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Office of Research & Development

National Health & Environmental Effects Research Laboratory

Western Ecology Division

Research Update

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Next issue: watch for The Golden Mouse!

"PCEIS" DATABASE WILL NET BIG RESULTS

It's pronounced like "Pisces", but *PCEIS* stands for *Pacific Coast Ecosystem Information System,* and it's about capturing information, not fish. *PCEIS* is the latest tool being developed at Western Ecology Division's marine research facility in Newport, Oregon, and it incorporates spatially-explicit information for the estuaries and coastal regions of the Northeast Pacific.

Still under development, *PCEIS* combines many types of data from *Coastal EMAP* (EPA's large scale Environmental Monitoring & Assessment Program) and USGS (US Geologic Survey), and integrates them into one central database, taking thousands of facts about estuarine/marine species and their habitats, and organizing them in a way that can be utilized by researchers according to their particular specifications. Geographical distributions of individual species can be exported into Excel, then input into GIS software for mapping and spatial analysis. *EMAP* has generated site-specific data for over 1500 invertebrate and fish species, collected from more than 200 estuaries in Oregon, Washington, and California.

Initially, the goal was to utilize just the EMAP data more efficiently. But *PCEIS* also incorporates information about species distribution from numerous other sources, including other Federal and State databases. EPA and USGS will generate a future version to span from Alaska to northern Mexico, which will also include wetland species.

One of the primary objectives is to provide information about native and non-native, or invasive, estuarine and coastal species, including additional information such as date of first recorded occurence and potential vectors for non-native species.

PCEIS is a unique research and risk assessment tool; it is the only integrated database to include both native and non-native species, georeferenced distributions ranging in spatial scale from tributaries to the entire Northwest Pacific, landscape data, and the ability to easily export data for spatial or statistical analysis. The database will provide researchers and managers with a powerful tool for extracting information to evaluate the effects of invasive species, nutrient enrichment, habitat alterations, and other stressors.

An expanded version should be available to the public in book form by 2008. *PCEIS* project leader **Henry Lee II** works at WED's Pacific Coast Ecology Branch in Newport, Oregon; Debbie Reusse is a Research Geographer with USGS-Western Fisheries Research Center. Contact: lee.henry@epa.gov

*left: Louisiana crayfish (*Procambarus clarkii*), one of many non-native species documented by PCEIS*

"GENE TEAM" STRIKES GOLD...AND MORE

New technology is making it possible to produce a variety of crops like soy, corn, and canola, which are resistant to pests and disease. Recently added to the list is bentgrass (*Agrostis Stolonifera* L.), a commercially grown perennial grass.

Bentgrass is commonly used on golf courses, and Oregon's grass-seed growers have expressed great interest in the GM research carried out by WED

Bentgrass has been altered genetically to be resistant to a commonly used weed killer.

EPA's Office of Pesticide Programs regulates such crops to ensure that the environment is protected from potential transfer of the new genes to surrounding crops and native plants.

Last year, a team of scientists from Western Ecology Division received EPA's prestigious Gold Medal for Service, and a Level I Scientific & Technological Achievement Award for their research demonstrating that genetically modified (GM) plants could spread beyond their original fields. Now, the same team has documented, for the first time in the United States, the escape of genetically modified material into wild plant populations up to several miles away. Their research showed that wild plants with the altered genes could become established after only a single growing season. Ecological consequences of GM gene flow in wild plants remains a topic of active research.

The study involved an experimental field of bentgrass in Central Oregon which is located next to areas of natural vegetation. Scientists tested 20,000 grass leaf samples outside the GM crop area using a unique environmental forensic method to search for a specific protein produced by the modified gene.

The Western Ecology Division research will help inform decisions about the potential risks posed by GM crops growing near fields of Oregon's economically important grass seed. It will help determine where the GM crop pollen is most likely to move, and how to calculate the distance it can travel and still remain viable enough for downwind fertilization to occur.

EPA's Office of Pesticide Programs will use this information to develop testing and monitoring systems, and to help inform regulatory decisions regarding the environmental safety of GM crops.

The Western Ecology Division team included **Connie Burdick, Anne Fairbrother, E. Henry Lee, Jay Reichman, Lidia Watrud,** and National Research Council fellow **Peter Van de Water.**

Contact:

watrud.lidia@epa.gov

Western Ecology Division's Jay Reichman, Connie Burdick, Lidia Watrud, E. Henry Lee, and Anne Fairbrother enjoy a celebration after the announcement of their EPA Gold Medal for Service Award and Level I STAA Award.

MERCURY FOUND IN ALL FISH FROM WESTERN U.S. STREAMS

Aquatic environments face increasing threat from mercury contamination and its potential harm to humans and wildlife. Western Ecology Division scientists **Spencer Peterson** and **John Van Sickle** recently completed a study of mercury contamination, based on collection and analysis of 2,707 fish samples from 626 sites in the western United States.

All fish tested contained mercury above detection limits (0.002 ppm). From this sampling, the scientists were able to estimate the length of streams affected by various mercury levels across the entire region.

An applied statistical sampling design was used to assess the condition of streams relative to mercury concentrations in fish. Salmonids like cutthroat and rainbow trout were the most common large fish to be tested in an estimated 125,000 km of the stream length in the region.

Salmonids exceeded the levels that would potentially affect fish-eating mammals like otter and mink in 11% of the assessed streams, and exceeded the levels that would potentially affect humans in 2.3% of streams tested.

However, fish accumulate mercury predominantly through their food, and predatory fishes accumulate higher concentrations of mercury than plant and insect-eating ones. In addition, mercury concentration increases as fish age and grow.

For predatory fish, mercury levels were almost three times as high as in herbivorous fish; they exceeded the levels that would potentially affect fish-eating mammals in 93% of the assessed streams, and exceeded levels that would potentially affect humans in 57% of assessed streams.

So, although these larger fish-eating fish are less widespread, they present a greater potential risk to sensitive consumers. Mammals (including humans) and birds that consume them greatly increase their exposure to mercury and its potential neurological effects.

Testing methods were developed which potentially have less impact on fish populations. Scientists had already done studies showing that small core samples of muscle had a direct proportion to the mercury levels in the whole fish, so it was possible to test with a biopsy sampling method that was generally not lethal to the fish.

Earlier studies required the use of whole-fish samples, (left) but new methods use biopsy sampling

Study Results:

Where does mercury enter the aquatic food chain? Peterson and Van Sickle concluded that the finding of mercury in nearly all tested fish suggested atmospheric deposition, rather than point source contamination. Atmospheric deposition occurs when a substance is carried in the upper atmosphere, and deposited far— sometimes thousands of miles— from its original source, for example, from coal-burning factories in China.

Contact Spencer Peterson: peterson.spencer@epa.gov

Read more about this study in Vol 41, No. 1:2007 issue of *Journal of Environmental Science and Technology.*

Wildlife may be at greater risk than humans for mercury poisoning since their mercury tolerance levels are lower

WED RESEARCH SHEDS LIGHT ON INTERMITTENT STREAMS

"seasonal streams provide disproportionately higher spawning and winter rearing for Coho salmon"

The U.S. Supreme Court recently heard cases that affect whether "intermittent" streams fall under the jurisdiction of the Clean Water Act.

Intermittent, or seasonal, streams, run during only part of the year. The ecological significance of such streams is receiving increasing attention, but information about their influence on fish populations has been limited.

A team of scientists at Western Ecology Division, led by **Jim Wigington** and **Joseph Ebersole,** has completed a major new study which focuses on these seasonal streams, and Supreme Court justices had the opportunity to review the study's findings as part of their preparation for the cases.

Presence of commercially important species like Coho salmon would be a significant consideration, since Coho spawn in the seasonal streams of the Oregon coastal mountains.

The team's research in a coastal Oregon watershed showed that seasonal streams provide disproportionately higher spawning and winter rearing for Coho salmon than the remainder of the stream network.

Residual pools in these streams also provide a place for the juvenile salmon to survive during dry periods. Loss of seasonal stream habitat would have a negative effect on Coho populations in coastal drainages.

Employing a tagging technology that utilizes "passive integrated transponders" (PIT), the scientists tracked the survival, movement and growth of thousands of juvenile Coho salmon throughout the stream network, and found that seasonal streams were an important source of Coho salmon smolts.

This research demonstrates the potential of seasonal streams to provide important ecological benefits to downstream waters, and could have far-reaching impacts on the Clean Water Act.

Denis White, M. Robbins Church, Scott Leibowitz, Renée Brooks, and **Jana Compton** also took part in the study, whose findings were published in the December 2006 issue of "Frontiers in Ecology & the Environment". Contact: wigington.jim@epa.gov

ESTUARINE HABITAT RESEARCH

*Dungeness crab (*Cancer magister*) is common in Pacific Northwest estuaries*

Some estuarine habitats play more crucial roles than others by supporting high animal diversity or providing important ecosystem services, such as food production or nursery grounds for ecologically or economically important species. WED scientists **Steve Ferraro** and **Faith Cole** recently completed a multi-year study in a Pacific Northwest estuary to determine how populations and communities of fish, crabs, shrimp, and other creatures (animals collectively called "nekton") vary among intertidal habitats.

Three of the 4 habitats in their study were defined by the presence of "ecosystem engineering species": plants and animals which, by their physical structure or behavior, create habitat for different nekton prey organisms and provide different types and degrees of shelter from predation. The fourth habitat was bare sand.

The study found strong and temporally robust associations between the nekton and the habitats. In general, the rank order of habitats in richness, abundance, and diversity was eelgrass > mud shrimp ≥ ghost shrimp ≥ bare sand.

The research results confirms the biological relevance of the habitats, and provides quantitative tools for identifying critical habitats, prioritizing habitats for environmental protection, and predicting the consequences of habitat changes on nekton populations and communities. Contact: ferraro.steven@epa.gov

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WESTERN ECOLOGY DIVISION SCIENCE REACHES AROUND THE WORLD

Peter Beedlow continues to assist EPA Region 10 (Alaska, Idaho, Oregon & Washington) and the state of Alaska in identifying potential effects of climate change in Alaska. Beedlow previously had conducted research on the effects of rising atmospheric CO_2 on Pacific Northwest forests. The effects of climate change could have a major impact on the environment and economy of Alaska. The EPA Administrator's Office assigned Region 10 the study, and they requested the assistance of Dr. Beedlow. Contact: beedlow.peter@epa.gov

Robert Lackey presented a lecture at the annual meeting of British Columbia's Ministry of the Environment in Victoria in October. Dr. Lackey summarized the results of the *Salmon 2100 Project.* Protecting remaining salmon populations in British Columbia and elsewhere in the Pacific Northwest continues to be a dominant environmental science and policy issue. Contact:

lackey.robert@epa.gov

Thomas Pfleeger and **David Olszyk** were invited to the Society of Environmental Toxicology and Chemistry/ Europe to present a paper on Pesticide Risk Assessment in May 2006. The paper, 'Using field grown potatoes to test for non-target plant effects from pesticides', outlined the authors' work with pesticide "drift", or the ability of pesticides to have an impact on plants outside their intended target area. Olszyk and Pfleeger also took part in discussions with European and Canadian scientists. Contact:

pfleeger.thomas@epa.gov

right: pesticides are commonly applied to food and other crops, as well as in homes and gardens

Henry Lee II provided scientific support to EPA's Office of Water during International Ballast Water Treaty discussions at the United Nations' International Maritime Organization. Lee's assistance was requested in addressing treaty language dealing with risk assessment for ships traveling between designated ports. A single liter of ballast water can contain dozens of different species and thousands of organisms; ballast water discharge is subject to biologically-based standards, including guidelines for restricting introduction of invasive species when ballast water is discharged in U.S. ports.

Contact: lee.henry@epa.gov

Leaders of *ONAMI—Oregon Nanoscience and Microtechnologies Institute*—met with Western Ecology Division Director **Thomas Fontaine** to talk about collaborative research on the effects of manufactured nanomaterials in natural systems. (Materials reduced to the nanoscale may suddenly have very different properties.) Of special interest is the potential use of WED's micro- and meso-cosms (sealed enclosures containing natural system components) for assessing ecological effects of nanomaterials, including how their physical and chemical properties can be related to their effects.

Jay Reichman traveled to Russia as part of an EPA team in a joint project with the US Department of State and the Ministry of Health of the Russian Federation. Goal: help Russian scientists adapt a former biological weapons plant for use as a risk assessment research facility, learning from research experiences at Western Ecology Division. Russian officials contacted EPA several years ago with a proposal to set up the cooperative program. Their scientists were recently able to procure genetic material to use in their research, which will help inform regulation of the fledgling agricultural bio-technology industry in that country. Contact: reichman.jay@epa.gov

Local high school students will benefit from the world-class scientific expertise resident at the Western Ecology Division in Corvallis, Oregon. **Ron Waschmann** has signed on to give technical and scientific assistance to Corvallis High School's biodiesel project. Biodiesel is a domestic, renewable fuel derived from natural plant sources. Using a research grant from Hewlett Packard, the students will investigate and compare the effects of biodiesel and gasoline fuel emissions on plant life. Students from biology, chemistry, horticulture and automotive classes will design, build, and operate open-top chambers to conduct their experiments.

Contact:

waschmann.ron@epa.gov

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CLIMATE CONDITIONS SIMULATED IN TERRACOSMS

The "grassland ecosystems" in Jillian Gregg's planter boxes don't look particularly unusual. But as the plants from Oregon's upland prairie ecosystem go through their growing cycle, they are being closely monitored for their reaction to artificially elevated temperatures that simulate climate change. The US Department of Energy's Climate Change Research Division has leased the unique teracosm research facility at Western Ecology Division, one of the few facilities of its kind in the nation. Principal investigator Jillian Gregg explains that the project's goal is to determine the effects of symmetric versus asymmetrically higher temperatures on the plants. *Symmetric warming* means that temperatures are elevated by the same amount over a 24-hour period. *Asymmetric warming*—which scientists have now documented—means that minimum dawn temperatures are more affected by climate change than mid-day maximum temperatures.

Jillian Gregg checks on plants growing in one of the mesocosms

Asymmetric warming could have a negative effect on plants, due to increased respiration and reduced growth overall. Or, conversely, the longer growing season with warmer minimum temperatures could increase plant growth. Gregg's three-year experiment should provide definitive answers.

The outdoor sunlit plant growth chambers, or teracosms, house the plants, giving year-round control of temperature, humidity, CO_2, soil moisture, and fertility under natural sunlight. Plants are grown in soils reconstructed to be as similar as possible to natural soils.

Gregg is a researcher working for Terrestrial Ecosystems Research Associates.

Contact:

gregg.jillian@epa.gov

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SCIENTISTS ASSESS FISH, STREAMS

New model could improve salmon management:

Computer simulation models are a valuable tool for addressing a wide range of management options. **Scott Leibowitz** has created a spatially-explicit simulation model for coho salmon. This model uses either actual stream networks to study specific management options or randomly generated stream networks to realistically represent a broad range of stream network conditions. This modeling tool provides EPA decision-makers with better information to meet the requirements of the Endangered Species Act and the Clean Water Act. Contact: leibowitz.scott@epa.gov

Many factors affect young salmon & steelhead:

Warm summer temperatures in streams of the Pacific Northwest can create stressful conditions for fish requiring cold water, like salmon and trout. Colder water from springs can enter streams, and create small pockets of refuge for fish, but **Joe Ebersole** has found that fish also respond to refuge depth, dissolved oxygen levels, and other factors, suggesting that cold water alone may not be sufficient to create a useful refuge in warm weather. The information will be useful in efforts to protect and restore stream habitats for salmon and trout. Contact: ebersole.joseph@epa.gov

Book is long-awaited outcome of "Salmon 2100"

The goal of the Salmon 2100 Project, organized by EPA fisheries biologist **Robert Lackey**, was to identify options that would have a high probability of success in restoring significant, sustainable runs of wild salmon in the Pacific Northwest. The resulting book provides a summary of practical policy prescriptions, says Lackey. Former EPA head William Ruckelshaus was keynote speaker at the project's January 2006 conference in Portland, Oregon, and each of the project's participating salmon experts and policy analysts contributed a chapter to the book, now available through American Fisheries Society (www.afsbooks.org). Contact: lackey.robert@epa.gov

Stressors on salmon include fishing , dams, disease, logging, and habitat degradation

SCIENCE...REACHING AROUND THE WORLD

Don Phillips traveled to universities in Brazil and Uruguay to consult with scientists on stable isotope analysis and modeling for an international study on estuarine food webs. Coastal lagoons in the two countries are important as feeding, reproduction, and nursery areas for a number of marine and terrestrial plants and animals, but are vulnerable to a variety of human-caused stressors. Phillips was invited to participate because of his role in developing modeling techniques using stable isotopes as environmental tracers. This project will foster collaboration and good-will in the international environmental research arena.

Contact: phillips.donald@epa.gov

Tom Pfleeger traveled to Majuro in the Marshall Islands for a three-month appointment as an Embassy Science Fellow. Pfleeger's assignment: evaluate critical environmental problems, and recommend solutions. Top priorities included creating a sustainable solid waste disposal and recycling program, and exploring sources of renewable energy. The island nation's fragile coral reef ecosystem constitutes its major potential for economic development through ecotourism, fishing and aquaculture. Contact: pfleeger.thomas@epa.gov

Biodiesel from coconuts is one of the options that could help cut down on imported oil in the Marshall Islands

LAST WORD: BLUEBIRDS OF THE WILLAMETTE

Nathan Schumaker and former EPA post-doc researcher **Laura Nagy** weren't your typical bird-watchers....they were evaluating the western bluebird as part of a 2-year study that is helping reveal how birds in the wild respond to stressors in their environment.

Schumaker and Nagy studied birds in the Willamette Valley, Oregon, measuring reproduction and survival to evaluate how birds cope with pesticides, habitat change, and other environmental stresses.

Their study demonstrates the value of PATCH (Program to Assist in Tracking Critical Habitat), a spatially explicit "life history" model developed by Schumaker.

PATCH is easily adaptable to the needs of researchers; with the input of data like habitat maps and reproduction rates, it can project where species will be found as the landscape changes over time, and predict increases or decreases in population density.

Schumaker and Nagy's database includes all information required to run a population model, including data on survival and reproduction rates. This database will consolidate all the required data in a summarized form.

Western Bluebird is examined and released

Ecological risk assessors throughout EPA will benefit from the improved model. Contact:

schumaker.nathan@epa.gov

United States Environmental Protection Agency
Office of Research & Development
National Health & Environmental Effects Research Laboratory
Western Ecology Division
200 SW 35th Street
Corvallis
Oregon 97333-4996

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