MILLIE JUDGE – Assessing Puget Sound Salmon Recovery Efforts, What have we learned?

ERIC GROSSMAN, CHRIS CURRAN, ANDREW STEVENS, GUY GELFENBAUM – Sediment budget and transport dynamics in the restored Nisqually Delta marshes facing sea-level rise

As part of the 2009 Brown's Farm restoration and reconnection of 762 acres of the Nisqually National Wildlife Refuge to tidal inundation, we continue to examine the nearshore hydrodynamics and sediment transport to assess habitat response and adaptive management opportunities using a combination of field measurements and numerical modeling. (1) A GIS-based rapid assessment protocol (RAP) utilizing available topographic elevation, tide gauge, and sediment delivery data, shows that the Nisqually marshes experience flood tide inundation capable of delivering sediment 11-28% of the time; currently the delta lacks distributaries. Scaling the existing data for fluvial sediment load of 20,000-100,000 tonnes per year by the flood tide inundation frequency and marsh area predicts that potential sediment accretion across the restored marshes ranges 0.1 to 3.3 mm/yr, which is generally lower than the rate of relative sea-level rise thought to be 2.0-3.5 mm/yr. (2) Initial simulations of a numerical sediment transport model (Delft3D) used to better understand the physical processes responsible for sediment transport, shows important tidal flow asymmetries due to McAllister Creek and inundation frequencies consistent with the RAP method. (3) Sediment flux measurements in all 5 tidal channels connecting the tide flats to the marshes in 2010-2011 provide a budget of water and sediment flux and important validation data for the models and suggest a very small net sediment flux into the restored marshes. The data and approaches help to assess physical processes affecting valued nearshore habitats as well as vulnerabilities and remaining information needed to plan for impending climate change impacts.

HUGH SHIPMAN – Beaches and shoreline modification in South Puget Sound

Seawalls and other forms of armoring extend to more than 25% of Puget Sound's shoreline. In recent years, concern about the impact of these structures on coastal habitats has grown. A 2009 scientific workshop, held on Puget Sound, underscored the significance of armoring as a national issue, but also emphasized that the expression of armoring varies greatly among regions due to geologic and ecological differences. Broad categories of identified impacts include direct loss of shoreline habitat, disruption of key processes such as sediment delivery and ecological connectivity, and resilience of coastal environments to rising sea level.

Armoring is regulated primarily under the Hydraulics Code and local Shoreline Master Programs. New armoring is often discouraged, but policies are often difficult to implement. Interest in "softer" methods of managing erosion is widespread, although the technical underpinning for such efforts remains limited. At the same time, coastal restoration efforts, both local and regional, are increasingly focusing on beaches. Numerous projects have been undertaken recently to remove armoring and historic fill from shorelines.

Regulation and restoration will both benefit from better scientific understanding of beach processes and the impacts of coastal structures. The availability and quality of key coastal datasets is improving and include topography and bathymetry, geology and slope stability, geomorphic characteristics, and inventories of modifications. What may be needed most is rigorous scientific investigations into beach processes and the relationships between geomorphic behavior and beach ecosystems.

BRANDEE ERA-MILLER AND RANDALL MARSHALL – Integrated ambient monitoring pilot report: Potential causes for impairment of rainbow trout early lifestages and loss of benthic biodiversity in Indian Creek

Ecology conducted pilot study in spring of 2010 to assess the suitability of a stream for salmon reproduction. The study also assessed the instream insect and plant communities to see if salmon have a healthy food selection while growing. The study used rainbow trout eggs placed in an urban stream to experience a realistic environmental exposure to the full spectrum of toxic chemicals present. Trout stayed in the stream approximately 34 days, until becoming fry. Passive samplers deployed alongside the trout accumulated the same chemicals as the trout and native stream organisms and provided a list of pollutants potentially responsible for toxic effects.

LINDA RHODES – Microbial and nutrient patterns in nearshore waters of South Sound in 2011

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 15N and 18O 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 15N, 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.

SIMONE ALIN, BRIAN ALLEN, ANDREW SUHRBIER, JOTH DAVIS, RICHARD FEELY, JAN NEWTON, AL DEVOL, CHRIS SABINE, BETSY PEABODY, BURKE HALES, BENOIT EUDELINE, DAN CHENEY, AND CHRISTOPHER KREMBS – Water chemistry, larval oysters, and ocean acidification in South Puget Sound

Recent observations have revealed subsurface marine waters in Puget Sound that are undersaturated with respect to aragonite throughout the year. Observations of high larval oyster mortality in low-saturation conditions (aragonite) suggest that water chemistry was an important contributor to recent declines in oyster populations and wild sets. To examine linkages between water chemistry and oyster settlement, we collected water and biological samples during the growing seasons of 2009 and 2010 at two index stations in Puget Sound (Dabob Bay in Hood Canal and Totten Inlet in South Sound). During both sampling years, partial pressures of CO2 (pCO2) were higher at the Totten Inlet site, and saturation states and pH values correspondingly lower. In 2010, pCO2 levels were much lower and pH and saturation states higher at both stations than in 2009, reflecting the importance of natural variability. Comparison between the two index stations suggests that the dominant controls on water chemistry at Dabob Bay are physical (upwelling), whereas at Totten Inlet, biology dominates nearshore carbon chemistry. Decreased pH and saturation states at the end of summer or early fall appear to coincide with the end of larval oyster settlement and the transition of the dominant shell mineralogy in juvenile oysters from aragonite to calcite, the less soluble form of calcium carbonate. Overall, this preliminary work reflects high spatial and temporal heterogeneity in nearshore environments that will require increased sampling with coupled biological and chemical observations to robustly describe patterns and attribute processes with respect to ocean acidification impacts on Puget Sound's biological communities.

GLENN VAN BLARICOM – University of Washington

Geoduck clam aquaculture operations have engendered significant cultural conflict and management interest based on concerns about associated ecological damage in southern Puget Sound. From summer 2008 through summer 2012 our research group evaluated responses of intertidal benthic communities to stages of geoduck aquaculture: a) initial outplanting of juvenile clams from hatcheries, and coincident placement of predator exclusion structures to protect young clams; b) removal of predator exclusion structures at 1-2 years into the culture cycle; and c) harvest of market-sized adult clams using localized sediment liquefaction and manual extraction at 5-7 years after initial outplanting. We evaluated effects of aquaculture stages on patterns of abundance and diversity in benthic infauna and mobile epibenthic macrofauna, and have evaluated effects on a common demersal fish (Pacific staghorn sculpin) known to have high site fidelity in our study plots. Studies of infaunal responses indicated only temporary and minor shifts in assemblage composition, and virtually no changes in diversity, associated with indicated operational stages. Variance in the data was driven by seasonal and spatial factors to a much greater degree than factors associated with aquaculture operations. Responses of mobile macrofauna to culture-associated disturbances were also temporary. Mean size and rate of weight gain in tagged staghorn sculpins were higher in cultured plots than in reference plots, but stable isotope signatures did not vary by plot type, indicating that sculpins probably fed at the same trophic level in cultured plots as in open sand habitats, but consumed food at higher rates in the cultured plots. In aggregate, our findings indicate minor transient effects of geoduck aquaculture on resident benthic communities in southern Puget Sound.

CASIMIR RICE, CORREIGH GREENE, JEFF CORDELL, JOSHUA CHAMBERLIN, JASON HALL AND LINDA RHODES – The state of lower and middle trophic levels in South Puget Sound's nearshore pelagic zone

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.

JIM WEST, JENNIFER LANKSBURY, SANDRA O'NEILL, AND GINA M. YLITALO – Toxic contaminants and trophic characteristics of South Puget Sound's pelagic food web

Results from long term monitoring of Pacific herring and other species indicate the pelagic food web in Puget Sound's Central Basin represents a hot spot of persistent bioaccumulative and toxic (PBT) chemicals in the northeastern Pacific region, from California to Alaska. Plotting contaminant tissue residues against δ15N (a proxy for trophic level), we compare biomagnification curves of polychlorinated biphenyls (PCBs, as a model for PBTs) across four basins in Puget Sound, including South Puget Sound (SPS). Results will cover primary producers (phytoplankton) through primary consumers (krill, e.g., Euphausia pacifica) to secondary and tertiary consumers (Pacific herring, Chinook salmon and gadoid codfishes). Although PCB concentration in the SPS pelagic food web were intermediate between the highly urbanized Central Sound and relatively uncontaminated Hood Canal, juvenile Chinook salmon exhibited an unusually high PCB burden in SPS – roughly twice the concentration of a deleterious effects threshold. The reasons for such a high PCB burden, and potential implications for early marine survival will be discussed.

ROB DUFF – Monitoring in Washington State: Now and into the Future

Various types of environmental monitoring will be discussed. The value of monitoring to guide restoration and measure success will be presented using examples in Puget Sound and across Washington State. Innovation in sampling approaches, communication strategies and the ever present challenge of scientific uncertainty will also be addressed. Finally, the realities of decreased funding will be acknowledged along with recommendations for future monitoring strategies.

NINA CARTER – Using best available science in making land use decisions

The presentation provides the audience with a short history of the Growth Management Act and how best available science is defined legally and how it is expected to be implemented. Included in the presentation are three examples of how best available science was applied (correctly or incorrectly) and concludes with suggestions on how to find and apply best available science to land use decisions.

MINDY ROBERTS -- What have we learned from the South Sound Science Symposium, and how can we use it?

This final presentation will summarize the overarching themes and directions from presentations at the 2012 South Sound Science Symposium. Over the years we have drawn a remarkable variety of presentations on our South Sound region, including the physical environment and pressures, water quality in marine and freshwater, and the terrestrial and aquatic biota. What have we learned, and how will we use the information?