Streamside Runoff

CENTER FOR STREAMSIDE STUDIES

Summer/Fall 2002
Volume XIV, No. 2

The mission of the Center for Streamside Studies is to provide the necessary information for the resolution of management issues related to the production and protection of forest, fish, wildlife, and water resources associated with the streams and rivers in the Pacific Northwest.

Message from the director:
new Center for Water and Watershed Studies

I am pleased to announce the formation of a new center at the University of Washington with an emphasis on Pacific Northwest watersheds: the Center for Water and Watershed Studies.

On September 1, 2002, two centers that have each been active for more than a decade—the Center for Streamside Studies and the Center for Urban Water Resources Management—will be merging, creating a strong regional center with a long and established record of research and outreach across the varied landscapes of the Pacific Northwest. The three objectives of the Center for Streamside Studies (CSS), research, education, and information transfer, will continue under a broader umbrella of interdisciplinary watershed studies encompassing diverse aquatic and human environments.

Dr. Susan Bolton, director of CSS and co-director of CWWS, and Clare Ryan, interim co-director of the CWWS.

CSS was created in 1987 as a result of the controversies concerning the management of forest, fish, wildlife, and water resources in the Pacific Northwest. The Center for Urban Water Resources Management (CUWRM) was established in 1991 with a more explicit focus on the consequences of urban land development on the region's water resources. Because good water management is critical for people and the environment, successful balancing of water supplies with water demands requires a broad range of disciplinary knowledge, research, and information. By merging these two centers, students, faculty, and off-campus collaborators will improve the value of research and educational outreach to the region.

Scientists trained in the Center's programs and methods will meaningfully contribute to decision-making and bring sharper attention to effective methods for sustaining, restoring, and rehabilitating watersheds. Practical application and policy decisions based on knowledge developed from the Center's work can change the way the Pacific Northwest regards and uses water, such as developing multiple uses of the same water, rehabilitating ecosystems damaged by ignorance or carelessness, and achieving better balance between demands on water and water resources. Through outreach, the Center will create new opportunities for exchanging information addressing these issues.

The Center for Water and Watershed Studies will be a source for aquatic and water management information, directed toward restoring and maintaining earth's water resources. The methods and research developed by the Center will provide models for solving both regional and global watershed issues. Moreover, the Center will offer formal structures and opportunities for additional interaction between researchers and professors, while building a broad, collaborative community of environmental interest and participation.

Over the past few years both CSS and CUWRM have worked together closely, and I see this merger as a natural step towards a more efficient and effective way to gather and disseminate research information. The new center will be under the leadership of Dr. Derek Booth, the director of CUWRM, and myself. However, over the next year while I am on sabbatical, Dr. Clare Ryan, professor of natural resource policy in the College of Forest Resources, will be acting co-director.

I have enjoyed being director of the Center for Streamside Studies for these past five years and look forward to the opportunities that the new Center will provide.

Susan Bolton

The effect of salmon nutrients on aquatic insects

Spawning salmon bring large quantities of marine nutrients into freshwater ecosystems. For example, Kennedy Creek, which drains into the southern end of the Puget Sound, receives up to 85,000 chum spawners in its approximately 4 km of available spawning habitat—about 3.5 kg of nutrient-rich salmon tissue per square meter of stream and riparian area (using an individual salmon mass of 5 kg and 10 m for the riparian zone on either side of a 10 m channel). Historically, this amount may have been even greater, particularly on other Pacific Northwest streams where salmon runs are currently much more depleted than Kennedy Creek.

Researchers have traced salmon nutrients to many different types of organisms, from freshwater invertebrates and fish to birds and bears and even to streamside vegetation. These organisms take up the nutrients by feeding directly on salmon eggs and spawned-out carcasses, incorporated dissolved nutrients (e.g., algae and fungi), or feeding on other organisms that have taken up salmon nutrients. Streams that are fertilized by salmon nutrients are hypothosized to be more productive than streams that receive relatively few or no salmon.

While the disturbance caused by digging redds can decrease insect populations initially, insect production may be subsequently increased by the availability of salmon nutrients. Long after the salmon carcasses and eggs have been consumed or decomposed, increased insect production would benefit the hatching fry and salmonids that remain in streams because insects are an important food source for them.

Past research has demonstrated that insects are attracted to and consume salmon carcasses and eggs, insect growth-rate increases with consumption of salmon muscle tissue, and more insects occur in local areas around salmon carcasses. These findings show that many individual insects eat salmon, potentially making insects significant consumers. However, given that streams are highly variable habitats that are frequently disturbed by high water flows, does the availability of marine nutrients really result in more insects overall? To answer this question, we are measuring aquatic insect *production*, the amount of biomass (or energy) produced in a given area over a given amount of time, commonly measured as g per m^2 per year. In this case we are comparing insect production in Kennedy Creek upstream and downstream of a series of waterfalls that prevents upstream salmon migration.

Jon Honea collects invertebrate samples in Kennedy Creek.

By tracing the pathways of stable isotopes of carbon and nitrogen through the stream food web, we can investigate the cause of differences in insect production. Marine-derived nutrients delivered by adult salmon have a carbon and nitrogen signature distinct from other nutrient sources available in Pacific Northwest streams. This distinction facilitates tracking salmon nutrients through the downstream insect community. Where relatively higher downstream production occurs in the insects shown to incorporate salmon nutrients, a strong causal argument can be made for the benefits of salmon carcasses. In addition, confidence intervals for insect production estimates will identify the strength of production response to salmon nutrients; environmental data will reveal or rule out other explanations for production differences; and past research will provide strong evidence supporting links between salmon carcasses and stream insects as well as provide additional examples of links between increases in stream nutrients and enhancement of production.

After two years of benthic sampling for insect production and analysis (with the help of dedicated lab assistants on the microscopes!), preliminary results show that the stream bed disturbance caused by salmon spawning activities severely impacts the insect community, reducing density and perhaps even diversity. However, one to two months after spawning disturbance ends, the insect community in the downstream spawning reach is similar to that in the upstream reach with no spawners. Recovery is likely aided by fertilization of the stream by salmon nutrients. Results of the stable isotope analysis show substantial quantities of salmon-derived carbon and nitrogen in insects shortly after spawning had ceased. For example, heptageniid mayflies in the spawning reach showed a relative enrichment of salmon-derived carbon and nitrogen of approximately 50% more than their upstream counterparts about one month after spawning began in late October. Enrichment remained very high through February and finally decreased in late May to levels similar to those before spawning. Perlid stoneflies, rhyacophilid caddisflies, and tipulid craneflies all showed similar patterns, but remained highly enriched in salmon carbon and nitrogen even through the last isotope sample date in May, perhaps due to the slower turnover time in these much larger insects.

The case study of Kennedy Creek is an important step in understanding the ecology of marine nutrients in salmon spawning streams. The results of this research will aid restoration and conservation efforts by providing a greater understanding of the role of salmon nutrients in aquatic insect community dynamics and the importance of insects as a link between generations of salmon.

(*Jon Honea is working on his Ph.D. in the College of Forest Resources.*)

Total suspended solids from stream crossing obliteration in the Clearwater National Forest, Idaho

During the 1950s through the 1970s extensive road networks were constructed in the Clearwater National Forest (CNF) in north central Idaho to accommodate tractor and "jammer" logging systems. Over time many of these roads have become obsolete because of decreasing timber harvest and advances in timber harvest technology, especially increased yarding distances. As a result, countless roads were simply abandoned and became overgrown. The dense brush and other vegetation that hid these roads also misled many people into believing they were stable. However, in late November to early December 1995 and February 1996, northern Idaho was hit by heavy rains on a deep snowpack, resulting in two flood and landslide events of historic magnitude, demonstrating the actual instability of many of these once forgotten roads. In the wake of these storm events, a significant increase in landsliding and sediment delivery to streams ocurred. In fact, of over 900 landslides identified in the Clearwater National Forest alone, an estimated 58 percent were determined to be road-related failures. Thus, roads were deemed the major contributor of sediment to streams beyond natural background rates. The need for an aggressive road decommissioning program became apparent. In 1996, the CNF accelerated its road decommissioning program, treating about 644 km of road through 2001. Prescriptions included numerous road-stream crossing obliterations.

Road-stream crossing obliteration is the complete removal of this transportation facility from the landscape. In the CNF, this typically means the use of heavy equipment and manual labor to install mitigation measures such as flow diversions and sediment traps; remove drainage structures such as culverts; pull back through fill material until a desirable stream grade and side slopes are attained; install energy dissipaters such as rootwads and rock or log weirs to mimic the historic channel morphology; and implement erosion control measures such as seeding and mulching. However, even with the utmost care and best of intentions one can only hope to minimize the sediment input to streams from this type of work, not eliminate it. Concern about processes of erosion and sedimentation instigated by human activity is especially high on the granitic soils of the Idaho Batholith, upon which a portion of the CNF exists, where sedimentation damage to valuable anadromous fishery resources in the headwaters of the Columbia River Basin is a critical issue.

In a pilot study, I investigated the effects of forest road-stream crossing obliteration on the short-term sediment production regime of several perennial headwater streams discharging 0.35 to 0.40 liters per second. Research objectives included determining the significance of the short-term increases in total suspended-solid concentrations and turbidity; describing changes in sediment yield; comparing the effectiveness of various sediment trap configurations; documenting currently accepted obliteration techniques; and compinge results to Idaho state water quality standards for streams with an aquatic life use designation.

Filled sediment trap that is no longer serving its function. Flow is able to go around the trap unmitigated.

A strong correlation (0.918) between total suspended-solid concentrations and turbidity was found for these streams, allowing for a linear regression analysis and subsequent estimation of missing turbidity data. Using this information, it was determined that the use of two sediment traps, even when they were not 100 percent functional, for the most part, kept the turbidity from exceeding the state standard. Total suspended-solid concentrations ranged from 2 to 5 milligrams per liter upstream to 3 to 70,000 milligrams per liter downstream, with the highest concentrations experienced where no mitigation (diversion or sediment traps) was used. As the number of sediment traps increased from 1 to 2, the downstream peak concentrations decreased an order of magnitude from 30,000 to 3,000 milligrams per liter. Although monitoring was completed before any of the sites achieved background values, total suspended-solid concentrations and turbidity were elevated with respect to background levels for at least 24 to 48 hours, albeit extreme differences in concentration were of very short duration. Sediment yields ranged from 90 kilograms at the unmitigated site to 3 kilograms at the highly mitigated sites with two sediment traps.

Additional results and discussion can be found in the thesis Short-term total suspended-solid concentrations resulting from road-stream crossing obliteration in the Clearwater National Forest, Idaho, due out in December 2002. This was intended as a pilot study for further investigation of the effects of this type of work on aquatic ecosystems planned for the Clearwater National Forest by Dr. Randy Foltz (rfoltz@fs.fed.us) of the Rocky Mountain Research Station Forest Sciences Laboratory in Moscow, ID.

(*Tim Brown just finished his Master of Science thesis in the College of Forest Resources and will be continuing on for a Ph.D. in Civil and Environmental Engineering at the University of Washington.*)

Announcements

Restoration book

The Restoration of Puget Sound Rivers edited by Montgomery et al. will be out in early November from UW Press. For more information, contact Leslie Wall at the Center.

CONGRATULATIONS

Sandra Clinton is moving to the Bay area to work as a researcher at the University of California-Berkeley. CSS will miss her, but we wish her all the best.

Congratulations to the following students who completed their degrees: **Kevin Brinck** *Measuring metrics, which yardstick will tell me what I want to know?* (MS, Quantitative Ecology and Resources Management); **Tim Brown** *Short-term total suspended-solid concentrations resulting from road-stream crossing obliteration in the Clearwater National Forest* (MS, Forestry); **Gardner Johnston** *A comparison of historic and current stream shade in eastern Washington* (MS, Forestry); **Derek Stuart** *A study of periphyton induced pH fluctuation on the White River, Washington* (MS, Civil and Environmental Engineering)

CALENDAR OF EVENTS

October 1 – December 3, 2002 **Tuesday Morning Seminars**, 8:30 – 9:30 am, 22 Anderson Hall, UW Campus. For a schedule, contact Leslie Wall at 206.543.6920, cssuw@u.washington.edu.

October – December 2002, **NMFS Northwest Fisheries Science Center seminars** (co-sponsored by CWWS), Thursdays, 11:00 am – 12:00 pm, Northwest Fisheries Science Center, 2725 Montlake Blvd. East.

February 6, 2003 **2003 Annual Review of Research**, HUB West Ballroom, University of Washington campus.

February 10, 2003 **Walker Ames Lecture by Dr. Robert Costanza**, systems ecologist and ecological economist.

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