commencing at 5:30 and continue to about 9:30. Each attendee receives 2 free drink tickets for wine or beer and an assortment of appies. There will be a registration table at the ELC.
Meeting check-in	Check-in occurs for accommodation at the Spakwus House dorms begins at 3:30 or at the Opening Mixer on Thursday evening or continental breakfasts at the ELC on Friday or Saturday mornings.
PERS Banquet	The PERS Banquet, included in the registration fee, occurs on Friday evening at the ELC beginning with a no-host bar. The meal includes a glass of red or white wine. The bar will open at 6:00 with a buffet dinner at 6:30. PERS is fortunate to have Barbara Wernick, Golder Associates, presenting "The Britannia Mine Post and Present – Reclaiming the Shoreline". The no-host bar will be available through dinner and for those who wish to linger until 10 pm.
Breakfast and Lunches	Meeting registration includes continental breakfast on Friday and buffet lunch on Friday and Saturday at the ELC.
Fast Talks	A session of "fast talks" will include a 3-5 presentations. Each presenter will have 5 minutes for a fast talk consisting of a title slide and 10 content slides giving an overview of research question and results. The title slide will be shown during introduction of each presenter and the 10 content slides will be advanced automatically at 30-second intervals. An additional half-hour will be available to gather in breakout groups focusing on one of the fast talk topics for facilitated discussion. An optional poster or handout of conceptual diagrams and data may be helpful as an additional component of each presenter's contribution to the meeting. To facilitate logistics of the fast talks, PERS requests that each presenter brings their presentation to the meeting on a flash drive to be loaded unto the PERS computer prior to their session. Presenters are asked to form their fast talk to have a title slide and then 10 content slides set up to advance at 30 second intervals. For authors creating fast talks on Mac computer's, please test their presentation on a PC computer to make sure they are compatible. To ensure a timely session, we would like to avoid having presenters use individual computers that would require set up to the projector in the meeting. Please note that the Cheakamus Centre may not have WiFi reception so please avoid internet streaming within the fast talk presentation.

Panels	The 2016 PERS conference will feature two Panels involving 3-4 brief perspective presentations relevant to a provocative overarching topic. The entire panel should occupy an hour, at least 15 minutes of which should be allocated to facilitated discussion. The panel presentations will be held in the Spakwus House Presentation Room.
Posters	Posters will be attached to walls in the Spakwus House Poster Room walls adjacent the Presentation Room using supplied tape or attachment clips. At the beginning of the Poster session, the lead author of each will be given one minute at the beginning of the session to introduce the topic of the poster in the Poster Blitz. Then, the remainder of the hour will be available to explore information in more detail through audience circulation and group discussions around each highlighted poster.
Coffee and Tea breaks	Coffee, tea and water, along with muffins and fruit, will be available in mid-morning on Friday and Saturday during the poster sessions. An afternoon serving will also occur on Friday as well.

SCHEDULE-AT-A-GLANCE

Thursday, March 10

5:30 – 9:30 pm	Registration and Opening Mixer Cheakamus Environmental Learning Centre (ELC)

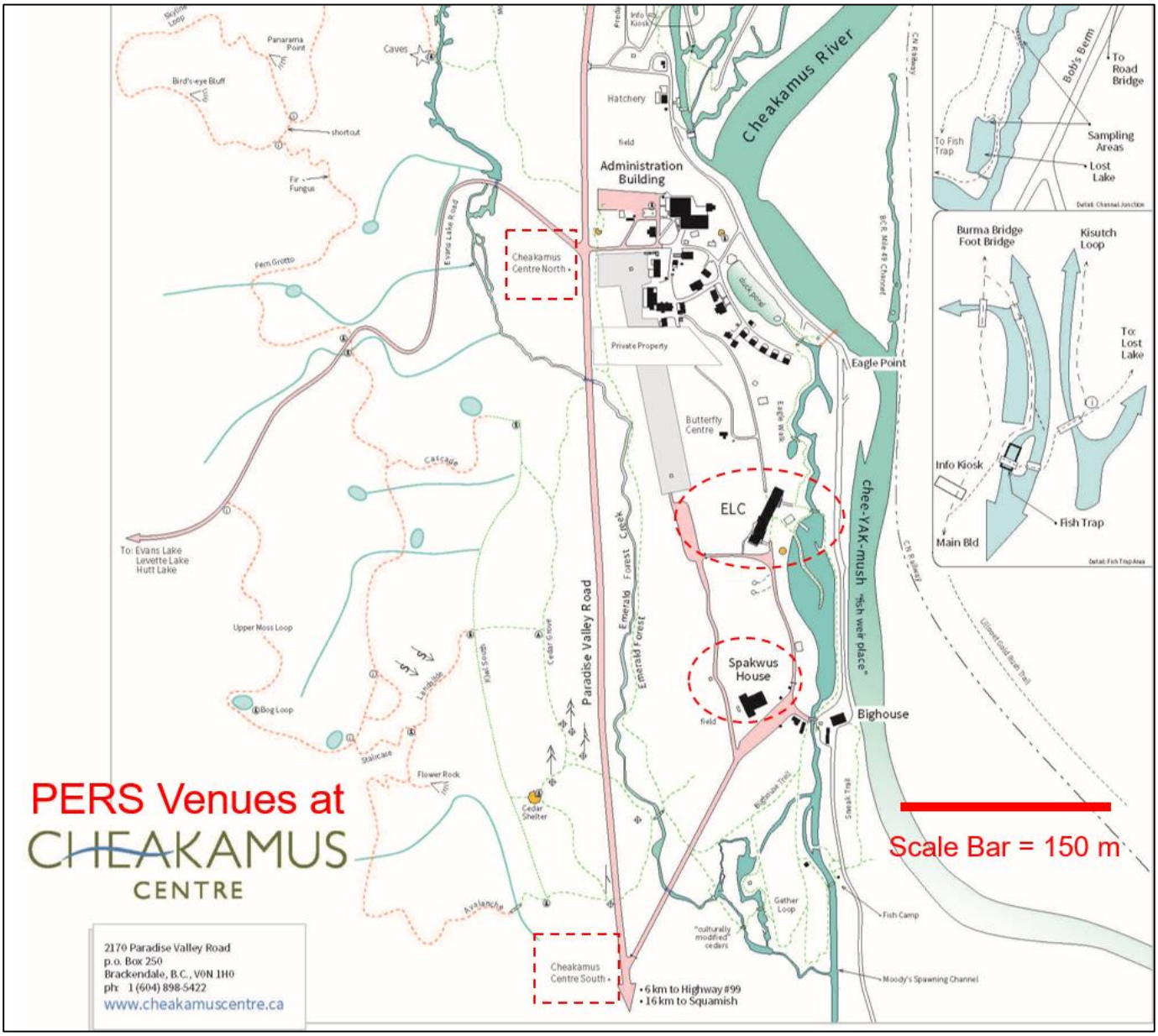
Friday, March 11

8:00 – 9:00	Continental Breakfast & Registration, ELC
9:00 - 9:15	Squamish Nation Invocation, Spakwus House (SH) Presentation Room
9:15 - 9:30	Welcome by PERS President Tony D'Andrea, SH Presentation Room
9:30 - 9:45	Program Overview, SH Presentation Room
9:45 - 10:45	Poster Session 1 & Coffee/Tea, SH Poster Room
10:45 - 11:45	Fast Talk 1 – Hypoxia, energy, cleanup & climate change, SH Presentation Room
12:00 - 1:00	Lunch, ELC
1:00 – 2:15	Fast Talk 2 – Invertebrates and climate change, SH Presentation Room
2:15 – 3:30	Special Panel 1 – Marshes, sediment grain size & climate change, SH Presentation Room
3:30 – 4:30	Fast Talk 3 – Eelgrass, habitats & climate change, SH Presentation Room
4:30 – 5:00	Coastal & Estuarine Research Federation (CERF) Presentation By Hilary Neckles, President-Elect, SH Presentation Room
5:00 - 6:00	PERS Business Meeting, Spakwus House
6:00 – 10:00	No-Host Bar and Banquet, ELC
	Featuring Barbara Wernick, "The Britannia Mine Post and Present – Reclaiming the Shoreline"

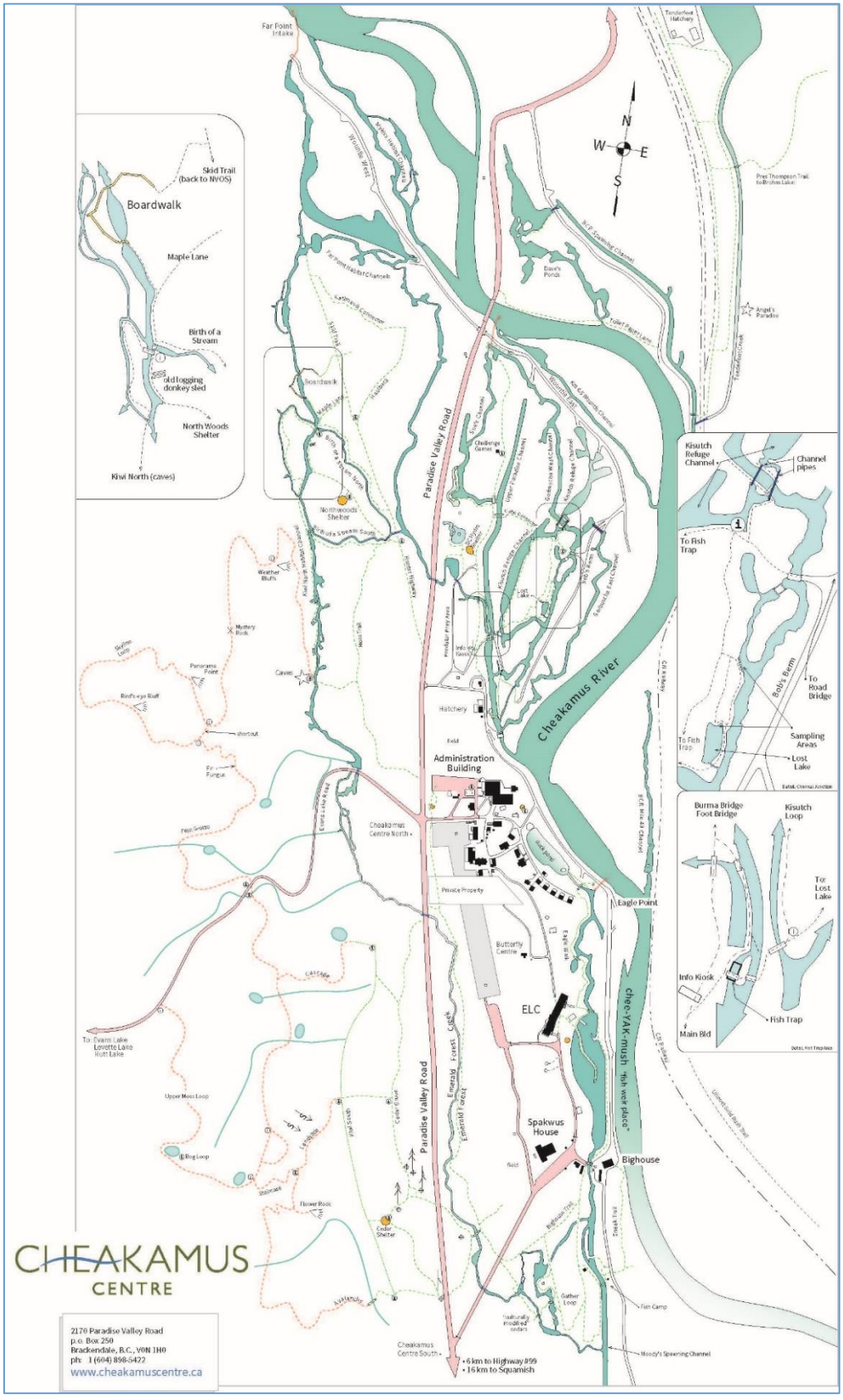
Saturday, March 12

7:30 - 8:30	Continental Breakfast & Registration, ELC
8:30 - 9:30	Plenary, featuring Bill Crawford, "Making Sense of the Variability in BC Coastal Waters Over the Past 60 Years", SH Presentation Room
9:30 - 10:30	Special Panel 2 – Aquaculture Management Issues, SH Presentation Room
10:30 - 11:30	Poster Session 2, Coffee/Tea, SH Poster Room
11:30 - 12:30	Lunch and Awards, ELC
12:30 - 4:00	Optional Field Trips

PERS VENUES AT THE CHEAKAMUS CENTRE



CHEAKAMUS TRAILS



DRIVING DIRECTIONS TO SQUAMISH:

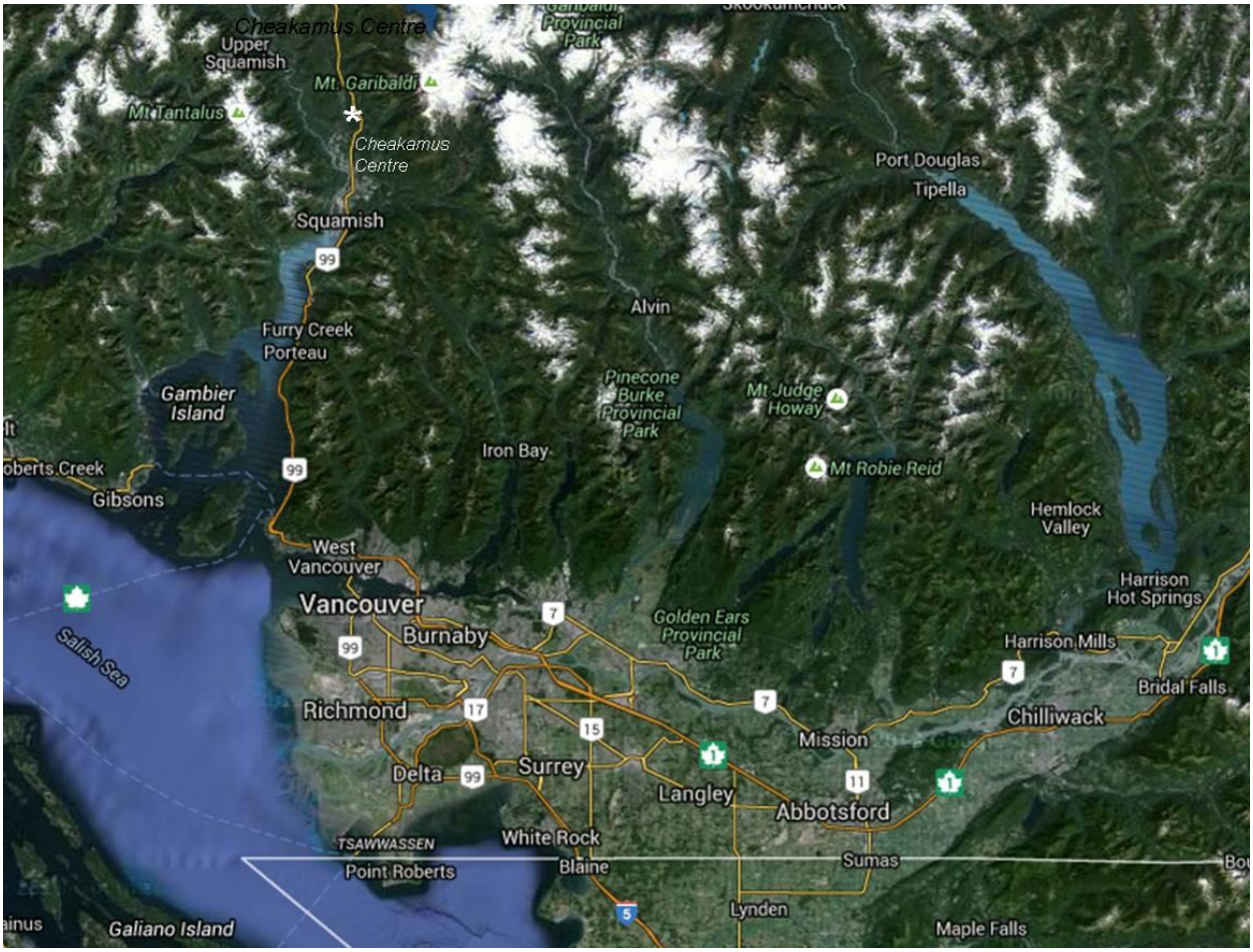
Take I5 north to Blaine, Washington. Two options exist to get to the Sea-to-Sky Highway to Squamish:

1. Enter British Columbia using the Peace Arch border crossing and follow Highway 99 north through Vancouver and West Vancouver to Sea to Sky Highway to Squamish. However, this route is susceptible to road work (i.e. repairs to Burrard Bridge leading to downtown) and traffic starts to get congested around 3:00;

   OR (recommended*),*

2. Enter B. C. using I5 exit 275 to Highway 543 that ends at the Truck Route border crossing. Follow Highway #15 (176 Street) north to the TransCanada #1. Follow north to Vancouver exit, and travel west on the TransCanada over the Port Mann Bridge (crosses the Fraser River) and Iron Workers Memorial Bridge (Crosses Burrard Inlet at Second Narrows) to the Sea to Sky Highway (#99) to Squamish. There is an automatic toll ($3.50 each way) on the Port Mann.

   Alternately, you may also take I5 north to the US-Canada border and the enter BC using the Peace Arch crossing. After entering BC, travel north approximately 0.6 miles to the 8th Avenue exit and travel east along 8th Avenue to Highway #15 (176 Avenue). Turn left and travel north to the TransCanada Hwy #1 as above.



DRIVING DIRECTIONS TO CHEAKAMUS CENTRE

Once entering Squamish along the Sea-to-sky Highway #99, drive 10 km (6.2 miles) north past downtown Squamish to the Alice Lake turnoff (see map on the following page).

Turn left (west) off Highway #99 across from the Alice Lake exit unto Squamish Valley Road.

Travel along Squamish Valley Road, keep right, and travel over the CN Rail tracks past Cheekye station and Fergie's Café just before the Cheakamus River.

Cross the bridge over the Cheakamus River and take the right fork onto Paradise Road.

Travel approximately 1.3 km (0.8 miles) to the Cheakamus Centre entrance on the left at 1600 Paradise Road. Park near the Spakwus House dorm.

DRIVING DIRECTIONS TO THE EXECUTIVE SUITES HOTEL

The Executive Suites Hotel is located at Tantalus Road approximately 10 km (6.2 miles) south of the Cheakamus Centre. It can be reached from the Sea-to-Sky Highway #99 by turning east at Garibaldi Way and left at the first street, which is Tantalus Road. The Executive Suites Hotel entrance is located to the right approximately 1 km (0.6 mile) north of Garibaldi Way.

Driving Directions Map to Cheakamus Centre

CHEAKAMUS CENTRE

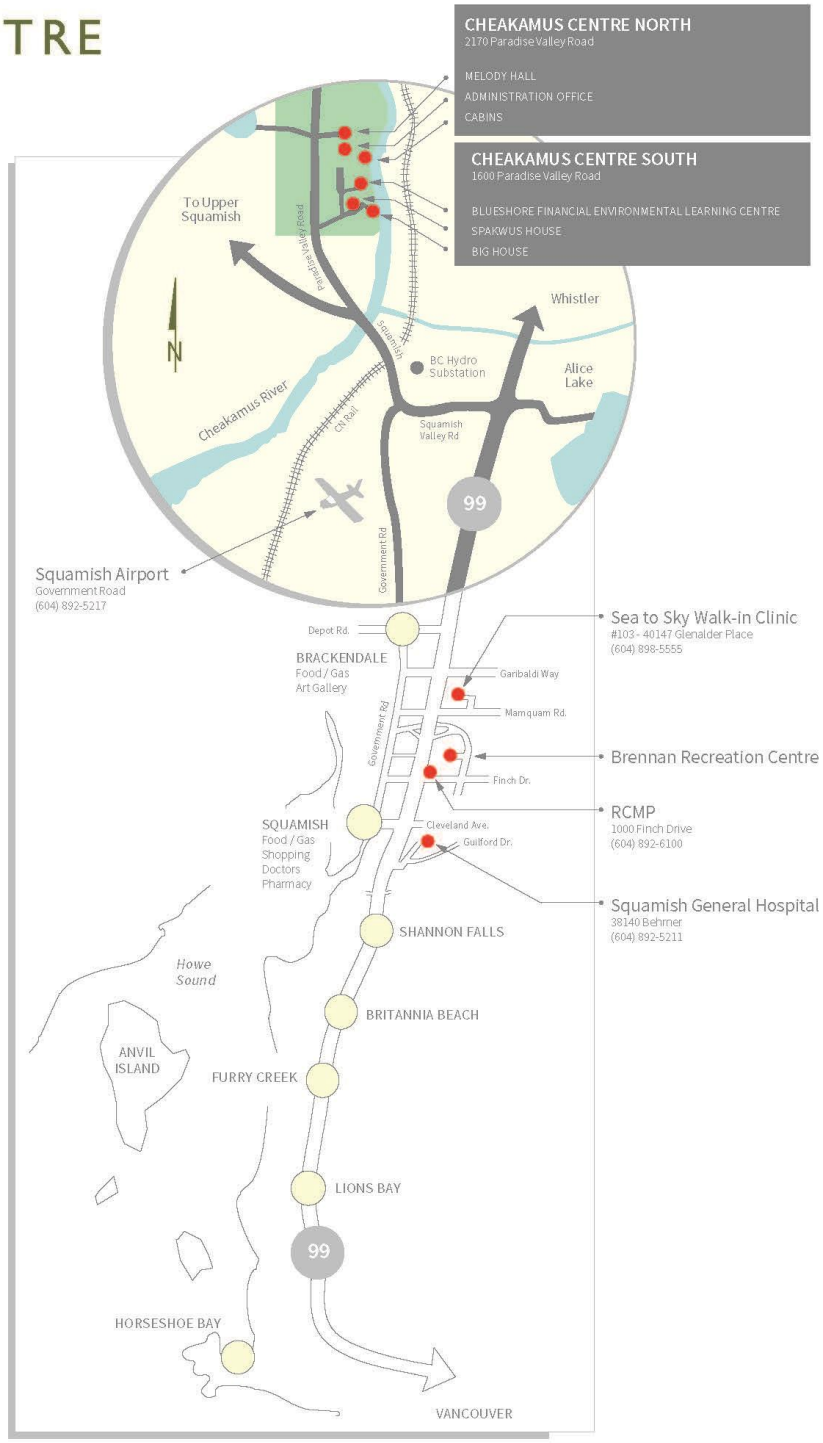
Cheakamus Centre
PH: 1 (604) 898-5422
www.cheakamuscentre.ca

DRIVING TO CHEAKAMUS CENTRE
Heading NORTH on #99

Drive 10km past downtown Squamish to the Alice Lake turnoff.

TURN LEFT (west) off highway 99 across from the Alice Lake turnoff on to Squamish Valley Road.

KEEP RIGHT over CN Rail tracks past Cheekye, over bridge and take the right fork on the Paradise Valley Road.



POINTS OF INTEREST AND RECOMMENDED EATERIES IN SQUAMISH AREA

There are lots of things to do in the Squamish area, ranging from word class skiing at Whistler and Blackcomb (downhill) and Callaghan Valley (cross country) to mountain biking, and hiking. For folks planning on spending extra time in Squamish, a good source of information is the Tourism B.C. website at: (http://www.hellobc.com/squamish.aspx).

The Squamish Adventure Centre located at the Sea-to-Sky Highway #99 intersection with Loggers Lane accessed by the exit opposite the Cleveland Avenue exit to downtown Squamish is an excellent stopping point to get advice on things to do and see in the area.

Points of interest include:

Britannia Beach located 12 km south of Squamish, includes the Britannia Mine museum that reflects one of the historic economic drivers for the region.

The Sea-to-Sky gondola, 3 km south of downtown Squamish provides excellent views of Howe Sound and Squamish River and Paradise valleys, as well as short alpine forest trails radiating from the Summit Lodge.

Shannon Falls and Stawamus Chief, both within provincial parks are local landmarks, with the impressive granite face of the Stawamus Chief being very popular with rock climbers. Do not leave valuables in the vehicle.

There are numerous trails throughout the area, easily accessed using the river dikes. At the Cheakamus Centre, the dike along the Cheakamus River provides a scenic walk and trails to rock outcrops/caves and old growth forest exist near the Spakwus House within the Cheakamus Centre property. Please check to confirm trails are open (e.g. Edith Tobe) before using them.

Within Squamish there are some recommended restaurants from our PERSian culinary aficionado, Colin Levings:

- Fergie's Café, 70002 Squamish Valley Rd, Brackendale (breakfast and lunch only)
- Living Room Restaurant and Lounge, Executive Suites Hotel and Resort, 40900 Tantalus Rd, Squamish
- Sushi Sen Japanese Restaurant, 40382 Tantalus Way, Squamish (dinner only)
- Timberwolf Restaurant, Best Western, 38922 Progress Way, Squamish

Also, these restaurants were recommended for their food, but not necessarily ambience, by Trip Advisor…

- Watershed Grill, 41101 Government Road, Brackendale
- The Nest Restaurant, 41340 Government Road, Brackendale
- The Crabapple Café, 41702 Government Road, Brackendale

PERS 2016 ANNUAL MEETING PROGRAM SCHEDULE
CHEAKAMUS CENTRE, BRACKENDALE, B.C.

Thursday, March 10

5:30 PM - 9:30 PM	Registration & Traditional PERS Opening Mixer, located in the Environmental Learning Centre (ELC), an evening of food, drink and reconnecting

Friday, March 11

8:00 AM - 9:00 AM	Registration, Continental breakfast, ELC
9:00 AM - 9:15 AM	Squamish Nation Invocation, Spakwus House (SH) Presentation Room
9:15 AM - 9:30 AM	Welcome by PERS President Tony D'Andrea, SH Presentation Room
9:30 AM - 9:45 AM	Program Overview, SH Presentation Room
9:45 AM - 10:45 AM	Poster Session 1 with Coffee & Tea, SH Poster Room

Featuring opening Poster Blitz, where each author presents a 1-minute introduction for their poster prior to viewing the posters listed below.

- **Sonni Tadlock,** Marco Hatch, Skye Augustine, QUANTIFYING FOOD SPECIES PRODUCED BY ANCIENT CLAM GARDEN TECHNOLOGIES OF THE SALISH SEA
- **Amy Rose Irons**, Marco Hatch, Skye Augustine, ASSESSING THE IMPACTS OF CLAM GARDENS ON INVERTERBRATE SPECIES DIVERSITY IN THE SALISH SEA
- **Edith Tobe,** EELGRASS RESTORATION IN THE SQUAMISH ESTUARY – A CASE STUDY
- **Dan Buffett**, Eric Palm, BC SPARTINA UPDATE – 2015 AND MOVING FORWARD IN 2016
- **Catherine Gerstle**, Marjorie Wonham, INTERTIDAL BIODIVERSITY COMPARISON IN HOWE SOUND: PROVINCIAL PARK VS. INDUSTRIAL SITE
- **Margot Hessing-Lewis**, MARINEGEO; LOCAL AND GLOBAL MARINE HABITAT MONITORING
- **Jenna Keeton**, Daniel Schindler, Lety Hopper, A VALUATION OF FISHERIES IN SOUTHEAST ALASKA
- **Kyle William Fawkes**, Marjorie Wonham, HOW DO PLANKTON AFFECT SALMON? AN NPZ MODEL FOR THE STRAIT OF GEORGIA
- **Lyndsey Swanson**, Gabriela Hannach, PUGET SOUND PHYTOPLANKTON: AN APPLICATION OF FLOWCAM TECHNOLOGY
- **Ashleigh Pilkerton**, GROWTH RATES OF JUVENILE SEA STARS, P. OCHRACEUS AND E. TROSCHELII
- **Carolyn Prentice,** Margot Hessing-Lewis, Anne Salomon, IS BLUE THE NEW GREEN? QUANTIFYING THE CARBON STORAGE CAPACITY OF EELGRASS MEADOWS IN THE PACIFIC NORTHWEST
- **T Kazmiruk**, V. Kazmiruk, and Leah Bendell**,** TRACE METALS IN URBAN ESTUARIES: IMPLICATIONS FOR REMEDIATION

10:45 AM - 11:45 AM	Fast Talk 1 – Hypoxia, energy, cleanup & climate change, SH Presentation Room

- **Natasha Christman**, Jude Apple, Robin Kodner, Jan Newton, PHYSICAL AND MICROBIAL DRIVERS OF OXYGEN DYNAMICS AND HYPOXIA IN BELLINGHAM BAY, WA
- **Andrea Copping**, HOW CAN WE SAFELY GENERATE ENERGY FROM THE SEA?
- **Jason Stutes**, Emily Duncanson, Jessica Blanchette, Marina Sandercock, Hun Seak Park, Pete Adolphson, Arianne Fernandez, HAVE YOUR CAKE AND EAT IT TOO: REMEDIATION AND RESTORATION AS DRIVERS OF AN ENVIRONMENTAL CLEANUP IN ANACORTES, WA

12:00 PM - 1:00 PM Lunch, ELC

1:00 PM - 2:15 PM Fast Talk 2 – Invertebrates and climate change, SH Presentation Room

- **Andres Jose Quesada**, Katherina Schoo, Brian Bingham, LIPID PROFILES OF TWO SYMBIONTS FROM THE SEA ANEMONE ANTHOPLEURA ELEGANTISSIMA
- **Aaron Matthius Eger**, Janelle Curtis, Marie-Josée Fortin, Isabelle Côté, Frédéric Guichard**,** TRANSFERABILITY AND SCALABILITY OF SPECIES DISTRIBUTION MODELS: A TEST WITH SEDENTARY MARINE INVERTEBRATES
- **Sylvia Behrens Yamada**, Scott Groth, GROWTH AND LONGEVITY OF THE RED ROCK CRAB, CANCER PRODUCTUS
- **Colin Levings**, A GAMMARID AMPHIPOD AS A POTENTIAL INDICATOR OF DEGLACIATION AND ESTUARINE CHANGE
- **Sylvia Behrens Yamada**, William Peterson, Michael Kosro, BIOLOGICAL AND PHYSIC OCEAN INDICATORS PREDICT THE SUCCESS OF THE INVASIVE EUROPEAN GREEN CRAB, CARCINUS MAENAS.

2:15 PM - 3:30 Special Panel 1 – Marshes, sediment grain size & climate change, SH Presentation Room

- **Sean Boyd**, Brent Gurd, SOME TIDAL MARSHES ON THE FRASER RIVER ESTUARY ARE DISAPPEARING AND WE DON'T KNOW WHY
- **Nathaniel Jones**, Jeffry C Borgeld, DREDGING OR TEMPORAL CHANGES IN OCEAN CONDITIONS? DETERMINING THE DOMINANT DRIVER OF GRAIN SIZE DISTRIBUTION IN HUMBOLDT BAY ON THE NORTHWEST COAST OF CALIFORNIA
- **Gary Williams**, REMOVAL OF DENSE ANTHROPOGENIC LOG ACCUMULATIONS TO RESTORE HABITAT IN THE TSAWWASSEN SALT MARSH, FRASER RIVER ESTUARY
- **Dan Buffett**, Eric Palm, INITIATING AN ESTUARY MONITORING PROGRAM IN BC

3:30 PM - 4:30 PM Fast Talk 3 – Eelgrass, habitats & climate change

- **Cynthia Durance**, INTER-ANNUAL VARIATION OBSERVED IN A LARGE EELGRASS (ZOSTERA MARINA) MEADOW, AND POTENTIAL CHANGES THAT MAY RESULT FROM CLIMATE CHANGE.
- **Anthony D'Andrea**, Elizabeth Perotti, Cinamon Moffett, Stacy Strickland, POTENTIAL EFFECTS OF NON-NATIVE EELGRASS ON SHELLFISH COMMUNITY STRUCTURE IN NETARTS BAY, OREGON
- **Steven Peter Ferraro**, QUANTITATIVE REPRODUCIBLE HABITAT–COMMUNITY PATTERNS IN PACIFIC NORTHWEST ESTUARIES AND BEYOND

4:30 PM - 5:00 PM Coastal & Estuarine Research Federation (CERF) Presentation by Hilary Neckles, President-Elect

5:00 PM - 6:00 PM PERS Business Meeting, Spakwus House

6:00 PM - 10:00 PM No-Host Bar and Banquet, ELC

Featuring Barbara Wernick, "The Britannia Mine Post and Present – Reclaiming the Shoreline"

Saturday, March 12

7:30 AM - 8:30 AM Registration & Continental Breakfast, ELC

8:30 AM - 9:30 AM Plenary, featuring Bill Crawford, "Making Sense of the Variability in BC Coastal Waters over the Past 60 Years", SH Presentation Room

9:30 AM - 10:30 AM Special Panel 2 – Aquaculture Management Issues.

- James Brennan, Leah Bendell, Ken Ashley, "AQUACULTURE IN THE SALISH SEA: AN EMERGING MANAGEMENT CHALLENGE?"

10:30 AM - 11:30 AM Poster Session 2 with Coffee & Tea, SH Poster Room

11:30 PM - 12:30 PM Lunch with Student Awards Presentation & Closure, ELC

12:30 PM - 4:00 PM Optional Field Trips

- Field Trip 1 - Squamish River estuary restoration sites with Edith Tobe
- Field Trip 2 - Quest University Tour led by Quest students
- Field Trip 3 – Sea to Sky Gondola ride (PERS has 15% reduction off regular rate)

PERS 2016 ANNUAL MEETING ABSTRACTS

Friday Banquet Talk

THE BRITANNIA MINE PAST AND PRESENT – RECLAIMING THE SHORELINE

Barbara Wernick, Principal/Senior Environmental Scientist, Golder Associates Ltd. (bwernick@golder.com)

The former Britannia Mine, located adjacent to Howe Sound, 45 km north of Vancouver, Canada operated primarily as a copper and zinc mine from 1904 to 1974 and at its peak was the largest copper mine in the British Commonwealth. During its operational life, the mine generated over 40 million tonnes of tailings which were largely deposited onto the Britannia Creek fan area and the marine, subtidal slope of Howe Sound along Britannia Beach. As was typical of mines in production in that era, planning for closure was deficient and maintenance of pollution control works ordered by the provincial government before the mine shut down was poor, resulting in ongoing discharge of mine water into Britannia Creek for some 30 years after the mine closed. Studies in the late 1990s indicated that marine water in Howe Sound at the mouth of Britannia Creek was lethal to caged fish and that the intertidal community within 1 km on either side of the Creek mouth was depauperate of species typically found at unaffected sites in Howe Sound. The provincial government ultimately assumed ownership of the mine in 2001 and began an ambitious remediation program intended to intercept, collect and treat water-borne metals discharging to the environment. As a result, significant improvements in water quality and the intertidal community have occurred. Remediation work at the mine also stimulated renewed interest in the community and subsequent investment into the restoration of the iconic Mill building at the Britannia Mine which was declared a National Historic Site in 1989.

Saturday Plenary

MAKING SENSE OF THE VARIABILITY IN BC COASTAL WATERS OVER THE PAST 60 YEARS.

Bill Crawford, Emeritus Research Scientist, Fisheries and Oceans Canada, Institute of Ocean Sciences (billcraw@telus.net)

We are now in a classical El Niño winter. El Niño and La Niña events (collectively labelled ENSO) usually change the tracks of storms heading toward BC in winter, which in turn lead to major changes in seawater temperatures along our outer coast well into spring. In addition, ENSO events set up the Pacific Decadal Oscillation that determines ocean currents and sea surface temperatures throughout the entire North Pacific Ocean. The distribution of these temperature changes through the BC inside passage and inlets depends on local tidal currents and mixing, as well as estuarine circulation. I will show these ocean changes, their passage through BC waters, and their impacts on distribution of marine life.

Abstracts - Fast Talk

INITIATING AN ESTUARY MONITORING PROGRAM IN BC

Dan Buffett*, Ducks Unlimited Canada (d_buffett@ducks.ca), Eric Palm, Ducks Unlimited Canada (e_palm@ducks.ca)

Along the BC Coast over 442 estuaries that have been mapped using standardized criteria and spatial tools (Ryder et al. 2007). During that project, estuaries were ranked for their biological importance to water birds. While this project ranked estuaries at a regional scale, it did not provide an indication of estuary health at the finer scale of an individual estuary. To date in BC, while some estuary monitoring does occur the methods are often specific to one estuary and therefore if a trend is observed it is unknown whether it is a local or regional trend and it is unknown how estuaries are performing relative to each other. Ducks Unlimited Canada and in association with some of our conservations partners, initiated an estuary monitoring project in 2015. Initial work included reviewing recommending estuary monitoring parameters from the literature, initiating capacity building between organizations, and identify key management questions. Subsequent steps planned for 2016 include refining parameters to measure, outreach to other partners, pilot a subset of monitoring protocols in a few estuaries, and statistical design of monitoring parameters with a goal of an operational program in 2017. The presentation will share some of the results of the proposed monitoring parameters, initial results of some trials such as the use of unmanned aerial vehicle i.e. drones to detect large wood debris in a portion of Fraser estuary, next steps of the project with the intention of receiving feedback from PERS attendees and identifying potential interested partners.

PHYSICAL AND MICROBIAL DRIVERS OF OXYGEN DYNAMICS AND HYPOXIA IN BELLINGHAM BAY, WA

Natasha Christman*, University of Washington (nrchri10@uw.edu), Jude Apple, Padilla Bay National Estuarine Research Reserve (japple@padillabay.gov), Robin Kodner, Western Washington University (Robin.Kodner@wwu.edu), Jan Newton, University of Washington (janewton@uw.edu)

Keywords: oxygen, plankton, hypoxia

Bottom water hypoxia is a feature of many coastal embayments and fjords in the Salish Sea. Ongoing research in Bellingham Bay (Bellingham, WA USA) 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 influence of anthropogenic nutrient loading on patterns of regional hypoxia is poorly understood. The present study has continued an established monitoring program documenting the range, duration and severity of low dissolved oxygen in Bellingham Bay in the summers of 2013-2015, while adding an experimental component investigating factors that regulate respiration in the water column. Results suggest the displacement of an oxygen-depleted layer of bottom water in the bay is strongly correlated with spring-neap tidal cycling. In 2015, anomalously low river discharge and high temperatures may have also contributed to the lowest observed oxygen concentrations in our record (1.2 mg/L O_2). In addition, manipulative experiments were conducted to investigate factors regulating oxygen consumption in bottom waters. Organic matter availability appears to be a prominent limiting factor to Bellingham Bay oxygen consumption and ongoing research is investigating whether shifts in the resident phytoplankton community may affect the quality of carbon available for respiration. The study's findings broaden our knowledge of factors regulating the consumption of oxygen in bottom waters of the Pacific Northwest and provide insight into the effects of organic carbon delivery and climate change.

HOW CAN WE SAFELY GENERATE ENERGY FROM THE SEA?

Andrea Copping*, Coastal Division, Pacific Northwest National Laboratory (andrea.copping@pnnl.gov)

The looming effects of climate change, including ocean acidification, rising temperatures, and changes in nearshore areas due to sea level rise, are of great concern for the integrity of ocean systems, the organisms who depend on the oceans, and the habitats they support. As part of mitigating climate change, many nations are exploring development of a range of
low carbon energy sources, including renewable energy from the ocean. There are however, concerns that the introduction of machines into the ocean, including tidal turbines, wave energy converters, ocean current turbines, and offshore wind turbines, could harm the marine animals and habitats we study. In particular, marine mammals, fish, seabirds, mobile invertebrates, and benthic habitats are considered to be at risk in coastal and estuarine areas. Ironically, the species of greatest concern for potential effects of marine renewable energy are those most vulnerable to climate change. Because the marine renewable energy industry is in its infancy, there are few data that adequately describe the interactions between devices and the environment; this level of scientific uncertainty is confounding our ability to understand and safely develop ocean energy. This talk will briefly cover the potential effects that marine renewable energy might cause on the marine environment, and discuss a path forward for understanding, monitoring for, and mitigating, these effects.

POTENTIAL EFFECTS OF NON-NATIVE EELGRASS ON SHELLFISH COMMUNITY STRUCTURE IN NETARTS BAY, OREGON

Anthony D'Andrea*, Oregon Department of Fish and Wildlife, Marine Resources Program (tony.f.dandrea@state.or.us), Elizabeth A. Perotti, Cinamon L. Moffett, Stacy A. Strickland **(**http://www.dfw.state.or.us/mrp/shellfish/seacor/index.asp)

Keywords: Community structure, Eelgrass ecosystems, *Zostera japonica*, *Zostera marina*, Shellfish, Bivalves

The non-native eelgrass *Zostera japonica* was introduced in the 1930s to the Pacific Northwest and has since become well established in many estuaries. Several of these estuaries have expansive native *Zostera* marina beds and support communities of ecologically, recreationally, and commercially important shellfish. However, there is limited information about the effects of *Z. japonica* expansion on these communities. In 2013-2014, the Oregon Department of Fish and Wildlife conducted a shellfish population and estuarine habitat study in Netarts Bay. Both rapid and detailed assessment methods were applied extensively across the study area in grid and random points with stratified by tidal elevation and region of the estuary. Post hoc, we identified four bed types in the bay (*Z. marina [ZM], Z. japonica [ZJ]*, mixed eelgrass species [M], and non-vegetated beds [NV]), and explored multivariate patterns in the related shellfish communities. We found significant interactive effects of tide level and eelgrass bed type on shellfish community composition. Thus, the potential effect of *Z. japonica* on shellfish community composition was context dependent. However, there were some general patterns observed in the study: a significant increase in shellfish biodiversity in ZJ relative to NV; both positive and negative effects on recreationally important bivalves; and distinct shifts in species composition in *ZJ* and M beds. These results enhance our understanding of the potential effects of *Z. japonica* but highlight the need for further research to evaluate how these community shifts may affect ecosystem structure and function.

INTER-ANNUAL VARIATION OBSERVED IN A LARGE EELGRASS (ZOSTERA MARINA) MEADOW, AND POTENTIAL CHANGES THAT MAY RESULT FROM CLIMATE CHANGE.

Cynthia Durance, Precision Identification (precid@shaw.ca)

The Roberts Bank eelgrass meadow, located in the Fraser River Estuary, is one of the largest in British Columbia. The area colonized by native eelgrass, *Zostera marina*, more than doubled between 1967 and 2003, partially due to anthropogenic modifications to the habitat. Detailed monitoring between 2003 and 2014 revealed large inter-annual variation in biomass and some changes in distribution. The expansion of the eelgrass habitat and the potential effects of sea level rise and global warming on this system will be discussed.

TRANSFERABILITY AND SCALABILITY OF SPECIES DISTRIBUTION MODELS: A TEST WITH SEDENTARY MARINE INVERTEBRATES

Aaron Matthius Eger*, Department of Biology, University of Victoria (http://aaroneger.weebly.com), Janelle M. R. Curtis, Pacific Biological Station, Fisheries and Oceans Canada, Marie-Josée Fortin, Department of Ecology & Evolutionary Biology, University of Toronto, Isabelle M. Côté, Earth to Ocean Research Group, Department of Biological Sciences, Simon Fraser University, Burnaby, Frédéric Guichard, Pacific Biological Station, Fisheries and Oceans Canada

Species Distribution Models (SDMs) are often used to delineate a species' distribution. However, it is not always clear how the estimated parameters and corresponding occurrence probabilities vary across taxa, scales, and techniques. The extent to which an SDM is usable depends on its scalability, i.e. how well a model performs when applied beyond the borders (up scaled) or to a subsection (downscaled) of the area for which it was developed, and on its transferability, i.e. how a model performs when transferred from the area for which it was developed (our reference) to a new area of the same scale. We used four northeast Pacific marine benthic invertebrates (*Parastichopus californicus*, *Panopea generosa*, *Strongylocentrotus droebachiensis*, and *Strongylocentrotus franciscanus*) at three spatial scales to explore these issues. We found that downscaled models increased the predictive accuracy of our SDMs. Transferred and up scaled models had lower predictive accuracy than their reference counterparts but still performed better than random. Therefor future modeling projects should involve the testing of and possible application of downscaled models to reference or improve their predictive accuracy. While it is not preferable to use an up scaled or transferred model, they can provide acceptable alternatives if information is needed quickly and other options are not available. While our analysis revealed some species-specific differences, patterns were not consistent across our study. Our results provide insights into the techniques available for researchers and managers developing SDMs at varying scales, with different species, and with different levels of initial information.

QUANTITATIVE REPRODUCIBLE HABITAT–COMMUNITY PATTERNS IN PACIFIC NORTHWEST ESTUARIES AND BEYOND

Steven P. Ferraro, retired (steveferraro@peak.org)

Keywords: habitats, communities, estuaries

Discovering quantitative reproducible habitat-community patterns requires the use of operational definitions of habitats and community appropriate for the epistemological purpose. When the target biotic community is quantitatively sampled in a statistically rigorous, unbiased, representative manner in an ecologically relevant space–time frame, tests for quantitative reproducible habitat-community

patterns can be made under the a priori assumption that the community is defined appropriately. When, under these conditions, quantitative reproducible habitat-community patterns are found, the operationally defined habitat types are appropriate in the spatial and temporal domain they were tested. By statistical inference and trial and error quantitative reproducible habitat-community patterns have been found for the nekton and benthic macrofaunal community for multiple habitat types in Pacific Northwest (PNW) estuaries. This scientific method can be used to generate an ever-increasing amount of new synthesizable information on quantitative reproducible habitat-community patterns in PNW estuaries and beyond.

DREDGING OR TEMPORAL CHANGES IN OCEAN CONDITIONS? DETERMINING THE DOMINANT DRIVER OF GRAIN SIZE DISTRIBUTION IN HUMBOLDT BAY ON THE NORTHWEST COAST OF CALIFORNIA

Nathaniel D. Jones*, Humboldt State University, (ndj24@humboldt.edu); Jeffry C. Borgeld, Humboldt State University, (Jeffry.Borgeld@humboldt.edu)

Keywords: Surface sediments, erosion, morphology

ABSTRACT: A 2001 study concluded Humboldt Bay sediment size had increased with time since initial surveys in 1971. The proposed driving force for this trend were tidal currents, waves, and dredging in the bay. The objective of this study is to utilize sediment size distribution data from recent studies in Humboldt Bay, during fall 2014 and spring 2015 to determine if dredging or seasonal variability of tides and waves was the dominant cause of changes in grain size distribution seen in previous studies. Data from measurements and previous studies are compared with dredging records and ocean conditions to determine if dredging or tidal and wave energy was the driving force on changes in sediment distribution within Humboldt Bay.

A GAMMARID AMPHIPOD AS A POTENTIAL INDICATOR OF DEGLACIATION AND ESTUARINE CHANGE

Colin Levings*, Fisheries and Oceans Canada, West Vancouver (retired) (cklevings@shaw.ca)

Keywords: Climate change, indicator species, amphipod

The gammarid amphipod *Gammarus setosus* Dementieva is adapted to the cold conditions of northern estuaries. As far as known, in British Columbia *G. setosus* is only found on mainland fjord estuaries that are connected with glaciers (e.g. Squamish River estuary, Homathko River estuary). This species has potential as an indicator of climate warming if glacial melt is increased to the extent that temperatures in an estuary linked with a glacier-fed river are affected. *G. setosus* is a relatively large estuarine amphipod with a few distinctive morphological features that enable quick identification in the field, with the aid of a hand lens. Further survey work as well as ecophysiological studies are needed to confirm the idea of using this species as an indicator. Other issues relating to potential use are sample survey design, number of amphipods to be examined to confirm a change in the amphipod community, and possible short term evolution in response to temperature changes.

LIPID PROFILES OF TWO SYMBIONTS FROM THE SEA ANEMONE *ANTHOPLEURA ELEGANTISSIMA*

Andrés J. Quesada*, [2]Salish Sea Research Center, Northwest Indian College, (andresjquesada@gmail.com), Katherina L. Schoo, Shannon Point Marine Center, Western Washington University, Brian L. Bingham, Department of Environmental Sciences, Western Washington University

Keywords: invertebrate ecology, symbiosis, fatty acids

Anthopleura elegantissima is the most abundant intertidal sea anemone on the Pacific coast of North America. It may host two distinct symbionts, the dinoflagellate *Symbiodinium muscatinei* (zooxanthellae) and the chlorophyte *Elliptochloris marina* (zoochlorellae). These symbionts are taxonomically, ecologically, morphologically, and metabolically different: *E. marina* is negatively affected by high light and temperatures, so zoochlorellate *A. elegantissima* are restricted to cooler, shaded sites, whereas zooxanthellate individuals thrive in areas with more sunlight. We collected anemones hosting *S. muscatinei* and anemones hosting *E. marina*, separated the symbionts from the host tissues, and compared the fatty acid profiles of the two symbionts. Significant differences were present in their fatty acid profiles, with docosahexaenoic acid (DHA) and palmitic acid abundant in *S. muscatinei*, and oleic and α-linolenic acids abundant in *E. marina*. The high concentrations of unsaturated fatty acids in *E. marina* may help it perform better than *S. muscatinei* at lower temperatures and may explain why anemones hosting *E. marina* are more abundant in low intertidal habitats and higher latitudes.

HAVE YOUR CAKE AND EAT IT TOO: REMEDIATION AND RESTORATION AS DRIVERS OF AN ENVIRONMENTAL CLEANUP IN ANACORTES, WA

Jason Stutes, Hart Crowser, Inc., (seagrasser@gmail.com), Emily Duncanson Hart Crowser, Inc., Jessica Blanchette, Hart Crowser, Inc., Maria Sandercock, Hart Crowser, Inc., Hun Seak Park, Washington State Department of Ecology, Toxics Cleanup Program, Pete Adolphson, Washington State Department of Ecology, Toxics Cleanup Program, Arianne Fernandez, Washington State Department of Ecology, Toxics Cleanup Program

The Custom Plywood project, a Puget Sound Initiative site, provided a rare opportunity to implement meaningful restoration of a historical industrial waterfront as part of broader site-wide cleanup action. Implementation was phased based on cleanup actions and available funding ultimately resulting in nearshore excavation and restoration in 2013. As part of these cleanup activities, Hart Crowser assisted in the design of a beach face that was not only protective of capped contamination remaining in the upland portion of the site, but also restored historical ecological function to the nearshore. The beach design promoted forage fish spawning and use by out migrating salmonids, and restored emergent nearshore/wetland plants as part of a pocket estuary. Performance surveys over the past two years have quantitatively examined salmonid use, epibenthic zooplankton productivity, forage fish spawning occurrence/success, and wetland plant recruitment. The monitoring results show an increase in use, activity and productivity along the beach and within the estuary year to year compared to an adjacent unrestored shoreline. Not only did we remove contamination that was a potential human health risk but we also restored the physical and ecological processes at the beach. Our remediation design has restored ecological function to the Fidalgo Bay system which has experienced over a hundred years of industrial waterfront use.

REMOVAL OF DENSE ANTHROPOGENIC LOG ACCUMULATIONS TO RESTORE SALT MARSH IN THE TSAWWASSEN SALT MARSH, FRASER RIVER ESTUARY

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

Keywords: salt marsh vegetation, anthropogenic log impacts, threespine stickleback

Since the 1980's large accumulations of anthropogenic logs that have inundated tidal marshes within Boundary Bay and the Fraser River estuary have periodically been removed to restore marsh vegetation and associated ecological functions. In 2007, 4.5 ha of densely log inundated salt marsh within the Tsawwassen salt marsh adjacent Roberts Bank in the Fraser River estuary was cleared to allow salt marsh vegetation to naturally recover, and paired culverts were installed through the dike and a system of dendritic channels were excavated in 2008 to improve tidal flushing. A post-construction monitoring program was conducted for six years to document re-establishment of the salt marsh vegetation and fish utilization. Vegetation establishment was rapid and complete within 3-5 years, and the dendritic channels supported threespine stickleback (*Gasterosteus aculeatus*) and staghorn sculpin (*Leptocottus armatus*), with the former species spawning within the channels. The restored salt marsh also supports great blue heron, raptors such as northern harrier, as well as other avian species that utilize the Pacific Flyway along the Salish Sea.

BIOLOGICAL AND PHYSIC OCEAN INDICATORS PREDICT THE SUCCESS OF THE INVASIVE EUROPEAN GREEN CRAB, *CARCINUS MAENAS*

Sylvia Behrens Yamada*, Oregon State University (yamadas@science.oregonstate.edu), William Peterson, NOAA-Fisheries (bill.peterson@noaa.gov), P. Michael Kosro, Oregon State University (kosro@coas.oregonstate.edu)

Keywords: population, recruitment success, invasive species

An introduced population of European green crabs was established in San Francisco Bay prior to 1989. Subsequently, their larvae were carried northward to Oregon, Washington, and British Columbia by the unusually strong Davidson Current during the winter of the 1997/1998 El Niño. Since this colonizing event, green crabs in Oregon and Washington have persisted at low densities. In this study, we show that after the arrival of the strong founding year-class of 1998, significant recruitment to the Oregon and Washington populations has occurred, but only in 2003, 2005, 2006, 2010 and 2015. Warm winter water temperatures, high positive values of the Pacific Decadal Oscillation (PDO) and Multivariate ENSO (El Niño Southern Oscillation) indices in March, weak southward shelf currents in March and April, a late biological spring transition, and high abundance of subtropical copepods are all strongly correlated with strong year-classes. We hypothesize that northward transport of larvae from California by coastal currents during warm winters is the mechanism by which the larvae are delivered to Oregon and Washington estuaries. Among the best indicators of northward flow (and green crab recruitment) were the date of 'biological spring transition', the sign of the PDO, and the biomass of southern copepod species, which indicate (1) stronger northward flow of coastal waters during winters, (2) relatively warm winters (sea surface temperature >10°C), which enable larvae to complete their development, and (3) coastal circulation patterns that may keep larvae close to shore, where they can be carried by tidal currents into estuaries to settle.

GROWTH AND LONGEVITY OF THE RED ROCK CRAB, *CANCER PRODUCTUS*

Sylvia Behrens Yamada*, Oregon State University (yamadas@science.oregonstate.edu), Scott Groth, Oregon Department of Fish and Wildlife (scott.d.groth@state.or.us)

Keywords: life history, mark-recapture, recreational fishery

Red rock crabs, *Cancer productus*, are important components of Pacific Northwest nearshore communities and recreational crab fisheries. While an understanding of life history parameters is critical to fisheries management, few studies have been conducted on red rock crabs. The growth and longevity of the red rock crab was studied at two sites representing an unfished population in a marine preserve (Friday Harbor, WA) and a heavily fished saline estuary population (Coos Bay, OR). Growth in crustaceans is incremental and age classes are unevenly mixed, making these investigations difficult. An array of techniques was used, including size distribution analysis, growth within confinements, and mark-recapture in describing the life history of *C. productus*. Carapace width increased from 20-30% with molt increment and intermolt period varied with size and sex. Longevity estimates of up to 5-6 years are longer than previously described. Recreational fishing pressure in Coos Bay is linked to in a noticeable absence of large males at this site. Since only crabs > 115 mm were harvested by the recreational fishery, no adjustments in fishing regulations need to be made at this time.

Special Topics

SOME TIDAL MARSHES ON THE FRASER RIVER ESTUARY ARE DISAPPEARING AND WE DON'T KNOW WHY

Sean Walter Boyd, Environment Canada, Science & Technology Branch(sean.boyd@canada.ca), Brent Gurd, BC Ministry of Forests, Lands and Natural Resource Operations (brent.gurd@gov.bc.ca)

Keywords: Fraser River estuary, tidal marsh, bulrush, recession

Roughly 50% of the bulrush zone on Sturgeon Banks (Lulu Island, Richmond) on the Fraser River estuary, B.C. has disappeared in recent decades. Stem density measurements in 1989 and 2011 indicate that the marsh leading edge receded by 350-400 m, equivalent to a mean loss of 15-20 m/yr. This loss is a huge concern given the importance of marsh primary production to the ecology of the Fraser River estuary. For decades the Steveston North Jetty and dredging of the Fraser River diverted sediments and fresh water away from Sturgeon Banks, and this would have altered the substrate accretion and salinity regimes on the banks. The slope of the tidal platform is shallow so even minor changes in substrate elevation, salinity, or some other abiotic factor could have affected marsh growth and survival, resulting in the large (horizontal) losses. We used high quality GPS units to map the marsh leading edge on Sturgeon Banks and at Westham Island (our control site) in 2011 and again in 2015 to determine recent rates of change. On average, the leading edge at Westham Island advanced by ca. 0.8 m (0.2 m/yr) but there was no change on Sturgeon Banks, suggesting that marsh recession there may have slowed or halted completely. We are evaluating air/satellite photos and LIDAR maps, as well as sediment accretion/salinity regimes, to determine which proximate factor(s) may have been responsible for the marsh recession and to develop management prescriptions to try to reverse the situation.

AQUACULTURE IN THE SALISH SEA: AN EMERGING MANAGEMENT CHALLENGE?

Leah Bendell, Simon Fraser University (bendell@sfu.ca), James S. Brennan*, Marine Ecological Consulting Services (jsbrennan360@gmail.com), Ken Ashley, British Columbia Institute of Technology Rivers Institute (ken_ashley@bcit.ca)

Estuaries and other nearshore marine areas are the most productive parts of marine ecosystems, but have experienced substantial degradation and loss as a result of coastal development. One form of nearshore industrial development that has received less regulatory oversight is shellfish aquaculture. Shellfish aquaculture has a long history in the Washington and British Columbia, and has been expanding rapidly in recent decades, in part because of state and federal initiatives to promote aquaculture. Yet, this form of nearshore development is not managed similar to other forms of coastal development, despite the fact that it occurs directly within nearshore marine waters and may be contrary to established regional ecosystem management goals and objectives. This panel will provide an overview of aquaculture practices, environmental impacts, critical data gaps for informed management decision making, and a review of coastal management regulations relevant to shellfish aquaculture expansion. The basis for guiding aquaculture expansion, framing management goals for protection and restoration, and developing a set of questions that regulatory agencies should consider to enable informed management decisions that balance economic and environmental perspectives will also be addressed. This review will provide the foundation for a panel discussion and audience participation, from which we hope to receive feedback for development of recommendations to provide to regulatory agencies that will ensure that the expansion of aquaculture does not conflict with established protective standards and goals of restoring nearshore habitats and species.

Posters

BC *SPARTINA* UPDATE – 2015 AND MOVING FORWARD IN 2016

Dan Buffett, Ducks Unlimited Canada (d_buffett@ducks.ca)

The BC *Spartina* Working Group continues working towards eradication of non-native *Spartina* along the West Coast of North American in partnership with other Washington, Oregon and California. Our approach of steering committee consisting of government agencies and non-government organizations appears to date as the best model given limited and fragmented funding but utilizes the in-kind funding of all committee members and external funding from our 2015 funders of Port Metro Vancouver, Province of BC and National Wetlands Conservation Fund. In 2015, we continued on integrated use of manual and herbicide treatment of *Spartina anglica* in Boundary Bay and Roberts Bank, we expanded and are near containment levels of *Spartina densiflora* in the Baynes Sound area of Vancouver Island, and continue to evaluate the control options of shading, herbicide and other control on *Spartina patens* in the Port Moody area of Burrard Inlet as well as in the Courtenay River estuary and south towards Baynes Sound. In 2016 pending confirmation of funding, we will continue mapping and control in our core treatment areas, expanding mapping and outreach on Vancouver Island, and near complete of our evaluation of treatment options and begin restoration recommendations for *S. patens*.

HOW DO PLANKTON AFFECT SALMON? AN NPZ MODEL FOR THE STRAIT OF GEORGIA

Kyle Fawkes* (Quest University, kyle.fawkes@questu.ca), Marjorie Wonham (Quest University, Marjorie.Wonham@questu.ca)

Keywords: trophic dynamics, biological oceanography, spatial heterogeneity

Plankton forms the basis of marine food webs. The timing and abundance of spring plankton blooms influences the success of many upper trophic level populations, including juvenile Pacific salmon. The Strait of Georgia, British Columbia, is an oceanographically complex region composed of many islands and channels. This geographic complexity leads to spatial variability in the plankton blooms, which puts additional stress on populations of out-migrating juvenile Pacific salmon. Here we present a simple NPZ model describing the planktonic ecosystem of the southern Discovery Passage in the Strait of Georgia, with the aim of improving predictions of bloom timing and salmon success.

INTERTIDAL BIODIVERSITY COMPARISON IN HOWE SOUND: PROVINCIAL PARK VS. INDUSTRIAL SITE

Catherine Gerstle* (Quest University, catherine.gerstle@questu.ca), Marjorie Wonham (Quest University, marjorie.wonham@questu.ca)

Keywords: industrial impacts, shoreline hardening, monitoring

Greater biodiversity increases the efficiency and stability of ecosystems, and of the goods and services on which humans depend. Rates of biodiversity loss are now estimated to exceed background by at least an order of magnitude, with consequences that are difficult to predict. To study the effects of changing biodiversity, we need accurate and repeated species censuses, but our current knowledge of biodiversity is seriously limited at international, federal, and provincial levels, particularly in marine systems. Howe Sound is a large fjord in southern British Columbia with an extensive history of forestry and mining impacts. Unfortunately, little is known of its intertidal diversity historically or today, which makes it difficult to assess impacts or recovery. We conducted a biodiversity inventory of the hard and soft intertidal habitat on the east side of the sound (at Porteau Cove Provincial Park) and the hard substrate on the west side (at the Woodfibre LNG site). The most recent intertidal inventory from the park, in 1990, reported only 7 species, and there are no published inventories from the WLNG site. We found a total of 13 algae, 25 invertebrates, and 1 plant species between the two sites. Differences in dominant taxon abundances between the sites may reflect differences in abiotic conditions, biotic interactions, or industrial history. The biodiversity inventory results were used to develop and deliver public outreach and education materials on intertidal biodiversity at PCPP.

MARINEGEO; LOCAL AND GLOBAL MARINE HABITAT MONITORING

Margot Hessing-Lewis* (Hakai Institute, margot@hakai.org)

Keywords: Seagrass, Monitoring, Ecosystems

Nearshore vegetated habitats play critical roles in coastal ecosystems. From carbon storage to nursery function, they provide valuable services for linked social ecological systems. Yet, monitoring efforts to track change in these critical habitats are often poorly resolved in geographic scope and methodological standardization. This hinders the use of monitoring data to inform management and conservation decisions. Monitoring networks with spatial reach offer coordinated and integrated efforts to address broad questions of both global and local import including: 1) How are habitats changing spatially and temporally? 2) What factors drive productivity of nearshore habitats? and 3) How does habitat-associated biodiversity affect metrics of its resilience? MarineGEO is a new Smithsonian program that

brings together an international consortium of research sites. Its goal is to conduct monitoring of nearshore habitats with a focus on common overarching research questions, standardized methodologies, and comparative-experimental approaches. The Hakai Institute's research station on Calvert Island will the primary node for MarineGEO in British Columbia. Here, monitoring will focus on vegetated habitats including seagrass beds, kelp forests, rocky intertidal benches and soft sediment systems. Monitoring efforts will be strongly tied with other research projects led by Hakai scientists and university affiliates. In BC, the Hakai Institute is also building networks with other groups working on nearshore habitat research and monitoring throughout the province. Our aim is for MarineGEO BC to coalesce existing data and support future monitoring efforts, with a focus on understanding and responding to change in coastal marine ecosystems.

ASSESSING THE IMPACTS OF CLAM GARDENS ON INVERTERBRATE SPECIES DIVERSITY IN THE SALISH SEA

Amy R. Irons*, Salish Sea Research Center, Northwest Indian College (airons@students.nwic.edu); Marco B.A. Hatch, Salish Sea Research Center, Northwest Indian College; Skye Augustine, Salish Sea Research Center, Northwest Indian College and Gulf Islands National Park Reserve, Parks Canada

The world's oceans are impacted by human interactions that create largely negative consequences, however Indigenous societies have developed technologies and management practices have been shown to have positive benefits on ecosystems that have sustained resources for millennia. An example is clam gardens, clam gardens are rock wall structures constructed by First Nations people within the intertidal area that trap sediment and extend the area for productive clam growth. Clam gardens have been shown to increase the abundance and growth rate of clams when compared to non-walled beaches. Researchers have primarily focused on the increased productivity of clams, while the rock wall structure may also alter conditions for other invertebrate species. In fact, ethnographic studies have shown that clam gardens had multiple purposes besides being productive bivalve habitats. To better understand the ecological role of clam gardens, this study quantified invertebrate species diversity on a clam garden rock wall and compared it to a control non-walled beach with similar tidal height and wave energy. Specifically, the hypothesis was tested that a clam garden rock wall will have greater invertebrate species diversity than a non-walled beach. This research shows the ecological impact of clam gardens on intertidal invertebrate species diversity and acts as an example of how traditional technologies can aid in maintaining complex marine invertebrate communities. In this way, we can look to First Nations technologies that have worked for millennia and see how they may be implemented in modern applications to create sustainable solutions that can positively impact resilient ecosystems.

TRACE METALS IN URBAN ESTUARIES; IMPLICATIONS FOR REMEDIATION

Kazmiruk, T*., V. Kazmiruk, and L.I. Bendell. Leah Bendell (bendell@sfu.ca) Department of Biological Sciences, Simon Fraser University

The ability of estuarine sediments to integrate long-term information and the marked tendency for trace metals towards solid phase partitioning makes sediments attractive for assessing the impact of industry and urban development on the fluvial ecosystems over time. This study first determined concentrations of copper (Cu), zinc (Zn), lead (Pb), and cadmium (Cd) within the estuarine sediments of Mackay, Mosquito, and Lynn Creeks, and the Seymour River, BC. Determined concentrations were then compared to ISQG / PEL and historical deposition concentrations. Patterns in sediment trace metal concentrations were assessed by constructing three-dimensional plots of core depth versus sample site. Patterns of trace metals deposition within Mackay, Mosquito, and Lynn Creeks and the Seymour River

were dependent on the percentage of the finest particles of the two different fractions of sediments (< 0.25mm and < 0.063 mm) and amounts of organic matter. Copper was the most widely spread within all estuaries with the highest concentrations (more than nine fold above the value of ISQG) occurring in the high tide intertidal zone of Mackay Creek. These results indicate that the urban estuaries accumulate contaminants such as metals to levels of toxicological concern. The estuarine environment is important both scientifically and economically, and understanding of the role that biogeochemical and physical processes play in the functioning of estuarine aquatic ecosystems is fundamental to evaluating complex management issues.

A VALUATION OF FISHERIES IN SOUTHEAST ALASKA

Jenna Keeton*, Aquatic and Fishery Sciences University of Washington (jenna.keeton@gmail.com), Daniel Schindler Aquatic and Fishery Sciences University of Washington (deschind@uw.edu), Lety Hopper, Rivers Without Borders (lety@riverswithoutborders.org)

Coastal communities across the globe are reliant upon fishing for food, income, and jobs. Historically and throughout modern-day, fishing has proven to be a prolific and dependable occupation. In Southeast Alaska, commercial fisheries targeting salmon, halibut, herring, crab, and other shellfish earn a yearly average income of $175.4 million. Fisher revenue has remained steady between 1975 and 2014 largely due to diversification of both fishing gear and target species. Direct ex-vessel earnings to fishers do not account for value added as seafood products travel through the economy, therefore fisher income can reliably be multiplied by at least 2-3 times to capture added growth. Processors and the managing seafood industry provided over $138 million in labor income for 2,600 jobs on average between 2013 and 2014. Additionally, the sport fishing industry contributed $312.5 million in angler spending in 2007 and $81.4 million in income, a result of constant growth in spending and related income to businesses since 1988. Although labor income and angler spending cannot be directly summed, it is feasible to report that fisheries workers earn an average of $400 million per year. Fisheries in Southeast Alaska show resilience to fishing pressure and produce a remarkably stable yearly income to fishers. However, this system is keenly susceptible to immediate and long term threats from mining, coastal development, and climate change. As of current, Southeast Alaska estuarine and river systems are considered functioning and economically strong. In order to retain the economic value of this region, the environment must be conserved.

GROWTH RATES OF JUVENILE SEA STARS, *P. OCHRACEUS* AND *E. TROSCHELII*

Ashleigh Pilkerton* Washington Conservation Corps, AmeriCorps member, Padilla Bay National Estuarine Research Reserve (apilkerton@padillabay.gov)

Sea stars are keystone species in many rocky intertidal habitats and influence community structure and function. In 2013, sea star wasting syndrome (SSWS) began decimating sea star populations along the West Coast of North America. Subsequent to this die-off, some sites have observed juvenile recruitment, but our limited knowledge of sea star growth rates makes it difficult to predict recovery trajectories. Our project seeks to quantify the growth rates of two common sea star species affected by SSWS (i.e. *Pisaster ochraceus, Evasterias troschelii*) and explore the growth rate variability between species, size and age classes. During the 10-month study, stars were kept in individual cages with unlimited food (*Mytilus trossulus*) and relatively stable water temperatures (12.2±0.5C). Wet weight, arm length, and other image-based metrics of growth were recorded biweekly with food consumption recorded weekly. Results indicate varying growth rates among species with mean monthly wet weight increases of 35.5%, *P. ochraceus,* and 46.9%, *E. trochelii*. Additionally, *P. ochraceus* growth rates differed

among size and age classes, with larger and older stars growing more slowly. Given growth is ongoing, empirical growth rates were compared to several growth models (e.g. logistic, Gompertz, von Bertalanffy) to help predict time required to reach terminal adult size. Estimates range from 1-2 years and vary between model types. Our research provides important baseline data regarding *P. ochraceus* and *E. troschelii* growth rates and a metric for estimating the age of individuals observed in the field as monitoring and recovery of sea star populations continues.

IS BLUE THE NEW GREEN? QUANTIFYING THE CARBON STORAGE CAPACITY OF EELGRASS MEADOWS IN THE PACIFIC NORTHWEST

Carolyn Prentice* (Simon Fraser University, ciprenti@sfu.ca), Margot Hessing-Lewis (Hakai Institute, margot@hakai.org), Anne K. Salomon (Simon Fraser University, aks21@sfu.ca

Keywords: seagrass; climate change; carbon storage

The potential for sedimentary storage of carbon in marine vegetated habitats (blue carbon) is an important consideration in climate change mitigation. Seagrass meadows are particularly efficient carbon sinks, sequestering billions of tons of carbon and storing it for millennia if left undisturbed. However, current data on seagrass carbon stocks is sparse and regionally biased. In the Pacific Northwest, we lack information on the magnitude and variability of carbon storage. To fill this gap, I propose an empirical study to examine: (1) the amount of carbon stored both above and below-ground in eelgrass *(Zostera marina*) meadows, (2) the sources of carbon in these sediments, and (3) the environmental parameters that alter the magnitude of these carbon stocks. To address these questions, I will sample three contrasting eelgrass meadows on the central coast of British Columbia. I will take sediment cores from each meadow, and analyze subsections for organic carbon content and stable isotopes. Carbon storage parameters and variation among seagrass sites will be evaluated. Sediment type, flow rates, depth, as well as seagrass canopy height and density will be evaluated as drivers influencing the magnitude of carbon storage. Based on previous studies, I expect that shallow meadows with fine sediments and low currents will store more carbon than deep, high current meadows with coarse sediments. This research will provide much needed data on the carbon storage capacity of *Z. marina* meadows, which is a necessary first step if blue carbon is to be included in carbon financing mechanisms in this region.

PUGET SOUND PHYTOPLANKTON: AN APPLICATION OF FLOWCAM® TECHNOLOGY

Lindsey Swanson* Environmental Lab, King County Department of Natural Resources and Parks; (lyndsey.swanson@kingcounty.gov), Gabriela Hannach, Environmental Lab, King County Department of Natural Resources and Parks (gabriela.hannach@kingcounty.gov)

Keywords: FlowCAM, Puget Sound, phytoplankton

Since 1995, the King County Marine and Sediment Assessment Group has been collecting a suite of environmental data for the Central Basin of Puget Sound to assess the region's water quality. In 2008, a phytoplankton component was added to the program. The subsequent acquisition of a FlowCAM® particle analysis system in 2014 allowed the program to start generating an extensive dataset for Puget Sound phytoplankton. This data is of critical importance in order to examine relationships between observed biological changes and anthropogenic stressors, such as climate change and urban development. Semi-automated particle analysis instrumentation is being used increasingly in lieu of, or alongside, traditional microscopy methods to study marine plankton. Our benchtop FlowCAM® system uses light microscopy, flow cytometry and image analysis to analyze live particles of interest in water samples. System software computes a large number of particle properties and metrics that are then

used by pattern recognition software to aid in the identification of images, partially automating the image classification process. While improving sample processing speed and data representativeness, limiting factors associated with the method include a reduction in taxonomic resolution relative to traditional microscopy and a significant time investment for developing image analysis classification routines. Despite limitations, the data generated by this system is proving useful in revealing important trends and dynamics in Puget Sound's phytoplankton communities. Currently, twice-monthly samples from eight Central Basin locations are analyzed year round by FlowCAM® and fifty-nine taxonomic categories are characterized using relevant descriptors such as particle size, abundance, and biovolume.

QUANTIFYING FOOD SPECIES PRODUCED BY ANCIENT CLAM GARDEN TECHNOLOGIES OF THE SALISH SEA

Sonni A. Tadlock*, [1]Salish Sea Research Center, Northwest Indian College (stadlock@students.nwic.edu), Marco B.A. Hatch, Salish Sea Research Center, Northwest Indian College, Skye Augustine , Salish Sea Research Center, Northwest Indian College, and Gulf Islands National Park Reserve, Parks Canada

Adaptation to the changing climate that is altering food systems is the greatest challenge facing the world today. Indigenous peoples within North American have built a body of knowledge that is based on experience and awareness of the natural world around them. Since time immemorial, First Nations have shaped the environment to create and maintain highly productive food systems. One example of this knowledge is the ancient mariculture known as Clam gardens, a purposely constructed rock-walled terrace that increases the habitat and productivity of traditional foods. This study aims to quantify the food species found within the rock wall structure of a clam garden compared to a non-walled beach to provide a baseline representation of the food species associated with a modified beach. This was done using low tide observational surveys to measure the abundance of edible invertebrates found within the intertidal portion of a clam garden rock wall and control site. Data analysis shows marked differences in the abundance and diversity of food species found at walled site compared to the control non-walled site. This research supports a growing understanding that Indigenous communities have been active managers of ecosystems and food systems for thousands of years, and highlights the positive relationship that can exist between increased ecosystem productivity and abundance of traditional foods.

EELGRASS RESTORATION IN THE SQUAMISH ESTUARY – A CASE STUDY

Edith Tobe*, Squamish River Watershed Society, (tobe@shaw.ca)

From 2005 to the present the Squamish River Watershed Society, in partnership with the Seagrass Conservation Working Group, has been actively restoring eelgrass (*Zoster marina*) beds to the Squamish Estuary, in particular in the Mamquam Blind Channel. To date over 5,000 shoots have been successfully transplanted and have resulted in three main new eelgrass beds. The Squamish Estuary is inundated by the fresh water of the Squamish River resulting in low salinity levels and a challenge for eelgrass beds to become established. The restoration works completed to date have been a positive indicator as to how eelgrass restoration can be effective, even in difficult habitats, and how the intertidal zones almost instantly change from "moonscape" poor aquatic zones to rich biodiverse sites in which salmonids, herring, crustaceans, and other aquatic species quickly inhabit.

PERS 2016 Annual Meeting Attendees

Last Name	First Name	Affiliation	Email
Apple	Jude	Padilla Bay National Estuarine Research Reserve & Washington Department of Ecology	japple@padillabay.gov
Ashley	Ken	BC Institute of Technology, Rivers Institute	ken_ashley@bcit.ca
Balke	Eric	Simon Fraser University & BC Institute of Technology Rivers Institute Ecological Restoration M.Sc. Program	ebalke@gmail.com
Barry	Karen	Vancouver Island Conservation Land Management Program	Karen.Barry@gov.bc.ca
Bendell	Leah	Simon Fraser University	bendell@sfu.ca
Bohlmann	Heath	Padilla Bay National Estuarine Research Reserve	hbohlmann@padillabay.gov
Boyd	Sean	Science and Technology Branch, Environment Canada	sean.boyd@canada.ca
Breckenridge	Joanne	University of British Columbia	jbrecken@eos.ubc.ca
Brennan	James	Marine Ecological Consulting Services, LLC	jsbrennan360@gmail.com
Buffett	Dan	Ducks Unlimited Canada	d_buffett@ducks.ca
Byrne	Shane	Simon Fraser University & BC Institute of Technology Rivers Institute Ecological Restoration M.Sc. Program	sabyrne@sfu.ca
Chalifour	Lia	University of Victoria	liac@uvic.ca
Christman	Natasha	University of Washington	nrchri10@uw.edu
Copping	Andrea	Pacific Northwest National Laboratory	andrea.copping@pnnl.gov
Crawford	Bill	Institute of Ocean Sciences, Fisheries & Oceans Canada	billcraw@telus.net
D'Andrea	Anthony	Oregon Department of Fish and Wildlife	tony.f.dandrea@state.or.us
Doyle	Bridget	Royal Roads University, Environment and Management & Tsleil-Waututh Nation, Environmental Programs	bdoyle@twnation.ca
Durance	Cynthia	Precision Identification	precid@shaw.ca
Eger	Aaron	University of Victoria	aeger@uvic.ca
Fawkes	Kyle	Quest University Canada	kyle.fawkes@gmail.com
Ferraro	Steven	retired	steveferraro@peak.org
Gerstle	Catherine	Quest University Canada	catherine.gerstle@questu.ca
Gilbert	Jeannie	Rosewolf Scientific	jeannie.gilbert@gmail.com
Gurd	Brent	BC Ministry of Forests, Lands & Natural Resource Operations, South Coast Region	brent.gurd@gov.bc.ca
Hessing-Lewis	Margot	Hakai Institute	margot@hakai.org
Hopper	Leticia	Rivers Without Borders	lety@riverswtihoutborders.org
Irons	Amy	Northwest Indian College	airons@students.nwic.edu
Isnardy	Vanessa	British Columbia Institute of Technology	vanlogie@gmail.com
Jones	Nathaniel	Humboldt State University	ndj24@humboldt.edu

PERS 2016 Annual Meeting Attendees

Last Name	First Name	Affiliation	Email
Keeton	Jenna	University of Washington	jenna.keeton@gmail.com
Letay	Sylvia	BC Ministry of Forests, Lands & Natural Resource Operations, South Coast Region	sylvia.letay@gov.bc.ca
Levings	Colin	Fisheries and Oceans Canada	cklevings@shaw.ca
Lewis	Randall	Squamish First Nations	randallw._lewis@squamish.net
Lingard	Stephanie	Instream Fisheries Research Inc.	steph_lingard@hotmail.com
Naito	Brian	Fisheries and Oceans Canada	brian.naito@dfo-mpo.gc.ca
Neckles	Hilary	US Geological Service Patuxent Wildlife Research Center	hneckles@usgs.gov
Newton	Jan	University of Washington	janewton@uw.edu
Nutton	Byron	Fisheries and Oceans Canada	byron.nutton@dfo-mpo.gc.ca
Pilkerton	Ashleigh	Padilla Bay National Estuarine Research Reserve	apilkerton@padillabay.gov
Poppe	Katrina	Western Washington University	katrina.poppe@wwu.edu
Prentice	Carolyn	Simon Fraser University & Hakai Institute	carolynisabella@gmail.com
Quesada	Andres	Northwest Indian College	aquesada@nwic.edu
Roberts	Erin	Simon Fraser University & BC Institute of Technology Rivers Institute Ecological Restoration M.Sc. Program	erin.roberts89@gmail.com
Rutherford	Erin	Simon Fraser University & BC Institute of Technology Rivers Institute Ecological Restoration M.Sc. Program	erineileenrutherford@gmail.com
Stutes	Adrienne	DOWL	alstutes@gmail.com
Stutes	Jason	Hart Crowser	seagrasser@gmail.com
Swanson	Lyndsey	Environmental Lab, King County Department of Natural Resources and Parks	lyndsey.swanson@kingcounty.gov
Tadlock	Sonni	Northwest Indian College	stadlock@students.nwic.edu
Tobe	Edith	Squamish River Watershed Society	tobe@shaw.ca
Wernick	Barbara	Golder Associates Ltd.	Barbara_Wernick@golder.com
Williams	Gary	GL Williams & Associates Ltd.	glwill@telus.net
Williams	Linda	Squamish First Nations	linda_williams@squamish.net
Wonham	Marjorie	Quest University Canada	marjorie.wonham@questu.ca
Yamada	Sylvia	Integrative biology, Oregon State University	yamadas@science.oregonstate.edu