

# SOUTH SOUND SCIENCE SYMPOSIUM 2012

New Findings, Collaborative Actions, Positive Change



This event is a unique opportunity for scientists to explore how we can work together to identify and relate changes in the health of the South Puget Sound ecosystem. In addition to the general session presentations, scientists and technical staff from educational institutions, government, and tribal natural resource agencies, non-profit groups, and the private sector were invited to contribute their knowledge to this event in the form of technical posters and research abstracts.

All submitted abstracts are compiled below. Underlined type indicates the presenting authors for the poster session. Special Thanks to all of the partners that made this event possible. Watch for these and archived abstracts from past conferences at the South Sound Science Symposium web site: [www.sciencesymposium.org](http://www.sciencesymposium.org)



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## South Sound Science Symposium Poster Abstracts

**2011 Sediment Quality Assessment of South Puget Sound and Budd Inlet for the Puget Sound Ecosystem Monitoring Program**  
Margaret Dutch, Sandra Weakland, Valerie Partridge, Kathy Welch, Edward R. Long – Washington State Department of Ecology

Regional and bay-scale sediment monitoring provides information on current conditions and changes over time in sediment contamination, toxicity, and benthos in geographic areas and urban bays of Puget Sound. The Washington State Department of Ecology has conducted sediment monitoring at these scales as part of the Puget Sound Ecosystem Monitoring Program since 1997. In 2011, sediments were sampled throughout the South Puget Sound region for characterization of current sediment quality region-wide and for comparison with 1999 South Sound baseline conditions. Additional samples were taken in Budd Inlet for determination of a sediment quality

baseline in that bay. Samples were analyzed for over 130 chemical contaminants, two toxicity tests, and identification and quantification of benthic invertebrates. Results of sediment chemical and toxicity analyses are summarized as Sediment Chemistry Index (SCI) and Sediment Toxicity Index (STI) values for each station, for the South Sound region, and for Budd Inlet. SCI values for the region for both 1999 and 2011, and for Budd Inlet for 2011 surpassed the new Puget Sound Partnership SCI target value, indicating high sediment quality with respect to contaminants. The regional SCI values did not differ significantly between years. The SCI value for Budd Inlet for 2011 was slightly lower than that for the region. SCI results were categorized as “minimum exposure” at the majority of regional and bay stations, and as “low exposure” at a small number of stations at the heads of Budd Inlet and Shelton Harbor. No chemical concentrations in 2011 exceeded the

Washington State Sediment Quality Standards at either the regional or bay-wide scale, meeting the target value for that measure, an improvement from 1999. The incidence and spatial extent of toxicity according to the STI increased significantly region-wide from 1999 to 2011. The STI for Budd Inlet in 2011 categorized the majority of stations and area with some degree of toxicity. Thus, the indications of sediment quality in South Puget Sound and Budd Inlet in 2011 are mixed, with low contamination by priority pollutants, but a greater degree of toxicity.

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**Environmental Controls on Installed Woody Plant Establishment in the Hydrologically Restored Tidal Freshwater Wetlands of the Nisqually River Delta**  
[Caitlin Guthrie](#) - Capitol Land Trust

Tidal freshwater wetlands are some of the most highly productive wetland systems on the planet. However, alterations to the land surrounding major Puget Sound river deltas have resulted in a 60% to 83% loss of tidal wetlands. As our awareness of ecological services grows, and freshwater tidal wetlands rise in restoration priority, understanding the environmental controls on this native habitat type is of the utmost importance. Currently, a lack of scientific knowledge leaves data gaps for tidal swamp restoration implementation. The purpose of this study was to determine the relationship between restored tidal processes and installed native woody plant establishment in a Puget Sound tidal swamp. In this observational study, we determined survivorship, growth and vigor of installed plants, while also measuring numerous environmental controls, including: elevation, water table depth, competition, salinity, and soil characteristics (moisture, pH, texture, bulk density and organic matter). Planting success was significantly correlated with elevation, depth to water table, salinity, soil organic matter, and soil bulk density. Increased planting success occurred at higher elevations, deeper water tables and lower salinities. At growing season salinities above three ppt and at elevations below ½ meter above mean higher high water, planting success was greatly reduced. However, specific installed species, including *Malus fusca*, *Lonicera involucrata* and *Rosa pisocarpa* survived at higher rates in these marginal conditions. By gaining an understanding of processes and natural patterns, we are able to advance the efficacy of future Pacific Northwest tidal forested restoration projects.

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**Novel Larval Trapping Technique Indicates Importance of Rare Events Driving Connectivity of Geoduck Clams in Puget Sound**

[Bonnie Becker](#)<sup>1</sup>, [Michael Behrens](#)<sup>2</sup>, [Christine Henzler](#)<sup>3</sup>, [Elizabeth Hoaglund](#)<sup>3</sup>, [Yvonne Shevalier](#)<sup>1</sup>, [Brenda LeMay](#)<sup>1</sup> - [University of Washington at Tacoma](#)<sup>1</sup>, [Pacific Lutheran University](#)<sup>2</sup>, [University of California at Santa Barbara](#)<sup>3</sup>

Quantifying connectivity among populations of sessile bivalves has implications for key conservation and management questions. Traditional sampling techniques, such as nets and pumps, collect larvae during a discrete period. These approaches are further limited by the resource-intensive task of sorting and identifying larvae from the rest of the plankton, restricting the number of time points that can realistically be sampled. We use a novel approach, passive larval trapping, which takes a time-integrated sample, paired with Fluorescent In Situ Hybridization with Cell Sorting (FISH-CS), which automates the sorting and identification processes, to map larvae of geoduck clams in Quartermaster Harbor, Puget Sound, WA. Our findings indicate that although there is a low level of small larvae in the Harbor throughout the season, a pulse of larger larvae were captured in early summer. In contrast, medium sized larvae were found in the slow-moving inner harbor. Our results imply that at least some of the larvae were retained in the harbor for their entire planktonic larval duration. Our results represent the first published observation of geoduck larvae in situ and will be used to further study the connectivity of populations in the South Puget Sound.

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**Biodiversity of Mobile Benthic Fauna in Geoduck (*Panopea generosa*) Aquaculture Beds in Southern Puget Sound, Washington**

[Rana Brown](#) - Squaxin Island Tribe

Aquaculture of the geoduck, *Panopea generosa* Gould, 1850, has increased dramatically in the last decade in southern Puget Sound, Washington, and the effects of these intertidal aquaculture geoduck beds on local fauna is mostly unknown. This study examined the species composition, relative abundances, and biodiversity indices of mobile benthic fauna in geoduck farm areas of southern Puget Sound. Surveys of geoduck farms in two different

stages of aquaculture production were carried out using a trapping strategy with two types of traps. The site in Eld Inlet had predator protection tubes around the planted geoduck. The site in Nisqually Reach was in grow-out phase with no predator protection. Nearby areas with no aquaculture were used as control sites. Traps yielded 1161 individuals from 15 species of mobile benthic animals over the course of this study. The graceful crab, *Cancer gracilis*, accounted for 76.3% of all specimens. The effects of geoduck aquaculture on biodiversity were subtle and not consistent between the two locations. Using Coleman rarefaction analysis, species richness was significantly higher ( $p < 0.05$ ) in the geoduck farm in Eld Inlet compared with its control site, but no significant difference was observed in species richness between the geoduck farm in Nisqually Reach with its control site. Biodiversity was higher in the Nisqually Reach compared to Eld Inlet, and Simpson's biodiversity index for the Nisqually Reach geoduck farm was significantly higher than its control site (0.73 and 0.62, respectively,  $p = 0.001$ ). Large differences in capture rates were noted between female and male *Cancer gracilis* crab in Eld Inlet and Nisqually Reach. Possible causes of the observed differences between the sites are discussed.

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**Bulkhead Removal Projects in the South Puget Sound**  
[Stephanie Williams<sup>1</sup>](#), [Jim Johannessen<sup>1</sup>](#), [Alexis Blue<sup>1</sup>](#),  
[Brian Combs<sup>2</sup>](#) - Coastal Geologic Services<sup>1</sup>, South  
Puget Sound Salmon Enhancement Group<sup>2</sup>

Shore modifications, such as bulkheads, revetments, and seawalls, can negatively impact and impair the ecological functioning of nearshore coastal systems. However, in many cases shoreline modifications are not functioning or not necessary; under these circumstances shore modifications can be removed and the beaches and bluffs returned to their natural, functioning state. The proliferation of bulkheads in Puget Sound is a legacy associated with shoreline development and private property and therefore is surrounded by complex and sensitive issues; however, the cumulative impacts of shoreline modifications to the nearshore ecosystem cannot be overlooked.

Furthermore, these modifications often result in the loss of the very feature that attracted coastal property owners in the first place, the beach. Shore modifications reduce littoral sediment input from bluffs by impounding sediment that would otherwise sustain beaches and spits down-drift. The installation of shore modifications typically results in direct burial of the backshore and portions of the beachface, resulting in reduced beach width and loss of habitat area. Beaches also become more coarse-grained as sand is winnowed out by wave energy reflected off of the bulkhead and then transported away. This leads to a direct loss of nearshore habitats due to reduction in habitat patch area, backshore and marine riparian vegetation, connectivity, and shoreline complexity. Bulkhead removal is one way to reduce the impacts of a legacy of shore modifications. This poster details bulkhead removal projects at the residential or small parcel scale that are at varying stages of development in South Puget Sound. These projects were initiated by the South Puget Sound Salmon Enhancement Group and People for Puget Sound, which underscores the importance of collaborative partnerships in solving environmental problems. Projects from Thurston and Mason Counties with feasibility and varying levels of design completed will be outlined in this presentation. Moving forward we believe that a showcase of successful bulkhead removal projects, partnerships with local agencies and organizations, funding sources or incentive programs, and informed property owners will help perpetuate naturalization of Puget Sound shores and move toward a recovering nearshore ecosystem.

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**New Feeder Bluff Mapping in the South Puget Sound**  
[Stephanie Williams](#), [Jim Johannessen](#), [Andrea MacLennan](#) - Coastal Geologic Services

The term *feeder bluff* refers to sediment source bluffs that are known to contribute the vast majority of sediment to Puget Sound beaches within net shore-drift systems. Net shore-drift is the long-term net effect of sediment transported alongshore. Within net shore-drift cells, natural erosion and recession of feeder bluffs maintain and sustain beaches and associated

valued nearshore habitats. Planning and shoreline management policies to protect feeder bluffs require maps showing their location and extent. Feeder bluff mapping has previously been conducted in several counties with results applied by a wide variety of groups working in the nearshore, including local governments, tribes, WRIAs, MRCs, and non-profits. Completion of a contiguous Sound-wide feeder bluff mapping dataset will provide consistent data specific to coastal processes for use by resource managers and planners throughout the region. This data could be used for true process-based analysis and restoration planning. Ecology acquired funding from the US EPA to complete this work. Coastal Geologic Services, teamed with Qwg Applied Geology and Sound GIS, were contracted to produce Sound-wide feeder bluff mapping for nearly 2,500 miles of Puget Sound shore. The project approach involves compilation of existing feeder bluff mapping, incorporation of new mapping, and integration of data into a GIS framework. Existing feeder bluff mapping data was reviewed for completeness, accuracy, and consistency. New mapping is being conducted primarily in the field with a GPS along with remote mapping. In total, existing mapping data covers 700 miles, field mapping covers 600 miles, and remote mapping covers 200 miles of shore. In areas outside of net shore-drift cells, such as bedrock shores, estuaries, and deltas, (950 miles) existing PSNERP shoretype mapping will largely be integrated. The majority of South Puget Sound has recently been field mapped in fall 2012 totaling 242 miles of shoreline. By completing this dataset and providing it to local governments and the public, data can be applied to coastal restoration and appropriate protection measures of Puget Sound shorelines.

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### **Metallothionein as a Bio-indicator of Metal Toxicity in Commencement Bay**

[Michelle McCartha](#), [Jim Gawal](#), [Bonnie Becker](#) - [University of Washington Tacoma](#)

The metal stress protein, metallothionein (MT), is produced by benthic invertebrates in response to metal pollution, and as such provides a valuable tool for monitoring metal pollutant impacts in Puget Sound. By using MT as a bio-indicator, instead of directly sampling the metals in the sediment and

within organisms, the biotic response to metals can be evaluated. In this pilot study, we are exploring the degree of correlation between MT in benthic invertebrates and metal contamination both in the field and in the lab. First, MT concentrations in a small, ubiquitous thyasirid clam, *Axinopsida serricata*, are being analyzed and compared with metal concentrations found in sediments to determine the benthic response to metal stress *in situ*. Seven stations (with three replicates per station) were sampled, five in Commencement Bay and two control sites near the Nisqually delta. Sediments were analyzed for total organic carbon, grain size, and metal concentrations (Cd, Cu, Pb, and Zn). Clams collected from each site were sorted, identified, and will be analyzed for MT using a spectrophotometric method. In addition, sediments were collected from all stations to be used in a lab validation study using clean polychaete worms, *Alitta virens* (formerly *Nereis virens*) purchased from a supplier. Worms will be raised in the lab in replicate treatments with sediments from each of the seven sites to determine how the proteins develop over a specific time period in a controlled environment. Results are pending, although preliminary results indicate that there is a detectable amount of MT in *Axinopsida serricata* and *Alitta virens*. This study will evaluate the utility of using MT in small benthic infauna as a tool in determining the response of benthic communities to metal toxicity. This research may be useful in future restoration efforts monitoring the benthic health of Commencement Bay and Puget Sound.

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### **An Environmental Indicator for Summer Low Flow Trends**

[Paul Pickett](#) - [Washington State Department of Ecology](#)

An environmental indicator was developed to show changes in low flow conditions in rivers and streams draining to Puget Sound. This indicator is being used for the Puget Sound Partnership “State of the Sound” report and for the Governor’s Salmon Office “State of Salmon in Watersheds” report. Twenty-nine rivers and streams, including several draining to South Puget Sound, were selected based on the availability of long-term flow records, their representativeness of hydrologic regimes and land uses, and their overlap with past indicators and with climate modeling sites. The trend in the annual minimum summer 30-day average flow was selected because of its significance to

salmon habitat needs. Water Year 1975 was selected as the first year in the trend in order to capture as long a record as possible for all rivers and streams, and to minimize long term climactic effects like Pacific Decadal Oscillation, without mixing data from pre- and post-dam construction. Trends are determined both with a linear regression of annual low flow against time, and with a Mann-Kendall non-parametric test. If either test shows significance with probability less than 0.5 the trend is considered a “weak trend” (more likely than not the trend exists), and if the probability is less than 0.1 the trend is considered a “strong trend” (highly likely the trend exists). If neither test shows significance with a probability less than 0.5, there is “no trend” detected. The analysis of the indicator through Water Year 2011 shows that 59% of gages (17 out of 29) had stable or increasing flows. The other 12 gages showed significant declining trends. Most South Sound rivers showed increasing or stable flows, except for the Deschutes River near Rainier, which had a strong decreasing trend. Determining the factors influencing the trends requires additional analysis. However, a few patterns can be observed: 1) Most rivers with dams regulating flow had no trend or an increasing trend. 2) Unregulated streams in fast-growing areas show decreasing trends. 3) Many glacially-fed rivers show increasing trends. The indicator has been reviewed extensively and several suggestions made for improvement and enhancement.

#### **Kitsap County Shoreline Restoration – Priority Analysis, Feasibility, and Site Selection**

Wendy Gerstel<sup>1</sup>, Paul Schlenger<sup>2</sup>, John Small<sup>3</sup>, Patty Charnas<sup>4</sup>, Christina Kereki<sup>4</sup>, Kathlene Barnhart<sup>4</sup> – Qwg Applied Geology<sup>1</sup>, Confluence Environmental Company<sup>2</sup>, Anchor QEA<sup>3</sup>, Kitsap County Department of Community Development<sup>4</sup>

Kitsap County is currently evaluating its unincorporated shoreline for opportunities to protect and/or restore natural coastal sediment processes. Of the county’s 218 miles of shoreline, 82 miles (38 percent) are armored. Private landowners are being involved in the process of finding sites with either existing or a potential for high value coastal habitat, identified by its sediment input potential. This project is supported by a grant from the U.S. Environmental Protection Agency and is collaborative between the Kitsap’s Dept. of Community Development, Qwg consultant team, interested landowners, and a technical advisory group of regional experts in the physical, biological, and social sciences. First, sediment sources were mapped in a GIS framework (using

LiDAR, shoreline oblique photos, T-sheets, and geologic maps at the largest digital scale available) and classified into four general types; 1) shallow landslides (debris-flow type), 2) deep-seated landslides, 3) mix of shallow and deep-seated landslides, and 4) tributaries. The basin and wave environment conditions of tributary stream deltas were visually characterized to determine which streams are likely to contribute sediment to the beach. Landform categories provide relative estimates of sediment input rates and volumes. Next, priority drift cells and reaches were identified through a GIS-based relative value rating process incorporating:

- potential sediment input (assuming connectivity between bluff and beach)
- existing sediment input (accounting for current extent of disconnection between bluffs and beach from armoring, structures, etc.)
- wave energy
- sediment type
- relative position of sediment input source in the drift cell.

The GIS analysis relies on cross-checking with professional experience, field knowledge, and collaborative professional judgment of the project team. The results of the GIS analysis of these various measureable and mappable shoreline parameters is being combined with the results of a shoreline landowner survey to select appropriate sites for restoration or conservation within identified priority drift cells and reaches. Survey responses are currently being used to contact those landowners expressing interest in considering the range of alternatives to traditional shoreline armoring. A series of public workshops, one of which has already taken place, are being used to build relationships and exchange project and site information with interested landowners.

#### **Microbial and Nutrient Patterns in Nearshore Waters of South Sound in 2011**

Linda D. Rhodes<sup>1</sup>, Anne E. Baxter<sup>1</sup>, Jason E. Hall<sup>1</sup>, Sean M. Naman<sup>2</sup>, Dana m. Rudy<sup>1</sup>, Correigh M. Greene<sup>1</sup> – NOAA Fisheries/Northwest Fisheries Science Center<sup>1</sup>, University of British Columbia, Dept. of Zoology<sup>2</sup>

Nearshore waters are an interface between deeper, open marine pelagic systems and the

intertidal/shoreline zone, and both are expected to influence microbial character and water quality. Microbes, such as phytoplankton and bacteria, are crucial for generating and recycling nutrients and energy through food webs. As part of a larger pelagic food web assessment, 14 sites representing four shore geomorphologies (river delta, small embayment, large embayment, exposed shore) were monitored from April through October in 2011. Measurements included physicochemical properties of the water column, microbial abundances, bacterial community profiling, microbial heterotrophic production, and dissolved inorganic nutrients. Selected sites and time points were assayed for  $^{15}\text{N}$  and  $^{18}\text{O}$  stable isotopes of nitrate. Proximal land use and water velocity were expected to affect microbial characteristics.

Abundances of microbes varied among sites, with the south Budd Inlet site adjacent to Olympia consistently exhibiting the highest bacterial counts. In contrast, sites in the northeastern section near Tacoma Narrows displayed low abundances of all microbes measured. A robust inverse relationship between microbial measures (bacterial abundance, chlorophyll *a*) and dissolved nutrients (nitrogen, phosphate) suggests that both phytoplankton and bacteria are detectably modulating these nutrients. Bacterial communities tended to display greater similarity among sites within each monthly sample, indicating that there are basin-wide seasonal influences. While most of the stable isotope results were consistent with values for endogenous marine nitrate sources, two samples were enriched for  $^{15}\text{N}$ , suggesting possible human or animal sources. These and other observations indicate that a suite of physical, nutrient, and microbial measurements can contribute to describing and understanding nearshore pelagic water dynamics.

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**New Geological Mapping Along Hood Canal**  
[Trevor Contreras, Michael Polenz](#) - Washington State Department of Natural Resources, Dept. of Geology and Earth Resources.

Geologists of the Washington State Department of Natural Resources have mapped eleven 7.5-minute quadrangles along Hood Canal in the past four years in support of the Hood Canal Dissolved Oxygen Project and the Puget Sound Partnership. These geological maps provide valuable information on the

type, thickness, and age of rock material surrounding the canal, as well as geologic hazards, such as landslides, and can be used for a wide variety of applications, including growth management decisions, habitat restoration and groundwater studies. Mapping started near Belfair and covers the quadrangles surrounding the canal as far north as Brinnon, with complete coverage anticipated in three years. The mapping is at 1:24,000 scale, using LiDAR (light detection and ranging)-based digital elevation models to assist with the detailed classification and analysis of the materials and landforms. The maps are available free of charge and can be downloaded online at: [http://www.dnr.wa.gov/Publications/ger\\_24k\\_mapping\\_status.pdf](http://www.dnr.wa.gov/Publications/ger_24k_mapping_status.pdf)

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**Mapping Environmental Indicators in the Puget Sound Region**  
[Jonathan Walker](#) - ICF International

Accurate portrayal of data through visually cohesive map graphics is a critical component of relaying scientific data to stakeholders in the Puget Sound Community. Policy decisions ought to be based on reality and undistorted by political bias, inaccurate representation, or by simple miscommunication of current environmental conditions and any progress that has been made. The intent of this poster is to showcase the necessary steps to undertake when compiling the map graphics in a report detailing environmental indicator data. Sample indicator maps created by Master's students from the University of Washington's GIS & Sustainability Management Master's Program were thoroughly analyzed to arrive at a consensus of the positives, problematic components, and suggestions for each map. From this analysis, five major cartographic discussion points emerged that resulted in the clear need for undertaking an approach that embodies forethought, organization and a cohesive look for the creation of all environmental indicator map graphics, as well as beginning to successfully incorporate the passage of time into every project. The implementation of these recommendations can hopefully help support the Puget Sound Partnership's work of successfully communication through map graphics, furthering the

conversation about the health and outlook of the Puget Sound Region.

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**Long Distance Migration and Evidence for Annual Homing in English Sole (*Parophrys vetulus*): these flatfish are not so flat.**  
[Mary Moser<sup>1</sup>](#), [Mark Myers<sup>1</sup>](#), [James West<sup>2</sup>](#), [Sandra O'Neill<sup>1</sup>](#) - [NOAA Fisheries<sup>1</sup>](#), [WA Dept. of Fish and Wildlife<sup>2</sup>](#)

English sole are used as a sentinel species for contaminant studies in Puget Sound because they are abundant, easily sampled, and broadly distributed in benthic habitats of this area in the northwestern United States. These small flatfish exhibit relatively sedentary behavior during summer feeding periods, but their movements and habitat use during the rest of the year are largely unknown. Thus, sole tissue contaminant loads may not necessarily reflect contaminant exposure from the capture site alone. We used acoustic telemetry to test this idea. In August 2007 we collected adult English sole from Eagle Harbor, a small, contaminated embayment of Puget Sound, and surgically implanted uniquely-coded acoustic transmitters in 19 adult fish (> 27 cm). To document sole movements, we operated an array of eight submersible receivers inside and near the entrance to Eagle Harbor. In addition, we obtained detection data from over 200 other receivers maintained throughout Puget Sound by a consortium of regional researchers. All of the tagged fish were detected on our receiver array immediately after release, and 16 were detected outside of Eagle Harbor at a variety of locations in Puget Sound. Some of these fish made dramatic movements across the Sound and traveled minimum distances of 32 - 106 km. Half of the fish that were detected outside Eagle Harbor returned to their capture site in the spring of 2008. These data elucidated surprisingly extensive and rapid movements by these relatively small flatfish and a strong seasonal fidelity to summer capture locations. Consequently, the exposure of English sole to sediments outside their capture area may be much greater than previously thought. In addition, these results illustrate the tremendous value of pooling resources to maintain large arrays of acoustic receivers and the power of data sharing.

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**La Nina Events Lead to More Robust Flow Distributions for Small Streams in Thurston County: A Statistical Study of Water Years 2008, 2009, 2010, 2011 and 2012**

[Nadine Romero](#), [Mark Biever](#), [Howard Hama](#) - [Thurston County, Dept. of Water Resources](#)

During the last 5 water years annual stream discharge for four watersheds have doubled or tripled due to a return to normal rainfall years (54 inches of rainfall in WY 2010 and 2011). Thurston County Water Resources Program has computed statistics and frequency analysis on the stream flow record for four gaging stations including: Percival, Woodland, Woodard and Black River. We find that the broad distribution of rainfall each water year for the last 3 years has created more robust and varied stream flow distributions including higher summer low flows and baseflows. While extreme event patterns have not developed in the last 3 years (daily extremes or high monthly totals) steady inputs of rainfall through late spring brand yet another style of La Nina. Interestingly, lake levels and ground water systems follow suite and major rivers such as the Deschutes, Nisqually and Chehalis were above the 95% percentile through mid-August of 2012 for the 38 to 82-year records. Weather projections anticipate El Nino conditions to develop through 2013 which may end up offsetting the important recharge of these systems.

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**Distribution of Pacific Lamprey in Puget Sound Watersheds Based on Smolt Monitoring**  
[Mike Hays<sup>1</sup>](#), [Molly Hallock<sup>1</sup>](#), [Carrie Cook-Tabor<sup>2</sup>](#), [Richard Hays<sup>3</sup>](#), [Steve Rubin<sup>1</sup>](#), [Dorothy Chase<sup>1</sup>](#), [Christina Luzier<sup>2</sup>](#), [Mary Moser<sup>3</sup>](#) - [U.S. Geological Survey<sup>1</sup>](#), [US Fish and Wildlife<sup>2</sup>](#), [NOAA<sup>3</sup>](#), [WA Fish and Wildlife<sup>1</sup>](#), [Student Conservation Association<sup>3</sup>](#)

Native lamprey play an important role in stream communities; however, endemic populations are declining worldwide. A petition to list Pacific lamprey (*Entosphenus tridentatus*) as threatened or endangered under the Endangered Species Act of 1973 was not reviewed partly because the necessary population data, including simple presence or absence, was lacking. We sampled lamprey captured during salmonid smolt monitoring from February to August 2011 to determine the current distribution of Pacific lamprey in major watersheds flowing into Puget Sound, Washington. In addition, we evaluated the use of visual techniques to identify juvenile *Entosphenus* and *Lampetra* genera for Puget Sound populations and identified data gaps for future research. Smolt traps were a viable option for sampling lamprey

populations as juvenile lamprey (all species) were captured at all 18 trap sites. Pacific lamprey were identified in 13 of 18 sampled watersheds and were common in several south Puget Sound systems. Based on comparisons with PCR, we verified that previously described visual techniques to identify Pacific lamprey ammocoetes from other lamprey species were successful for 97% of tested samples. The absence of Pacific lamprey from some watersheds may have indicated extirpated populations, but could have been due to low abundance or poor capture efficiencies at the smolt traps. No eyed juveniles of Pacific lamprey (macrophthalmia) were captured; however, they may have migrated at times outside our sampling period as similar-sized river lamprey (*Lampetra ayresii*) macrophthalmia were commonly captured. Although salmonid smolt traps can be an effective method for monitoring presence/absence of Pacific lamprey, other capture techniques (e.g., electrofishing or environmental DNA) may be required in some locations.

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#### **Response of Fish Distributions and Benthic Habitats to Nisqually Delta Restoration**

[Steve Rubin<sup>1</sup>](#), [Chris Ellings<sup>2</sup>](#), [Eric Grossman<sup>1</sup>](#), [Mike Hayes<sup>1</sup>](#) - U.S. Geological Survey<sup>1</sup>, Nisqually Indian Tribe<sup>2</sup>

The Nisqually River delta is the site of the largest estuary restoration project in Puget Sound to date. The culminating event was the return of tidal inundation to 750 acres of the delta following dike removal in fall, 2009. Coordinated, multidisciplinary monitoring of fish populations, benthic habitats, sediment characteristics, macroinvertebrate communities, eelgrass extent and character, and physical processes including hydrodynamics and sediment transport/deposition were conducted in 2010 and 2011. Sampling was designed to determine the spatial and temporal distributions of salmonids and other fishes and to describe the habitat characteristics and physical processes that influenced those distributions. Fish sampling with a lampara net suggested that the nearshore habitat was important to salmon in May and June while delta flats habitats were important to wild Chinook salmon in July and August. In addition, salmon used eelgrass and non-eelgrass habitats while shiner perch and tubesnouts were found only in eelgrass habitats. Benthic sampling produced

130 taxa and species and abundance differences were related to percent clay. Also, the kurtosis and skewness of the sediment grain size distribution and total organic carbon were important factors affecting species abundance. Inshore areas were predominately silt with annelids being the most common species. In comparison, offshore areas were composed mainly of sand with arthropods and mollusks prominent. Future plans include continued monitoring and integrating fish, sediment, and invertebrate results from the offshore sampling with concurrent inshore sampling.

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#### **2012 State of Our Watersheds in South Puget Sound – Salmon Recovery – Are We Making Progress? Our Treaty Rights Remain at Risk**

[Marilu Koschak<sup>1</sup>](#), [John Konovsky<sup>2</sup>](#) - Northwest Indian Fisheries Commission<sup>1</sup>, Squaxin Island Tribe<sup>2</sup>

As tribal people, we have told stories for a long time and we have to keep telling our stories. The stories enclosed in the 2012 State of Our Watersheds (SOW) report are important because they tell the stories of all of us. They document the story of environment change resulting from increased population growth, polluted stormwater runoff, climate change, urban growth, and the diking, filling and armoring of our rivers, estuaries and shorelines. The 2012 SOW report examines key indicators of habitat quality and quantity across more than 20 watersheds in western Washington. The chapters in this report are individual “stories” compiled by each tribe describing the loss of habitat in their watersheds. The chapters do not represent the tribes’ only problems or areas of interest. Instead they are intended to utilize a wide range of science and data to create a specific and representative mark in time constructing an accurate measuring stick to document the trends of salmon habitat. This way, we will know where we are making progress, where we continue to lose ground, and where we need to target our efforts. This report is part of the “Treaty Rights at Risk” initiative begun by the tribes in 2011 as a call to action for the federal government to exercise its trust responsibility to the tribes and lead a more coordinated and effective salmon recovery effort. This poster will focus on the Squaxin Island Tribe’s chapter of the report, specifically WRIAs 13 and portions of 12, 14, and 15. Key habitat indicators for this report were selected by the Squaxin Island Natural Resource

staff and the NWIFC's Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP). Geographic Information Systems (ESRI-GIS Mapping Software) spatial data analysis and cartography were used to develop maps and data numbers/statistics for the report. All data sets used for the SOW are public (Federal, State, County, NWIFC-SSHIAP, or the University of Washington). A review of these key environmental indicators for the Squaxin Island Tribe's Area of Concern indicates a continued decline in forest land cover, riparian conditions, water quality and quantity, as well as marine shoreline habitat.

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**Evaluating Vegetation Response to Estuary Restoration: Nisqually River Delta Case Study**  
[Lisa Belleveau<sup>1</sup>](#), [Kelley Turner<sup>1</sup>](#), [Isa Wool<sup>1</sup>](#), [Jean Takekawa<sup>2</sup>](#), [Jesse Barham<sup>2</sup>](#), [Christopher Ellings<sup>3</sup>](#), [Gerardo Chin-Leo<sup>4</sup>](#) - U.S. Geological Survey Western Ecological Research Center<sup>1</sup>, US Fish and Wildlife Service - Nisqually National Wildlife Refuge<sup>2</sup>, Nisqually Indian Tribe<sup>3</sup>, The Evergreen State College<sup>4</sup>

Estuaries are biologically productive and diverse ecosystems that protect inland areas from flooding, filter fresh water entering marine waters, and provide economic, recreational, and aesthetic value. The Nisqually Delta in Washington State is an estuary that has been modified by restricting tidal flow to reclaim tidal lands for agriculture. Recently, the Nisqually National Wildlife Refuge, working in collaboration with the Nisqually Indian Tribe and Ducks Unlimited, restored a large amount of the tidal flows as part of the largest estuary tidal marsh restoration project in the Pacific Northwest. This thesis contributes to understanding vegetation response to estuary restoration by determining the elevation and pore-water salinity field conditions for nine common salt marsh species in the Nisqually Delta: *Carex lyngbyei*, *Distichlis spicata*, *Grindelia integrifolia*, *Jaumea carnosa*, *Juncus balticus*, *Potentilla anserina*, *Salicornia virginica*, *Spergularia sp.*, and *Triglochin maritimum*. Vegetation surveys were conducted from March to September of 2010 at 21 plots to measure growth over time. In August of 2010 an additional 30 plots were surveyed to estimate peak growth. At each of the plots, pore-water salinity, substrate elevation (as an indicator of submergence time), as well as percent cover, stem density, and maximum height was measured for each species. Using these data, the elevation and salinity

range of each species was determined. Correlation analysis was conducted to explore the relationships among biological (percent cover, height, and density) and physical parameters (salinity and elevation). The seasonal plots were analyzed by establishing salinity and elevation zones and investigating the growth patterns within these zones over time. Overall, pore-water salinity and elevation had a positive influence on the salt marsh vegetation species studied. These species can tolerate high salinities, but submergence time (i.e. elevation) may be the dominant factor explaining differences in their growth and distribution. This research provides knowledge that can be used to identify suitable locations for salt marsh habitat restoration, and to ensure successful colonization of native species. Future research suggestions include continued monitoring of the Nisqually Delta vegetation along with the sedimentation and subsidence processes that affect their distribution and colonization success.

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**Coldwater Refugia Sites in the Mainstem Deschutes River- Use by Juvenile Coho**  
[Scott Steltzner](#) - Squaxin Island Tribe

The Deschutes watershed at 165 square miles is the second largest drainage basin in South Puget Sound. After anadromous fish were introduced in the early 1950's the river became a significant producer of natural origin coho. More recently coho production has crashed and at least one year class is on the verge of extinction. In the 1980's, adult returns numbered in the tens of thousands; by the 2000's, the returns had sunk by one or two orders of magnitude. The Deschutes is one of the most studied systems in all of Western Washington concerning degrading habitat conditions contributing to population declines. The most significant data gap is the spatial identification of juvenile coho rearing locations; particularly during summer low flow periods. In the spring of 2012 a total of 103,000 marked hatchery origin coho were released into the upper watershed. A total of 33 refugia sites have been identified within the mainstem using in-stream temperature recorders and data from thermal imaging flights. In the summer of 2012 snorkel surveys were conducted at 15 of these refugia sites. No coho were found within any site sampled on the mainstem. A presence/absence snorkel survey of two Deschutes

tributaries showed hatchery origin coho were present. Next steps include enumerating out-migrant coho at the WDFW smolt trap and conducting another round of fish introductions and snorkel surveys in the tributaries in the spring of 2013.

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**South Puget Sound -2011 and 2012 in Review: Aerial and Water Column Observations from Ecology's Long-term Monitoring Program**

[Christopher Krembs](#), Julia Boss, Skip Albertson. Mya Keyzers, Laura Friedenber, Brandon Sackmann, Carol Maloy - Washington State Department of Ecology

Marine water in South Puget Sound has been the focus of ongoing water quality concerns. Concentrated, frequent, vast algal bloom and jelly fish patches at the surface and low oxygen water at depth have been persistent features for decades. The remoteness of South Puget Sound from the ocean and disproportionally long shoreline make it particularly vulnerable to land based influences. We documented extensive dinoflagellate blooms and jelly fish aggregations in all finger inlets of South Sound during 2011 and currently, in 2012. These features align with a 13-year increase in macronutrients in surface waters. In 2012 the water column was however unusually cold and significantly fresher. As a result oxygen levels at depth have noticeably recovered. Our observations illustrate the importance of climate variability and distant oceanic influences for the South Puget Sound oxygen budget despite persistent high algal biomass at the surface.

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**Apparent Early Marine Survival of Salmonid Smolts in South Puget Sound**

[Scott Steltzner](#)<sup>1</sup>, Kyle Brakensiek<sup>2</sup>, Cameron Sharpe<sup>3</sup>-Squaxin Island Tribe<sup>1</sup>, North West Indian Fisheries Commission (formerly)<sup>2</sup>, WA Dept. of Fish and Wildlife (formerly)<sup>3</sup>

Several species of salmon in south Puget Sound currently exhibit low marine survival. Rates for wild and hatchery coho have plummeted from 28% in the late 1980's to less than 3% by the early 2000's. Steelhead and yearling Chinook have exhibited similar

declines. Modelling using Ecopath with Ecosim indicated that a trophic shift had occurred in South Sound that was negatively affecting early marine survival for yearling strategy fish. To investigate this hypothesis the Squaxin Island Tribe partnered with the Washington Department of Fish and Wildlife (WDFW) to deploy a regionally scaled acoustic array throughout the marine waters of South Puget Sound.

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**Pocket Estuaries in WRIA's 13 and 14: Identification, Habitat Rating and Fish Use**  
[Scott Steltzner](#) - Squaxin Island Tribe

Non-natal pocket estuaries are hypothesized to be an important habitat feature for early marine fry migrant Chinook salmon. In 2005 the Puget Sound Action Team (PSAT) identified, mapped and rated pocket estuaries within Deep South Sound in a desk top exercise employing aerial photography. This information was subsequently used in the geographic ranking of pocket estuaries in the South Sound chapter of the 2007 Puget Sound Chinook recovery plan. In this study we used the PSAT methodology to perform a 100% shoreline survey of the entire WRIA 13 and 14 shorelines to identify pocket estuaries and document stressors in the nearshore. We evaluated 244 discrete sites finding significantly more pocket estuaries than estimated by PSAT. Eight pocket estuaries were sampled bi-monthly for two years utilizing a nearshore beach seine. Field work began in February and ended in June when early entry Chinook, hypothesized to be fry migrants from South Sound streams, were no longer captured. Sampling consisted of one seine haul from within the pocket estuary and one haul from the associated open beach. In both sampling years chum dominated the catch for juvenile salmonids. Chinook were the second most abundant salmon species; however, overall Chinook numbers were low. Over the sampling period there was no statistical difference between the use of the pocket estuaries and the associated open beaches for any species.

## **Identifying Gravel Deposition and Scour Areas in the Upper Puyallup River**

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Pierce County is actively pursuing a solution to flooding in its main stem rivers due to gravel accumulation. Gravel Removal and Comprehensive Sediment Management is described in detail in the Pierce County Rivers Flood Hazard Management Plan. The following will explain a method Public Works and Utilities, Surface Water Management utilized to identify gravel deposition and scour areas in the Upper Puyallup River. This process makes extensive use of bare earth LiDAR points stored in LAS format and the processing power of GIS software. Point data is converted into a 3D surface which is then rasterized for use in a map algebra process that results in riverine areas of deposition and scour.

## **The State of Lower and Middle Trophic Levels in South Puget Sound's Nearshore Pelagic Zone**

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Debate over the condition of lower and middle trophic levels (zooplankton including ichthyoplankton and jellyfish, juvenile salmon, and forage fish) in south Puget Sound's nearshore pelagic zone has been muddled by a lack of data directly addressing the status of these groups. There are two aspects of this uncertainty: 1) the current status of species within the trophic group, and 2) the reference state by which these trophic groups can be assessed. Here we address each of these questions using data from daytime surface trawls collected in 2011 as part of a large-scale synoptic survey linking Puget Sound's abiotic conditions and its food web. Our analysis included temporal (i.e., historical data) and spatial (south Puget Sound compared to other basins) reference information. Regardless of the type of reference, we found cause for concern for South Puget Sound's pelagic biota. Using temporal comparisons to similar work in the 1970's, we found that juvenile forage fish densities may be much lower now than they were over 30 years ago, and the frequency of high jellyfish

densities may have increased. Using spatial comparisons, we found systematic inter-basin differences in pelagic biota that were consistent over the course of the season, with South Sound, Central Sound, and Hood Canal basins dominated by jellyfish, and the Whidbey and Rosario Basins to the north dominated by fishes.

## **Migrating and Integrating WDFW and NWIFC Fish Distributions and Aquatic Data to the National Hydrographic Dataset**

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Washington state and federal agencies have adopted the National Hydrographic Data set as the official framework for representing stream, coastline, water body, and watershed information. WDFW and NWIFC are cooperating on an EPA funded project to migrate our respective fish distributions, barriers, and habitat data (currently maintained on separate agency specific stream networks and with different attributes) to the NHD, and reconcile the differences to produce a single integrated dataset. The NHD provides a rigorous stewardship and update process led by USGS, maintains a network with flow direction to enable upstream or downstream tracing, and several tools to create and analyze agency specific data as linear events. Using the Nisqually river basin as an example, we have evaluated the results of our data integration, and conducted several pilot analyses combining water quality and regulated facilities data from the WA Dept. of Ecology, USGS stream gauges, and NOAA fish distribution models. Moving forward we will develop a set of consistent physical reach-based stream attributes such as gradient, bankfull width, confinement, and watershed characteristics to form the basis of multi-agency monitoring, habitat modeling and restoration planning.