Streamside Runoff

CENTER FOR STREAMSIDE STUDIES

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The mission of the Center for Streamside Studies is to provide the scientific information necessary 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.

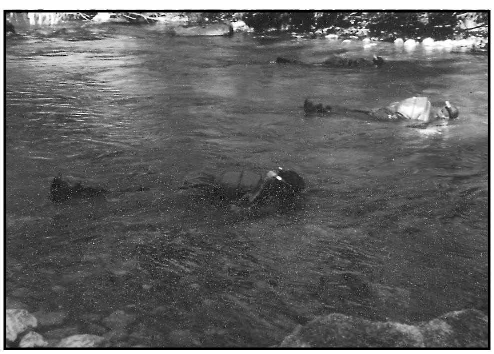
The return of the salmon:

An experiment to study the return of anadromous salmonids above Landsburg Diversion, Cedar River, Washington

Protection and rehabilitation of freshwater habitat and associated watershed processes are critical to conservation and restoration of Pacific salmon. There are a number of small diversions and dams, such as Landsburg, that block migration of adult salmon in the Pacific Northwest. Barrier removal or installation of passage facilities at these structures will likely be an important measure in restoring access to freshwater habitat. These blockages not only restrict access to spawning and rearing areas, they sever an important link — subsidies of marine-derived nutrients supplied via adult salmon — between oceans and rivers that is critical to the structure and function of watersheds in the Pacific Northwest.

The National Marine Fisheries Service's (NMFS) Northwest Fisheries Science Center and the Center for Streamside Studies are collaborating with Seattle Public Utilities on a long-term ecological research project. In the Cedar River Municipal Watershed scientists are studying the ecological effects of the return of anadromous salmonids above Landsburg Diversion. As part of the city of Seattle's Habitat Conservation Plan (HCP) for the Cedar River Watershed, a fish ladder will be installed in 2002 or 2003 at Landsburg. For 90 years this diversion has blocked anadromous fish migration to approximately 27 km of some of the best mainstem and tributary habitat in the Puget Sound region. The exclusion of anadromous fishes above Landsburg has a number of potential ecological implications including:

- a reduction in the amount of marine-derived nutrients and organic matter delivered to the watershed; and
- an impact on the population structure of resident vertebrates above Landsburg.



Snorklers in the Cedar River

Salmon carcasses and eggs provide many resources to stream ecosystems, however, there are other potential effects returning salmon may have on resident vertebrates. Populations of resident salmonids (rainbow and cutthroat trout) and other vertebrates (sculpins, Pacific Giant Salamander, Tailed frogs) above the diversion have been isolated from anadromous salmonids for a number of generations. Therefore, there are likely to be some interesting effects on the population dynamics of resident vertebrates resulting from biotic interactions (e.g., competition, predation) among the vertebrate community. Installation of the fish ladder also presents a unique opportunity for examining spatial patterns of colonization of habitat that has been unavailable for nearly 90 years (i.e., approximately 20 generations of steelhead and chinook, and 30 generations of coho salmon). Results from this study will provide information on the rate at which anadromous salmon naturally colonize newly available habitat and the means by which they distribute themselves into freshwater spawning areas—information that currently is not available for any species. Because colonization can be tracked from the beginning, it will be possible to generate estimates of dispersal distributions of colonizing fish and an unambiguous description of the numbers of fish as they move into previously uninhabited spawning areas. We can also compare predictions from fish habitat models to salmon use in the newly available habitat. These data will aid in management of other systems where barriers are removed or made "fish-friendly", as well as testing the robustness of fish habitat models.

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This past summer a crew of NMFS scientists and UW students habitat typed approximately 27 km of mainstem and tributary habitat, as well as conducted fish population surveys (snorkel surveys, electroshocking) within different habitat types. We are collecting water samples monthly to establish baseline conditions for nutrient chemistry. This past October we collected riparian vegetation, stream algae, aquatic insects, and fish to analyze for the isotopes of carbon and nitrogen. The isotope data will furnish clues to trophic linkages among food web components, as well as provide baseline data before inputs of marine-derived nutrients arrive in the watershed.

This project presents a rare opportunity to experimentally evaluate the effectiveness of opening up previously isolated habitat to anadromous fish. If we are to restore threatened and endangered populations of Pacific salmon, we need to know what are the most effective restoration techniques. This cannot be done without monitoring and evaluation. If a stable source of long-term funding can be found, we hope that this project will continue over the next 10 to 15 years. Such long-term data are essential to understanding the role of salmon in our watersheds, which may ultimately lead to restoring populations of salmon to northwest rivers.

(Peter Kiffney is an affiliate professor in the College of Forest Resources and a researcher at the National Marine Fisheries Service)

Juvenile salmonid movement through culverts

Salmon are an important part of Pacific Northwest culture and economy, but have disappeared from almost half of their historical breeding grounds in Washington, Oregon, Idaho, and California. Despite large investments in fish ladders, hatcheries, and regulations protecting riparian zones, there are continuing reductions in salmon abundance. Historical watershed reconstruction has shown that key habitat features for coho have been lost, and currently numerous efforts are underway to restore off-channel habitat throughout the state with the hope of restoring stocks.

Culvert repair or redesign for better fish passage has the potential to open up good habitat. In the State of Washington culverts are designed to meet average barrel velocity requirements that can range from three to six feet per second depending on culvert length and the species of fish for which passage is designed. Presently, passage regulations are designed for returning adult salmon and not juveniles. However, recent studies have documented the importance of upstream passage for salmonid juveniles and described the swimming capabilities of salmon fry. Smaller fish have slower swimming speeds, which causes them to expend more energy relative to their size during burst and prolonged speeds. When passing through culverts, fish often use a prolonged speed with an occasional burst at the inlet or outlet, or a series of bursts between resting areas.

In 1997, a flume study identified certain culvert characteristics that influenced passage of juvenile coho (60-90 mm). Passage was found to be greatest in corrugated pipe and least in smooth pipe.When moving through roughened pipe, juvenile coho used the boundary layer, a low velocity area along the side of roughened pipe, to facilitate passing.

A culvert in Stossel Creek

Currently, the environmental conditions that stimulate movement are being examined. The Washington State Department of Transportation recently supported a field study to examine spring movement of swim-up fry (fish that have just left the redd) and a data study to identify factors that trigger Fall juvenile movement from mainstem rivers into tributaries.

In the first part of the field study, Battelle Laboratories researchers used bread-baited minnow traps in two streams with Remote Site Incubators (RSI) to detect fry movement. Coho fry were found in traps up to 210 m upstream from the RSIs.

In the second part of the field study, UW researchers examined habitat use by fry and the effect of culverts on upstream movement. Distribution of coho fry appeared to be more strongly influenced by water velocity rather than a habitat type. The researchers also found that 30 to 50 mm fry strongly preferred very low velocity habitat with 70% of the fish in areas with velocity less than 0.1 foot/second and 90% in areas with velocity less than 0.4 feet/second. Juveniles were often found milling about in large aggregations (20 or more fish) suggesting that feeding territories had not yet been established. Recapture rates for marked juvenile coho were too low to make inferences about behavior.

Data previously collected by Washington Department of Fish and Wildlife on Fall movement of juveniles were also analyzed. At most sites movement occurred over a narrow range of 2-3 weeks from year to year and usually during new moon. However, at one site, movement into the tributaries occurred over a 20-week period. Preliminary results indicate that the largest proportion of juvenile coho move into off-channel habitat when mainstem flows increase by at least 2000 cfs during a new moon phase.

(Jamal Moss is a graduate student in the School of Aquatic and Fishery Sciences)

Pilot scale constructed wastewater treatment wetland

The City of Stanwood, WA, operates an experimental constructed wetland to treat primary municipal effluent (wastewater that has already undergone one stage of treatment) at the local wastewater treatment plant. The pilot wetland system consists of four "free water surface" units ("cells"), each of which is composed of a marsh followed by a wet meadow. The entire wetland treats approximately 18,000 gallons per day, representing 7% of total plant flow. Water quality monitoring has been collaboratively conducted at the wetland since June 1998 in three separate studies. Study results indicate that the amount of wastewater pumped into the wetland ("loading rate"), the amount of time water resides in the wetland ("HRT"), and temperature are the most important considerations, while plant species and cover are relatively unimportant for system design and function.

Kurt Marx studied the effects of loading rate on wastewater treatment, with special attention to ammonia removal. Efficient nutrient removal was primarily a function of lower loading rate, higher HRT, higher temperature, and wetland type (less removal in the marsh, more in the wet meadow). Actual retention times were 31% to 77% lower than designed, a phenomenon commonly seen in treatment wetlands and usually attributed to flow short-circuiting.

Margaret McCauley examined the effect of plant species on water quality. The experimental plots did not bring the wastewater down to permitted standards, which was not expected given their small size (1.0 x 3.7 m) and short HRT. There was no significant difference in overall effluent quality among the three species examined, but hardstem bulrush appears to affect phosphorus output. The presence of emergent plants does improve wastewater treatment effectiveness, particularly the removal of organics. Differences in pollution abatement among plant species are more pronounced in warmer months. Continuous standing water killed reed canarygrass, which may or may not be desirable, depending on whether a goal of a project is to maintain a population of native plants.

Four cells in the treatment wetland.

Although Marx found water quality differences in cells with different loading rates, these cells also had different amounts of plant cover. Lenore Jensen is finishing the last part of this project by focusing on this aspect. Although the cells had substantially different levels of plant cover, the only significant comparative differences in water quality were found for summertime phosphorus and annual and summertime ammonia. There was no evidence that treatment ability or HRT was affected by different levels of plant cover.

These findings are important because the City expended a good deal of effort in vegetative planning, especially with respect to species composition. Yet species and cover were relatively unimportant factors in pollutant removal. Temperature remained the most important parameter in nitrogen removal efficiency. Given that this is uncontrollable without substantial resource investment, it is recommended that future planners in cool-temperate climates focus on loading rates and HRT.

(*Lenore Jensen is a graduate student in Civil and Environmental Engineering)*

Restoration of Puget Sound rivers

The recent listings of salmon as endangered species has led to substantial interest in river restoration in the Pacific Northwest (PNW). In Washington State, for example, the Governor's plan for responding to the ESA listing of Puget Sound salmonids commits to a science-based program of salmon recovery, and millions of dollars in state and federal funding is already programmed for habitat restoration efforts. This emphasis on a habitat restoration program to recover salmon populations assumes that such efforts will be based on a solid understanding of fluvial processes and aquatic ecology that allows confident prediction of both river and salmonid response to restoration projects.

This may sound simple, but rivers are inherently complex systems. Although the physics of river processes is relatively well understood, it remains difficult to confidently predict a river's response because of the controlling influence of local conditions, legacies of past actions, and the influence of upstream processes. In addition, much of our fundamental understanding of river processes and dynamics come from regions outside the PNW. The onset of a regional program of river restoration provides an opportunity to evaluate the state of river restoration in general through examination of efforts for restoring Puget Sound Rivers.

The University of Washington's Quaternary Research Center, Center for Streamside Studies, and Center for Urban Water Resources Management are organizing an edited volume on the Restoration of Puget Sound Rivers. The book will assess the current state of river restoration efforts in the PNW, formalize an analytical framework within which to guide the design and evaluation of river restoration projects, and provide information needed by practitioners, policy makers, and the general public. Chapters for the book will come from invited presentations at the Society for Ecological Restoration symposium in April 2001 (see calendar for more information).

Announcements

CONGRATULATIONS

Congratulations to the following students who completed their degrees: **Lenore Jensen** (M.S. Civil and Environmental Engineering) *The Effects of Plant Abundance on a Pilot Scale Treatment Wetland*; **Chris Konrad** (Ph.D. Civil and Environmental Engineering) *Frequency and Extent of Hydrologic Disturbances in Streams in the Puget Lowland, Washington*; **David Landsman** (M.S. Forest Resources) *The Strengths and Weaknesses of the Washington State Salmon Recovery Funding Board (SRFB) Process*; **Diana Olson** (M.S. Forest Resources) *Fire in Riparian Zones: A Comparison of Historical Fire Occurrence in Riparian and Upslope Forests in the Blue Mountains and Southern Cascades of Oregon*; **Jen O'Neal** (M.S. School of Aquatic and Fishery Sciences) *Biological Evaluation of Stream Enhancement: A Comparison of Large Woody Debris and an Engineered Alternative.*

CALENDAR OF EVENTS

February 1, 2001 - **CSS Annual Review** joint with the Center for Urban Water Resources Management, HUB West Ballroom, UW campus, 8 AM to 4 PM.

April 2-6, 2001 - **Restoration and Recovery: Beyond Good Intentions**, sponsored by the Society for Ecological Restoration, Meydenbauer Center, Bellevue, WA. The **Stream Restoration** section of the symposium (out of which will come the book Restoration of Puget Sound Rivers) will be a concurrent session on the 5th-6th. For more information view http://www.halcyon.com/sernw.

January 9 – March 6 and March 27 – May 29, 2001 - **Tuesday Morning Seminars**, 22 Anderson Hall, UW Campus. For a schedule, contact Leslie Wall (cssuw@u.washington.edu or 206-543-6920) or view http://depts.washington.edu/Events.

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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