



Streamside Runoff

CENTER FOR STREAMSIDE STUDIES

Urban Stream Rehabilitation in the Pacific Northwest: Physical, Biological, and Social Considerations

Winter/Spring 1998
Volume X, No. 1

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.

Last spring, the Center for Urban Water Resources Management was awarded a three-year grant from the joint National Science Foundation/U. S. Environmental Protection Agency interdisciplinary program, "Waters and Watersheds." The project was developed by four faculty from the University of Washington, Derek Booth and Stephen Burges (Civil Engineering), Sally Schauman, (Landscape Architecture), and James Karr (Departments of Fisheries, Public Affairs, and Zoology). In addition, several graduate students in departments across campus—Chris Konrad and Marit Larson (Civil Engineering); Sarah Morley (Fisheries); Stephen Kropp (Marine Affairs); and Sandra Salisbury, Karen Billica, and Cory Parker (Landscape Architecture)—have begun working on various aspects of this project, together with what we hope to be the active and ongoing participation of water-resource agencies across the region.

Urban streams are degraded streams; this much is common knowledge. Society is eager to "rehabilitate" these streams and to limit future damage as new areas are urbanized. Any framework for rehabilitation or protection must be grounded in an understanding of the specific factors responsible for degradation, their consequences, and the causal pathways linking them to human activities. With an improved understanding of what determines stream condition in urban areas, we can better evaluate prospective rehabilitation "candidates;" define realistic rehabilitation goals; guide the design of successful rehabilitation projects; and limit damage to high quality aquatic systems through improved planning, design, construction, and manage-

ment in urban areas. Our overall goal in this project is to document the consequences of urban development on the physical and biological condition of urban streams and to use that knowledge to demonstrate specific rehabilitation strategies likely to restore valued properties of those systems.

Since the beginning of the project in April 1997, we have accomplished several tasks:

1. Site selection for examining process and elemental changes and cultural context of stream degradation.

We have selected eighteen sites that span a gradient from low to high urbanization. Since highly urban streams exhibit cumulative changes in almost every physical and biological condition, our sites emphasize the lower end of this spectrum, where degradation can be seen incrementally, in an effort to define critical causal mechanisms that initiate degradation. Physical, biological,

and social conditions have been characterized for all sites, though there are four areas of special emphasis for evaluating processes of stream degradation.

a) Benthic macroinvertebrates - The condition of the stream biota are being evaluated with the benthic index of biological integrity (B-IBI). To supplement an expanding data base on streams from the Puget Sound lowlands, we have selected sites exhibiting a wide range of B-IBI scores within a relatively narrow band of total impervious area (total impervious area 3 to 30%). By focusing on the subtle yet biologically

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important differences in watersheds that are not captured by simplistic measures such as gross impervious area, we expect to improve our understanding of the important processes responsible for degradation.

Closer examination of the links between physical and biological characteristics of streams will also enable us to gauge the sensitivity of specific index metrics to physical, chemical, and biological processes. This information will be particularly useful in applying IBI as a diagnostic tool in the evaluation of rehabilitation projects.

b) Channel form - We seek to identify the changes in urban stream flow patterns and activities in riparian zones which modify channel-forming processes as well as the consequent channel geometry and its longitudinal (downstream) variation. Paired sites, and multiple sites along a single stream system, should help us isolate the effects of riparian intrusion and more frequent high discharges from urban catchments. Parallel, long-term studies (>10 years) at nearby sites will improve our ability to set these short-term measurements in a broader context.

c) Bed sediment - Stream beds represent a nexus whereby urban activities clearly produce changes in ecologically-relevant stream conditions. Stream bed conditions include structural features of the bed such as grain size distribution and abundance of fine material as well as process characteristics such as the frequency and areas of bed mobilized and fine sediment deposition. These conditions have direct bearing on many elements of benthic communities including periphyton, invertebrates, and fish embryos.

d) Cultural landscape - We seek to understand how differences in land use and direct human interactions with stream systems influence stream condition. Understanding patterns and characteristics more subtle than gross impervious area should help us better evaluate the social contributions to degradation and the social potential of managing rehabilitation.

2. Evaluation of visual preferences for rehabilitation design and human behaviors exhibited to-

ward urban riparian areas and rehabilitation designs.

a) Visual preferences - One masters' thesis has already been completed on the preliminary evaluation of visual preferences for typical restoration techniques.

b) Observed behaviors - An initial scoping study of observed behaviors towards urban riparian systems has been made. In this survey, focused interviews were conducted with 18 respondents who had day-to-day working knowledge of local riparian systems. We asked them to list and to describe the activities that nearby residents undertook relative to either the stream or the riparian corridor. This list will provide us with an initial set of terms that describe human interactions with urban streams.

3. Assessment of rehabilitation project costs and outcomes.

Although this topic is a primary focus only in subsequent project years, some efforts are beginning. Available data, primarily from the largest stormwater management agency in the region, is being collated to determine "true" (i.e. actual end-of-construction) costs. We are also beginning to compile the available data on biological and physical characteristics of stream channels, before and after construction of stream-rehabilitation projects, in order to start quantifying benefits and to identify where additional targeted monitoring in year two of this project will be most beneficial. In subsequent years of the project, we look to apply an improved understanding of degradation processes to the very tangible problems of minimizing urban consequences on natural stream systems, long-term, with only limited available resources.

Derek Booth is the Director of the Center for Urban Water Resource Management, Research Assistant Professor in Civil Engineering, and holds adjunct appointments in the College of Forest Resources, the Departments of Geological Sciences and Landscape Architecture at the University of Washington.

NEW LOCATION FOR 8TH ANNUAL REVIEW!

CSS will hold its 8th Annual Review in the Husky Union Building (HUB) West Ballroom instead of South Campus Center. Parking is available in the Central Plaza Garage and Paldelford Parking Garage for \$6.00. There is no registration fee and everyone is welcome to attend. If you would like a copy of the agenda, or have any questions, call Leslie at (206) 543-6920.

Calendar of Events

8th Annual Review - January 29th, 1998 from 8:00 AM to 4:00 PM, **NEW** location: HUB (student union building) West Ballroom.

Salmon and the City - May 20 & 21, 1998, co-sponsored with the American Public Works

Association and others. The conference will discuss salmon habitat. Further details will be announced as the date approaches.

Riparian Conference - Autumn 1998, co-sponsored with the Society for Ecological Restoration. Details TBA.

Interactions of Salmon, Bear and Riparian Vegetation in River Corridors of the Pacific Northwest

Interactions between Pacific salmon (*Oncorhynchus spp.*) and bear (*Ursus spp.*) may play an important role in influencing the stature and dynamics of riparian vegetation. It has been known for some time that anadromous salmon returning to their natal streams make significant contributions of marine-derived carbon and nutrients to the aquatic ecosystem. These inputs enhance productivity at various trophic levels within aquatic food webs, but they may also fertilize riparian vegetation. Preliminary data suggest that marine-derived nutrients accumulate in riparian vegetation, and that this enrichment is enhanced where the influence of bear is strongest. Bears may act as an important vector for moving nutrients from the stream to the riparian zone through the killing and consumption of salmon and subsequent deposition of carcasses and feces within the riparian forest. Inputs of marine-derived nutrients may enhance growth rates of riparian trees and influence the production of large woody debris, which may in turn affect structural habitat and productivity within the stream corridor.

The objectives of this project are to determine the extent to which riparian vegetation acquires marine-derived nitrogen from spawning salmon; to assess the impacts of marine-derived nutrients on riparian growth and community composition; and to assess the relative importance of bear activity (e.g., carcass and feces distribution) and hyporheic flow as pathways for transfer of nitrogen (N) from stream to riparian systems. The principal methods used in the evaluation of these objectives are the measurement of naturally occurring stable isotopes ($^{15}\text{N}/^{14}\text{N}$) and experimental manipulation of salmon carcasses and bear feces. The significance of this research lies in the discovery of how synergistic interactions between salmon and bear can act to influence riparian forests, and how materials from those forests act to influence the strength of salmon populations.

Jim Helfield is a doctoral student in Forestry working with Bob Naiman and Bob Bilby. Jim will be presenting at the Annual Review in January.

Residence Time of Large Woody Debris in the Queets River, Washington

Instream large woody debris (LWD) provides a number of useful functions in freshwater ecosystems, including sediment and nutrient retention, salmonid habitat enhancement, and stable colonization sites for incipient floodplain vegetation. In this study increment cores from instream LWD were crossdated against cores from living riparian conifers to estimate the year each LWD piece was recruited to the channel. Debris pieces that were decayed or otherwise incompetent to provide cores were dated using standard ^{14}C techniques. Size and species composition were compared to that of the riparian forests from which the LWD originated. The depletion rate of LWD from the channel followed an exponential decay curve in which most LWD pieces were not more than 30

years old, although several pieces have remained in the channel for 300 years or more. Hardwood species were better represented in riparian forests than as instream LWD, and conifers were better represented as LWD than in riparian forests, indicating that hardwoods are depleted from the channel faster than conifers. An assumed long-term equilibrium between LWD recruitment and depletion suggests that harvesting of large conifers from riparian forests could have deleterious impacts to streams within three decades.

Tim Hyatt is a Master's student in Forestry working with Bob Naiman and Pete Bisson. He will be presenting at the Annual Review.

Effects of Acid Mine Effluent and Waste Rock Leachate on Watershed Ecology

The Alder mine is an inactive and abandoned gold, silver, copper, and zinc mine in Okanogan County, WA. It produces acidic metal-rich effluent that affects the quality of water in a mountain headwater stream. The results of a preliminary study conducted in August of 1997 indicate that the concentrations of heavy metals in the stream were above water quality standards and that the density and diversity of benthic macroinvertebrates were less below the mine than above. The evolution of carbon dioxide was elevated in soil and decomposing logs where groundwater was contaminated by acidic mine effluent. The pH of the

mine effluent was 4.5 where it flowed into the ground, increased to 5.5 as it flowed towards the creek and reached normal levels (6.5) when it eventually mixed with the water in the creek. The Alder Creek watershed, therefore, is a good site for experiments to test the hypothesis that chemical criteria do not measure the secondary effects of chemical pollution such as bioconcentration and bioaccumulation.

Dan Peplow is a Master's student working in Forestry with Bob Edmonds. He will be presenting at the Annual Review.

WELCOME

CSS would like to welcome several new graduate students. Dan Peplow is working on acid mine effects on watershed ecology with Bob Edmonds. Graham Mackenzie and Jon Honea are working on a proposal with Bob Gara and Rick Edwards about pathways of marine-derived nutrients from decomposing salmon carcasses through stream to terrestrial trophic webs. Nancy Gove is studying the effects of land use on nutrients in streams with Loveday Conquest. CSS would also like to welcome Jane Cassady as the Research Coordinator for the EPA Ecosystems Research Consortium.

Deans Thorud and Nowell have appointed Dr. Susan Bolton as Director of CSS and have recommended to the president of the University of Washington that Susan receive the Corkery Chair.

GOOD LUCK!

Sylvia Kantor worked at CSS from 1993 to 1996 as a graduate student, then as a program assistant, and later as program manager - essentially running the Center for Streamside Studies. She left in 1996 to work full time editing the book, River Ecology and Management: Lessons from the Pacific Coastal Ecoregion, which is now in press with Springer-Verlag in New York and is expected in Spring of 1998. Best of luck!

CONGRATULATIONS

Congratulations to Barry Thom who earned his Master of Science: The effects of woody debris additions on the physical habitat of salmonids: a case study on the Oregon coast.

Thanks to everyone who contributed articles for this issue of Streamside Runoff.

The Center for Streamside Studies is a joint effort of the College of Forest Resources and the College of Ocean and Fishery Sciences

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In this issue:
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