



# **An Overview of Water Research and Education at WSU**

**Interdepartmental Water Quality Summit**

**April 22, 2004**

**1:00 to 5:00 p.m.**

**Lighty 405, WSU Pullman Campus**

**Co-sponsored by**

**The State of Washington Water Research Center**

**WSU Extension**

**College of Engineering and Architecture**

**College of Agricultural, Human, & Natural Resource Sciences**

**Office of Research**

## **AGENDA**

- I. (1:00 p.m.) Program Overview and Introductions - Linda Kirk Fox, Associate Dean and Associate Director, Washington State University Extension
- II. (1:20 p.m.) Priority Water Issues and Research Needs for Washington State - René-Marc Mangin, Eastern Regional Director, Washington State Department of Ecology
- III. (1:50 p.m.) Overview of Water Research and Education at WSU
  - A. Department Overviews of Current Research or Outreach Work
- IV. (3:00 p.m.) Break
- V. (3:15 p.m.) Continue with Overviews from Departments
- VI. (3:45 p.m.) Interdisciplinary Research Project Funding Opportunity - Ken Spitzer, Associate Vice Provost, Washington State University Office of Research
- VII. (4:00 p.m.) Roundtable Discussion Addressing the Following Questions:
  - A. How can we improve communication between departments and faculty?
  - B. How can we improve coordination of activities (research, extension, and education)?
  - C. Can we more effectively utilize our information department(s) to:
    - 1. get the word out about our activities
    - 2. provide outreach (educate people)
  - D. Identify and discuss other potential limiting factors to most effectively utilize the resources of WSU to address water quality issues.
- VIII. (4:45 p.m.) Summarize and Identify Next Steps
- IX. (5:00 p.m.) Adjourn

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## DEPARTMENT OVERVIEWS

### COLLEGE OF AGRICULTURAL, HUMAN, AND NATURAL RESOURCE SCIENCES

#### DEPARTMENT OF CROP AND SOIL SCIENCES

##### **Chemical Movement and Plant/Soil Management in Agricultural Watersheds**

*From Field to Watershed Basin of Dryland Cropping Systems* (Jeffrey Smith and Kent Keller, [ckkeller@wsu.edu](mailto:ckkeller@wsu.edu)) - This project was developed to understand the relationship of agricultural chemical movement from the field to basin scales. Smith and Keller are interested in determining if the patterns of chemical detection are similar at the edge of cropped fields and at scales that contain larger land areas. The researchers are monitoring chemicals, such as nitrate, in ditches and streams from the Cunningham Research Farm down Missouri Flat Creek to the South Fork of the Palouse River. These data are being compared to similar data being collected by the U.S. Geological Survey at Hooper, Washington. To date, the researchers can discern similar patterns of some chemicals at different scales in times of moderate to high discharge. Affiliated research by David Huggins, Frank Young, William Pan, Bruce Frazier and Richard Koenig is defining best management practices in dryland cereal-based cropping systems for minimizing nitrate leaching to groundwater. Site-specific, landscape driven nutrient management recommendations are evolving in conjunction with modeling from Claudio Stockle and Joan Wu.

*Watershed Management in the Yakima Valley* (Robert Stevens, [stevensr@wsu.edu](mailto:stevensr@wsu.edu), and Brian Leib) - In 1991 the researchers initiated the Granger Drain Hydrologic Unit project that was a cooperative effort with the Natural Resources Conservation Service (NRCS), the Agriculture Stabilization and Conservation Service, and producers to reduce sediment and nutrients in the Granger Drain return flow to the Yakima River. Over the six years of the project the researchers laid the foundation of research, demonstration and education that resulted in the significant impacts that the irrigation districts and producers were able to achieve when the total maximum daily load was put in place. Stevens did the first demonstration work with polyacrylamide in the Yakima Valley and it has been a vital tool in the clean up. Recent work with Leib has looked at reducing sediment lost in tail water ditches at the bottom of fields. Stevens has also been a member of a national team that developed the Phosphorus Loss Index for rating systems for vulnerability to phosphorus runoff losses, currently being utilized by the NRCS. Affiliated research has been conducted by Robert Stevens, Joan Davenport and William Pan to define best management practices for minimizing nutrient runoff and leaching to groundwater in a diversity of crops such as potato, onion, hops, grapes, and corn.

*Invasive Weed Management in Western Washington Riparian Zones* (Timothy Miller, [twmiller@wsu.edu](mailto:twmiller@wsu.edu)) - Foliar applications of imazapyr, glyphosate, or triclopyr to Japanese knotweed transplants, or Giant knotweed (*P. sachalinense*) transplants, or seedlings in the greenhouse during 2003 revealed insights on potential management options, and future trials will be extended to Himalayan knotweed (*P. polystachyum*) transplants and perhaps some Bohemian knotweed. In field trials, plants were treated with glyphosate, triclopyr, imazapyr with different application methods and rates. Giant knotweed (*P. sachalinense*) on Big Quilcene River in Jefferson County was treated at

early flower (July 31, 2003), while Japanese knotweed on Hutchinson Creek in Whatcom County was treated at early flower (August 6, 2003) or after petal fall (October 1, 2003). Injury was monitored and resulted in excellent stem control with maximal selectivity, since only the weeds were actually treated (contrasted with foliar herbicide treatments that result in not-target vegetation also being treated).

*Riparian Re-vegetation* (Timothy Miller, [twmiller@wsu.edu](mailto:twmiller@wsu.edu)) - Along Four Mile Creek (south of Lynden) and Joe Leary Slough (west of Burlington), Miller established studies in 1999 and 2000 aimed at best management practices for control of reed canarygrass (RCG, *Phalaris arundinacea*) coupled with riparian tree planting. While spring applications of glyphosate provided fair to excellent control of RCG, initial control was critical to the success of maintaining plots during the next two summers. If initial control was excellent (as at Joe Leary Slough), all maintenance programs (spot-treatments with glyphosate, mowing, or bark mulch) effectively controlled RCG and resulted in good establishment of Arroyo willow (*Salix lasiolepis*) and Red alder (*Alnus rubra*). If initial RCG control was fair or poor (as at Four Mile Creek), only spot-treatment with glyphosate or mowing provided good conditions for tree establishment, bark mulch failed. Clipping RCG and broadleaf weeds resulted in good tree survival and growth, but consumed an additional 30% more time than other control methods. Additionally, tree protectors were important to tree survival and growth at Four Mile Creek, but not at Joe Leary Slough.

## **Chemical Movement in Urban Systems**

*Chemical Flows in Golf Courses* (Eric Miltner, [miltner@wsu.edu](mailto:miltner@wsu.edu)) - Miltner has been studying the effectiveness of artificial seasonal wetlands and bioswales on golf courses for their effectiveness in filtering nutrients from surface and shallow subsurface flow. The objective is to reduce the off-site flow of fertilizer nutrients applied to turfgrass. Results to date indicate that nitrate concentrations are rarely above 1 ppm in soil solution and rarely above 0.5 ppm in the wetlands. Concentrations of orthophosphate are rarely above 0.1 ppm in soil solution and rarely above 0.05 ppm in the wetlands. In a separate experiment Miltner is studying the runoff of fertilizer nutrients and pesticides applied to two golf courses into fish-bearing streams on the properties. For more than 22 months, nutrient levels have consistently been below threshold limits for both nitrate and orthophosphate. There has been one incident where pesticide detection in a stream could be attributed to an application made on the golf course. On one course, there have been several detections of herbicides in the stream at the point at which it enters the golf course property, indicating input from applications made at other locations upstream from the course.

*Floating Green Lysimeter* - (William Johnston, [wjohnston@wsu.edu](mailto:wjohnston@wsu.edu), Eric Miltner, [miltner@wsu.edu](mailto:miltner@wsu.edu), William Pan, [wlp@wsu.edu](mailto:wlp@wsu.edu)) - Johnston, Miltner, and Pan have utilized the floating green on the Couer d'Alene golf course as the world's largest lysimeter for monitoring nutrient and pesticide movement through a working golf green. Concerns for chemical leaching and potential effects on groundwater through intensively managed golf greens have raised the level of interest in these systems. Water and chemical leachates are collected and cataloged in tanks in an under-green storage room. This research demonstrated that frequent, low-dose nitrogen applications minimized nitrate leaching to acceptable levels. Pesticide movement is under current study.

*Lake Steilacoom Phosphorus Project* (Shiou Kuo, [skuo@wsu.edu](mailto:skuo@wsu.edu)) - Eutrophication of Steilacoom Lake is well recognized. A past study has demonstrated that more than three quarters of its phosphorus came from Ponce de Leon and Clover Creeks, the two tributaries of the lake. However, almost 10 years has passed since the last study of phosphorus input and output of the lake. Sufficient changes in land uses may have occurred, which warrants another study to determine if substantial changes of soluble phosphorus and particulate phosphorus in the creeks have occurred during this time. Given the known impact of high soil available phosphorus on phosphorus transport to surface water, it would be desirable to understand the current soil phosphorus status within the watershed. Considering that a significant portion of land in urban settings is utilized for lawns and turfgrass for sports purposes, it is also desirable to know soil phosphorus status in the lawns and phosphorus transport coefficient.

The reactive soluble phosphorus (RSP) consisting of orthophosphate and condensed phosphates in Ponce de Leon Creek showed a distinct seasonal pattern. From the fall of 2001 to the summer of 2002, it rose with increasing rainfalls in the fall and winter, reaching a maximum in the mid-winter. It dropped sharply in March 2002, but remained at a relatively high level that averaged  $28.8 \text{ g L}^{-1}$ . Unlike RSP, the total phosphorus, which included RSP and particulate phosphorus, decreased consistently. The proportion of the total phosphorus in RSP form was highest during the winter period, which suggests that the water discharged into the creek was predominantly from groundwater that tends to be high in RSP but low in total phosphorus. The same seasonal pattern was also found for RSP concentration in Clover Creek. More of the phosphorus in Clover Creek was in particulate phosphorus, and the average concentration of total phosphorus was about the same between the two creeks. With a greater drainage basin and, likewise, a greater annual flow of water into the lake, Clover Creek could have contributed more phosphorus into the lake than Ponce de Leon Creek. As such, controlling phosphorus inputs into both creeks from their drainage areas would be necessary to help reduce the total phosphorus input into the lake. Soluble reactive phosphorus in the lake water essentially followed the same seasonal pattern as that of RSP in the two tributaries of the lake. The lysimeter study on the lawns bordering the lakeshore showed that the phosphorus transport coefficient for the lawns was far better correlated with soil total phosphorus than with soil slope, averaging  $0.63 \text{ kg P ha}^{-1}\text{yr}^{-1}$  over four sites. Much of the phosphorus input from the lawns was RSP, which is readily available for biota in either terrestrial or aquatic systems.

### **Chemical Movement of Hazardous Wastes**

*Research Activities of the Soil Physics/Vadose Zone Hydrology Group* (Markus Flury, [flury@wsu.edu](mailto:flury@wsu.edu)) - The soil physics group at WSU does research on physical phenomena related to vadose zone hydrology. Specific research areas include: (1) characterization of water flow and solute transport in the vadose zone; (2) colloid-facilitated transport of contaminants through the vadose zone; (3) modeling sorption kinetics and transport of organic chemicals, colloids, and viruses; (4) characterization and evaluation of dye tracers for solute transport studies; and (5) quantification and modeling of dispersion during solute transport in porous media.

### **DEPARTMENT OF ENTOMOLOGY**

Several faculty in the Department of Entomology are involved in research, extension, and teaching programs throughout the state that have both direct and indirect implications for water quality

concerns in the Pacific Northwest (PNW). In general, all Entomology faculty subscribe to the principles of Integrated Pest Management (IPM) as an ecologically based strategy for managing risk of crop and public health pests while promoting sound environmental stewardship. IPM systems rely on a thorough knowledge of population ecology, pest population monitoring, and taking action in response to economic thresholds of pest density. Pesticides are viewed as one of many tools for managing pest populations, but when pesticides are chosen, the least toxic material (from the perspective of nontarget fish and wildlife and biological control organisms, namely generalist predators and specialist parasitoids) should be the priority. Entomologists especially support the use of the category of pesticides described under regulatory parlance as “reduced risk.” By using a management strategy grounded in sound principles of population ecology and adhering to a goal of conserving natural enemies (a.k.a. biological control organisms), many faculty in the Department of Entomology contribute at least indirectly to water quality protection. Implementation of ecologically based IPM programs will inevitably lead to a reduction of pesticide contaminants and a reduction of potential hazards in aquatic systems.

### **Specific Faculty Programs Related to Water Quality Issues in the PNW**

*Biological Control of Weeds, Pullman Campus* (Gary Piper, [glpiper@wsu.edu](mailto:glpiper@wsu.edu)) - Research is conducted on the biological control of invasive noxious weeds in rangeland, wildland, and aquatic ecosystems using nonindigenous arthropods and plant pathogens. Successes in controlling noxious aquatic weeds like purple loosestrife can reduce the use of aquatic herbicides and thus the uncertainty about hazards when pesticides are introduced directly into water habitats. Relevant courses taught include: Introduction to Pest Management in a Quality Environment (IPM 201); Pesticides and the Environment (IPM 452/552); Systems of Integrated Pest Management (IPM 462/562); Applied Biological Control (ENTOM 551); and Integrated Biological Control (ENTOM 565).

*IPM, Prosser Campus* (Doug Walsh, [dwalsh@tricity.wsu.edu](mailto:dwalsh@tricity.wsu.edu)) - Walsh is the statewide IPM coordinator for WSU and also the director of field research for U.S. Department of Agriculture IR-4 programs conducted in the U.S. Environmental Protection Agency Region 10. He has several collaborative projects involving the study of arthropod population dynamics in disturbed and rehabilitated riparian habitats in the lower Yakima River watershed of south-central Washington state. The major focus is developing the relationship among the host plants with constituent arthropod populations. Studies have indicated that some exotic, flowering species of plants that persist in degraded riparian buffers and at the interface of riparian habitats and cultivated areas serve as preferred hosts to pest species of arthropods more so than native plant species in rehabilitated buffers. Data have also indicated that populations of beneficial arthropods are increasing in the presence of exotic flowering plant species.

*Ecotoxicology and IPM, Puyallup Campus* (John Stark, [starkj@wsu.edu](mailto:starkj@wsu.edu)) - The mission of the Ecotoxicology program at WSU Puyallup is to study the impacts of pesticides and other toxicants on populations, communities, and food webs with particular emphasis on aquatic organisms inhabiting rivers and streams in the Pacific Northwest, including salmon and the invertebrates that they feed upon. This is accomplished through a mix of laboratory and field studies. The laboratory studies involve developing toxicity data for animals exposed to various chemicals. The effects of low concentrations of the mixtures and concentrations of pesticides commonly found in Washington fresh water systems are also being investigated. Additionally, a new fish research lab has recently

been built to work on the effects of pesticides on salmon. Field studies involve placing water fleas (*Daphnia*) in rivers and streams and following their growth and development and comparing this to the chemicals that move through the rivers and streams. Indices of stream health based on species diversity and abundance are also determined. Mathematical models of toxic effect based on demography are produced which estimate population growth or decline under stressful conditions. Stark's team teaches the modular course, Pesticide Toxicology and Mode of Action (ENTOM 556/557/558).

*Environmental and Analytical Chemistry, Tri-Cities Campus* (Vincent Hebert, [vhebert@tricity.wsu.edu](mailto:vhebert@tricity.wsu.edu), FEQL web site: <http://feql.wsu.edu/index.htm>) - Hebert is the Residue Laboratory Director for the Food and Environmental Quality Lab (FEQL) and is responsible for the IR-4 program for residue analysis of minor use pesticides. Research is also conducted on pheromone environmental chemistry for improving the deployment of the mating disruption technique for controlling codling moths. Widespread use of mating disruption will reduced the reliance of broad spectrum organophosphate insecticides that have been found in waters of the Pacific Northwest. The residue laboratory has the infrastructure necessary to analyze a wide range of contaminants from all media, including water and sediment. Hebert is particularly interested in atmospheric transport and photo-oxidation of contaminants. This research has relevance to water quality in light of known regional mass transport of agricultural residues to aquatic systems in mountainous regions of California. Hebert teaches the course, Environmental Chemistry (CHEM 481/581) and is involved with pesticide applicator training around the state. He also serves on the ad hoc technical advisory committee for the Washington State Department of Agriculture Surface Water and Endangered Species Program.

*Environmental Toxicology, Tri-Cities Campus* (Allan Felsot, [afelsot@tricity.wsu.edu](mailto:afelsot@tricity.wsu.edu), FEQL web site: <http://feql.wsu.edu/index.htm>) - Felsot is a professor assigned to the Food and Environmental Quality Lab (FEQL) and holds an appointment as extension specialist for toxicology. He is involved with pesticide applicator training programs around the Pacific Northwest. Current research interests include drift measurement, modeling, and the design of no-spray buffer zones for protecting nontarget organisms (aquatic or terrestrial, plants or animals). He considers focusing on drift management a priority because it is likely the mechanism causing pesticide residue contamination in aquatic systems of eastern Washington and Oregon. Previous related research projects at WSU have involved analysis of the movement of systemic insecticides applied under drip irrigation. Felsot prepares hazard/risk assessments and commentaries related to issues ranging from human toxicology to ecological toxicology. He teaches several courses, including Fundamentals of Environmental Toxicology (ES/RP 531), Applied Environmental Toxicology (ES/RP 532), and Comparative Physiology and Biochemistry (BIOL 554). He also team teaches the course Grape Pest Management (ENTOM 490) and the modular series Pesticide Toxicology and Mode of Action (ENTOM 556/557/558).

## **DEPARTMENT OF INFORMATION**

In the past two years, the Department of Information has produced two major satellite teleconferences on water quality issues in cooperation with Bob Simmons, Chair, Mason County Extension, and Jan Seago, Water Resources Coordinator, Thurston County Extension. The first teleconference was produced on May 31, 2002, and is entitled "Living on the Edge: Grassroots

Watershed Planning in the Pacific Northwest.” This program includes three pre-produced video segments shot on location in Washington, Idaho, and Oregon and live participation by local water council members from communities in these three states.

The second teleconference was produced on November 18, 2003, and is entitled “Funding Watershed Restoration in the Pacific Northwest.” This program was produced in cooperation with Boise State University’s Environmental Finance Center and featured guests from the center as well as the U.S. Environmental Protection Agency’s Region 10 office in Seattle and from a private consulting firm in Seattle which specializes in helping clients secure funding for environmental funding. This broadcast was viewed at 51 sites in seven different states, including 23 sites in Washington, nine in Idaho, 17 in Oregon, one each in Alaska and Montana, the Center for Watershed Protection in Maryland, and Southern Illinois University in Carbondale, Illinois.

Contact information:

- *Scott Fedale*, Chair and Director, Department of Information, Washington State University, Pullman, Washington. E-mail: [fedale@wsu.edu](mailto:fedale@wsu.edu).

## **WSU EXTENSION**

**Watershed Stewards Program** - The Watershed Stewards Program trains volunteers to lead and participate with their communities in natural resource management. The program trains and supports adult volunteers who are interested in teaching others about the basics of watersheds, wetlands, streams, water quality, forestry, native plants, wildlife and other natural resource topics. The program consists of a series of 12 training sessions, including field trips, followed by 60+ hours of volunteer service. The program is currently offered in Clark, Island, Jefferson, King, Okanogan, and Pierce Counties. They are funded primarily through local jurisdictions and grant funds. For more information: <http://wawater.wsu.edu/pages/Activities.htm>

**Water Resources Education for Real Estate Professionals Program** - Development practices and landscape modification play significant roles in determining the long-term health of aquatic systems and drinking water quality. Developers and real estate professionals with a background in water resource issues can make better informed and potentially more environmentally suitable decisions regarding development practices, as well as educate their clientele about land stewardship and water quality. To educate this priority audience, a water resource education program was established to provide professional development for developers and real estate professionals. The program is a series of individual courses providing participants with certified clock hours for their biennial professional license certification. The nine stand-alone courses cover the science, policy and regulation of water resource related issues. These self-supporting programs have created a strong niche for WSU Extension in providing effective water resource education in areas experiencing development pressures. Extension offices offering these classes are Island, Jefferson, Thurston, and by fall of 2004, Spokane County. For more information: <http://wawater.wsu.edu/pages/Activities.htm>

**Pacific Northwest Regional Water Quality Coordination Project (WSU, OSU, UA, UI, and the U.S. Environmental Protection Agency Region 10)** - This project provides regional water quality outreach programs and activities designed to better integrate research, education, and extension efforts throughout the Pacific Northwest (Alaska, Idaho, Oregon, and Washington). Activities have included conferences (e.g., "Getting It Done: The Role of TMDL Implementation in Watershed Restoration," October 2003), regionally broadcast programs for watershed organizations (e.g., "Funding Watershed Restoration in the PNW," November 2003), development of Extension water quality publications and providing specialized training to Extension faculty and other water resource professionals. This project is funded through a U.S. Department of Agriculture-Cooperative State Research, Education, and Extension Service grant and continued funding is anticipated. For more information: <http://www.pnwwaterweb.com>

**4-H Environmental Stewardship Projects** - 4-H Programs such as the Discovery Project, EM\*Power, Earth Savers, Challenge, Forestry, and Experiencing Water Resources offer youth opportunities to learn about the ecology of their areas and ways to protect natural resources. Each 4-H member chooses a project that is pertinent to their family, community and interests. There are 11,200 youth enrolled in 4-H stewardship projects statewide. More information can be found at: <http://4h.wsu.edu/>

**WSU Extension Agriculture and Natural Resource Programs** – Most Extension programs have elements that are integrally related to water resource protection and management. These include the Master Gardener program, traditional agricultural support programs, the Pesticide Education Program, irrigation management, forestry education, or urban-based programs such as TeenWorks. In some counties Extension personnel are involved in local watershed planning and salmon recovery processes.

#### **Other WSU Extension, County-specific Programs**

*Native Plant Salvage Project (Thurston County)*- The purpose of the project is to teach residents how to use native plants in their landscapes and restoration efforts to protect water resources and improve fish and wildlife habitats. The program involves more than 300 volunteers and reaches more than 2,500 people annually.

*Water Education and Training Program (Ferry County and Colville Reservation)* – This program provides water resource related curricula, newsletters and training to community members, school staff and volunteers. The program emphasizes youth education, providing hands-on learning experiences combined with opportunities to share discoveries and learn with the community. Among other activities, classes from each participating school build scale models of a "local terrain" watershed that becomes school property for future watershed education activities. For more information: <http://ferry.wsu.edu/water/index.htm>

*After-School Forestry Education Programs* – More than 16 County Extension offices are funded through their counties with federal funding to offer after-school forestry education programs. These programs emphasize forest ecology, management, natural resource and watershed stewardship.

*Conservation Tools for Landowners Program (Island, King, Kitsap and Jefferson Counties)* – This grant-funded program educates volunteers and private landowners about the variety of conservation tools available for land protection, focusing on non-regulatory, incentive-based programs. It brings together public and private organizations working to conserve natural lands.

### **Resources Available through WSU Extension**

WSU Extension has personnel at research stations and county-based offices across Washington State. These individuals and their programs offer a tangible link to real world water resource issues. They offer connections to farmers and natural resource managers, local agencies, decision makers and numerous organizations. These connections can assist in identification of potential research projects, community projects for WSU courses, sites for research projects and project partners. For more information: <http://ext.wsu.edu/locations/>

Some County offices have groundwater flow demonstration models and water quality testing field kits that they make available to local educators. The PNW Regional Water Quality Project has developed and placed a Domestic Water Use manual in all County offices as a quick reference for the front line staff to answer water quality questions from residents. In addition, WSU Extension has more than 90 publications related to water quality and natural resource stewardship.

## **COLLEGE OF ENGINEERING AND ARCHITECTURE**

### **DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

The Department of Civil and Environmental Engineering (CEE) has a long and proud history of accomplishments in the areas of water-related research and education. Our program is also an active participant in the cross-disciplinary Center for Multiphase Environmental Research (CMER) which further expands our interests and abilities in research associated with water and the environment. We currently have 5 faculty in water resources and environmental engineering at the Pullman campus and 1 at the Tri-Cities campus. We are also in the process of hiring a new faculty member for fall. As summarized below, the areas of expertise are extremely diverse enabling us to cover a broad array of topics.

#### **Faculty Research Interests**

- *Michael Barber* - Surface water hydrology and hydraulics, primary productivity, nutrient and flow transport modeling, engineered wetlands, remote sensing, and watershed management. E-mail: [meb@wsu.edu](mailto:meb@wsu.edu).
- *Akram Hossain*, (Tri-cities campus) - Groundwater and mathematical modeling, contaminant transport, and environmental processes.
- *Rollin Hotchkiss* - Reservoir sedimentation, physical hydraulic modeling, sediment transport, open channel flows related to fish passage, and turbulence. E-mail: [rh@wsu.edu](mailto:rh@wsu.edu).

- *Frank Loge* - Water and wastewater treatment, water reuse, fecal source tracking, analysis of occurrence and fate of human and salmonid pathogens in surface waters, fate and transport of pharmaceuticals and hormonally-active compounds in the subsurface. E-mail: [floge@wsu.edu](mailto:floge@wsu.edu).
- *Richard Watts* - Physiochemical treatment processes, particularly chemical oxidations applied to the treatment of contaminated soils and groundwater, hazardous and industrial wastes. E-mail: [rjwatts@wsu.edu](mailto:rjwatts@wsu.edu).
- *David Yonge* - Treatment of industrial wastewaters, innovative treatment technologies, sorption phenomena, subsurface hazardous material contamination, water and wastewater treatment. E-mail: [yonge@wsu.edu](mailto:yonge@wsu.edu).

### **Research Facilities**

CEE has state-of-the-art water-related research facilities located in Albrook, Sloan, and Dana. Since the early 1950's, the CEE faculty have conducted expert engineering services in hydraulics and water resources in Albrook Laboratory. Albrook is a modern facility containing some 30,000 square feet of working space, supported by a full compliment of experimental and computational equipment. Some of the more notable elements include computerized laser Doppler anemometry, an acoustic Doppler velocity probe, pumps capable of delivering over 35 to 70 cfs, a fluorometer, boats, a vast array of flumes and channels including a 75-foot long flume, storage tanks, and data acquisition devices.

The Department also maintains a number of research laboratories in Sloan and Dana equipped with new chromatography systems, atomic absorption spectrometers, pollutant analyzers, a scintillation counter, climate control rooms, and associated computer data acquisition and analysis systems. Additionally, the department maintains a microcomputer laboratory now equipped with more than 20 microcomputers, an HP 9000 workstation network with five CPUs, and several auxiliary terminals.

### **Example Research Projects**

*Primary Productivity in Stanley, Redfish, Alturus, and Pettit Lakes* - Nutrients are essential for healthy aquatic ecosystems; however, problems arise when concentrations become too high or too low. As a supplement to natural fertilization, scientists are experimenting with artificial stimulation with nutrients. WSU researchers are involved in determining the effects of artificial fertilization on primary productivity in lakes and rivers. Using C-14 as a tracer, *in situ* incubation of water samples is conducted to determine overall productivity as a function of depth in the photic zone. Ecological changes due to nutrient addition can be determined.

*Biological Reduction of Cr(VI)* - Biological reduction through the stimulation of indigenous bacteria can have significant advantages over chemical reduction processes at sites contaminated with hexavalent chromium (Cr(VI)). Consequently, we are studying the fundamental and applied aspects of Cr(VI) reduction in both batch and continuous flow column experiments using pure and mixed

cultures of bacteria to enable the development of a model that can be used to design and operate *in situ* groundwater remediation systems.

*Sediment Erosion Prediction and Modeling* - Sediment erosion from agricultural lands is an important source of pollution in many streams and rivers. Currently, we are working on two projects related to improving the prediction of sediment yield and transport. One project uses remote sensing and field data to quantify conditions leading to ephemeral gullies as significant sources of sediments; the other project involves modifying the code of a popular model to improve the scaling effects of expanding a field-scale model to a watershed-scale simulation tool.

*Jordan Skills Enhancement* - Working with the WSU International Programs office, CEE faculty have presented workshops and conducted research in Jordan on a wide-range of water and wastewater reuse issues.

*Understanding of Fenton-Like Reactions for In Situ Remediation of Contaminated Groundwater* - The research aims to obtain a understanding of modified Fenton's reagent as an chemical oxidation process. Two principles serve as themes: (1) that hydroxyl radicals are only partially responsible for the success of Fenton-like oxidation, and (2) naturally-occurring trace minerals may play an important role relative to soluble iron catalyst addition. Results of this research will provide definitive information on the site and process conditions necessary for the successful application of modified Fenton's reagent.

Contact information:

- David McLean, Chair, Department of Civil and Environmental Engineering, Washington State University, Pullman, Washington. E-mail: [mclean@wsu.edu](mailto:mclean@wsu.edu), web site: <http://www.ce.wsu.edu/>

## COLLEGE OF SCIENCES

### ENVIRONMENTAL SCIENCE AND REGIONAL PLANNING PROGRAM

The interdisciplinary Environmental Science and Regional Planning (ESRP) Program has been involved with water quality related research and education since its inception in 1969. Up to the present time graduate students in the program have completed 115 thesis projects (MS, MRP, and PhD) related to water quality in lakes, rivers, wetlands, wells, dam impoundments, irrigation canals, and ocean waters. Most of the work has been carried out at Pacific Northwest locations, but some projects have involved other locations in the United States or foreign countries. Participating faculty from many departments across campus, in addition to the ESRP core faculty, have supported and guided these projects through the years as the thesis supervisors for these students.

The range of specific topics of the 115 research projects is very wide. In order to give some perspective to the thesis topics, a few recent titles are listed below as illustrations.

- *Modeling of Populus Trichocarpa Along Lower Rush Creek in the Bottomlands, Mono County, California*, J. Bellona, MS Dissertation, 2003. This model study demonstrated that a return to historic flows in this creek was the key to restoring its overall health after water diversions to Southern California had damaged the bordering cottonwoods.
- *Overcoming Jurisdictional and Property Boundary Issues in Watershed Planning*, W. Bumback, MS Dissertation, 2003. This thesis described a program to improve watershed management in Georgia through education of local officials about non-point source pollution.
- *Integration of Macroinvertebrates and Chemical Indices to Assess Water Quality of an Irrigation Waterway*, S. Early, MS Dissertation, 2001. This thesis compared macroinvertebrate bioassays with chemical analyses as indicators of water quality in the Amon Wasteway in south central Washington.
- *Water Quality Improvements and Coho Salmon Habitat on Three Lower Yakima River Tributaries: Sulphur, Spring and Snipes Creek*, J. Perryman, MS Dissertation, 2002. This thesis evaluated the suitability of the three streams for further increases in salmon spawning.
- *Farming Systems, Runoff, and Contamination of Water in Kamundi Watershed in Malawi*, A. Kamperawera, PhD Dissertation, 1999. This dissertation evaluated effects of cropping systems and grass hedgerows on non-point source pollution from croplands.
- *Woody Debris and Macroinvertebrate Community Structure of Low-Order Streams in Colville National Forest, Washington*, M. Rogers, MS Dissertation, 2003. This thesis examined the effects of large amounts of woody debris on the stream ecology of forested headwater streams of the national forest.
- *Chironomids (Diptera: Chironomidae) as an Indicator of Eutrophication in Lake Maury, Newport News, Virginia*, C.K. Knudson, MS Dissertation, 2000. This thesis determined the eutrophied status of the lake through identification of the genera of chironomids that composed the benthic community in the lake.

Among frequent themes for the 115 projects are (1) sources of, (2) effects of, (3) measurements of, and (4) corrective measures for contamination of lake, stream, aquifer, and marine waters; management practices and regulatory actions to control water quality; the use of modeling in water related studies; and social aspects of water issues. At the present time there are five graduate students undertaking water quality related projects. Two concern tribal water quality issues, one concerns amphibians as biomarkers, one examines large woody debris as a means of stream stabilization, and the last is on total maximum daily loads in the Little Spokane River watershed.

Interests of the broad range of ESRP participating faculty beyond the core ESRP faculty will be covered in the course of the various presentations during the summit. Only core faculty are provided below. Their research and teaching activities are not exclusively on water quality but in several cases include water quality.

- *William Budd* - Budd's work has been in ecological planning including watershed management. E-mail: [budd@wsu.edu](mailto:budd@wsu.edu).
- *Andrew Ford* - Ford specializes in systems dynamics and has applied this modeling technique to a wide range of problems including Snake River salmon migrations and effects of water withdrawals at Mono Lake in California. E-mail: [forda@wsu.edu](mailto:forda@wsu.edu).
- *Eldon Franz* - Franz is an ecologist who has worked on the effects of stress, including water stress, on plants. E-mail: [franz@wsu.edu](mailto:franz@wsu.edu).
- *Richard Gill* - Gill's current work is on recovery of degraded plant communities at Mount Saint Helens and in Central Utah. E-mail: [rgill@wsu.edu](mailto:rgill@wsu.edu).
- *William Hendrix* - Hendrix works on applications of GIS to environmental and landscape subjects. E-mail: [whendrix@wsu.edu](mailto:whendrix@wsu.edu).
- *George Hinman* - Hinman's recent work has included compliance with state and federal groundwater quality regulations for disposal of low level waste and low activity waste onsite at Hanford. E-mail: [ghinman@wsu.edu](mailto:ghinman@wsu.edu).

Several courses taught by core faculty in ESRP are listed below and include water quality topics, although water quality is only part of the material covered.

- ES/RP 101, Environment and Human Life. Covers water quality as part of a survey of the environment.
- ES/RP 150, Natural Science in the Environment. Includes fieldwork on the water quality of local streams.
- ES/RP 310, Modeling the Environment. Includes systems dynamics studies of freshwater systems.
- ES/RP 335, Environmental Policy. Covers the Clean Water Act, the Safe Drinking Water Act, and land use policies affecting water quality.
- ES/RP 444, 544, Environmental Assessment. Includes water quality as a major component of environmental quality.
- ES/RP 550, Systems Dynamics Models of Environmental Systems. Course includes modeling techniques applied to water quality issues.

## COLLEGE OF VETERINARY MEDICINE

### DEPARTMENT OF VETERINARY MICROBIOLOGY AND PATHOLOGY

There are several faculty involved with water quality research in the Department of Veterinary Microbiology and Pathology (VMP) including Doug Call and Thomas Besser in collaboration with Dale Hancock and John Gay (Veterinary Clinical Sciences), and Frank Loge (Civil and Environmental Engineering, adjunct in VMP). Three major projects are briefly described below.

**Bacterial Source Tracking (BST)** - Call, Loge, and Gay have an ongoing NRI-sponsored research project that employs DNA microarrays to screen more than 4,300 genetic markers for possible application in bacterial source tracking. The goal of this project is to identify markers suitable for library-independent identification of the major contributors to water-borne fecal contamination.

**Water Dissemination of Enteric Bacteria** - Hancock and others were recently awarded a National Institute of Health contract to form a Zoonosis Research Unit at WSU. Part of this project includes examining the dissemination of both pathogens and antibiotic resistant bacteria through irrigation systems. This project includes development of a reusable tangential flow system to concentrate bacteria for analysis from large volumes of water (10 to 200 liters). Analysis will include pathogen detection using conventional microbiology, real-time PCR, and microarray detectors.

**Water Dissemination of Fish Pathogens** - Call and Loge are working in collaboration with scientists at the National Marine Fisheries Service to study the ecology of fish pathogens in estuary environments. This project includes immunological and toxicological components.