Puget Sound Nutrient Dialogue

Green River Community College

July 19, 2017

Photo by: Jessie Payne, Ecology

Presentation Information

Our intent for the Puget Sound Nutrient Dialogue is to bring together scientists, academics, policy and decision makers, environmental organizations, tribes, and the public to share new and emerging science about the effects of excessive nutrients on the health and water quality of Puget Sound.

Understanding the problem is the first step to making informed decisions about how to manage our impacts to Puget Sound to ensure it is resilient to climate change and regional population growth.

What is the Puget Sound Nutrient Source Reduction Project –

Dustin Bilhimer, Ecology

- Ecology is engaging stakeholders in a collaborative effort that uses best available science to develop a nutrient source reduction plan.
- We will use the Salish Sea model to quantify the water quality benefits of key actions to reduce nutrients in terms of meeting dissolved oxygen numeric criteria.
- Puget Sound is a valuable natural resource and economic asset as well as one of our regional icons, we must figure out how to grow and maintain Puget Sound's resiliency.

More: http://www.ecy.wa.gov/puget_sound/reducing-nutrients.html

Nutrient and phytoplankton trends and ties to climate in central Puget Sound –

Kimberle Stark and Stephanie Jaeger, King County

- Over the last two decades, observations in the Central basin of Puget Sound do not show large changes in annual nutrient concentrations or ratios, with the exception of beach sites near a freshwater source. Seasonal trends over time are present in some areas.
- Patterns in near-surface nutrient concentrations are driven by changes in phytoplankton and algae production, which in turn are impacted by weather, climate, circulation, river flow, and other environmental factors.
- Seasonal and geographic differences in phytoplankton composition and abundance occur in the Central basin and are associated with temperature and salinity differences as well as weather and climate factors.

More: http://green2.kingcounty.gov/marine/Monitoring/Phytoplankton

Changes in Puget Sound from Ecology's long-term marine water quality monitoring program – *Christopher Krembs, Ecology*

- Many water quality indicators vary with larger scale climate fluctuations. Despite these large inter-annual variabilities, trends in long-term monitoring data are evident.
- On a Puget Sound-wide scale, marine nitrate concentrations have increased over the period from 1999-2012 in many regions of Puget Sound. This trend is affecting the nutrient balance in Puget Sound which has implications for nutrient cycling and the species composition at the base of the food web.
- Many eutrophication indicator species (macro-algae, Noctiluca, other dinoflagellates, and jellyfish) have been documented in large quantities near the surface of Puget Sound. At the same time phytoplankton has decreased in the upper water column.

More Info: http://www.ecy.wa.gov/programs/eap/pscoastalintro.htm

Impacts of excessive nutrients on eelgrass and kelp – *Bart Christiaen, DNR*

- Eelgrass and kelp are critical nearshore vegetation types that provide habitat for diverse communities.
- Excessive nutrients have contributed to global declines in eelgrass and kelp, through increased shading in the water column and changes in sediment chemistry.
- Some areas in Puget Sound may be similarly affected, especially protected embayments and areas with longer water residence times.

More Info: http://www.dnr.wa.gov/programs-and-services/aquatics/aquatic-science

Regional declines in Puget Sound benthic communities –
Sandy Weakland, Ecology

- Changes in species abundance and diversity have been observed in Puget Sound benthos.
- Benthic species are adversely affected in terminal inlets.
- Increase in pollution/hypoxia-tolerant species and a decrease in sensitive species has occurred over time.
- Laboratory chemistry measures and toxicity tests do not correlate well with the benthic community indices.

More Info: http://www.ecy.wa.gov/programs/eap/psamp/

Noctiluca bloom in Puget Sound.
Photo credit: Eyes Over Puget Sound

Salish Sea Model (SSM) Panel

Cristiana Figueroa-Kaminsky, Tarang Khangaonkar, Anise Ahmed, Teizeen Mohamedali, Greg Pelletier

The SSM, developed by Pacific Northwest National Labs (PNNL) in collaboration with Ecology, and supported via grant funding from EPA, is a state-of-the science modeling system comparable to other efforts employed for studying large, complex estuarine systems.

Salish Sea Model framework

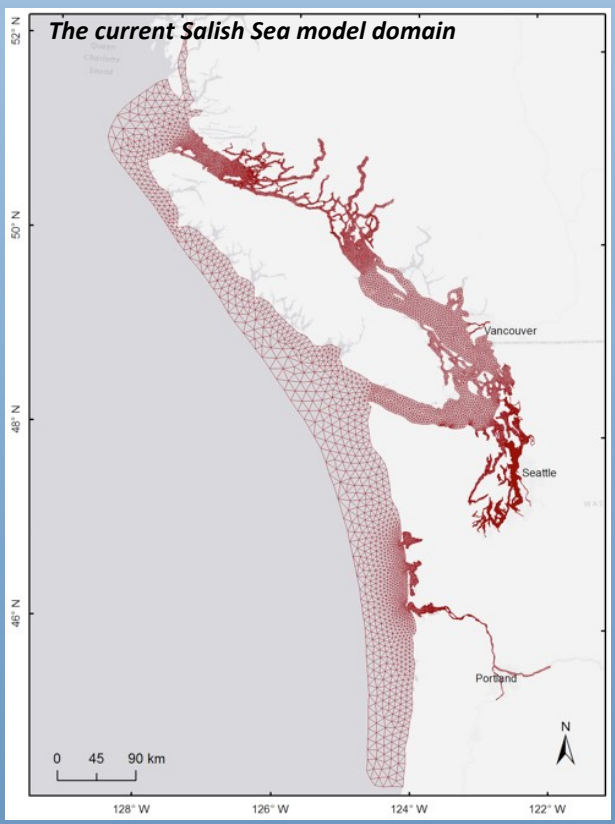
- The modeling system includes a comprehensive biogeochemical component for impact assessments related to nutrient pollution management, sea level rise, climate change, and ocean acidification for Puget Sound.
- The model has already been used for applications to assist with nearshore habitat restoration planning and design, analysis in support of re-establishment of fish migration pathways, and assessment of basin-wide water quality impacts.
- The SSM currently exhibits a generally high level of skill in reproducing hydrodynamic and water quality variables both spatially and temporally. Further performance improvements are expected as model enhancements are implemented.

Salish Sea residence time distribution

- The SSM confirms that high residence times play an important role in biogeochemical processes and are characteristic of 'trapped' basins within the Salish Sea.
- We can now use the SSM as a tool to quantify residence times for any portion of the model domain or year.
- Residence time maps show us areas that are susceptible to biogeochemical stressors, and can be made available to the scientific community.

Nutrient loading in the Salish Sea model

- Nutrients are an important part of productivity in the Salish Sea, however, excess nutrients, particularly nitrogen, can be problematic for water quality and can deplete oxygen levels.
- The Pacific Ocean is the largest source of nitrogen to the Salish Sea and upwelled waters are a major driver of productivity. However, over-enrichment of nutrients from human sources result in increased oxygen depletion and acidification.
- Wastewater treatment plants are the largest local source of nitrogen, followed by watershed loads (which include all sources upstream, delivered to Puget Sound by rivers).



Salish Sea Model Panel (continued)

- We have estimated reference conditions for nutrient loading to the Salish Sea in the absence of human activities.
- In the absence of reductions in human nutrient sources, the impact of local human nutrient sources on water quality will increase in the future due to projected climate change and population growth, which result in changes in the timing of river flows, reduced flushing in the sound, urbanization/land use change, and increases in wastewater discharges.

Current model results

- Puget Sound is sensitive to the influx of anthropogenic organic carbon which micro-organisms consume for energy resulting in decreasing dissolved oxygen levels and changes to the carbonate system chemistry.
- Specific parts of the Sound, such as shallow inlets and bays in southern Puget Sound and areas north of the Triple Junction, within the Whidbey basin, are more sensitive to eutrophication and acidification from human sources.
- ·Multiple areas of Puget Sound exhibit low dissolved oxygen levels that fall below state and federal water quality standards for extended periods of time on the order of weeks to several months long.

More Info: http://www.ecy.wa.gov/programs/wq/PugetSound/DOModel.html OR http://salish-sea.pnnl.gov/

The role of nutrients in Puget Sound food webs: insights from empirical and modeling studies – *Chris Harvey and Correigh Greene, NOAA*

- The Northwest Fisheries Science Center is investigating how nutrients are affecting primary production and thereby influencing the base of Puget Sound's food webs.
- Through the Salish Sea Marine Survival project, this question is being tested by examining how marine survival of Chinook and Coho salmon is related to zooplankton and early growth. Preliminary modeling indicates a very robust effect of diatom production on marine survival.
  A long term metric of primary production using growth in geoducks is also under development.
- Nutrient loading and primary production scenarios will be tested in a Puget Sound ecosystem model presently under development.

More Info: http://marinesurvivalproject.com/

Chinook Salmon. Photo Credit: NOAA Fisheries

Speaker Bios (in order of presentations)

Heather Bartlett, WA Dept. of Ecology

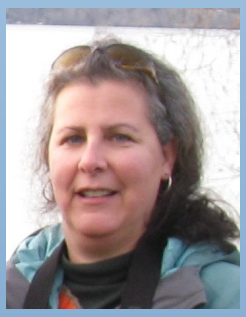
Heather leads the WA State Department of Ecology's Water Quality Program. Heather has over 25 years of natural resource and public health experience and a degree in biology from Washington State University. She has a track record of working through complex and controversial issues. Before coming to Ecology, she was in senior management positions with the WA Departments of Health and Fish & Wildlife for the state drinking water program and the state hatcheries programs respectively.

Sarah Brace, Veda Environmental

Sarah has over 20 years of experience in facilitating conversations in natural resources planning. Her background in marine sciences and environmental policy allow her to design meeting, workshops and forums that bring the experts together for engaging and productive discussions with concrete outcomes. Sarah is Co-owner and Principal of Veda Environmental based in Seattle and Bellingham.

Dustin Bilhimer, WA Dept. of Ecology

Dustin earned his Bachelor of Science degree in Ecology, Evolution, and Conservation Biology from the University of Washington in 1998. He has over 17 years experience at the Department of Ecology including working as a principle investigator for stream temperature TMDL studies, policy and GIS support for the statewide TMDL program, TMDL coordinator for Washington's Pacific Coast watersheds, and is now the TMDL coordinator for Puget Sound.



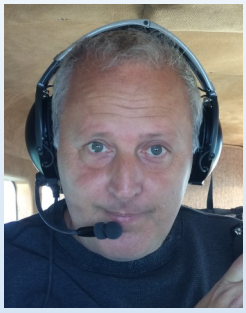
Kimberle Stark MSc., King County Water & Land Resources Division

Kimberle is a marine biologist and project manager for King County's Marine Water Quality Monitoring Programs, which include physical, chemical, and biological components measured at various spatial and time scales in both water and sediment. For the past several years, Kimberle has been focused on lower trophic level biological monitoring and factors that influence abundance, distribution, and variability of these organisms.

Stephanie Jaeger MSc., King County Water & Land Resources Division

Stephanie completed her M.S. in Oceanography at Oregon State University in 2006. She is now an oceanographer for King County's Puget Sound water quality monitoring program. Stephanie is the project lead for continuous real-time monitoring using moorings and ocean acidification monitoring. Her prior background includes work on biogeochemical cycling in marine environments, marine instrument development and best practices for quality data from sensors, and science education and outreach.

Christopher Krembs Ph.D, WA Dept. of Ecology

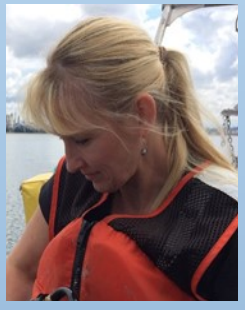


Christopher Krembs pursued his academic career as a biological oceanographer at several universities in Germany and the US, publishing in the field of marine microbial ecology and sea ice research. He received his Ph.D. in 1999 from the Christian-Albrechts University in Kiel. From 2002-2008 he held a position at the Applied Physics Laboratory, UW. Since 2008, he has been the lead Oceanographer for the Marine Waters Monitoring Program at the WA State Dept. of Ecology. Christopher is known for his innovative approaches to advance and communicate science and is creator of the Eyes Over Puget Sound condition report.

Bart Christiaen Ph.D, WA Dept. of Natural Resources

Bart Christiaen graduated from the University of Liege (Belgium) with a Masters in Oceanography in 2007. He earned a PhD in Marine Sciences at the University of South Alabama in 2014, where he studied the effects of human disturbance on seagrass ecosystems. After graduating he worked for a start-up biofuels company called Algae Systems. Since November 2014, he has been the lead ecologist for the Submerged Vegetation Monitoring Program (SVMP) at the Washington State Department of Natural Resources (DNR).

Sandy Weakland MSc., WA Dept. of Ecology



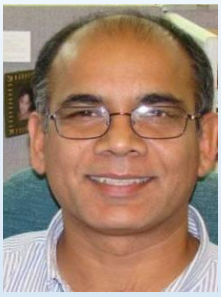
Sandra Weakland has a Masters in Environmental Studies from the Evergreen State College. She has been a member of the Ecology's Marine Sediment Monitoring Team since 1994. Sandra is responsible for database management, data analysis and report writing, mapping, and field logistics.

Cristiana Figueroa-Kaminsky, P.E., WA Dept. of Ecology

Cristiana is a chemical engineer with over twenty six years of experience in environmental impact analysis. She has conducted observational and modeling atmospheric studies, and currently supports studies to improve the water quality of rivers in western Washington and the Puget Sound.

Tarang Khangaonkar Ph.D, P.E., Pacific Northwest National Labs

Dr. Khangaonkar manages the Coastal Ocean and Salish Sea Modeling Program at PNNL's Marine Sciences Laboratory. He provides senior leadership to PNNL's activities in numerical modeling studies related to coastal ocean hydrodynamics, water quality, sediment transport, and fate and transport analysis. He has over 26 years of experience with various types of numerical models capable of circulation, fate and transport, and water quality kinetics. Dr. Khangaonkar and his team have led the development of the Salish Sea Model.

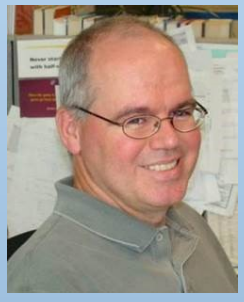


Anise Ahmed Ph.D, P.E., WA Dept. of Ecology

Anise has a Master's and Doctoral degrees in Environmental Engineering. He has over 25 years of experience as an environmental engineer dealing with Water Quality. He is the Ecology contact for Mixing Zone models CORMIX and Visual Plumes. His experience with water quality and hydrodynamic model includes - GEMSS model for Oakland Bay, South and Central Puget Sound and Budd Inlet, collaboration on FVCOM model development for Salish Sea, QUAL2K models for several streams in Washington State, and evaluation of WASP model for Willapa Bay.

Teizeen Mohamedali MSc., P.E., WA Dept. of Ecology

Teizeen Mohamedali is an Environmental Engineer at the Washington State Department of Ecology in the Bellingham Field Office. She has a BS in Environmental Science from Western Washington University and an MS in Civil/Environmental Engineering from Stanford University. She is on the Salish Sea Modeling Team, and also works on TMDL modeling projects. She enjoys finding creative ways to communicate complex scientific information.



Greg Pelletier P.E., WA Dept. of Ecology

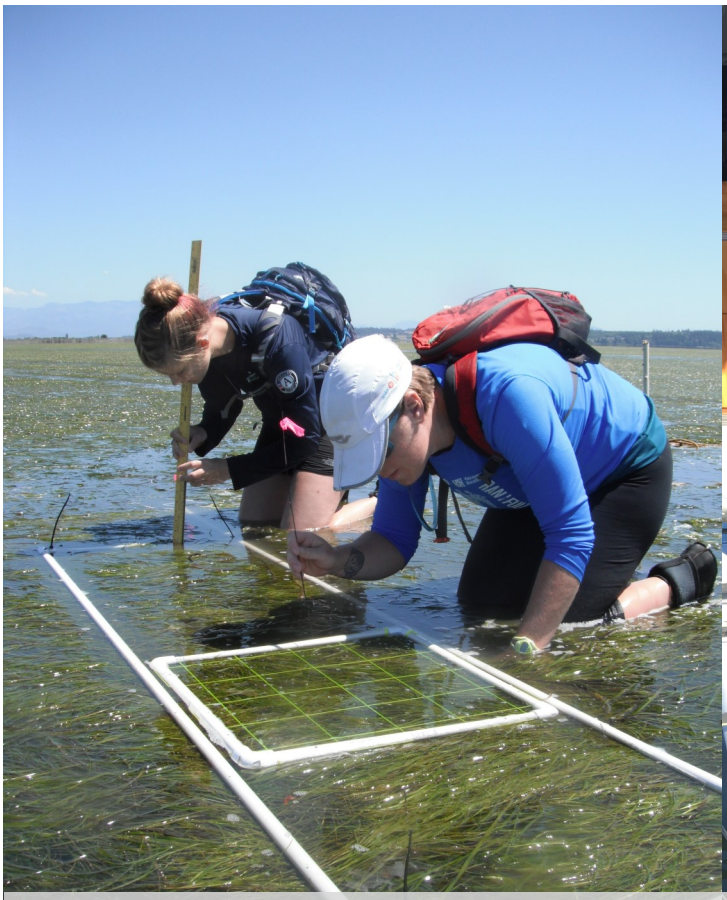
Greg is a senior engineer at the Department of Ecology's Environmental Assessment Program. He has provided scientific grounding and technical support for state-wide regulatory management of nutrient loading from point and non-point sources to meet water quality standards since 1988. He is recognized nationally and internationally as an authority on numerical modeling of water bodies to assess current conditions and predict water quality due to changing pollutant loads.

Correigh Greene Ph.D, NOAA Dept. of Fisheries

Correigh Greene is a research biologist in the Watershed Program of NOAA Fisheries. He has studied the population biology and habitat relationships of salmon in Puget Sound since he started in 2001. Currently, his research ranges from causes of long term declines in marine survival, to trophic relationships in pelagic waters, and effects of estuary restoration on juvenile chinook salmon.

Chris Harvey Ph.D, NOAA Dept. of Fisheries

Dr. Chris Harvey has been a food web ecologist at the NOAA Northwest Fisheries Science Center since 2001. He leads the Integrative Marine Ecology Team and also serves as co-lead of the California Current Integrated Ecosystem Assessment project.



Eelgrass surveys in Padilla Bay
Photo credit: Jude Apple

Marine water quality monitoring
Photo Credit: Carol Maloy

We would like to recognize Chanele Holbrook, Sheelagh McCarthy, and Sarah Brace for their help organizing the event and thank the following organizations that participated:

DEPARTMENT OF ECOLOGY
State of Washington

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

WASHINGTON DEPARTMENT OF NATURAL RESOURCES
HILARY S. FRANZ
COMMISSIONER OF PUBLIC LANDS

Pacific Northwest
NATIONAL LABORATORY

King County

Green River
COLLEGE

veda
ENVIRONMENTAL

Funding for this event was provided in large part by the U.S. EPA, National Estuary Program grant program