PERS 07 – 2007 Annual Meeting of the Pacific Estuarine Research Society

University of Victoria, Graduate Student Centre
22-24 February 2007

SCHEDULE AT A GLANCE

Thursday 22 February	
Time	**Activity**
1600	Registration Opens
1800	Reception Begins
2100	Reception Closes

Friday 23 February	
Time	**Activity**
0800	Buffet Breakfast
0830	Introduction
0900	*Physical Processes, Mapping and Trend Analysis*
1030	break
1100	**Keynote Speaker** Dr. Len Bahr
1200	Lunch
1300	*Integrating Biophysical Knowledge*
1445	Intro to Posters
1500	Posters & Coffee
1700	PERS Business Meeting
1830	Banquet Starts
2000	**Keynote Speaker** Mr. Terry Glavin

Saturday 24 February	
Time	**Activity**
0800	Buffet Breakfast
0900	*Research and Critters*
1030	Break
1100	Resume Session
1130	Student Awards
1200	Lunch
1300	Post Meeting Events

Index to Presentation Abstracts = page 5; Index to Poster Abstracts = page 27

Additional Acknowledgements for PERS 07

Numerous organizations and individuals helped support the 2007 Pacific Estuarine Research Society Meeting (PERS 07). Members of the local organizing committee provided a huge amount of organizational horsepower (inset at upper right) ! Jeannie Gilbert, organized the website, including the implementation of web registration and payment. Thanks to the Centre for Earth and Ocean Research (CEOR) at UVic for stepping forward very early with a donation to support the meeting. BC Ferries, the Victoria Harbour Authority and Royal Roads University helped support our reception and breaks. We appreciate the support of Archipelago Marine Research Ltd., Coastal and Ocean Resources Inc., Precision Identification and G.L. Williams Associates in supporting members of the organizing committee. Thanks to Karel Roessingh for agreeing to a music gig at very short notice (www.roessong.com). A special thanks to our keynote speakers, Len Bahr and Terry Glavin (http://transmontanus.blogspot.com/), for contributing their wisdom to the meeting. We added a new feature to PERS this year, a silent auction, and many local organizations and individuals stepped forward to support the auction (inset at lower left) and, as a result, the student awards and travel program.

Local Organizing Committee

Heather Anderson, Archipelago Marine Research Ltd. – registration
Erica Beauchamp, Coastal & Ocean Resources Inc. – silent auction
Neil Borecky, Coastal & Ocean Resources Inc - silent auction
Sarah Cook , Archipelago Marine Research Ltd. – facilities
Cynthia Durance, Precision Identification – abstracts & scheduling
Jodi Harney, Coastal & Ocean Resources Inc. – student judging
John Harper, Coastal & Ocean Resources Inc. – co-chair
Gina Lemieux, Archipelago Marine Research Ltd., - post meeting events
Mary Morris , Archipelago Marine Research Ltd. – co-chair
Gary Williams, G.L. Williams Associates – abstract review
Victoria Wyllie-Echeverria, University of Victoria – student volunteers

Silent Auction Contributors

Neil Borecky
Clover Point Cartographics
Coastal & Ocean Resources Inc.
Harbour Publishing
James Bay Massage Therapy
James Brennan
John Harper
KEG downtown
Lush
Marine Ecology Station
Ministry of Forests
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PERS 07 Board

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http://www.pers-erf.org/index.html

The Pacific Estuarine Research Society gratefully acknowledges support for the PERS 07 meeting from:

CEOR

Centre for Earth and Ocean Research

http://web.uvic.ca/ceor/

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http://www.victoriaharbour.org/

Session #1, Friday Morning

Physical Processes, Mapping and Trend Analysis (*Cynthia Duraance*)

9:00 T04

Coastal Erosion Management and Severe Storm Response or "Why soft solutions are better."
Rowland J. Atkins, Golder Associates Ltd., Victoria, BC*

9:15 T17
Liquid Natural Gas Facilities in Estuaries: Effects on Water Circulation, Salinity, and Temperature
**Robert McAdory, Gary Brown, Ben Brown, US Army Corps of Engineers Coastal and Hydraulics Laboratory, Vicksburg, MS*

9:30 T03
Coastal and Marine Research in Ucluelet; an Integrated Insight. A Study of Ucluelet Harbour
Rachel White, Hilary Harrop-Archibald*, Keith Holmes*, Dr. Rosaline Canessa, , Department of Geography, University of Victoria*

9:45 T18 STUDENT PRESENTATION
High Resolution Mapping and Description of High Estuarine Vegetation in the Capital Regional District, British Columbia
A. Magnus Bein, Environmental Studies and Biology student, University of Victoria

10:00 T05 STUDENT PRESENTATION
A Recent Decline of *Neocalanus plumchrus,* the Dominant Calanoid Copepod in the Strait of Georgia, British Columbia
Rana El-Sabaawi, Akash Sastri and John Dower, Department of Biology, University of Victoria, Victoria, British Columbia*

10:15 T01
Sources and Growth Dynamics of Fecal Indicator Bacteria in a Coastal Wetland System and Potential Impacts to Adjacent Waters
Melissa Evanson and R.F. Ambrose, Environmental Science and Engineering, University of California at Los Angeles, CA*

10:30 Break

11:00 Keynote Speaker, Dr. Len Bahr

12:00 Lunch

Session #2, Friday Afternoon (Jim Brennan)
Integrating Biophysical Knowledge to Manage and Restore Estuarine Habitats
13:00 T07

Eelgrass (*Zostera marina*) Restoration in British Columbia: 1982 to 2007.
Cynthia Durance, Precision Identification, Vancouver, British Columbia

13:15 T10

Experience With Estuarine and Salt Marsh Compensation in Southwestern British Columbia: Monitoring Results and Management Applications Over the Last 20 years.
Gary Williams, GL Williams & Associates Ltd., Coquitlam, BC

13:30 T16

Dry Creek Estuary Restoration: 1997 - 2006
Rob Russell, Fisheries and Oceans Canada, Nanaimo, BC

13:45 T06 STUDENT PRESENTATION

Comprehensive Assessment of the Elwha River Estuary and Nearshore Interface
Matthew Beirne, Larry Ward, Mike McHenry, Lower Elwha Klallam Tribe, Port Angeles, WA, *Rebecca Paradis, Peninsula College, Port Angeles, WA

14:00 T02
Eelgrass (*Zostera marina* L.) status and trends in greater Puget Sound: A Submerged Vegetation Monitoring Project Update
Jeffrey Gaeckle, Blain Reeves, Pete Dowty, Helen Berry, Thomas Mumford, Nearshore*

14:15 T12

San Juan County Soft Shore Restoration Blueprint
**Jim Johannessen, Andea MacLenna, Coastal Geologic Services, Inc., Bellingham, WA, Tina Whitman, Friends of San Juan*

14:30 Poster Introductions (*Ted DeWitt*)

Session # 3, Saturday Morning

Research Aimed at Estuarine Critters (*Helen Berry*)

9:00 T21 STUDENT

Re-Establishment of the Native Oyster (*Ostrea conchaphila)* in Netarts Bay, Oregon
P*amela Archer*[1]*, Marine Resource Management Program, College of Oceanic & Atmospheric Sciences, Oregon State University*
Jessica Miller[2]*, Coastal Oregon Marine Experiment Station, Oregon State University,*
Dick Vander Schaff[3]*, The Nature Conservancy of Oregon*

9:15 T15 STUDENT
Assessing the Ecological Connectivity of Eelgrass Habitats and Protected Areas:
A tail of the Population Genetic Structure of the Eastern Pacific Bay Pipefish,
Syngnathus leptorhynchus.
Ramona DeGraff, Univeristy of British Columbia, Vancouver, BC

09:30 T09
Salmonids and their Range of Apparent Resilience to Estuarine Change – Four Genera in Two Hemispheres
Colin Levings, Fisheries and Oceans Canada, 4160 Marine Drive, West Vancouver BC

09:45 T20
Improved Benthic Sample Handling and the Benefit to your Data
Valerie Macdonald

10:00 T08
The Exotic Salt Marsh Grass *Spartina Patens* in Washington State:
Small Patch, Difficult Challenge
**David H. Milne*

10:15 T19
Will the European Green Crab persist in Pacific Northwest Estuaries?
Sylvia Behrens Yamada, Graham E. Gillespie and Andrea Randall, Zoology Department, Oregon State University, Corvallis, OR, Fisheries & Oceans Canada, Pacific Biological Station, Nanaimo, B.C. and Chinook, WA.*

10:30 Break

11:00 T11
Ranking Estuaries along the BC Coast
Jamie K. Kenyon, Canadian Wildlife Service, Pacific Wildlife Research Centre, Delta, BC

11:15 T14
A link between the land and sea: Understanding small estuaries in Gwaii Haanas National Park Reserve of Canada.
Marlow G. Pellatt, Ph.D., RPBio.,

Oral Sessions – Key to Abstracts

Last Name	*First Name*	*Session*	*Number*	*Page*
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Berry	Helen	Friday afternoon	T02	7
Bos	Julia	withdrawn	T13	18
De Graaf	**Ramona**	**Sat morning**	**T15**	**20**
Durance	Cynthia	Friday afternoon	T07	12
El-Sabaawi	**Rana**	**Friday morning**	**T05**	**10**
Evanson	Melissa	Friday morning	T01	6
Johannessen	Jim	Friday afternoon	T12	17
Kenyon	Jamie	**Sat morning**	T11	16
Levings	Colin	**Sat morning**	T09	14
Macdonald	Valerie	**Sat morning**	T20	25
McAdory	Robert	Friday morning	T17	22
Milne	David	Sat morning	T08	13
Paradis	**Rebecca**	**Friday afternoon**	**T06**	**11**
Pelatt	Marlow	Sat morning	T14	19
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Yamada	Sylvia	Sat morning	T19	24

Note: Bold indicates student presentation

T01

SOURCES AND GROWTH DYNAMICS OF FECAL INDICATOR BACTERIA IN A COASTAL WETLAND SYSTEM AND POTENTIAL IMPACTS TO ADJACENT WATERS

Melissa Evanson and R.F. Ambrose, Environmental Science and Engineering, University of California at Los Angeles, CA*

Coastal wetlands are receiving increased attention as a putative source of fecal indicator bacteria (FIB) in Southern California coastal waters. We examined temporal trends of water and sediment-associated FIB after rain events along with spatial sediment characteristics at two sites within the Santa Ana River wetlands and made comparisons to FIB levels observed in adjacent surf zone waters. During the first two rain events, total coliforms (TC), *E. coli* (EC) and enterococci (ENT) in wetland water and sediment samples peaked either on the same day or within several days of the rain event, while the third event resulted in elevated wetlands sediment TC levels only. TC in adjacent coastal waters consistently peaked on the same day as the rain event and decreased quickly thereafter (within one day). The TC/EC ratios of surf zone samples consistently fell below 10, indicating an increased probability of human fecal contamination whereas wetland TC/EC ratios were higher, averaging approximately 60 and 14 at each site. These results suggest sediment-associated FIB populations may be distinct from those found in the water samples, or at least have internal dynamics independent of water-borne populations. Increases in sediment-associated FIB may be due to *in situ* population growth and/or increased survival due to changes in environmental parameters (salinity, moisture and nutrient input) resulting from the rain events. Spatial differences in between the two sites may be due to sediment differences such as organic content and finer grain size and/or discrete sources of FIB.

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Eelgrass (*Zostera marina* L.) status and trends in greater Puget Sound: A Submerged Vegetation Monitoring Project Update

Jeffrey Gaeckle, Blain Reeves, Pete Dowty, Helen Berry, Thomas Mumford, Nearshore Habitat Program, Washington Department of Natural Resources, Olympia, WA; Sandy Wyllie-Echeverria, UW Botanic Gardens, College of Forest Resources, University of Washington, Seattle, WA.*

The Nearshore Habitat Program in the Washington State Department of Natural Resources (WADNR) has monitored seagrass (*Zostera marina* L.) status and trends throughout greater Puget Sound since 2000 as part of the Submerged Vegetation Monitoring Project (SVMP). The SVMP experimental design and statistical framework extrapolate sound-wide *Z. marina* area from random site-level sampling throughout the greater Puget Sound study area. In 2005, the SVMP estimated 20,400 ha of *Z. marina* area distributed equally between flats and fringe seagrass habitat types. There was no significant change in the 2005 sound-wide *Z. marina* area estimate relative to previous years. The *Z. marina* area estimates at half of the sites sampled in 2004 and 2005 were stable, while 6% increased in area and 25% decreased. A depth distribution analyses found the shallow depth of *Z. marina* was consistent throughout the five SVMP regions whereas the maximum depth varied greatly between regions. The results of a multiple parameter assessment of site- and regional-level change showed overwhelming evidence of significant negative changes in *Z. marina* in two regions of Puget Sound. Additional monitoring and the development of a new Eelgrass Stressor Response Project will focus on factors that cause seagrass decline in Puget Sound.

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ORAL PRESENTATION

T03

Coastal and Marine Research in Ucluelet; an Integrated Insight

Rachel White, Hilary Harrop-Archibald*, Keith Holmes*, Dr. Rosaline Canessa, Department of Geography, University of Victoria*

Imminent development of a golf course and resort is planned for the land adjacent to Olsen Bay on the Ucluelet Peninsula. This will have implications for the riparian habitat from upstream to the intertidal area near the developing site. It is important to have baseline data which addresses this integrated riparian ecosystem.

Integrated riparian habitat studies of Big Tree Creek and Olsen Bay were undertaken as part of a 4th year undergraduate field course in Coastal and Marine Resources through the Department of Geography, UVic. The studies included mapping eelgrass (*Z. marina*) in Olsen Bay in 2006 in comparison with mapping completed in 2002 by the Ucluelet Harbour Project; a Shorekeepers intertidal survey; a stream invertebrate study; and a morphological survey of the stream.

A healthy eelgrass bed and several patches were mapped in Olsen Bay. Based on the stream invertebrate study the stream was able to support a variety of invertebrate habitats. The morphological stream survey showed that the stream was highly vulnerable to increased sediment loads.

This information will be useful for the community as a record and tool for future monitoring purposes, illustrating how development may affect this integrated riparian habitat overtime.

Presenting Authors (oral presentation):

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Coastal Erosion Management and Severe Storm Response or "Why soft solutions are better."

Rowland J. Atkins, Golder Associates Ltd., Victoria, BC*

Based on the 2006-2007 winter BC has experienced so far, it is easy to believe that the weather is getting stormier. Storms generally cause erosion on the coast and traditional erosion management practices have relied on hard solutions like seawalls, groynes and riprap to protect infrastructure. These approaches generally serve to disconnect the land from the sea and have unintended consequences. More recently developed approaches include softer solutions like beach nourishment, dune stabilization and bioengineering which retain key linkages between land and sea. However, there is a perception of "safety" with concrete and rock which does not translate to more malleable designs.

This presentation outlines elementary differences between approaches, discusses potential consequences and explores the perception of "safety". Examples from a FEMA deployment along the Gulf Coast of Florida during and following the 2004 hurricane season are used as highlights. Observations from 425 miles (600 km) of shoreline indicate that the softer solutions responded better to the severe storms than the harder solutions. These observations are directly relevant to the Pacific Northwest where much of the coastline is in a "sediment-limited" state and prone to erosion by storm waves.

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T05

A recent decline of *Neocalanus plumchrus,* the dominant calanoid copepod in the Strait of Georgia, British Columbia

Rana El-Sabaawi*, Akash Sastri and John Dower
Department of Biology, University of Victoria, Victoria, British Columbia, Canada.

The Strait of Georgia (SoG) is one of the most productive estuaries on Canada's west coast. In recent years, the abundance and biomass of several key species of SoG copepods have declined, and at least one species (*Neocalanus plumchrus*) has crashed. *N. plumchrus* has traditionally dominated the biomass and abundance of copepods in the SoG, and is believed to be an important source of food for juvenile fish and marine birds. We present four years (2002-05) of copepod biomass and abundance data from the SoG and review how the community has changed over those years, relative to historical data. Data were collected as part of the STRATOGEM (the Strait of Georgia Ecosystem Modelling) project, one of the most comprehensive sampling programs ever to take place in the SoG. We consider several factors that contributed to this decline, including: increased temperatures, decreased nutrient concentrations, an increase in the temporal mismatch between *N. plumchrus* and its food supply and, finally, an overall reduction in food quality.

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Comprehensive Assessment of the Elwha River Estuary and Nearshore Interface

*Matthew Beirne, Larry Ward, Mike McHenry, Lower Elwha Klallam Tribe, Port Angeles, WA *Rebecca Paradis, Peninsula College, Port Angeles, WA*

The Elwha River Ecosystem and Fisheries Restoration Act (1992, PL-102-495) provides for the removal of two large antiquated hydroelectric dams on the Elwha River in Washington State. Prior to the initiation of removal activities in 2009, the Lower Elwha Klallam Tribe and other project partners are involved in the collection of biological, physical, and chemical data in riparian, estuarine and nearshore habitats. This river system historically included all species of native Pacific salmon and char, including runs of legendary 100-lb (45 kilo) Chinook salmon. Among these projects is a comprehensive assessment of the estuarine and nearshore wetlands complex. This characterization of existing conditions within the wetlands complex will facilitate the monitoring of physical, chemical and ecological changes during and after the dam removal process. The estuarine assessment includes the vegetative community, macro-invertebrate and vertebrate species (small mammals, birds, fish, and amphibians) composition, water quality monitoring, and beach profile monitoring. The spatial and temporal use of the estuary complex by juvenile salmonids, and their dietary preferences is a substantial component of this study.

Presenters: Matthew Beirne, Lower Elwha Klallam Tribe; Rebecca Paradis, REU student, Peninsula College, Port Angeles, WA 98362.

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T07

Eelgrass (Zostera marina) restoration in British Columbia: 1982 to 2007.

Cynthia Durance, Precision Identification, 3622 West 3rd Ave., Vancouver, British Columbia V6R 1L9 (604) 734-5048 precid@shw.ca

A significant loss of eelgrass (*Zostera marina*) habitat has occurred in the Pacific Northwest over the last century primarily due to filling, dredging, and forestry operations. Early attempts to transplant eelgrass using methods developed elsewhere were less than successful in the Pacific Northwest.

A transplant method was developed in the mid-1990s in British Columbia that has proven highly successful. The method accounts for genetic variation between populations of eelgrass, seasonality, and the hydrodynamic regime of transplant sites. The method has been employed at over 30 compensation sites since 1994. The transplanted areas typically achieve natural density and cover within three years. The earliest transplant of 5,400 square meters in 1994 has provided donor stock for several subsequent transplants.

The factors that have contributed to successful restoration and compensation are discussed.

**The Exotic Salt Marsh Grass Spartina Patens in Washington State:
Small Patch, Difficult Challenge.**

**David H. Milne*
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January 17, 2007

ABSTRACT.

Spartina patens, an intertidal grass native to the U.S. East Coast, was discovered growing in a salt marsh at Dosewallips State Park (Washington, USA) in 1982. The tiny colony reached a maximum size of about 653 m2 in 1991, when an effort to eradicate it was launched.

This small infestation has resisted extermination for 15 years. After an initial decline (about 58 plants in 1991 to 27 in 2002), numbers increased (to 49 in 2005). Patches older than 5 years are still being discovered.

Two oversights helped the plants evade extermination; lack of systematic exploration of the site for outliers and new patches, and absence of a record keeping system for tracking plants and treatments. These lapses were the result of an initial assumption that the small infestation would be easy to eliminate quickly, with no special plan needed. Large seed-setting patches went undetected for years, and/or were discovered, then forgotten, as a result.

Control workers overlooked half of the plants present at the site during nearly every year between 1995 and 2006. With renewed effort after 2003, they have now reduced the area occupied by the plants to less than 1 m2 in 2006.

T09

Salmonids and their range of apparent resilience to estuarine change –four genera in two hemispheres

Colin Levings, Fisheries and Oceans Canada, 4160 Marine Drive, West Vancouver BC Canada V7V 1N6

I will discuss the apparent resilience of *Salmo, Oncorhychus, Salvelinus,* and *Hucho* to key estuarine biophysical and community attributes, using a case history approach with literature data. Some species on European coastlines eg sea trout (*S. trutta*) are holding their own or are being restored. A similar latitudinal trend for estuarine impacts was found for three of the genera on the Asian coast. *Salmo spp.* has almost been extirpated or is now very rare in estuaries of enclosed seas (Aral, Caspian, Black) primarily because of reduced fresh water and impediments to upstream migration. *S. trutta* and *O. tshawytscha* have adapted to the estuarine environment in the Southern Hemisphere (Chile, New Zealand) and appear to cope with very dissimilar estuarine fish communities compared to those in their native range. Biological resilience in estuaries may be an important factor for salmonid conservation because of the globalization of estuarine fish communities in temperate zones. Relative to other fishes, the community ecology of salmonids in estuaries is poorly understood. Estuaries are available as habitat for non-indigenous fish species from both freshwater and marine ecosystems. Some northeast Pacific examples relevant to salmonids will be discussed.

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Experience With Estuarine and Salt Marsh Compensation in Southwestern British Columbia: Monitoring Results and Management Applications Over the Last 20 Years.

Gary Williams, GL Williams & Associates Ltd., Coquitlam, BC

The introduction of the national fish habitat policy and guiding principle of no net loss by Fisheries and Oceans Canada in 1986 resulted in the construction of substantial acreage of intertidal marsh compensation for waterfront development in British Columbia. In the Fraser River estuary alone, over 8.8 ha were constructed between 1986 and 2005. Monitoring data collected from projects in the Fraser River estuary, estuaries on Vancouver Island, and Burrard inlet show that estuarine marshes dominated by *Carex lyngbyei* differ substantially from marine salt marshes dominated by *Salicornia virginica* and *Distichlis spicata* in tidal zone position, vegetation composition, and soil characteristics (particle size, bulk density, moisture content, % organic matter, total carbon, nitrogen and phosphorus), which affect ecological functioning. Recent observations of the constructed marshes show that river channel and salt marshes are susceptible to differing physical and biological perturbations that can affect long-term success. From a landscape and management perspective, marsh compensation has been extended to habitat mitigation banking for port development and salmonid aquaculture; providing landscape features for shoreline park design; and restoring salmonid and waterfowl habitat in degraded estuaries in estuary-wide conservation and recreation plans. The paper will summarize estuarine marsh data and experience over the last 20 years in southwestern British Columbia.

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T11

Ranking Estuaries along the BC Coast

Jamie K. Kenyon, Canadian Wildlife Service, Pacific Wildlife Research Centre, Delta, BC and Ducks Unlimited Canada, Surrey, BC; Dan A. Buffett, Ducks Unlimited Canada, Surrey, BC; John L. Ryder, Ducks Unlimited Canada, Surrey, BC Present Address: Yukon Land Use Planning Council, North Yukon & Peel Watershed Commissions, Whitehorse, Yukon; Marianne Ceh, Ducks Unlimited Canada,Surrey, BC Present Address: Natural Resources Canada, Vancouver, BC; Kathleen Moore, Canadian Wildlife Service, Pacific Wildlife Research Centre, Delta, BC

Estuaries in British Columbia (BC) comprise less than 3% of the province's coastline, but these productive and diverse habitats are seasonally important to waterfowl and other species. Despite their importance and rarity, over 50% of the province's estuaries are threatened by coastal development, modification, and pollution. Effective conservation of estuaries requires an objective, landscape-level assessment to identify and rank estuaries. Members of the Pacific Coast Joint Venture (PCJV) developed a comprehensive set of repeatable decision rules that identified 442 estuaries and mapped the extent of each estuary using a Geographical Information System and spatial data. Estuary size ranged from less than 10 ha to approximately 21,700 ha, and the most frequent size class was 0 - 10 ha. Estuaries were assigned to 5 Importance Classes based on the criteria of estuary size, habitat rarity (intertidal, salt marsh), species rarity (kelp, eelgrass, mussels, *Salicornia*, *Ulva*), herring spawn index, and waterbird density index. The project enabled PCJV members to prioritize resources (funding, staff) for estuary conservation at the scale of the BC coast, develop a baseline to monitor change in land status of conservation and economic tenures over time, and highlight gaps in information needs.

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San Juan County Soft Shore Restoration Blueprint

***Jim Johannessen, MS, LEG, Coastal Geologic Services, Inc.*
Andrea MacLennan, MS, Coastal Geologic Services, Inc.
Tina Whitman, MS, Friends of the San Juans

The objective of this study was to prioritize beaches with documented or potential forage fish (surf smelt and sand lance) spawning habitat for bulkhead removal and soft shore protection in San Juan County, Washington. To reach this goal, the results of physical, biological and landowner willingness assessments were integrated into a GIS and analyzed to determine the best projects to seek funding for beach enhancement. A three-step process was employed to eliminate sites based on characteristics that influence the success and sustainability of a beach nourishment project. Initially a coarse filter eliminated sites based on existing qualitative data, followed by a secondary filter that utilized data collected during field visits. The final step in the prioritization applied a point system that weighed the quantity of spawning habitat to be enhanced with the likelihood of project success. Sites with the highest scores were of the highest priority for beach enhancement. Specific recommendations for beach enhancement were made for the top five scoring sites. This study was conducted by Coastal Geologic Services and Friends of the San Juans, and funded by a grant from the Russell Family Foundation.

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T13

Nutrient levels in Puget Sound: Decadal changes and controlling factors in regional basins and the Strait of Juan de Fuca.

Julia Bos, Skip Albertson, Carol Maloy, Adrienne Stutes, Mindy Roberts, Greg Pelletier*
Washington State Dept. of Ecology, Olympia, WA

One of the greatest concerns for the Puget Sound ecosystem is nutrient inputs and subsequent negative impacts on water quality. Human and natural factors all contribute to nutrient loading. In some regions, loadings of nitrogen are significant enough for it to be considered a pollutant. Historically, scientists thought that nutrient concentrations would not increase enough to be a concern in the Puget Sound system. To assess this idea of unlimited capacity, seasonal and inter-annual nutrient concentrations for the past three decades are compared to historical values in the Main, South Sound, Whidbey and Hood Canal basins and the Strait of Juan de Fuca. Data to support this analysis is from the Department of Ecology's ambient monitoring program where nutrient data is collected monthly from 40 core and rotational stations. In addition, datasets from intensive or seasonal surveys throughout Puget Sound are used. The use of nutrient levels as a measure in marine water quality and eutrophication indices will also be discussed.

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A link between the land and sea: Understanding small estuaries in Gwaii Haanas National Park Reserve of Canada.

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Gwaii Hannas National Park Reserve contains several small estuaries typical of fjord and inlet environments along the pacific coast of Canada. These estuaries provide critical habitat and level environments enveloped by mountainous terrain. They are an essential link among terrestrial, freshwater, and marine environments. The role of estuaries in the life cycle of pacific salmon and as a portal for the transport of marine derived nutrients into terrestrial environments has been documented throughout the Pacific Northwest. This paper will discuss ongoing work regarding GPS mapping of intertidal vegetation zones in east, west and south coast estuaries in Gwaii Haanas as well as preliminary stable isotope analysis (^{15}N) of salmon rearing systems on the west coast of BC. The utility of mapping as a conservation tool and ^{15}N as an indicator of MDNs will be discussed. Increased understanding of "land-sea" linkages in coastal systems serves to get marine, terrestrial, and aquatic scientists thinking about interplay of ecosystems and the need to work together to effectively conserve larger ecosystem processes.

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T15

Assessing the Ecological Connectivity of Eelgrass Habitats and Protected Areas: A tail of the population genetic structure of the eastern Pacific bay pipefish, *Syngnathus leptorhynchus.*

Ramona C. de Graaf, University of British Columbia

Populations require a network of interconnected habitats to maintain biological processes such as reproduction. Defining the spatial scale and patterns of exchange among interbreeding groups is critical to establish breeding units and population boundaries. Investigating genetic connectivity (dispersal) of individuals among habitat patches is an effective way to measure these population parameters and assess the ability of protected areas to maintain population processes.

Eelgrass habitats play a critical role for nearshore and offshore marine ecosystems as nurseries, spawning habitats, and as habitat for resident species. Locally, significant losses of eelgrass habitat have been documented and ultimately these losses will affect ecological function and species diversity. Monitoring eelgrass habitat function can be achieved by studying populations of such eelgrass specialists as the eastern Pacific bay pipefish, *Syngnathus leptorhynchus.*

My masters' research focused on measuring the ecological connectivity of eelgrass beds by investigating the genetic population structure of *Syngnathus leptorhynchus* in Barkley Sound, British Columbia. I will present my findings of pipefish population boundaries and breeding units. This will include an assessment of the degree of connectivity (gene flow) of the bay pipefish within and outside of a *de facto* marine reserve, the Broken Group Islands, Pacific Rim National Park Reserve of Canada. The influence of seascape features on gene flow will also be discussed.

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DRY CREEK ESTUARY RESTORATION – 1997 - 2006

Rob Russell, Fisheries and Oceans Canada

Historically, Dry Creek estuary, in Port Alberni, BC, was subject to heavy industrial use. Paper mill and sawmill operations, including hog fuel and wood chip stockpiles, logboom storage, and a conveyor were degrading coho and chum salmon habitat. In 1997 the paper mill modernized and habitat mitigation consisted of remediating 2,500 m^3 of hog fuel-contaminated soil east of the conveyor. The remediated-area and an additional 8,100 m^2 were transplanted with estuarine marsh species harvested from the Somass River in 1997 and 1998. Based on positive monitoring results, the conveyor was removed in 1999 and further transplanting completed. Additional improvements included paving the upland hog and chip storage areas, installing new drainage collection, excavating a 470 m^2 tidal rearing channel adjacent Dry Creek, and planting 675 m^2 of native trees and shrubs along the creek and shore between the mills. With sawmill modernization in 2000, 600 m^2 of estuarine marsh and adjacent backshore was planted, and transplants were monitored annually. In 2004, another section of intertidal conveyor was removed and the exposed area allowed to re-colonize with marsh. A post-project assessment of the Dry Creek estuary in 2006 showed contiguous intertidal and backshore vegetative cover between the paper mill and sawmill.

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T17

Liquid Natural Gas Facilities in Estuaries: Effects on Water Circulation, Salinity, and Temperature

Robert McAdory, Gary Brown, Ben Brown, US Army Corps of Engineers Coastal and Hydraulics Laboratory, Vicksburg, MS*

Liquid natural gas (LNG) terminals are rapidly becoming common features of North American estuaries and ports, with at least 50 planned or in operation. Depending on facilities needed to off-load the LNG and the particular technologies used to warm the low temperature liquid into a usable gas, the facilities can affect the movement, salinity, and temperature of nearby estuarine waters, among other effects. The proposed LNG facility at Bradford Landing on the Columbia River involves the construction of a new terminal that may alter the flows in its vicinity and the split of flows around nearby islands. Two facilities on the Sabine-Neches Waterway will produce cold fresh water that has the potential to alter the salinity and temperature of the Sabine-Neches Estuary. These effects were studied using a hydrodynamic model of each estuary under differing conditions of river flow or disposal of the cold fresh water produced. This presentation will consider the effects proposed LNG terminals might have on estuaries in which they are sited. Results showing potential effects on circulation, salinity, and temperature will be presented. These calculations will be used later to consider the effects of the facilities on the ecology of an estuary.

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High Resolution Mapping and Description of High Estuarine Vegetation in the Capital Regional District, British Columbia

A. Magnus Bein, Environmental Studies and Biology student, University of Victoria

Tidal marshes, meadows, and swamps were mapped at a scale of 1:1,000 and inventoried in Esquimalt Lagoon, Esquimalt Harbour, Portage Inlet, the Gorge Waterway, and Victoria Harbour in the summer of 2005. The high estuarine ecosystem units had a total area of 6.6 ha and mainly occurred on sheltered shorelines with benches of substrate, such as upper harbours and the lower reach of creeks. Tidal marshes covered 3.8 ha and were composed of *Salicornia virginica*, *Distichlis spicata,* and *Carex lyngbyei* associations. *Spergularia canadensis*, *Schoenoplectus americanus*, and other tidal marsh associations had a very small area. Tidal meadows had a total area of 2.4 ha and were represented mainly by *Juncus arcticus* association*,* *Leymus mollis*, *Agrostis* sp., and *Elymus repens* also occurred to a lesser extent. Tidal swamps included *Salix* sp., *Malus fusca,* and *Rosa nutkana* associations. Freshwater marshes in the high estuarine zone, were represented by *Typha latifolia, Agrostis* sp., *Phalaris arundinacea*, and *Eleocharis* sp. associations. The results indicated the biodiversity importance and scarcity of these habitats in the urban estuaries and lagoons of the CRD. The low area of high estuarine habitat combined with human threats make conserving and restoring tidal wetlands a high priority.

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Oral presentation

T19

Will the European Green Crab persist in Pacific Northwest Estuaries?

Sylvia Behrens Yamada, Graham E. Gillespie and Andrea Randall, Zoology Department, Oregon State University, Corvallis, OR, Fisheries & Oceans Canada, Pacific Biological Station, Nanaimo, B.C. and Chinook, WA.*

A strong cohort of young green crabs, Carcinus maenas, appeared in estuaries along the coasts of Oregon, Washington, and the west coast of Vancouver Island following the strong El Niño of 1997-98. Unusually strong northward-moving coastal currents (up to 50 km/day from September 1997 to April 1998) must have transported green crab larvae from more established source populations in California to the Northwest. Coastal transport events and recruitment of young green crabs have been much weaker in recent years.

While it was hoped that green crabs would go extinct in the Pacific Northwest once the original colonists reached the end of their life span of 6 years and no new larvae arrived from California, this has not happened. Local recruitment has occurred in Oregon and Washington estuaries and inlets on the west coast of Vancouver Island. Good recruitment in 2003, 2005 and 2006 is linked to warm winters and shore-ward transport in late winter to early spring when larvae are believed to be settling out.

An extensive survey by Fisheries and Oceans Canada biologists found green crab populations on the west coast of Vancouver Island, with densities of over 1 per trap per day in some inlets. However, no green crabs were found in the inland sea between Vancouver Island and the mainland. Therefore outreach efforts should continue to prevent the establishment of this invader in these waters via ballast water or shellfish transport.

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Improved Benthic Sample Handling and the Benefit to your Data

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Careful handling of benthic samples in the field improves the overall quality of benthic invertebrate data by minimizing damage to the collected organisms. Biologica has designed a frame-and-tray style washing stand which provides optimum recovery of invertebrates. This recovery system supports improved taxonomic resolution and provides consistency and reliability of benthic invertebrate data.

T21

Re-establishment of the native oyster (*Ostrea conchaphila)* in Netarts Bay, Oregon

Pamela Archer[1], Marine Resource Management Program, College of Oceanic & Atmospheric Sciences, Oregon State University
Jessica Miller[2], Coastal Oregon Marine Experiment Station, Oregon State University
Dick Vander Schaff[3], The Nature Conservancy of Oregon

The native Olympia oyster (*Ostrea conchaphila*) was once abundant in estuaries from Sitka, Alaska to Baja California. Populations throughout the region declined in the late 1800s and early 1900s, likely due to over-harvest, lack of settlement substrate, and declines in water quality. Historically, native oysters co-existed with native eelgrass (*Zostera marina*) in so-called "oyster gardens." Efforts to re-establish a self-sustaining population of *O. conchaphila* within Netarts Bay, Oregon, began in 2005. The goals of this study are to track the recovery trajectory of Olympia oysters planted in Netarts Bay and quantify the response of native eelgrass to the addition of shell substrate on the eelgrass bed. Thus far, 400 bags of oyster cultch have been spread across ~5000 m^2 of eelgrass-dominated tidal flat in the central portion of the estuary. Oysters were planted at three densities to determine oyster and eelgrass responses to variable stocking densities. We will measure oyster survival, growth, and reproduction and eelgrass abundance, growth and reproduction. Limited baseline data were collected in 2006, and the majority of field work will occur in 2007. We will combine the information collected with long-term restoration monitoring protocols to develop a comprehensive strategy and guidance for future re-establishment efforts.

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P1

Sex Peromones: New Tools for Controlling European Green Crabs?

Sylvia Behrens Yamada, Michaela Dawkins, Ashley Quaintance, Larissa Suggs, Zoology Department, Oregon State University, Corvallis, Oregon 97331.*
Joerg D. Hardege, Ralf Bublitz. Department of Biological Sciences, Sensory and Chemical Ecology Group, University of Hull, HU6 7RX, UK.

The continual persistence of European green crabs on the west coast of North America stresses the need to develop effective control tools before this invader builds up its population and measurably impacts native communities and shellfish growing areas.
We tested the effectiveness of green crab sex pheromones as potential tools in locally controlling this species in marine protected areas, research reserves and on shellfish grounds. Traps were deployed using synthetic female green crab sex pheromone (10^{-4} or 10^{-3}M) in slow- and fast-release gel matrices as well as a mixture of female pheromone and male urine (which includes male pheromone) as attractants. Control treatments consisted of fish bait and empty traps (no attractant).
While green crab female pheromone is a powerful attractant at close range (<1 meter radius), it was not effective in attracting male green crabs in a field setting. A preliminary trial using a combination of female pheromone and male urine, however, showed great promise. We plan to continue our field trials in 2007 with male urine and with male sex pheromone once we are successful in isolating it and in producing it synthetically.

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Assigning Ecological Value to Coastal Landscapes Used by Breeding Great Blue Herons

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Conservation efforts of the COSEWIC listed Great Blue Heron (*Ardea herodias fannini*) have involved purchase of land containing large, active colonies. Short-term, this approach succeeds in protecting the colony from many human disturbances. However, colonies do still abandon, either due to human disturbance or more often due to disturbance from Bald Eagles (*Haliaeetus leucocephalus*). Both the human and Bald Eagle population within the Strait of Georgia has increased over the last two decades resulting in single colony purchases being insufficient at conserving herons during their breeding season. A new conservation plan identifying landscape suitable for supporting heron colonies is advocated. This new plan requires a credible scientific argument to define priority landscape for preserving habitat. Our argument is based upon a conceptual model that related heron breeding colonies to landscape, using relevant data to implement the model and support its scientific conclusions. Based upon the ideal free distribution and Nash equilibrium, our model used the observed distribution of herons on the foraging areas and breeding colonies to estimate the distances herons are likely to travel between colonies and foraging areas. A spatial analysis assigned ecological value to the coastal landscape, determining priority areas for conservation within the Fraser River delta.

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P3

First steps in understanding the role of nutrient and material subsidies to *Zostera marina* communities in marine-dominated estuaries

*Margot Hessing-Lewis *, Sally Hacker and Bruce Menge, Oregon State University, Corvallis, OR.*

Zostera marina dynamics in marine-dominated West Coast systems may respond differently to nutrient and material subsidies compared to *Z. marina* dynamics studied on the East coast of North America. These differences may occur because many estuaries in the Pacific Northwest of North America are tightly coupled with nearshore oceanography, and are subject to highly seasonal freshwater inputs. This presents a different environmental context from which to study eelgrass dynamics and community regulation. Specially, this research aims to understand how marine-based subsidies, including nitrogen and kelp, control the interactions between the algal, epiphytic and seagrass primary production in these estuaries. The mechanisms regulating these basal food web interactions will be explored, as well as their seasonal and interannual variability. Preliminary research predicts that stronger coupling will occur during the dry, summer months, when riverine inflow is low and estuarine waters are dominated by marine forcing. Monitoring data from four estuaries collected during summer 2006 will be presented, in comparison with past results from the Pacific Northwest Coastal Ecosystems Research Study. An overview of this interdisciplinary project, employing both oceanographic and ecological methodology will be presented.

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Tidal channel meander development in the Skagit River marshes: a depositional rather than erosional process

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

Abstract: The existing paradigm explaining tidal channel meander development and geometry invokes tidal erosion as the formative process. However, GIS change analysis of historical aerial photos indicates that tidal channel meanders in the Skagit River marshes are instead formed by the opposite process—sediment deposition. Meander bend formation begins with the deposition of a sediment bar near the mouth of an existing blind tidal channel. This sediment island accretes, becomes colonized by vegetation, and effectively splits the downstream reach of the blind tidal channel into two new forks. One fork persists, maintained by tidal prism associated with the antecedent blind tidal channel. The other fork atrophies and either fills entirely with sediment or fills partially to form a blind tributary to the antecedent blind tidal channel; the fate depends on the tidal prism available to the secondary fork. Both forks are generally formed at right angles to the antecedent blind tidal channel, and parallel to the river distributary to which the blind tidal channel is tributary. This pattern is consistent with previously described depositional development of whole blind tidal channels from abandoned river distributaries (Hood 2006, 2007). Depositional blind tidal channel formation may be dominant in sediment-rich estuarine systems, particularly in river-dominated deltas. Erosionally formed channels are likely associated with wave- and tide-dominant estuarine systems, or sediment-poor systems.

P5

Eelgrass Conservation in Communities in British Columbia

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The BC Community Eelgrass Network, composed of 22 coastal community groups, is an integral component of eelgrass conservation efforts along the entire BC coast. Network participants map, monitor, restore and steward eelgrass habitats (*Zostera marina*) from Haida Gwaii to Boundary Bay. Since 2002, they have used their maps to influence shoreline decisions, made partnerships with government and industry and are including their eelgrass maps in larger shoreline conservation initiatives. This poster will give examples of the work achieved thus far with over 1,000 community volunteers.

Factors Affecting the Distribution of *Beggiatoa spp* in Hood Canal and Quartermaster Harbor

Matt Lonsdale and Pamela Michael, University of Puget Sound, Tacoma WA

Dead zones and fish-kills have been associated with *Beggiatoa spp*, a sulfide reducing bacteria. *Beggiatoa spp* was suggested to exist in Hood Canal (HC) early as the 1950s and its extent was first surveyed in 2006 in both HC and Quartermaster Harbor (QH). Samples of both water and benthic materials were taken from HC and QH to determine the cause of the bacteria and video transecting was used to map the distribution and abundance of the bacteria in HC. In QH, the mats were associated with low levels of sediment sulfides while in HC, there was no conclusive evidence regarding mat association with sulfides. There was no association in the level of settled organic material and mat distribution at either location. Mats were associated with high levels of primary productivity, and in HC, low dissolved oxygen. Planktonic blooms may cause eutrophication and high levels of organic material on the benthos, low to hypoxic dissolved oxygen at depth, low nitrogen at the surface, and an increase in overall turbidity. Continued monitoring of HC and QH could show a definitive pattern and the link between the environmental factors and the distribution and abundance of the *Beggiatoa spp* mats could be determined.

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P7

Long-term Monitoring of Puget Sound, Gray's Harbor and Willapa Bay: Status and Trends in Water Quality from 2001-2005

Stutes, Adrienne L., Julia K. Bos, Carol Maloy, Brian Grantham and Skip Albertson, Washington State Department of Ecology, Olympia, WA*

Human populations in the Puget Sound region and adjoining watersheds have steadily increased in recent decades, impacting water quality in Puget Sound. In addition, atmospheric and oceanographic inputs such as air temperature, winds, sunlight, river flows, and the properties of oceanic water entering the Sound also influence water quality. Using data generated by The Washington Department of Ecology's long-term marine waters monitoring program, water quality indicators have been developed. Properties used to develop indicators include temperature, density, dissolved oxygen, nutrients and fecal coliform bacteria levels. These variables have been used by WaDOE to create an index of sensitivity to eutrophication, and an index of water quality, in order to evaluate status and trends at monitoring stations. We present 5-year trends in these variables at 40 core long-term monitoring stations, as well as results of the indices. This analysis was recently published in the Puget Sound Update, by the Puget Sound Action Team.

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Using an Acoustic Doppler Current Profiler to measure Water Column Velocities within Eelgrass Meadows in Humboldt Bay, California

Jeff Robinson, Humboldt Bay Harbor, Recreation and Conservation District, Eureka, California; Thomas Gast, Thomas R. Payne and Associate, Arcata, California*

Approximately 45% of California's critical eelgrass (*Zostera marina*) habitat occurs in Humboldt Bay, California. Baseline information was sought in evaluating estuarine ecology utilizing acoustic Doppler technology to economically measure water column velocities within and over eelgrass meadows, measure the height of the canopy, and bottom depth. A Teledyne RD Instrument (TRDI) 1200 kHz Rio Grande Acoustic Doppler Current Profiler (ADCP) was used in conjunction with an Airmar 235kHz, 6º digital depth sounder and global positioning system (GPS) signals. This poster describes the methods used and displays preliminary water column velocity results. Humboldt Bay has an area of 64.2 km^2 mean high water and 28.0 km^2 at mean lower low water with two primary eelgrass habitat basins, North Bay and South Bay. Eelgrass habitat may be influenced by a myriad of variables such as water column depth and velocity as well as substrate, nutrient availability, and light penetration. Eelgrass shoot densities in North Bay are significantly less than in South Bay. Preliminary ADCP measurements were conducted in both basins to assess whether differences in water column velocities could be detected and related to different shoot densities at the different sites. This method clearly demonstrated the viability of utilizing the ADCP for current measurements within the eelgrass canopy.

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P9

Habitat Mapping of the Sidney, B.C. Waterfront Using Acoustic and Video Imaging Techniques

Sarah E. Cook, Archipelago Marine Research Ltd., Victoria, B.C., Canada, Brian Bornhold and John Harper, Coastal and Ocean Resources, Sidney, B.C., Canada and Kelvin Kopeck, Terra Remote Sensing Inc., Sidney, B.C.*

Seabed habitat mapping was conducted off Sidney, British Columbia to a distance of approximately 300 m offshore. A seabed geophysical survey was carried out using high-frequency (390 kHz) sidescan sonar, to provide 100 percent acoustic coverage of the substrates in the area. High-resolution geo-referenced video images were collected using the Seabed Imaging and Mapping System (SIMS), which allows for ground-truthing of the substrate interpretation of the sidescan sonar data and characterization of the floral and faunal community. Substrate type and biota were mapped and combined into habitat associations.

A habitat association is defined by three constituents: dominant substrate type, vegetation and fauna, where dominant is defined as occurring in >50% of the classified images. Associate (1-25%) and observed (<1%) constituents are also defined. These are combined into an expanded legend that accompanies the map and quantifies the differences between habitats.

Five primary habitat associations were defined for the Sidney Waterfront: (1) Sand-Pebble with Eelgrass, (2a) Intertidal Rock-Boulder-Cobble with Rockweed and Foliose Green Algae, (2b) Nearshore Cobble-Boulder with Bladed Kelps, (3) Sand-Pebble Flats with Filamentous Red Algae, (4) Rock Shoals with Bladed Kelp, Foliose Red Algae and *Agarum* and (5) Dense Clay with Piddock Clams. Many anthropogenic features were also identified including outfalls, an artificial reef, riprapped shoreline and wrecks.

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***Zostera japonica* Removal Experiment in the Coquille Estuary**. *Chana Dudoit, Sylvia Behrens*

Yamada, and Steve Rumrill, Zoology Department, Oregon State University, Corvallis, OR, and South Slough National Estuarine Research Reserve, Charleston, OR.*

Japanese eelgrass, *Zostera japonica* was introduced to the Pacific Northwest in the 1950's as packing material for seed oysters. This invader spread unchecked, because it was thought to be beneficial to fish and invertebrates by providing them food and shelter. Only recently has this premise has been questioned. The Canadian Wildlife Service recognizes that *Z. japonica* degrades sandpiper foraging habitat by trapping sediment and transforming mudflats into contiguous meadows. When isolated patches of *Z. japonica* were discovered in Humboldt Bay, California Department of Fish and Game removed them with shovels.

We set up a small-scale *Z. japonica* eradication experiment in a high marsh in the Coquille estuary. In April 2006, we marked off 10 meter sections parallel to the shore and counted around 3.5 *Z. japonica* plants per section. We designated meters 0-140 and 280-420 as the un-manipulated control, and meters 140-280 as the removal treatment. All *Z. japonica* plants in the middle interval were manually removed using shovels. The largest patches were 1 meter in diameter. When we returned in June, the mean number of plants per 10 meter section had increased to 15, indicating that new seedlings had sprouted from seeds. While the density of plants was the same in the two treatments, only new shoots and no large patches were found in the removal treatment. Continual removal of patches could prevent them from merging into contiguous meadows. However, the presence of residual seeds in the sediment would make it very difficult to completely eradicate this invader from the Coquille estuary.

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P11

Effects of Green Macroalgae on Classification of Seagrass in Side Scan Sonar Imagery.

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High resolution maps of seagrass beds are useful for monitoring estuarine condition, managing fish habitats, and modeling estuarine processes. Side scan sonar (SSS) is one method for producing spatially accurate seagrass maps, although it has not been used widely. Our team recently developed image analysis methods for automatically classifying SSS imagery for seagrass presence, which produce seagrass maps with high thematic accuracy. However, seafloor objects with high acoustic reflection (such as bubbles trapped under macroalgae) could be mistaken for seagrass in SSS images. In this study, we investigated whether mats of green macroalgae on tide flats and in seagrass beds would interfere with the accuracy of SSS-based seagrass maps. Two 16-ha sites in Yaquina estuary (OR) were each surveyed in April (low macroalgae) and September (high macroalgae) using SSS and underwater video (UV). UV images were classified for presence of seagrass and macroalgae. SSS imagery was processed based on a supervised maximum likelihood classification of SSS focal mean brightness, focal standard deviation of brightness, and depth class, with signature-development training sites determined from georeferenced UV data. Preliminary analysis of the SSS imagery suggests that dense mats of green macroalgae reduced the thematic accuracy of the seagrass maps, but did not affect the estimation of total seagrass area.

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Thatcher Bay: A Case Study in Using Economic Value Indicators as a Guide for Restoration.

Joel Breems, Sandy Wyllie-Echeverria, Center for Urban Horticulture, University of Washington, Seattle, WA

As resource managers we are often faced with the task of determining when restoration is appropriate and which methods are apposite for the situation. In a region like the Pacific Northwest with a long history of resource extraction, processing, and utilization this question arises frequently.

Thatcher bay on Blakely Island provides evidence of this history. Thatcher Bay supported a town and sawmill until approximately 1930. During this time wood waste from the mill was deposited in the upland and intertidal areas of the bay. The wood waste persists to this day relatively un-impacted by time.

This scenario is not uncommon and developing a framework with which to determine the feasibility of restoration while providing a measure of cost effectiveness together answers the question of if and how restoration should be conducted. This framework will be implemented in Thatcher Bay through the characterization of the site and subsequent measure of the habitat area impacted. Using established economic values for eelgrass beds and the species which would utilize the habitat we can associate an economic value with the successful restoration of the bay. Using this value we can determine the appropriateness of restoration, and which methods are appropriate.

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P13

Modeling habitat capability for invasive species using the ShoreZone mapping system

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ShoreZone is a coastal habitat mapping and classification system in which low-altitude, georeferenced aerial imagery is collected specifically for the interpretation and integration of geological and biological features of the intertidal zone and nearshore environment. The mapping system (housed in ArcGIS and Access databases) provides a spatial framework for coastal habitat assessment on local and regional scales. Mapped regions now include more than 60,000 km of coastline in Washington, BC, and Alaska. Modeling habitat capability using ShoreZone is based on the rationale that habitat attributes for a particular species can be distinguished, rated in terms of importance, and used in nested queries of the ShoreZone database to identify areas most likely to support that species. This study employs an iterative “delphi” approach to identify and rank habitat attributes for the European green crab (*Carcinus maenas*) on the basis of scientific literature review and expert interviews. The resultant habitat capability model appraises the sensitivity of mapped shorelines to colonization by this invasive species. Identifying potential green crab habitat "hot spots" provides a spatial basis for the planning of monitoring stations for species detection and early intervention efforts.

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P14

Spices in Treated Sewage Effluent and in Puget Sound

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Cinnamon and vanilla spices were measured in fully treated effluent from the West Point Plant and in surface waters from Puget Sound. Samples were collected weekly, beginning one week before Thanksgiving 2006and ending post-New Year. Vanilla concentrations are determined for both natural vanilla (vanillin) and for artificial vanilla (ethyl vanillin). The concentrations of spices in open ocean waters are ~10^5 lower than found in the effluent. Trans-cinnamic acid concentrations average about 100 µg/L and have a concentration maximum post-Thanksgiving. Natural vanilla concentrations increased through the sampling period, starting at 90 µg/L and rising steadily to ~240 µg/L. Artificial vanilla concentrations are higher than for vanilla; pre-Thanksgiving concentrations were ~250 µg/L and post-holiday concentrations are ~350 µg/L. We converted these fluxes to 'home-baked cookie equivalents' using average concentrations of vanillin and cinammic acid in baked goods. The baked spice flux post-Thanksgiving is equivalent to about 240,000 cookies per day, roughly 2/3 butter or chocolate chip and 1/3 snickerdoodle or similar cinnamon-containing cookies such as gingerbread.

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Oil Spill Response Techniques for BC Coastal Wetlands

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Coastal marine wetlands and estuaries are ecologically important areas that are particularly sensitive to oil spills and oil spill cleanup. In BC, there are no inventories of marine wetlands that categorize the sites as to their sensitivity to oil spill and cleanup. To provide a framework for BC coastal wetlands, a generalized three-type marine wetland classification system is outlined, based on sediment characteristics, species composition and fluvial processes. The three types are: (a) *riverine, spatially complex wetland type* (b) *alluvial delta wetland type* and (c) *marine lagoon/tidal flat (non-estuarine) wetland type*.

Most of the research of the affects of oil spills and cleanup techniques has been done in *Spartina*-dominated marshes which has different sensitivity than salt marsh communities found in BC wetlands. Instead of assigning sensitivity rating to individual species, a system of characterizing species attributes that contribute to sensitivity (e.g., morphology, reproductive strategy, habitat preference) is suggested. Example BC species are then evaluated for sensitivity to oiling or clean up according to those attributes. For example, small, succulent annual plants will be more sensitive to oiling and certain cleanup methods than tall, perennial grasses. This generalized approach could be applied to planning spill response in BC coastal wetlands where site-specific inventory is not available.

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Using ShoreZone to Model Coastal Areas Sensitive to Climate Change: A process-driven approach

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As the evidence of global climate change and associated sea level rise become apparent, the ShoreZone coastal mapping system emerges as a valuable tool in assessing the potential impacts of such change. Along with a projected rise in sea level, more frequent and extreme weather events may affect coastal areas through flooding, storm surges, tidal height, and degree of onshore wave energy. Much of the current research on this topic is being conducted with the use of LIDAR technologies to evaluate changes based on inundation and elevation alone, but coastal processes are also important agents of change on local and regional scales. In this study, a hierarchical model has been created based upon exposure (wave energy), shoreline geomorphology, sediment texture, and sediment availability. This "climate change shoreline sensitivity index" (CCSSI), classifies discrete coastal units by the type of change that is likely to occur, erosion, inundation or accretion, and ranks it on a severity scale from high to low. By applying a coastal process-driven model to attributes mapped within the ShoreZone database and supervising the classification using video imagery, we can provide a rapid assessment of the potential shoreline changes as a result of climate forcing.

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Evaluating eelgrass (*Zostera marina*) as a juvenile habitat for rockfishes (*Sebastes* sp.): In search of a predictive model

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While the fact that eelgrass beds are valuable is generally undisputed, their value as a juvenile habitat for rockfish in particular is not well known. An even greater unknown is how eelgrass beds vary in their value as a juvenile habitat. The objectives of this study are to examine what variables influence the habitat value of an eelgrass bed for juvenile rockfishes (*Sebastes* sp), and to determine if this value can be predicted. In 2005 and 2006, environmental and biotic characteristics such as water motion, eelgrass characteristics, eelgrass growth, sediment type, and epiphyte loads were examined at five eelgrass beds in Barkley Sound, British Columbia. Fish assemblages at these sites were characterized using underwater visual surveys, and the potential for rockfish recruitment was measured using 'smurfs'. Correlation analysis will be used to determine how biotic and environmental variables influence the abundance and composition of juvenile rockfishes. Regression analysis will be used to determine whether the measured variables can be used to predict habitat value for rockfish. The application of this research will be for placing marine reserves in areas of high habitat value for juvenile rockfish.

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Nearshore Fish and Invertebrate Assemblages in Iniskin/Iliamna Bay Lower Cook Inlet.

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Fish and invertebrates assemblages in Iniskin and Iliamna bays on the west side of lower Cook Inlet are described based on field investigations conducted during 2004 - 2006. Nearshore habitats were sampled using two gear types: a 37-m beach seine was used to sample littoral habitats and a small otter trawl was used to sample demersal assemblages between 3 and 15 meters in depth. Within the study site, juvenile Pacific herring were numerically dominant despite reported declines in local spawning; young of the year appeared in June and remained the most abundant species through September. Juvenile salmonids were also abundant with chum dominating in April; and pinks dominated in May and remained abundant through July. In deeper subtidal areas (otter trawl samples), yellowfin sole and snake prickleback were numerically dominant. There were strong seasonal differences in fish assemblages reflecting a spring influx of transient and anadromous species. Invertebrates (with the exception of mysids) tended to concentrate in deeper areas with over 60 species sampled. Invertebrate abundances appeared to be less seasonal than were fish. Invertebrates were dominated by pandalid, hyppolytid, and crangonid shrimp. These groups also were important to the diet of dominant fish species within the study area.

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Does Variation in the Weight of *Zostera marina* Seeds Influence the Depth at which Germination Can Occur?

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Variation in seed weight between species in the same genera is common; whereas the weight of seeds within the same species, especially from the same location, tends to be relatively constant. This general rule does not hold true for the seagrass *Zostera marina* (eelgrass). In this species larger seeds, from the same location, can weigh nearly twice as much as smaller ones.
We designed a pilot study to determine if there was a relationship between seed weight and sprouting depth. Working at the level of an individual seed, we differentiated size classes from three different locations in the San Juan Archipelago, Washington State, and planted them at different depths in a common garden experiment in the laboratory using a randomized block design. Seeds were planted in January 2006 and germination success was evaluated in October 2006. Temperature and salinity were monitored throughout the experiment. We found that sediment depth did not appear to influence germination and that while both size classes germinated; more large seeds produced foliage leaves. We also found that although germination varied between sites, at one site 92% of the seeds did not germinate but remained viable. We discuss how this study is directing our future research.

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Comparing Estuaries and Fringing Salt Marshes in Southeast Alaska using the ShoreZone Mapping System

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Abstract:

The ShoreZone mapping system inventories and classifies coastal habitats using low-altitude aerial imagery captured during summer low tides. Supratidal, intertidal and nearshore subtidal flora and fauna are observed and recorded as *biobands*, which can be described as assemblages of one or more species with a specific across-shore elevation and characteristic pattern of colour and texture. Three wetland biobands of salt-tolerant grasses and herbs are used to define salt marsh and estuary habitats. The biobands observed, together with the geomorphological attributes, provide the basis for several summarizing categories, including habitat class. The *estuary* habitat class is used to describe areas that include wetland biobands in the upper intertidal, have some freshwater input from a stream or river and show a delta form.

Conventional definitions of estuaries imply large-scale features. The ShoreZone mapping system identifies 1) large-scale estuaries, 2) small-scale estuaries, 3) salt marsh areas not associated with freshwater and, 4) geomorphological wetlands. It is important to include fringing salt marsh areas in the analyses, as they would be excluded from traditional large-scale estuarine cataloguing and inventory efforts but may serve similar ecological functions. We will present summaries of shoreline lengths in these salt marsh categories and speculate on their ecological significance.

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Charting the genetic distinctness of *Cancer magister* megalopae recruiting into Glacier Bay, Alaska 2000-2004.

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Alaskan fisheries produce over half the US seafood production, and crustacean fisheries historically represented a significant part of this production. Many crustacean fisheries in Alaska, such as the Dungeness crab (*Cancer magister*) fishery, have failed to recover after fishery closures. *C. magister* is a large crustacean found along the western coast of Northern America, from Alaska to Baja California. This species has a relatively long pelagic phase (2.5- 4 months), indicating long dispersal distances, however Glacier Bay is affected by oceanographic barriers caused by the California and Gulf of Alaska current systems resulting in reduced recruitment of larvae. This lack of recruitment is one hypothesis for the lack of recovery of *C. magister* in Glacier Bay, Alaska. We used molecular genetics to better understand recruitment of *C. magister* larvae in Glacier Bay, Alaska. Cytochrome oxidase 1 (CO1) mtDNA was amplified and sequenced using 75 megalopae from each year (2000-2004). Phylogenetic trees were created and genetic differences calculated. 88 haplotypes were found, of which 3 major haplotypes, 8 intermediate haplotypes (a few individuals) and 77 singletons (one individual) were identified. Compared to California and Oregon populations, this genetic characterization is diverse and unique leading us to recommend Glacier Bay, Alaska be designated a marine reserve.

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Re-constructing migratory history in Pacific salmonids

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The importance of estuarine and ocean residence in the early life history of Pacific salmon is increasingly recognized. Estuarine residence provides potential opportunities for growth, refuge from predation, and time for physiological acclimation, which may affect subsequent survival rates. Furthermore, environmental conditions during initial ocean entrance appear to influence survival. Factors such as the timing and size of individuals at ocean entrance likely interact with environmental conditions to affect individual survival. There are few data, however, on individual estuarine and early ocean residence times and growth rates with which to examine these relationships. Otolith chemical, i.e., Sr/Ca ratios, and microstructural, i.e., increment analysis, combined provide a valuable tool with which to recreate juvenile migratory histories. Once we have a better understanding of existing variation in migratory behavior, we can examine the interaction between environmental conditions and those migratory patterns. We will present data from two pilot studies in which we used otolith Sr:Ca ratios to characterize estuarine and ocean residence, i.e. duration and growth, in juvenile steelhead along the Oregon coast and juvenile Chinook off the Columbia River. Additionally, we examined Ba/Ca and Mn/Ca ratios in juvenile Chinook salmon to determine if those elemental ratios may be useful in identifying an estuarine plume signature within the otolith to further refine migratory histories.

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Overview of the South Puget Sound Dissolved Oxygen Study

Albertson, Skip, Julia Bos, Mindy Roberts, Greg Pelletier, Karol Erickson, Carol Maloy and Ryan McEliece, Washington State Department of Ecology, Olympia,WA*

South Puget Sound, including Budd, Carr, and Case Inlets, has low levels of dissolved oxygen that do not meet state water quality standards and impair marine life. The Washington State Dept. of Ecology is conducting an intensive study to assess nitrogen loads and other parameters and how these potentially affect levels of dissolved oxygen. The South Puget Sound Water Quality Study Phase 1 Report (2002) indicated that both point sources from wastewater treatment plants and nonpoint sources from watersheds and rivers contribute significant nitrogen loads. The current project further refines those loadings by sampling up to 35 tributaries and up to 30 wastewater treatment plants. Data collected from 80 marine stations will enhance understanding of how nitrogen moves around South Puget Sound and the relationship with dissolved oxygen levels. Three-dimensional circulation and water quality models will simulate present conditions in South Puget Sound, based on the extensive data collection programs. The calibrated models will be applied to a variety of management actions to determine how much point and nonpoint source nitrogen loads must be reduced to meet water quality standards. The South Puget Sound dissolved oxygen study is part of Governor Gregoire's long-term effort to help restore and preserve Puget Sound.

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INDICATORS OF EMERSION STRESS IN EELGRASS (*ZOSTERA MARINA L.*)

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Zostera marina is in decline in the San Juan Archipelago. Westcott Bay and Nelson Bay have seen almost total loss of eelgrass and the population fragments left are entirely subtidal. It is unknown at this time what caused the loss. Increased emersion stress from global warming is a possible cause of the eelgrass decline. The quantification of *Z. marina* emersion stress indicators could be a useful monitoring tool for resource managers. Emersion stressors include desiccation, light levels that exceed photosynthetic capacity, leaf temperature and ultraviolet-B (UV-B) radiation. Eelgrass responds to these stressors by increasing light and UV-B radiation-blocking pigments and antioxidants as well as by changing morphology and possibly by obtaining endophytes. The first purpose of this proposed study is to locate eelgrass variables which could be measured by resource managers as a reliable indicator of emersion stress. We hypothesize that eelgrass dealing with longer emersion times will have higher levels of pigments and antioxidants, have shorter shoots and contain endophytes. A pilot study completed in summer 2006 has already provided preliminary evidence that supports some of our hypotheses.

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Seasonal use of Washington coastal estuaries by sevengill sharks (*Notorhynchus cepedianus*), as inferred by acoustic transmitter data.

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Understanding the ecology and behavior of apex predators is crucial for developing rigorous plans for ecosystem-based management, although these goals are rarely realized. We acoustically monitored sevengill sharks (*Notorhynchus cepedianus*) to document the extent, duration, and timing of habitat use by these large, highly mobile predators in Washington coastal estuaries. We implanted acoustic tags in 32 sevengill sharks (16 male, 16 female) in two adjacent estuaries (Grays Harbor and Willapa Bay, WA) and maintained an array of acoustic receivers deployed throughout both estuaries. Tagged sharks used these estuaries seasonally (between February and October) with females returning in the spring, on average, three weeks before males. Individuals displayed high regional fidelity, with 90% of sharks tagged in 2005 detected again in 2006. Spatial scale of movement was not constrained to a single estuary, with at least 70% of tagged individuals using both Grays Harbor and Willapa Bay. Sharks also appeared to segregate by sex over different habitats, with males using peripheral and south bay habitats early in the season, and females concentrating in the central basin. Over the winter, tagged sharks were detected from Puget Sound to the central Oregon coast, and as far south as San Diego.

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Surf smelt (*Hypomesus pretiosus*) spawning activity in San Juan County, Washington: A stewardship story,

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Forty-eight beaches have been identified in San Juan County that are used by surf smelt *(Hypomesus pretiosus*) for spawning. Spawning can occur year-round but the principal activity is during summer months. The eggs are found on the beach in the upper inter-tidal zone. Along with herring and sand lance these fish form an important link in the food web in Puget Sound. The combination of spawning during summer months and on the upper beaches exposes this population directly to impacts from humans. We were able to film the spawning activity on one of their frequently used beaches and for the first time capture and record how spawning takes place. The film was produced and is made available to the public as an educational outreach and marine stewardship tool.

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Genetic Characterization of Eelgrass (*Zostera marina* L.) from the San Juan Archipelago and Hood Canal

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Eelgrass (*Zostera marina* L.) beds in Puget Sound, Washington, as elsewhere, are increasingly impacted by human activities. To understand differential impacts on these populations, the University of Washington, Washington Department of Natural Resources and U. S. Geological Survey are collaborating on genetic studies of selected inter-tidal sites in Puget Sound. To describe levels of genetic diversity within and among these sites, and to map the distribution of clones, we are using autosomal microsatellite loci to characterize eight sites in the San Juan Archipelago, and six in Hood Canal. We used multilocus genotypes for which the observed probability of identity values (P_{IDobs}) can distinguish a single individual from among over 9900 individuals (P_{ID} = 1.007E-04). Genetic richness (G), a measure that describes the number of distinct multilocus genotypes (MLGs), was higher in Hood Canal (n = 164; G = 0.79, MLG = 129) than in San Juan Archipelago (n = 349; G = 0.34; MLG = 118). Clones crossed among sites within Hood Canal, but not within San Juan Archipelago. Clones also crossed between Hood Canal and San Juan Archipelago. Genetic data derived from each sample can be used to map the extent of each clone within and across populations.

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Gravel Beach Nourishment in Puget Sound, Washington: Projects and Monitoring
Poster submission for PERS 2007

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This presentation summarizes projects designed and implemented by Coastal Geologic Services in Northern Puget Sound, and presents the results of 2-8 years of monitoring at several soft shore protection projects that utilized gravel beach nourishment.

Marine Park is a heavily used shoreline park in Bellingham, Washington, owned by the Port of Bellingham. The park offers open views of the San Juan Islands and is one of the most visited in all of Bellingham Bay, where water access is very limited. The un-designed “revetment” was failing and liability and habitat issues lead to development of a soft shore protection approach. The beach was constructed in October to early November 2004. Approximately 1,400 cubic yards of rock, and concrete-asphalt debris and 1,200 cubic yards of fill from the beach were first removed from the site. Seventy tons of creosote piles were removed from the intertidal. The gravel beach extended down to between +2 and +4 ft MLLW and up to a broad sand-covered backshore area. Two drift sills were required in this highly impacted coastal reach, where the coastal railroad line has cut off the naturally limited sediment supply. Construction was completed under the total budget and within the allowed construction window. The initial physical monitoring results will be presented, including beach stability and the position of beach sediment relative to nearby eelgrass beds.

Driftwood Beach, located in San Juan County, was designed and constructed for the landowners association in early of 1999. The project involved creating a 600-ft long enhanced gravel beach waterward of narrow upland access area. The project consisted of removing nonnative materials and importing beach gravel and sand. A barge equipped conveyor offloading was used. Results of 5-years of monitoring revealed that Driftwood Beach remained stable since project construction with less than 0.25 ft of vertical change over the majority of the beach. There was no indication of waterward migration of gravel below the lower project extent during the 5 years instead; there was net onshore sediment transport. Through observations to 2006 (year 8) the project achieved the goals of protecting the community-owned beach area, remaining stable and not negatively impacting adjacent eelgrass and macro algae.
These projects illustrate the need for site-specific assessment and restoration/ rehabilitation design for Puget Sound coastal sites. The success the three projects demonstrates the feasibility of beach restoration and rehabilitation in Puget Sound for erosion control that avoids negative impacts of bulkheading, and improves habitat conditions.

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***Carcinus maenas*: Invading an Estuary Near You?**

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Carcinus maenas, an invasive species of crab, was first observed in San Francisco Bay in 1989. Since then, it has been sighted sporadically in various estuaries on the west coast of North America, as far north as Vancouver Island. San Francisco remains the apparent sole source of all recruits. Managers need to determine where to appropriately allocate resources to mitigate negative impacts of the European green crab. By combining oceanographic data and models with biological development models, I will construct a deterministic model that predicts larval movement and development along a flat coastline representing western North America. In the northeastern Atlantic, most larvae are found in the ocean from April to July, but further south the larval abundance peaks twice a year, February – April and October – December. Development time of the larvae is driven primarily by temperature and can take from 4 – 9 weeks. Ocean temperature and current velocities vary seasonally and interannually and are expected to shift under various climate change scenarios, which will influence how far north *C. maenas* can successfully recruit. This modeling approach will address how far from San Francisco and under what conditions we can expect *C. maenas* to recruit in the future.

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Field Equipment and Sample Handling as Related to Benthic Invertebrate Sample Processing

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In spite of the various designs of benthic invertebrate sample-handling equipment and the varying methods of use, successful benthic invertebrate field collections will result in reliable data if key components are employed. The key components are to wash the sediment in portions, rinse gently, preserve properly, transfer to alcohol, sort the debris using experienced personnel and use proven identifiers for identification of organisms.

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Characterizing impacts to nearshore habitats and *Z. marina* related to land use in large river deltas of Puget Sound

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Recent fragmentation and loss of *Z. marina* throughout the San Juan Islands (SJI) is suggestive of a regional stress or combination of stresses affecting habitat and/or survival. Analyses of satellite imagery, sediment cores and water quality indicate significant changes in surface water nutrient, productivity and sedimentation across Northern Puget Sound related to the Fraser River summer freshet that may affect habitat as well as seed production, recruitment, plant germination, growth, and/or recovery of *Z. marina*. Working with partners from University of Washington, Friends of the San Juans, and Washington Department of Natural Resources, the USGS Coastal Habitats in Puget Sound Large River Deltas Project is applying geophysical methods, process studies, and detailed geologic and geochemical analyses of sediments and water including lipid biomarkers to characterize nearshore habitats and change, and processes affecting habitat availability and function. Preliminary analyses of sediment cores across the SJI nearshore that show high sedimentation rates and combustion-related PAHs where sediment yields are presumed to be low due to small watersheds and where refineries and mills are absent, support the idea that modified river deltas, like the Fraser, Nooksack and Skagit, may be exporting water masses, sediment and contaminants across vast areas of Puget Sound-Georgia Straits and affecting nearshore habitats including *Z. marina*.

Investigating the range and physical biometrics of *P. scouleri* and *P. serrulatus* on eastern Vancouver Island and the surrounding islands

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There are three species in the genus *Phyllospadix* documented on the northwestern coast of North America. While some range and habitat data is known, and it has been confirmed that both *P. scouleri* and *P. serrulatus* not only occur on the turbulent outer coasts, but also on the southernmost east coast of Vancouver Island, the southern Gulf Islands and the San Juan Islands, not much information has been collected. In the summer of 2005, two study sites were established in *P. scouleri* beds on San Juan Island, to investigate shoot density, internode spacing variation and natural rate of recovery. In 2006, these sites were sampled again. These data are important, as few studies have been done concerning the growth habits of *Phyllospadix* spp. in the northern range of its distribution. In addition, this paper starts to delineate the range of both *P. scouleri* and *P. serrulatus* on eastern Vancouver Island and the surrounding islands. The purpose of this study was to investigate recovery and growth patterns in *P. scouleri*, to add to the growing database on disturbance studies and to start describing the range and growing habits, including mixed bed dynamics, of *P. scouleri* and *P. serrulatus*.

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Identifying source populations of burrowing ghost shrimp (*Neotrypaea californiensis*) for population management plans

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Dense populations of *Neotrypaea californiensis* have been impacting the commercial oyster farms along estuaries of Washington state and Oregon by burrowing into the muddy sediment where the oysters are grown. The oysters sink into the mud and die as a result of the shrimps' burrowing activity. Carbaryl, a common pesticide, is used in Washington estuaries to control the shrimp population, however, the use of carbaryl will cease in 2012 so alternative population management plans must be implemented. The purpose of this study is to determine the source populations of ghost shrimp larvae recruiting into the estuaries using molecular genetic analyses. Preliminary data suggest that larvae are seeded southward in a stepwise pattern from estuary to estuary via the California current during the summer recruitment period. This will aid in the development of an alternative management plan by being able to identify unique, estuary-specific genetic signatures of shrimp. Future studies will include analyzing shrimp populations from different recruitment years.

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Bathymetry, bottom mapping, and recovery projections of eelgrass for anchor buoy relocation project at Echo Bay, Sucia Island, WA

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As part of a regional plan to protect marine biodiversity and productivity and provide public access to remote state parks in the San Juan Archipelago, Washington State Parks (WSP) will relocate and alter existing mooring buoys within Echo Bay on Sucia Island and establish a voluntary “no anchor” zone. This action is primarily taken to avoid further disturbances to existing eelgrass (*Zostera marina*) beds. Habitat mapping using multibeam bathymetry, backscatter, and underwater video transects can guide removal and relocation efforts and provide a baseline of eelgrass abundance against which potential recovery can be compared. Statistical protocols associated with these techniques allow us to estimate the amount of eelgrass present, determine the minimum and maximum depth of plant growth, illustrate depth contours and characterize surface sediment profiles. These source data are then imported to ArcGIS for landscape-scale analysis. Our data and the fact that eelgrass is found at deeper depths (~ 10 m) within sites similar to Echo Bay in the region, suggests that areas adjacent to the existing maximum depth of eelgrass growth may support population expansion once buoys are relocated. Finally, economic value of potential eelgrass expansion will be assessed in terms of dollars per hectare per year based on ecological function and relative importance to economically valuable species.