Science to Policy: Many Perspectives, One River
Speaker Abstracts
May 7-9, 2007

DAY 1: Monday, May 7, 2007

1:30pm – 2:30pm
Presenters: Lyndal Johnson, NOAA Fisheries, Northwest Fisheries Science Center, Seattle, WA and Jennifer Morace, USGS Oregon Water Science Center, Portland, OR
Title: Fish and SPMDs: Contaminants in Water and Salmon in the Lower Columbia River and Estuary
In a collaborative project with the Lower Columbia River Estuary Partnership and Bonneville Power Administration, USGS and NOAA Fisheries scientists are monitoring concentrations of contaminants in the Lower Columbia Estuary environment and in outmigrant juvenile salmon to understand how salmon are exposed to toxic compounds and how these substances are affecting the productivity of endangered Columbia River salmon stocks. Levels of several persistent pollutants (PCBs, DDTs and other organochlorine pesticides, PBDEs, and PAHs) have been determined in juvenile Chinook salmon and their prey from six sites in the Lower Columbia River and Estuary, as well as in juvenile Chinook salmon and food samples from six hatcheries along the Columbia.

These compounds were also measured in the water using semi-permeable membrane devices (SPMDs), which are designed to detect very low concentrations of poorly water-soluble chemicals. Data on contaminants in the water column and the diet were used to model contaminant bioaccumulation in salmon, and results were compared to actual body burdens of contaminants in field-collected fish. Contaminant levels in bodies and stomach contents of some fish were above thresholds for effects on salmon health, such as delayed mortality, poor growth, and reduced disease resistance.

Results showed that juvenile salmon from several different stocks, including fish from the Upper and Middle Columbia and the Snake River, were using the Lower Columbia for rearing and feeding and were exposed to PCBs, DDTs, PBDEs and PAHs via their diet. Contaminant concentrations in the stomach contents of fish from sites in the Portland/Vancouver area were especially high. Contaminant concentrations in SPMDs were generally highest in these areas as well. Food and bodies of juvenile Chinook collected from Columbia River hatcheries also contained low concentrations of PCBs, DDTs, and low molecular weight PAHs, which likely contribute to background levels of DDTs and PCBs found in outmigrant salmon. Bioaccumulation modeling, using PCBs, predicted that juvenile salmon gradually moving down the Columbia from Bonneville to the estuary mouth and feeding along the way would reach peak body burdens around the Beaver Army Terminal area (RM 54), which was observed in PCB concentrations measured in salmon from different sites. The study suggested that the tidal freshwater environment between Portland and Beaver Army Terminal is an important source of contaminants for juvenile salmon, and reduction of toxicant concentrations in this region may contribute to stock recovery.

2:30pm – 3:00pm
Presenter: Henry Johnson, USGS, Oregon Water Science Center
Title: Pesticides in the agricultural environment: USGS results from Oregon and Washington
Hundreds of pesticides in thousands of different mixtures and strengths (formulations) are available for use in the United States. Pesticides are used on or around most agricultural products grown in Western Oregon and throughout the United States. Pesticide use can help farmers increase crop yields by eliminating competition from weeds and by eliminating or minimizing damage from insects and fungal infections. Pesticides are used in urban areas to prevent infestations of insects, for mosquito control, and for weed control in lawns, on driveways, and along roadsides.

National summaries of pesticide data indicate widespread detections in the Nation's streams. Ninety-seven percent of the urban and agricultural streams sampled by the USGS National Water-Quality Assessment (NAWQA) Program between 1992 and 2001 contained at least one measurable pesticide or pesticide degradate (a new chemical formed when a pesticide is modified by biological or physical processes). Pesticide occurrence in streams in the Willamette Valley mirror the National statistics: pesticides or pesticide degradates were detected in 298 of 301 samples (99 percent) collected from 48 surface-water sites in the Willamette Valley between January 2000 and September 2005.

Although pesticides are frequently detected in both urban and agricultural streams, studies in agricultural areas are more common and provide a richer data set for understanding pesticide transport in the environment. Agricultural areas comprise the largest developed portion of most catchments and they receive the majority of pesticide applications; therefore, it is logical that a large number of pesticide studies have occurred in agricultural areas. In recent years, studies of pesticides in largely urban settings in Western Oregon have become more common. Discussions of the occurrence and transport of pesticides in this talk largely draws on data from studies of agricultural streams in Western Oregon.

Pesticides are transported from fields to which they are applied despite complying with label directions and transport can occur even when care is taken during the application procedure. Most often, pesticides are transported to streams in runoff from a rain or irrigation event or by upwelling of contaminated shallow ground water into the stream. The marked seasonality of rainfall in Western Oregon has a strong influence on the timing and concentrations of pesticides detected in streams. Concentrations tend to be greatest during the late spring and early fall when rainfall is waning or beginning to increase, respectively. Pesticides that are applied during these transitions periods are more likely to be detected in streams at high concentrations. Pesticides often are detected in agricultural streams during periods when little or no rain has fallen due to upwelling of contaminated shallow ground water.

Pesticides are not uniformly detected in streams in Western Oregon. Land use and applications in close proximity to a stream are major determinants of pesticide occurrence in streams. Because pesticide products are registered for specific uses, for example to control crane flies in grass seed fields, knowledge of the geographic distribution of agricultural crops is a good predictor of the pesticides likely to be found in a nearby stream. Each pesticide has a unique set of physical properties that are engineered into the product, which increase its effectiveness when applied. For example, some break down quickly while others will remain unaltered for weeks or months, some adhere to soil while others readily dissolve in water. The properties of a pesticide affect the likelihood that a pesticide will be detected in a stream water sample.

Pesticide concentrations in Western Oregon streams typically are below EPA and State criteria and standards for the protection of aquatic life, when such standards exist. Many pesticides and most pesticide degradates have no standard or criteria. It is rare to detect a single pesticide or pesticide degradate in a stream water sample. Mixtures of 2, 3, 4, or more pesticides and pesticide degradates are common. State and Federal water-quality standards and criteria are derived from single chemical toxicity tests and are set at levels to protect organisms from death due to short-term (acute) and long-term (chronic) exposure to pesticides. Over the last decade, numerous studies have documented the effects of sublethal toxicity in organisms exposed to pesticide concentrations below established criteria and standards. Documented sublethal toxicity includes slowed growth, developmental deformities, feminization, and behavioral changes, all of which impact an organism's survival in the presence of natural predators.

3:00pm – 3:30pm
Presenter: Gene Foster, Oregon Department of Environmental Quality
Title: Community Partnerships to Reduce Impacts of Pesticides on Water Quality
Steelhead(*Oncorhynchus mykiss*) were listed as threatened under the Endangered Species Act in the Hood River Basin, an area of mixed land use. The causes of the population declines are unknown but orchard pesticide use was identified as one potential stressor because pesticide application overlaps with sensitive life stages of steelhead in small streams adjacent to orchards. Also, the organophosphate insecticides used are toxic to aquatic life at low concentrations. Oregon DEQ partnered with local orchardists, state and federal agencies, universities, and local Tribes to address this non-point source pollution issue. The goal of the project was to identify if there were: pesticide related water quality issues; evaluate the potential for in-stream effects on threatened steelhead; and protect aquatic resources through voluntary means with minimal negative impact to the orchard community. The objectives were to evaluate: the association between the in-stream organophosphate insecticide concentrations; the direct biochemical effects on steelhead; the potential for indirect effects on steelhead from changes in food web resources; share results early and often with local stakeholders; explain data in relation to effects and water quality criteria; engage the agricultural community for identifying and implementing solutions; use on-going effectiveness monitoring to measure success and provide feedback to support water quality management.

Water sampling for pesticides and general chemistry and in-stream bioassays with hatchery juvenile steelhead were conducted during the spray season. Macroinvertebrates were collected before and after orchard insecticide spraying upstream and downstream of orchard areas. The organophosphate insecticides chlorpyrifos and azinphos methyl were detected at concentrations above water quality standards downstream of orchard areas but not upstream. This coincided with depressed juvenile steelhead brain AChE activity in these same sample reaches. Macroinvertebrate species diversity was lower downstream of the orchard areas with a shift to species that are not preferred prey items of juvenile steelhead. The weight of evidence indicated that orchard use of organophosphate insecticides may have adversely affected steelhead directly by inhibition of AChE and indirectly through changes in food web structure in some of the steelhead producing streams in the Hood River Basin. The agricultural agencies used this information to identify Best Management Practices (BMPs) that could reduce the amount of pesticides getting into the streams. They then worked with orchardists who were willing to voluntarily change their pesticide management practices to achieve environmental results. As demonstrated through water quality data, the effort appears to be a success. When this project started in 2000, the pesticides chlorpyriphos and azinphos methyl were frequently detected during orchard use and at levels above water quality standards. Since then, detections of these pesticides are less frequent and the concentrations are lower.

4:00pm – 4:30pm

Presenter: Dennis Wentz, USGS

Authors: Dennis A. Wentz[1], George R. Aiken[2], Mark E. Brigham[3], Lia C. Chasar[4], David P. Krabbenhoft[5], Mark Marvin-DiPasquale[6], Barbara C. Scudder[5]

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Title: Transport, Methylation, and Bioaccumulation of Mercury in Stream Ecosystems in Oregon, Wisconsin, and Florida

During 2002-2006, the US Geological Survey studied mercury (Hg) transport, methylation, and bioaccumulation in eight streams in Oregon, Wisconsin, and Florida. The stream basins span large gradients in watershed area, land use/land cover, precipitation, and wet mercury deposition, but all basins receive Hg inputs predominantly from atmospheric deposition. In most of the streams, concentrations of filtered total Hg (FTHg) and filtered methylmercury (FMeHg) correlated positively with dissolved organic carbon (DOC), suggesting that transport of Hg-DOC complexes strongly influenced FTHg and FMeHg concentrations. Moreover, wetland density in the stream basins was the single most important ecosystem characteristic related to FTHg and FMeHg concentrations in stream water. In contrast, MeHg concentrations and MeHg production rates in streambed sediment did not correlate well with Hg concentrations in the overlying water and biota. Finally, FMeHg concentrations in stream water were strongly related to MeHg concentrations in aquatic invertebrates and to Hg concentrations in muscle tissue of forage and predator fish. We hypothesize that, for these stream ecosystems, watershed sources of MeHg—particularly wetlands in riparian and upstream areas—are more important than in-channel methylation processes as drivers of MeHg bioaccumulation in aquatic organisms. Consequently, assessments that focus more on streams than on stream basins may have limited success in understanding Hg cycling.

4:30pm – 5:00pm

Presenters: Agnes Lut, Oregon Department of Environmental Quality and
Aaron Borisenko, Oregon Department of Environmental Quality

Title: Willamette Basin Mercury Total Maximum Daily Load (TMDL): A Phased Approach

In Oregon, the state's Department of Human Services (DHS) has issued fish consumption advisories for the Willamette River and the Dorena and Cottage Grove Reservoirs because the levels of mercury in bass and northern pikeminnow exceed levels deemed to be safe for human consumption (0.35 parts per million). When State water quality standards are not met, the federal Clean Water Act requires the establishment of a Total Maximum Daily Load (TMDL). A TMDL determines how much pollution can be added to the river without exceeding water quality standards. The TMDL identifies where pollution comes from and divides or "allocates" the load of the pollutant among different sources. The goal of the TMDL is to reduce mercury levels in the basin to a point where fish are no longer unsafe to eat.

With grant funding from the US Environmental Protection Agency, the DEQ implemented a basin-wide mercury monitoring program to develop the Phase 1 TMDL for mercury. DEQ has utilized an incremental approach for the mercury TMDL with the establishment of interim targets and allocations. The interim total mercury water column target is 0.92 ng/L. Final targets and allocations will be completed in 2011 following additional data collection, analysis and stakeholder outreach.

DEQ's preliminary analysis indicates that the majority of the mercury in the Willamette River comes from non-point sources such as the erosion of native soils containing mercury and the runoff of atmospherically-deposited mercury.

Mercury is also discharged by some industrial and domestic wastewater treatment facilities. In the Cottage Grove watershed, mercury residuals from old mining operations represent a significant source of mercury to the system. Legacy mining, however, is a relatively small contributor of mercury to the mainstem Willamette River. DEQ's analysis suggests that in the mainstem Willamette River system a 27 percent reduction in the total mercury load is needed to reduce mercury in fish tissue to a safe level. This corresponds to the elimination or removal of 37.5 kg of total mercury per year.

Beginning in March 2007, DEQ will resume monitoring of Willamette River concentrations of mercury and methyl mercury. Additionally, DEQ will require selected municipal and industrial facilities to increase monitoring and reporting of mercury, and take steps to reduce known sources of mercury by developing mercury minimization plans. DEQ will also work with communities and businesses to reduce soil erosion that can carry mercury to rivers. Best management practices to reduce soil erosion in agricultural, forested and urban sectors will also serve to keep mercury out of the Basin's waterways. DEQ will evaluate the effectiveness of this implementation strategy and update the mercury TMDL in 2011.

DAY 2: Tuesday, May 8, 2007

8:30am – 9:00am

Presenter: Ed Furlong, USGS, National Water Quality Laboratory

Authors: Edward T. Furlong[1], Dana W. Kolpin[2], Michael J. Focazio[3], Michael T. Meyer[4], Steven D. Zaugg[1], Larry B. Barber, III[5]; Kymm K. Barnes[2],and Herbert K. Buxton[3]U.S. Geological Survey— [1]National Water Quality Laboratory, Denver, Colorado; [2] Iowa District, Iowa City, Iowa; [3] Toxic Substances Hydrology Program, Reston, Virginia; [4]Organic Geochemistry Laboratory, Lawrence Kansas, National Research Program, Boulder, Colorado

Title: Pharmaceuticals and Other Emerging Contaminants in Water Resources: Trends at the National Scale—Transport, Fate and Effects at the Watershed Scale

Since 1998, USGS has been developing and expanding its analytical capabilities to measure pharmaceuticals and other anthropogenic waste indicators (AWIs) in a variety of environmental matrices. Currently, more than 140 AWIs can be measured using a variety of LC/MS and GC/MS techniques. To date, over 500 samples have been analyzed for AWIs from across the United States representing a wide range of climatic and hydrologic conditions. Early research focused on broad-scale reconnaissance studies, providing the first nationwide data on the occurrence of AWIs in water resources of the United States. These results documented that AWIs are commonly present in streams and, to a lesser extent, aquifers, particularly at sites that are immediately downstream and down gradient of contaminant sources. Some of the most frequently detected compounds included cholesterol (plant and animal steroid), DEET (insect repellent), caffeine (stimulant), triclosan (antimicrobial disinfectant), and tri(2-chloroethyl)phosphate (fire retardant). Prescription pharmaceuticals and antibiotics also were commonly detected at ng/L concentrations. The detection of multiple AWIs was common, with as many as 38 AWIs being found in a single water sample. This suggests that when ultimate environmental effects from AWIs are explored, researchers will need to consider mixtures of these compounds.

Subsequent research has focused on sources of AWIs and their fate and transport through the environment. Samples from municipal wastewater treatment plants and animal waste storage lagoons document that both human and animal waste act as sources of AWIs to the environment. Early results suggest that concentrations of AWIs generally increase as the percent of streamflow derived from municipal discharge increases. In addition, instream processes affect OWC concentrations. Results from two separate losing stream reaches in Arizona and Iowa (with little to no ground water or surface water contributions to streamflow) had roughly a 65% decrease in total OWC concentration as water moved through these systems. The most current research has included the collection of both water and bed sediment samples for the analysis of AWIs to provide a better understanding of their environmental fate. Additional recent research investigating the presence of AWIs in biosolids has demonstrated the potential for these materials to act as non-point sources of AWIs across a wide range of landscapes.

9:00am – 9:30am

Presenter: Elena Nilsen, USGS, Oregon Water Science Center

Authors: Elena Nilsen[1], Robert Rosenbauer[2], Edward Furlong[3], Mark Burkhardt[3], Stephen Werner[3], Lisa Greaser[3], and Mary Noriega[3] [1]US Geological Survey, Oregon Water Science Center, Portland, OR [2]US Geological Survey, Geologic Division, Menlo Park, CA [3]US Geological Survey, Methods Research and Development Program, Lakewood, CO

Title: Pharmaceuticals and Personal Care Products (PPCPs) Detected in Streambed Sediments of the Lower Columbia River and Selected Tributaries

Modern chemistry has produced numerous compounds that facilitate everyday life and save lives in human and veterinary medicine. One byproduct of these advances is the accumulation of synthetic chemicals in the natural environment. These compounds include pharmaceuticals, synthetic fragrances, detergents, disinfectants, plasticizers, preservatives, and other classes, and are increasingly referred to under the umbrella term "pharmaceuticals and personal care products" (PPCPs). Various methods have recently been developed to screen for large suites of compounds having diverse polarities, moieties, etc. in a water medium. Reconnaissance efforts have been made in recent years to assess the presence of some of these compounds in natural waters. In 2005, the first methods capable of analyzing these compounds in solid media were published. To date, published studies using these methods have primarily focused on biosolids, irrigated soils, and test materials. Here we present a small-scale reconnaissance of PPCP compounds in natural bed sediments of the Columbia River and several of its tributaries.

Surface bed sediment samples were collected from the Columbia River, the Willamette River, the Tualatin River, and several small urban tributaries (24 samples total). Sites were targeted upstream and downstream of several area wastewater treatment facility effluents. Samples underwent accelerated solvent extraction (ASE) and were then analyzed for pharmaceutical compounds using methods developed at the U.S. Geological Survey's National Water-Quality Laboratory in Lakewood, Colorado. A separate ASE was performed on all samples, and extracts were analyzed for 61 wastewater indicator compounds.

Caffeine, trimethoprim, thiabendazole, diphenhydramine, diltiazem, and fluoxetine had multiple detections in these samples. Additionally, codeine, ranitidine, dehydronifedipine, miconazole, azithromycin and cimetidine were detected at or below the level of the lowest standard. The largest number of pharmaceutical compounds was found in sediments from the Tualatin River and Fanno Creek. Columbia River sediments contained thiabendazole, diphenhydramine, miconazole, and azithromycin. Forty-three wastewater indicator compounds were detected in at least one of the samples; many were present in multiple samples. Most notable was the presence of several strictly anthropogenic and known or suspected endocrine disrupting compounds (EDC): para-nonylphenol, tonalide (AHTN), galaxolide (HHCB), nonylphenol ethoxylate (NPEO), triclosan, bisphenol A and 17β-estradiol. At least one of these compounds was detected in each of the streams sampled except Kellogg Creek. The Tualatin River in particular had many detections of EDCs.

Some of these compounds have documented detrimental impacts on aquatic life. The effects of others require further study. It was previously unknown whether many of these compounds would be present in this system and/or whether they would accumulate in sediments. Detection of these compounds makes evident the need for consideration of a monitoring strategy that encompasses these classes of emerging contaminants, especially in light of the fact that their use and subsequent discharge into the environment is likely to increase into the future.

9:30am – 10:00am

Presenter: Jennifer Morace, USGS, Oregon Water Science Center, Portland, OR

Title: Water-quality results for the Columbia River Estuary, May 2004–April 2005: Pesticides, trace elements, wastewater compounds, and pharmaceuticals

In a collaborative project with the Lower Columbia River Estuary Partnership and Bonneville Power Administration, USGS and NOAA Fisheries scientists monitored concentrations of contaminants in the Lower Columbia River environment and in outmigrant juvenile salmon to understand how salmon are exposed to toxic compounds and how these substances are affecting the productivity of endangered Columbia River salmon stocks. Another presentation from this project will discuss results from the sampling of juvenile Chinook salmon, food samples, and semipermeable membrane devices (SPMDs).

The USGS collected depth- and width-integrated water samples from May 2004 through April 2005 at three fixed stations: the Columbia River just below Bonneville Dam, the Willamette River in downtown Portland, and the Columbia River at Beaver Army Terminal (RM 54). Samples were analyzed for nutrients, alkalinity, carbon species, trace elements, chlorophyll a, biomass, suspended sediment, and a select listing of pesticides. An expanded suite of pesticides and degradates was analyzed quarterly. Suspended-sediment samples also were analyzed periodically for organochlorine compounds, such as DDT and endosulfan, and trace elements. In addition to the fixed-station sampling, water-column samples were collected synoptically to characterize low-flow (August 2004) and high-flow (April 2005) conditions.

Besides the constituents listed above for the fixed station monitoring, an expanded suite of pesticides and degradates, wastewater compounds, and pharmaceuticals was also analyzed during these samplings. Some of these compounds, including copper and current use pesticides, were present at levels that could interfere with olfaction in salmon, resulting in sublethal effects in homing, feeding, reproduction, and predator avoidance. Salmon from the Portland sites also show signs of exposure to estrogenic compounds associated with wastewater. While dilution has a large effect on the concentrations of contaminants observed in the Columbia River, the input from tributaries, particularly the Willamette River, also plays a large role in water-quality conditions in the lower Columbia River.

10:00am – 10:30am

Presenter: Kurt Carpenter, USGS

Authors: Kurt D. Carpenter, U.S. Geological Survey, Portland, Oregon (kdcar@usgs.gov)

Title: Pesticides in Streams of the Lower Clackamas River Basin, Oregon, 2000-05

During 2000-05, the U.S. Geological Survey collected about 120 pesticide samples from the lower Clackamas River and its tributaries. In all, 57 pesticides and breakdown products were detected from the tributaries, with 26 compounds also being detected in the Clackamas River main stem, typically at much lower concentrations. At least 1 pesticide was detected in 65% of 34 of samples collected from the Clackamas River, averaging 2-3 pesticides per sample. Although pesticides were routinely detected in all of the tributaries sampled, the largest pesticide contributions were found to come from the Rock and Deep Creek Basins, where between 30 and 44 pesticides and breakdown products, respectively, were detected. The two most commonly detected pesticides were the triazine herbicides simazine and atrazine, which occurred in about half of the samples collected. The common herbicides glyphosate, triclopyr, and 2,4-D were also frequently detected. Some of the diazinon, chlorpyrifos, azinphos-methyl, and p,p-DDE pesticide concentrations in Clackamas River tributaries occasionally exceeded USEPA aquatic-life benchmarks, and several other compounds exceeded non-USEPA criteria. Of the 51 current-use pesticides detected in the basin, most have multiple uses: 48 have agricultural uses, 47 have uses associated with nursery crops, about half can be used in urban areas or on golf courses, many are used along roads and other right-of-ways, and some have forestry applications.

11:00am – 11:30pm

Presenter: Denise Laflammme, Washington Department of Health

Authors: Denise Laflamme and Elmer Diaz

Title: Polybrominated diphenyl ether (PBDE) flame retardants: use, toxicology, and human exposures

Polybrominated diphenyl ether (PBDE) flame retardants were used extensively in many consumer products for the past 30 years to reduce the risk of fires. Three commercial products of PBDEs have been used in different types of products. PBDEs are not chemically bound to the materials in which they are used and can migrate out of products. PBDEs are widespread in the environment, in wildlife, inside homes and other building, and in human tissues (blood, fat and breastmilk). Levels of PBDEs are increasing especially in the U.S. where use of PBDEs has been the greatest.

Information on the toxicology of PBDE flame retardants comes primarily from laboratory animal studies. These studies indicate that PBDEs impact the developing brain and reproductive systems. PBDEs also interfere with normal hormone function. The different commercial products of PBDEs exhibit toxicity at different doses. EPA recently proposed new Reference Doses (RfDs) for four PBDE congeners based on developmental neurotoxic endpoints.

People appear to be exposed to PBDEs mainly from eating animal-derived foods and from contact with PBDEs in indoor air and dust. However, how much individual sources, such as food or indoor dust, contribute to a person's overall exposure is not well understood. Studies indicate that nursing infants and toddlers are the most highly exposed to PBDEs from intake of breastmilk and from their higher exposures to PBDE-containing dust. Workers in some industries have also have increased PBDE exposures. Data on PBDEs in human tissues indicate that exposures are prevalent among the general public and exposures are increasing. Recent data indicate that some people may be near or at toxic effects levels observed in animal studies.

Information on current levels of PBDEs found in fish in Washington State does not indicate the need for fish advisories based on PBDE levels alone. For example, fish advisories for the Spokane River are based on levels of PCBs detected in fish. High levels of total PBDEs (> 1,000 ug/Kg) in some fish sampled in the Spokane river warrant ongoing testing to determine if levels are increasing.

11:30am – 12:00pm

Presenter: Dale Norton, Washington Department of Ecology
Authors: Art Johnson, Keith Seiders, Casey Deligeannis, Kristin Kinney, Patti Sandvik, Brandee Era-Miller, and Darren Alkire
Title: Distribution of PBDE Flame Retardants in Fish and Water from Washington Rivers and Lakes
The Department of Ecology analyzed polybrominated diphenyl ether flame retardants (PBDEs) in freshwater fish and water samples collected statewide during 2005-06. This was done in response to concerns over increasing PBDE levels in the environment and the potential for adverse human health effects from fish consumption. The goal was to establish baseline conditions that could be used to evaluate the effectiveness of the *Washington State PBDE Chemical Action Plan* and other efforts to reduce PBDE inputs to the environment.

Data were obtained on concentrations of PBDE-47, -49, -66, -71, -99, -100, -138, -153, -154,-183, -184, -190, and -209 in approximately 120 fish fillet samples, 23 whole fish samples, and 16 water samples, representing 32 waterbodies. The results were used to evaluate the environmental distribution and accumulation of PBDEs in Washington rivers and lakes.

Total PBDE concentrations appear to be <10 ug/Kg (parts per billion, wet weight) in fish fillets from most Washington rivers and lakes. Certain fish species from several large waterbodies – Palouse River, Columbia River, Lake Washington, Snohomish River, Cowlitz River, and Snake River – have total PBDE concentrations in the 10 – 200 ug/Kg range. PBDEs in fish from watersheds with minimal human disturbance are at or below the limit of detection. High PBDE levels are found throughout the Spokane River, exceeding 1,000 ug/Kg in some cases.

1:00pm -1:30pm
Presenter: Ian Waite, USGS
Authors: I.R. Waite, L.R. Brown, J. Kennen, T. Cuffney, J. May, J. Orlando, and K. Jones. U.S. Geological Survey
Title: Development of predictive disturbance models to assess biological conditions of invertebrates in wadeable streams in the Pacific Northwest and California
Trends in biological conditions of the Nation's waters are important to both Federal and State regulatory agencies. These agencies usually address biological conditions using various metrics (e.g., species richness) or indices (e.g., IBIs) of community structure and health. Another approach for assessing biological condition is the development of predictive models. These models allow the user to determine how the observed macroinvertebrate taxa sampled from a "test" site relate to the expected taxa based on the reference sites used to construct the model. Biological conditions are considered to be degraded when expected (based on reference conditions) species are not found at a test site. These types of models are also called O/E (i.e., ratio of observed to expected taxa)." This type of model, like IBIs, is very useful as a bioassessment tool for inferring impairment of sampled water bodies, but it is not a predictive model in the sense that it does not predict the condition of unsampled stream sites.

The U.S. Geological Survey's National Water Quality Assessment Program (NAWQA) is working to develop predictive disturbance models that use measures of watershed disturbance, including urban and agricultural land use, land cover, flow regime, and hydrologic infrastructure (e.g., number of dams, number of canals) as the predictors of biological condition at unsampled sites in California, Oregon, and Washington. For our response variables, we will be using various metrics of invertebrate community structure (e.g. number of species belonging to Ephemeroptera, Plecoptera, and Trichoptera) as our measure of biological condition. Previous attempts at predictive disturbance models generally have relied on multiple regression type models. NAWQA scientists have begun developing predictive disturbance models for urban systems using data from its urban gradient studies, mainly using a combination of multivariate statistics and multiple regression. A multiple regression model was developed for the Willamette Valley in Oregon by Van Sickle and others (2004) for select invertebrate and fish indicators. We plan to test their model against streams sampled by the NAWQA program in the Willamette Valley, expand their model with additional sampled streams, and develop separate models for other select regions including the Blue Mountain Ecoregion in Oregon, the Yakima Valley in Washington, and the Southern California urban coastal zone. We plan to publish our results in journal articles in 2008–9.

Development of predictive disturbance models will provide managers with a powerful tool for understanding the factors associated with degradation of water quality and biological communities and will allow managers to predict changes in water quality and biological communities, allowing them to make cost-effective decisions about how to avoid such degradation. There is tremendous interest in watershed disturbance models at all organizational levels—local [watershed groups], city, State, and Federal.

1:30pm – 2:00pm
Presenter: Chris Konrad, USGS
Title: Limits on biological conditions of streams associated with streamflow patterns
Streamflow is a principal factor affecting disturbance, habitat availability, and habitat conditions in aquatic ecosystems and the populations of organisms in those systems. Populations in aquatic ecosystems are affected by many other factors such as habitat complexity, nutrient and energy sources, chemical contamination, and biological interactions. As a result, biological responses to a single type of environmental factors are typically weak at regional scales. The U.S. Geological Survey's National Assessment of Water Quality (NAWQA) investigated limits on biological conditions associated with streamflow patterns at 114 sites in the western U.S. The structure (e.g., percent abundance) and composition (taxa richness) of invertebrate assemblages demonstrated both ceilings (upper limits) and floors (lower limits) associated with streamflow magnitude, variability, and timing. Invertebrate metrics showed specificity in their responses to particular types of streamflow patterns. The results indicate that biological responses to hydromodification may depend on both the initial biological condition of the community and the type and degree of hydromodification. This information can be used to assess the potential condition of a biological community given current streamflow patterns and the priority for re-establishing streamflow patterns in restoration efforts.

2:00pm – 2:30pm
Presenter: Jason May, USGS
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Title: **Response patterns of macroinvertebrate assemblages to landscape alteration and hydrologic infrastructure from a large-scale biogeographic perspective**
To assess the utility of developing biogeographic-scale macroinvertebrate response models to habitat modification, we quantified responses of macroinvertebrates to catchment-based measures of landscape alteration (percent developed basin and segment) and hydrologic infrastructure (number of dams and length of man-made channels within the watershed). We selected 332 sites representing a range of environmental conditions across the Western United States. Associations were examined at three biogeographic scales: (1) the Western United States; (2) biome level (mountain and xeric); and (3) eight sub-biome regions. Principal Components Analysis indicated that the generalized measures of landscape alteration and hydrologic infrastructure captured much of the variability in drainage area and flow regime. Richness of tolerant organisms (RICHTOL) and Ephemeroptera, Plecoptera, and Trichoptera (EPT) were the most responsive metrics, respectively showing statistically significant patterns for 21 and 24 of 28 possible scale-related interactions. EPT richness, Shannon diversity index, and functional feeding group diversity showed significant declining patterns with increasing habitat modification. While dominance metrics and RICHTOL were significantly positively correlated with increasing human influence and were relatively consistent across spatial scales. Biogeographic-scale measures of watershed impairment and understanding biotic response to those measures will help resource managers assess impacts of landscape alteration (including hydrologic modification) across multiple geographic regions.

3:00pm – 3:30pm
Presenter: Anne Hoos, USGS
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Title: Application of statistical-regression modeled estimates of stream nutrient loads to support nutrient-management strategies for estuaries in the Southeastern United States
The U.S. Geological Survey's National Water-Quality Assessment Program has compiled surface-water quality monitoring data and estimates of nutrient sources (wastewater, agricultural, urban, and atmospheric) from Federal, State, and local water-resource agencies throughout the southeastern region of the United States. These data provide input to the SPARROW (SPAtially-Referenced Regression on Watershed attributes) water-quality model to predict nutrient loads in individual stream reaches and transport and fate of these nutrients as they move through the stream network to coastal water bodies. Application of modeled findings addresses two questions about stream nitrogen loads entering the 17 nitrogen-impaired estuaries in the southeast, with implications for nutrient-management planning. First, what are the

proportional contributions of nitrogen delivered to each estuary from point-source wastewater discharges, agricultural and urban land, and atmospheric deposition, and how will changes in inputs from these sources affect the annual load delivered to the estuary? Second, what are the proportional contributions of nitrogen delivered to the estuary from each individual watershed in its drainage basin, and how does annual delivered load respond to incremental change in the amount of nitrogen exported from individual watersheds?

3:30pm – 4:00pm
Presenter: Dan Wise, USGS Oregon Water Science Center
Title: Regional Study of Nutrient and Sediment in the Pacific Northwest
Water-resource managers in the Pacific Northwest need information regarding the status of and trends in regional water-quality conditions in order to undertake effective watershed planning activities. This study focused on four topics that might be of interest to these managers: (1) annual loads of total nitrogen (TN), total phosphorus (TP) and suspended sediment (SS) transported within the Columbia River and Puget Sound Basins, (2) annual yields (instream load divided by catchment area) of TN, TP, and SS for catchments throughout the Pacific Northwest, (3) trends in TN, TP, and SS concentrations and loads for the period between 1993 and 2003, and (4) the relations between the yields and trends and catchment-landscape and climatic conditions.

Point-source nutrient loads (primarily from publicly owned wastewater treatment plants) generally were a small percentage of the total instream nutrient loads and a small percentage of the total catchment nutrient loads compared to nonpoint sources (fertilizer, manure, and atmospheric deposition). Yields of TN, TP, and SS were generally greater in catchments west of the Cascade Range, where precipitation and runoff were greatest. Yields of TN and SS were more sensitive to the percentage of agricultural land than to the percentage of urban land, whereas TP yields were more sensitive to the percentage of urban land than to the percentage of agricultural land. Point-source loads explained as much of the variation in TP yields as did nonpoint source loads but only half as much of the variation in TN yields as nonpoint-source loads. In smaller urbanized catchments, point sources tended to contribute a greater share of the total nutrient load than larger catchments with less urbanization. For most of the catchments, the net change in nonhydrologic characteristics (land use and other human activities) was not great enough to cause any significant trend in concentration or load for TN, TP or SS. When trends were measured, they generally were decreasing for TN and SS and evenly split between decreasing and increasing for TP. During the trend measurement period, there was a regionwide decrease in nonpoint-source nitrogen loads, an increase in population and, at least in the Willamette Basin, strong evidence that point-source nitrogen and phosphorus loads increased. These results suggest that the decreasing TN trends regionwide and decreasing TP trends in the lower Willamette Basin were due to decreasing nonpoint-source nutrient loads.

DAY 3: Wednesday, May 9, 2007

8:30am – 9:00am
Presenter: Jim Coyle, USGS
Title: Findings of a 1998 multimetric assessment of contaminant exposure and effects in resident fish of the Columbia River Basin
Between Fall 1997 and Spring 1998, resident fish representing two guilds (benthivores and piscivores) were collected at 16 sites in the Columbia River Basin as part of the U.S. Geological Survey (USGS) Biomonitoring of Environmental Status and Trends (BEST) Project Large River Monitoring Network (LRMN). Indications of contaminant exposure and effects were assessed based on the results of an integrated suite of methods that included whole-fish tissue residue analysis, biomarker responses, morphometric measurements, gross examination (health), reproductive endpoints and histological examinations. Site collection targets were 20 fish (10 males / 10 females) representing each guild (primarily common carp and largemouth bass). Ten of the sites had previously been sampled as part of the U.S. Fish and Wildlife Service's National Contaminant Biomonitoring Program and 5 sites had previously been sampled as part of the USGS National Water Quality Assessment (NAWQA) Program. The remaining site was located near a site of potential contamination indicated by elevated contaminant concentrations in osprey eggs. In all, 6 sites were located below Cascade Locks (4 on the mainstem and 2 on the Willamette between Oregon City and Portland). While the sampling design was not intended to be representative of the basin as a whole, spatial distribution of findings will be presented and discussed in relation to local land uses and proximal point sources.

9:00am – 9:30am

Presenter: Chuck Henny, USGS

Authors: Charles J. Henny[1], Robert A. Grove[1], James L. Kaiser[1] and Robert J. Letcher[2]
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Title: Contaminants and fish-eating Osprey nesting along the lower Columbia River

The Osprey (*Pandion haliaetus*) population nesting along the lower 410 km of the Columbia River was studied in 1997, 1998 and again in 2004. The number of nesting pairs was determined each year and a "sample egg" collected from 29 nests in 1997-98 and 40 nests in 2004. The egg contents were analyzed for organochlorine pesticides, congener-specific polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans and total mercury. Eggs collected in 2004 were also analyzed for flame retardants (polybrominated diphenyl ethers [PBDEs]), the pre-emergent chlorophenoxy herbicide dacthal and the fungicide chlorothalonil. Reproductive success was monitored at all nests, including those with an egg collected, to evaluate possible contaminant effects on reproductive success. For purposes of this investigation, the lower Columbia River was subdivided into four distinct reaches, primarily based on locations of major industrial areas, urban boundaries and other known sources of pollution (River Mile 29-82, 86-122, 124-143 and 149-286). Few Ospreys nest below RM 29. Geometric mean residue concentrations are reported for 1997-98 and 2004, and for each of the four river reaches. Also, the number of nesting pairs and reproductive success was documented for each river reach and time period. Rapidly increasing PBDE concentrations in fish from the upper Columbia River in Canada and other locations in the United States (often doubling in 2-3 years) causes concern for fish-eating birds like Ospreys. Therefore, 20 additional Osprey eggs will be collected in 2007 from River Mile 29-82 (the reach with the highest PBDE concentrations in 2004) to evaluate possible change in concentrations over the last 3 years.

9:30am – 10:00am

Presenter: Mark Siipola, US Army Corps of Engineers Portland District

Authors: Mark Siipola, Tim Sherman, Donna Ebner, Ruth Abney with field collection help by Wendy Briner and Jim Britton U.S. Army Corps of Engineers, Portland District, Jeff Steevens, Joan Clark, and Gary Ray
U.S. Army Corps of Engineers, Engineering Research and Development Center

Title: Assessment of *Corbicula fluminea* as a Potential Freshwater Bioaccumulative Test Species

The freshwater Asiatic Clam, *Corbicula fluminea,* native to China, Korea, and southeastern Russia, is found in abundance throughout the Pacific Northwest and North America. Though the clam can be found in almost any habitat, they prefer flat areas with sand or clay. They are primarily considered filter-feeders; however, they routinely bury in the sediment for extended periods and filter interstitial sediment water (pore water) or pedal-feed. Current analytical techniques often require more than 1 gram of tissue for determining bioaccumulated contaminant concentrations. Therefore, the larger tissue mass obtained from *C. fluminea* make it a better bioaccumulation test organism than the freshwater oligochaete, *Lumbriculus variegatus*. *C. fluminea* promises to fill the need for a trophic niche freshwater test organism or an indicator species for bioaccumulation studies and is proposed as a freshwater bioaccumulation species for the assessment of dredging and clean-up projects. In August and September 2005, 32 nearshore locations were sampled for *C. fluminea* along the Columbia River from Vista Park near Skamokawa, Washington (RM 32) to Warrendale, Oregon (RM 147). Four additional samples were collected in the lower Willamette River. Tissue samples were analyzed for the following bioaccumulative constituents: semivolatile compounds (including PAH), chlorinated pesticides, PCB (Aroclors and all 209 congeners), polybrominated diphenyl ethers (PBDE; fire retardants), organotins, and metals (Hg, Pb, Zn, Cd). All clam tissue had detectable levels of some bioaccumulative contaminants. Statistical relationships among sampling stations were elucidated using exploratory multivariate techniques. Relative abundances of major constituents were superimposed on regional maps of the sampling stations. A mid-reach point source for PCBs was identified as well as localized areas of DDTs, PBDEs, and PAHs.

10:00am – 10:30am

Presenter: Larry Caton, Oregon Department of Environmental Quality

Title: Assessing a Large Estuary with Statistical Confidence and Limited Cash: Coastal EMAP 2000. A probabilistic Columbia River Survey from the Bay to Bonneville Dam

The Western Coastal EMAP program is part of a national geographic assessment initiated on the East and Gulf coasts. The Oregon Department of Environmental Quality (DEQ) has partnered with the Coastal EMAP program since 1999. DEQ's annual surveys covered a range of coastal resource areas: small estuaries (1999, 2001, 2004-06); a lower Columbia River survey up to Bonneville Dam (2000); a small estuary intertidal survey (2002); and near-shore sampling aboard the NOAA ship McArthur II (2003).

Coastal EMAP uses a probability-based sampling design to assess large aerial resources, and draw conclusions about resource impairment with pre-determined statistical confidence: "For each indicator of condition, estimate the portion of the resource in degraded condition within ±10% for the overall system and ±10% for sub-regions (i.e., states) with 90% confidence based on a completed sampling regime." (National Coastal Assessment QAPP).

In 2000, EPA provided DEQ with fifty sampling locations scattered along the lower Columbia estuary; covering the tidally influenced portion of the river (the "sample frame"). To ensure relatively even longitudinal coverage, weighting factors divided the fifty sampling locations among three substrata (lower (20), middle (15), and upper (15)). The survey occurred from July to September in Oregon and Washington waters, and sampled the water column, whole fish, sediment, and infauna. <u>Habitat Quality Indicators</u> included water temperature, dissolved oxygen, salinity, and pH; and sediment TOC and silt-clay content. <u>Exposure Indicators</u> were sediment toxicity bioassays, and sediment and whole fish contaminant concentrations (metals, PAHs, PCBs, and DDTs and other chlorinated pesticides). Benthic infauna, and demersal fish and invertebrate data serve as <u>Biotic Condition Indicators</u>, and <u>Aesthetics</u> examined water clarity, anthropogenic debris, noxious sediment odors, and oil sheen.

10:30am – 11:00am
Presenter: Pat Cirone, formerly USEPA
Authors: Cirone, P, D. Davoli, S. Ellis, D. Karna, R. Melton, R. Poeton, M. Stifelman, M. Watson,.
EPA, Region 10 Report EPA910/R-02-006.
Title: Columbia River Basin Fish Contaminant Survey, 1996-1998
The Columbia River Fish Contaminant Survey Report presents the results of an assessment of chemical pollutants in fish and the potential risks from consuming these fish. The fish were collected throughout the Columbia River Basin in Washington, Oregon, and Idaho. In order to evaluate the likelihood that tribal people may be exposed to high levels of contaminants in fish tissue EPA, the Columbia River Intertribal Fish Commission (CRITFC) and its member tribes (Warm Springs Tribe, Yakama Nation, Umatilla Confederated Tribes, Nez Perce Tribe CRITFC and its member tribes, designed a study in two phases. The first phase was a fish consumption survey which was conducted by the staff of CRITFC and its member tribes. The fish consumption survey was completed in 1994 (CRITFC 1994). The conclusion of the tribal fish consumption survey was that tribal fish consumption was 6 to 11 times higher than the national estimate (CRITFC, 1994).

In 1994, EPA and CRITFC's member tribes initiated the fish contaminant survey which was designed by a multi-agency group including CRITFC, Washington Departments of Ecology and Health, Oregon Departments of Environmental Quality and Health, the Confederated Tribes of Warm Springs, the Yakama Nation, the Umatilla Confederated Tribes, the Nez Perce Tribe, U.S. Geological Survey, and U.S. Fish and Wildlife Service. Sample collection took place between 1996 and 1998 with the help of CRITFC's member tribes and staff of federal and state agencies. Chemical analyses were completed in 1999. The analyses were done by EPA and commercial laboratories. This study was *not* designed to evaluate: 1) the health of past or future generations of people who consume fish from the Columbia River Basin, 2) rates of disease in tribal communities, 3) specific sources of chemicals, 4) multiple exposures to chemicals from air, water, and soil, 5) food other than fish, and risks for a specific tribe or individual. The results of the study showed that all species of fish had some levels of toxic chemicals in their tissues and in the eggs of chinook and coho salmon and steelhead. The fish tissue chemical concentrations were variable within fish (duplicate fillets), across tissue type (whole body and fillet), across species, and study sites. However, the chemical residues exhibited some trends in distribution across species and locations. The concentration of organic chemicals in the salmonids (chinook and coho salmon, rainbow and steelhead trout) and eulachon were lower than any other species. The concentrations of organic chemicals in three species (white sturgeon, mountain whitefish, largescale sucker) and Pacific lamprey were higher than any other species. The concentrations of metals were more variable, with maximum levels of occurring in different species.

EPA uses a risk model to characterize the possible health effects associated with chemical exposure. For this model, toxicity information is combined with estimates of exposure to characterize cancer risks and non-cancer health effects. Different fish ingestion rates were used for the general public and for CRITFC's member tribes. Fish consumption rates for CRITFC's member tribes were based upon data from the CRITFC fish consumption survey (CRITFC, 1994) while those for the general public were based upon EPA analysis of national fish consumption rates (USEPA, 2000b). Using EPA's risk assessment models, hazard indices and cancer risks were estimated for people who consume resident and anadromous fish from the whole Columbia River Basin and from each study site in the basin. For adults, hazard indices and cancer risks were lowest for the general public at the average ingestion rate and highest for CRITFC's member tribes at the high ingestion rate. The chemicals which contribute the most to the health risks are the persistent bioaccumulative chemicals (PCBs, DDE, chlorinated dioxins and furans) as well as some naturally occurring chemicals (arsenic, mercury). Although some of these chemicals are no longer allowed to be used in the United States, a survey of the literature indicates that these chemical residues continue to accumulate in a variety of foods including fish. Human activities can alter the distribution of the naturally occurring metals (e.g. mining, fuel combustion) and thus increase the likelihood of exposure to toxic levels of these chemicals through inhalation or ingestion of food and water.

While contaminants remain in fish, it is useful for people to consider ways to still derive beneficial effects of eating fish, while at the same time reducing exposure to these chemicals. Fish are a good source of protein, low in saturated fats, and contain oils which may prevent coronary heart disease. Risks can be reduced by decreasing the amount of fish consumed, by preparing and cooking fish to reduce contaminant levels, or by selecting fish species which tend to have lower concentrations of contaminants. The results of this study confirm the need for regulatory agencies to continue to pursue rigorous controls on environmental pollutants and to continue to significantly reduce those pollutants which have been dispersed into our ecosystems. Reducing dietary exposure through cooking or by eating a variety of fish will not eliminate these chemicals from the environment. Elimination of many of the man-made chemicals from the environment will take decades to centuries. Regulatory limits for new waste streams and clean up of existing sources of chemical wastes can help to reduce exposure. The exposure to naturally occurring chemicals can be reduced through better management of our natural resources.

There are many uncertainties in this risk assessment which could result in alternate estimates of risk. These uncertainties include our limited knowledge of the mechanisms which cause disease, the variability of contaminants in fish and fish ingestion rates, and the effects of food preparation. The uncertainties in our estimates may increase or decrease the risk estimates reported in this study.