Third Nisqually Research Symposium:
Abstracts of Proceedings

Nisqually Reach Nature Center

Olympia, Washington

June, 1995

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Preface

The Nisqually River flows some 78 miles from its headwaters under the Nisqually Glacier on the south face of Mount Rainier, to its mouth on southern Puget Sound at Nisqually Reach. Along the way it passes through the pristine forests of Mount Rainier National Park and the managed forests of the U.S. Forest Service and industrial timber companies; below the hydropower impoundments of the City of Tacoma at Alder Reservoir and LaGrande Reservoir, the river exits the Nisqually Canyon and meanders through farm lands, Fort Lewis, and the Nisqually Indian Reservation; about four miles from Puget Sound the river begins its traverse of the Nisqually delta and the Nisqually National Wildlife Refuge.

The 716-square mile basin is drained by about 715 lineal miles of streams. The system provides over half the fresh water entering southern Puget Sound and spawning habitat for much of the south Puget Sound salmon.

The Nisqually basin has been the setting of much of the history which has defined the Puget Sound country. The first inhabitants, the Nisqually, were a cultural link between the Columbia basin people and the people of the inland sea. Hudson's Bay Company began agricultural operations here in the 1830s. The treaty between the United States and southern Puget Sound tribes was signed on the banks of Medicine Creek on the Nisqually delta. In recent decades the Nisqually has been the setting of some of Washington's most notable environmental controversy and cooperation.

The Third Nisqually Research Symposium continues the tradition begun in 1991 by Nisqually Reach Nature Center and American Littoral Society of providing a forum for scientific research on the Nisqually delta. This year's symposium expands its geographic scope to include the entire basin, and we are joined by Mount Rainier National Park, Nisqually Indian Tribe, Nisqually River Council, Nisqually River Education Project, and University of Washington's Pack Experimental Forest.

Third Nisqually Research Symposium
Agenda

University of Washington Pack Experimental Forest
Eatonville, Washington
Saturday, June 3, 1995

Morning Plenary Session: Landscape Management
9:00 - 10:15

TFW Watershed Analysis: Assessing Cumulative Effects of Forestry on the Mashel River
    Edward Salminen, Nisqually Indian Tribe
Preliminary Needs Assessment for the South Puget Sound Water Quality Management Area
    Kathie Emmett, Washington Department of Ecology
Integrated Landscape Management for Fish and Wildlife
    Andy Carlson and Mike Judge, Washington Department of Fish and Wildlife

Concurrent Session A - The River
10:30 - 12:00

Recent Evolution of Nisqually Glacier, Mount Rainier
    Carolyn L. Driedger, U.S. Geological Survey and Barbara A. Samora, National Park Service
Water Quality Monitoring to Address Nonpoint Pollution Problems
    Tony Whiley, Nisqually Indian Tribe
McAllister Creek Monitoring and Debris Analysis
    Susan Wertz et al., North Thurston High School

Concurrent Session B - Forest Ecosystems
10:30 - 12:00

The Nitrogen Dynamics and Growth Response from the Use of Biosolids in Forest Stands
    Charles Henry and Mark Grey, University of Washington College of Forest Resources

Movement and Migration Patterns of Terrestrial Adult Northwestern Salamanders
    Angela Stringer, University of Washington College of Forest Resources

The Forest Ecosystem Study: An Experiment to Develop Late Seral Habitat
    Suzanne Wilson, et al., U.S. Forest Service

Luncheon Speaker
12:30 - 1:00

Natural Urban Corridors
Jaimie Wright, Architect

Concurrent Session C - The Estuary
1:30 - 3:00

Phalaris arundinacea L.: Invasive Grass Species on the Nisqually Delta
Alexander Cobb, et al., The Evergreen State College

Nisqually Delta Oceanography and Plankton Populations
James M. Strong, South Puget Sound Community College
Mary Lou Peltier, Saint Martin's College

The Geoduck Clam (*Panope generosa*): Potential Benefits of a Co-managed Fishery
Harry Branch, The Evergreen State College

Concurrent Session D - Indicator Species
1:30 - 3:00

Monitoring Benthic Invertebrates to Protect Water Resources
Leska S. Fore, James R. Karr, & William J. Kleindel
University of Washington Institute for Environmental Studies

Response of Benthic Macroinvertebrates Along a Revegetated Portion of Eaton Creek
Chris Regan and Kit Paulsen, Washington State University Cooperative Extension

Managing Great Blue Herons in South Puget Sound
Donald Norman, Toxicology Task Force

Closing Plenary Session
3:15 - 4:00

Building the Basin Community
Tom Jay, Wild Olympic Salmon

TFW Watershed Analysis: Assessing Cumulative Effects of Forestry on the Mashel River

Edward Salminen
Nisqually Indian Tribe
Olympia, Washington

What is Watershed Analysis? Watershed Analysis is a process developed by forest landowners, Indian Tribes, environmental groups, and state agencies. It was adopted into the Forest Practices Regulations in 1992. Watershed Analysis is a biological and physical assessment of a watershed in order to address the cumulative effects of forest practices on public resources. Based on this assessment, prescriptions are developed to protect and allow the recovery of public resources. These prescriptions become conditions for future forest practices.

Overview of the Watershed Analysis Process. Watershed Analysis is performed on Watershed Administrative Units (WAUs) that range in size from 15 to 90 square miles. Each analysis is conducted by a team of experts in fisheries, hydrology, slope stability, etc. The Washington Department of Natural Resources (WDNR), or any landowner owning 10% or more of a WAU, can initiate a Watershed Analysis. All Watershed Analyses are subject to approval by the WDNR. Each Watershed Analysis takes from 4 to 5 months to complete.

Why Conduct a Watershed Analysis for the Mashel River? The Mashel River WAU is the furthest upriver watershed with anadromous fish use in the Nisqually River basin. The WAU is the fifth highest ranked WAU on the WDNR South Puget Sound Region watershed analysis ranking list, and the highest ranked WAU in the Nisqually River basin. The Mashel WAU is the primary wild steelhead- and fall chinook-producing tributary stream within the Nisqually Tribe’s treaty fishing area. The WAU contains the greatest proportion of unstable slope area and potential rain-on-snow affected area of any WAU within the anadromous portion of the Nisqually River basin. Concerns over unstable slopes, road-related sedimentation problems, and riparian harvesting effects on stream temperature and channel condition have resulted in numerous interdisciplinary team meetings on a timber-sale by timber-sale basis in the recent past. Many watershed-related issues do not lend themselves to analysis in the ID team format, and consequently have not been addressed. Many of these issues pose substantial risk to public resources and the Tribe’s treaty rights.

Mashel Watershed Analysis Time Line. The resource assessment phase of the Analysis was begun in May, and should last throughout the summer. In September the products of the resource assessments will be passed off to the prescription team, which will develop site-specific prescriptions to address any resource sensitivities that have been identified. The final prescriptions will be sent to the WDNR in late fall for final review and public comment.

Preliminary Needs Assessment for the South Puget Sound Water Quality Management Area

Kathie Emmett
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Southwest Regional Office
Olympia, Washington

This paper presents the results of a preliminary needs assessment for the South Puget Sound (SPS) Water Quality Management Area (WQMA). The assessment summarizes information currently available about the WQMA, identifies significant water quality issues and presents a general strategy for water quality management in the WQMA for the next five years. This needs assessment is the result of a combined effort involving staff from several programs within the Washington State Department of Ecology (Ecology) and comments received from other agencies, tribes and interested members of the public. The information and issues addressed were initially assembled from the contents of briefing papers and oral presentations made during a October 17 & 18, 1994 WQMA scoping workshop

The approach is based on a five-year management cycle containing these elements:

Year 1 Identify the issues by assembling available information and seeking suggestions from local communities (scoping).
Year 2 Collect necessary data and monitor.
Year 3 Analyze data.
Year 4 Develop and coordinate a Technical Report/action plan.
Year 5 Implement planned strategies and issue/reissue wastewater permits.

A WQMA needs assessment is produced during the first year of the five-year management cycle. The assessment will be used as a guide for future coordination, information gathering activities (monitoring, inventory), and the development of a public outreach plan in support of the WQMA. The outreach plan will describe additional opportunities for public involvement in the future. The results of this assessment will also be used to develop a WQMA project list that identifies specific sites for Total Maximum Daily Load (TMDL) studies, investigations, monitoring studies, Geographic Information System (GIS) resource mapping products, and Class 11 inspections of permitted wastewater dischargers. Wastewater permits regulate discharges to surface and ground water under federal and state clean water laws. A schedule for issuing wastewater permits within the WQMA will also result from this assessment. Sources of nonpoint source pollution discharges will be identified and categorized for incorporation into comprehensive watershed based solutions, including regulatory action and partnership programs. Contributions to the SPS WQMA assessment were made by many individuals representing a variety of areas of expertise. A sincere appreciation is extended to everyone who participated. Their contributions and input throughout the process has made this assessment possible.

Integrated Landscape Management for Fish and Wildlife

Andy Carlson and Mike Judge
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Integrated Landscape Management (ILM) is a cooperative management plan developed between landowners and fish and wildlife managers. This is a Washington Department of Fish and Wildlife process for converting from species-by-species management to a broader, landscape (ecosystem), proactive approach. This represents a major shift in management philosophy.

The ILM process will be applied to all 43 million acres in the state. Watersheds will provide the geographic boundaries for assessing the habitat needs of 19 priority habitats and 139 priority fish and wildlife species.

The Department is testing this approach in the 817,000-acre Lewis-Kalama River watershed located in southwest Washington. Fisheries and wildlife experts have the knowledge and ability to make ILM work, but to achieve success requires the voluntary cooperation of landowners and the public. Long- and short-term benefits will accrue to landowners and the public, but not all of these benefits can be quantified. The success of ILM rests on the ability of agency people and the public to work cooperatively.

Final products will include watershed-based species, habitat, and recreation plans and G.I.S. maps that can be used to protect and recover threatened and endangered species while providing wildlife viewing, fishing, and hunting opportunities.

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Recent Evolution of Nisqually Glacier, Mount Rainier

Carolyn L. Driedger, U. S. Geological Survey
and
Barbara A. Samora, National Park Service

Nisqually Glacier has attracted more attention from visitors, entrepreneurs, and scientists than any other glacier on Mount Rainier. Because of its accessability, Nisqually was one of the first glaciers in North America to receive extensive study. Pioneer climbers, photographers, and scientists have all contributed to recording Nisqually Glacier's past and present behavior.

Sometime before 325,000 years ago the ancestral Nisqually Glacier deposited thick layers of glacial debris in parts of the Nisqually River valley as far as 60 miles downvalley, near LaGrande. During a later advance about 20,000 to 10,000 years ago, Nisqually Glacier deposited a glacial terminal moraine now conspicuous as a small hill between the villages of Ashford and National.

Climatic cooling between about A.D. 1400 and 1840, called the Little Ice Age, caused many of the world’s glaciers to expand. Nisqually Glacier responded by advancing to the location of the current Nisqually Bridge where state highway 706 now crosses the Nisqually River.

Nisqually's dramatic retreat between the 1850s and early 1930s was well documented by pioneer photographers and journalists; the retreat raised fears that a reduction in meltwater would threaten operation of a new hydropower facility at LaGrande. In response, Tacoma City Light began making measurements in 1931 of surface elevations along profiles across the glacier. These data, with measurements from a third profile first surveyed in 1942, indicate that in addition to retreat, the glacier had thinned dramatically. By 1945 the uppermost profile indicated that the glacier was beginning to thicken, providing the first evidence that Nisqually Glacier was responding to cooler climatic conditions. The thicker ice moved in a wave down the glacier, increasing the ice thickness by about 50%. By the early 1960s the thick ice wave had advanced the glacier terminus 480 feet over bare ground. A second wave of thickened ice advanced the glacier almost 600 feet between 1974 and 1981, then again several feet between 1984 and 1986.

Since 1986 Nisqually Glacier has retreated again—more than 600 feet. However, a change in glacial behavior lies ahead. Although the lower glacier thinned more than 60 feet between 1985 and 1994, elevations on the upper part of the glacier have remained the same. This zone of thicker ice could flow downvalley during the coming decade and could cause either a brief advance, or at a minimum, slow the present rate of retreat.

This 64-year record of surface elevation measurements is a valuable record of glacial response to climatic changes and is the most lengthy in the Western Hemisphere. Now the National Park Service and U.S. Geological Survey work collaboratively on the measurement and analysis of surface elevation data and continue to track the changes of Nisqually Glacier.

Water Quality Monitoring to Address Nonpoint Pollution Problems

Tony Whiley
Nisqually Indian Tribe
Olympia, Washington

The Nisqually Indian Tribe began water quality investigations in the lower Nisqually Basin in 1990. Those initial studies were used to collect baseline data and identify nonpoint pollution sources potentially impacting lower tributaries.

From that work both the Mashel River and Ohop Creek were identified as having water quality problems significant enough to warrant more intensive investigations. Work on these tributaries began in the summer of 1993.

The results of this work will serve to provide informed recommendations regarding changes in land use practices within each basin. Concurrent with the Ohop Creek and Mashel River studies has been work on the Nisqually Reach. Shellfish beds in the Nisqually Reach were reclassified by the Washington State Department of Health due to elevated bacterial levels found in marine waters. The identification and correction of bacterial sources within the Nisqually Reach has been the main objective of this investigation.

McAllister Creek Monitoring and Debris Analysis

Jeff Vest, Rikki Dingle, Jenny Skinner, Mellisa Collins, Heidi Fulton, Karole Longoria, Michelle Mureiro, Kevin Gary, and Susan Wertz
North Thurston High School
Olympia, Washington

McAllister Creek is located in the lower reaches of the Nisqually River basin. It runs three miles from its source McAllister Springs, parallel to the Nisqually River, and enters saltwater on the west side of the Nisqually Delta at Nisqually Reach. McAllister Creek is impacted by human use along its short distance. At its source nearly all of its 21 million gallon flow is sometimes diverted during dry summer months to water customers in the City of Olympia. Much of the riparian streamside cover has been cut, and cattle graze in fields nearby. A fish hatchery and small dam have been built. A major road, Martin Way, and Interstate Highway 5 pass over the creek. McAllister winds through the Nisqually National Wildlife Refuge, and ends near Luhr Beach and Nisqually Delta mudflats. The estuary part of the creek has been studied by Jim Strong and his students at South Puget Sound Community College. The upper- and mid-section waters have been monitored by students from North Thurston High School for over four years.

This paper reports on data from selected monitoring sites, including photodocumentation, flow, width and depth, in-stream and streamside debris analyses, biodivirsity, salinity, dissolved oxygen, pH, total dissolved solids, phosphates, nitrates, turbidity, temperature, and fecal coliform bacteria. Specific recommendations are made concerning the improvement of the biologic and chemical health of the stream.

The Nitrogen Dynamics and Growth Response from the Use of Biosolids in Forest Stands

Charles Henry and Mark Grey
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Because of its high nutritional content, biosolids can serve as soil amendments for nutritionally deprived forest sites. Studies conducted over more than 20 years at the University of Washington's Pack Forest has largely confirmed the potential of biosolids to increase the productivity of many of our forest lands.

These studies clearly demonstrated that biosolids, applied at environmentally acceptable rates, will result in growth responses for both young seedlings as well as established stands.

A silviculture program utilizing biosolids must be carried out using environmentally responsible management techniques. A recent exposure risk assessment performed for the U.S. Environmental Protection Agency on non-agricultural land (including forests) has suggested that the constituents in typical biosolids in the Northwest pose insignificant risk to humans and the environment. However, application rates should not exceed the capacity of the system to utilize and retain the nitrogen applied, or losses through leaching can be expected. These application rates are based on the different transformations and losses of nitrogen occurring after the biosolids are applied, and where available N is matched to plant uptake rates. Application rates are normally limited to 5-20 t/ha and can typically be reapplied every 5 years. From our experience, these rates have provided excellent growth results and minimize the potential for nitrate leaching losses to occur.

Movement and migration patterns of terrestrial adult Northwestern Salamanders (*Ambystoma gracile*)

Angela Stringer
College of Forest Resources, Wildlife Science Group
University of Washington
Eatonville, Washington

Forest management practices may influence the quality of upland habitat and the accessibility of breeding ponds for pond-breeding salamanders in the Pacific Northwest. However, the details of terrestrial movement patterns and habitat use of salamanders are poorly known. We are conducting research on movements and habitat use of adult Northwestern Salamanders (*Ambystoma gracile*) using radio-telemetry. Northwestern Salamanders were captured in the fall (upland habitat) and in the spring (breeding pond at two locations in mid-elevation Douglas-fir forest managed for timber production. Large (> 25g) salamanders were surgically implanted with radio-transmitters and released at their respective capture points. After several days of initial post-release re-orientation, movement activities were characterized by a single long movement followed by an extended stay at a location point. The distances traveled between location points ranged from 1m to 36m and averaged 6m. The number of days spent at a single location point ranged from two to 41 days and averaged ten days. Location were never revisited. Movement directionality did not differ significantly from random except for movements to or from a breeding pond (migration). Movements tended to be temporally synchronous between salamanders and with weather changes, especially after long periods of no precipitation. Approximately half of the location points were under sword ferns (*Polystichum munitum*). Other cover objects recorded were intact logs, intact stumps, decayed stumps, and slash. Salamander movements within these location points were continuous, and ranged from a few centimeters to 0.5m depending on the cover object size.

The Forest Ecosystem Study:
An Experiment to Develop Late Seral Habitat

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Olympia Forestry Sciences Laboratory
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Our recent research shows that arboreal and forest-floor small mammals are more abundant in old growth forests than in young forests. Differences in abundance of fallen trees, snags, and understory development account for much of the variability in mammal populations across young and old stands. Additionally, we have shown that Spotted Owl habitat use is influenced by mammalian prey abundance and degree of understory development. We hypothesize that trophic pathways among plant, fungal, invertebrate, and vertebrate populations can be enhanced in managed stands, thereby reestablishing certain characteristics of old-growth forests. Our methods in young managed stands entail creating cavities in live trees to benefit Flying Squirrels and other cavity users. Also, we created three levels of overstory density to encourage understory diversity and enhance tree growth. Our experimental design consists of four randomized blocks. Two blocks have substantial coarse woody debris and two blocks have virtually none. Each block has four 13-ha stands and four treatments: no intervention, cavities added, variable density thinning with underplanting, and cavities plus thinning. We applied treatments during 1992-1993. Pretreatment and ongoing sampling encompasses vascular plants, coarse woody debris, fungi, forest-floor small mammals, arboreal rodents, and mammalian diets.

Natural Urban Corridors

Jaimie Wright
Architect
Tacoma, Washington

A proposal to establish natural urban corridors to create urban-rural connections defining communities within the beauty of nature.

Natural urban corridors are strips of land, near or within developed areas, set aside to preserve natural geography and conditions in perpetuity. The corridors would celebrate nature's magnificence on a scale as grand in interpretation as the National Parks do. The corridors will follow the shore line, the highlands, the draws and streams that criss-cross throughout the forest. The scale is large enough to influence the character of an area.

"Urban" means they begin in communities. Ultimately corridors will be essential geographic locations, within community plans, like grids and neighborhood boundaries. Whole communities laid out as a part of the natural setting. The totality of place defined by geography, climate, flora, and fauna

Phalaris arundinacea L.: Invasive Grass Species on the Nisqually Delta

Alexander Cobb, Matt Fontaine, Jacob Hendrickson,
Michael Spadafora, and Kathryn H. Burgess
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Olympia, Washington

Reed Canarygrass (*Phalaris arundinacea* L.) is frequently used to stabilize stream banks and as a forage grass for livestock, but is gaining a reputation as a serious threat to natural areas due to its ability to out compete most other grass species under a wide variety of conditions.

P. arundinacea monoculture now covers a considerable portion of the Nisqually Delta. We mapped where the species has spread within the dike on the Nisqually National Wildlife Refuge and estimated the area that the grass now covers.

We also studied how *P. arundinacea* responds to mowing, since this is a commonly used management technique for controlling invasive plant species. *P. arundinacea* is highly rhizomatous. We sought to determine whether mowing stimulates, reduces, or does not affect rhizome growth by comparing the proportion of above- to below-ground biomass in samples from patches of *P. arundinacea* that have been frequently mowed to the proportion in samples from patches that have never been mowed. We examine what these data mean regarding the effectiveness of mowing as a control tactic for P. arundinacea.

Nisqually Delta Oceanography and Plankton Populations

James M. Strong
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Olympia, Washington

Mary Lou Peltier
Saint Martin’s College
Lacey, Washington

In the summer of 1992 a major effort was undertaken by persons affiliated with three colleges to define some of the physical and chemical oceanography and plankton populations occurring around the Nisqually Delta. The studies mapped such parameters as dissolved oxygen, pH, alkalinity, temperature, salinity, fecal coliform, and light penetration. An in-depth study of the growth rates of sea lettuce was undertaken as a senior research thesis at the University of Puget Sound. Attempts were made to map the deep water, intermediate depth and shallow water currents on incoming and outgoing tides .

The Nisqually River - McAllister Creek plume was found to be measurable on the outgoing tide as far as the northern end of Ketron Island. On the incoming tide the Nisqually plume was measurable as far west as the vicinity of the navigation buoy “Gr 3.” The plumes were very strongly influenced by wind speed and direction.

The waters were well oxygenated throughout the water columns. The plankton studies indicated that populations were greatest in the shallow waters of Hogum Bay and west along the mudflats.

The Geoduck Clam (*Panope generosa*): The Potential Benefits of a Co-managed Fishery

Harry Branch
The Evergreen State College
Olympia, Washington

The geoduck is a unique, long lived animal. Successful management policy has been difficult to establish for the geoduck fishery because of the animal's low level of recruitment, which may be virtually zero for years at a time. Their survival has been largely a factor of their longevity; geoducks live to over 150 years of age.

Management policy has been difficult to enforce because geoducks are harvested from subtidal grounds by divers. The fishery has been characterized by vertically integrated monopolies capable of concealing their assets, and resultant fraud, poaching and the fishing out of the most productive areas of their historic range.

The harvest of geoducks could be stabilized under a system of co-management. Co-management systems incorporating cooperatives are well suited to fisheries harvesting specific geographic areas. Cooperatives are successfully operating in the lobster fisheries of Belize, Mexico and New England, and the coastal fisheries of Japan.

Co-ops in some lobster fisheries construct habitat protection to increase juvenile survival. A geoduck co-op might be encouraged to improve sites by seeding, transplanting and grooming, and to harvest by thinning only crowded sites. When harvesters have a guaranteed future which they can physically observe, their natural tendency is to protect and enhance this future.

Under the co-op model, individual harvesters remain private operators, and although they get back-up for capital investments and other help from their co-op, they are still subject to normal market pressures. The co-op model favors the existence of small scale, autonomous, stable operations.

Government planning, managing and enforcement activities are reduced in a system of co-management to random monitoring and auditing. The result is cost-effective protection of the public trust.

Monitoring Benthic Invertebrates to Protect Water Resources

Leska S. Fore, James R. Karr, and William J. Kleindl
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Since the Clean Water Act amendments of 1972, federal and state agencies have been mandated to monitor the chemical, physical and biological integrity of rivers and streams. The emphasis until recently has been on chemical criteria such as nitrogen, dissolved oxygen, and fecal coliform. Continued loss of species and degradation of aquatic resources has shifted the focus of monitoring to biological criteria.

In order to assess the biological integrity of northwestern streams, we collect invertebrate samples from stream riffles and evaluate the species richness and composition of the instream biology. Sites with high numbers of mayfly, stonefly, and caddisfly taxa indicate excellent instream conditions. These invertebrates require conditions that are also favorable to salmon—cool, clean, fast-moving water with complex cobble substrates. Juvenile salmon also favor these organisms in their diet. Stream sites that have been damaged by timber harvest, grazing, and urbanization have higher proportions of tolerant organisms such as soft-bodied flies (tipulids and simuliids) and worms (planaria, oligochaetes and tubificids), some snails, and small crustaceans (amphipods). We evaluate attributes of the invertebrate assemblage and score them in reference to minimally disturbed sites. Attribute scores are then integrated into an overall numeric index, the benthic index of biotic integrity (B-IBI), that is used to rank streams or stream reaches according to their biological condition.

Response of Benthic Macroinvertebrates Along a Revegetated Portion of Eaton Creek: Study Design and Preliminary Information

Chris Regan and Kit Paulsen
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Native Plant revegetation projects have become increasingly popular along stream corridors throughout Washington. It is believed that changes in riparian vegetation will cause changes in stream characteristics. In February, 1995, a 600 yard section of Eaton Creek was revegetated. As these plants grow, how will water quality be affected? How will the benthic macroinvertebrate population change with an increase to shading and detritus loading? How rapidly will changes in environmental conditions become evident in the benthic macroinvertebrate populations? Will benthic macroinvertebrate sampling provide a more rapid indication of response to revegetation than ambient water quality monitoring?

Macroinvertebrate and water quality data are being collected along Eaton Creek in an attempt to answer these questions. It is believed that macroinvertebrates respond to changes in water quality before chemical tests indicate any significant improvements. If macroinvertebrate monitoring along the revegetation site shows significant increases in population diversity and/or density, rapid bioassessment will prove a safe and relatively easy method to track stream rehabilitation along revegetation corridors.

The study consists of five sample sites along a revegetated portion of Eaton Creek. Samples are collected quarterly at these five sites with a Surber sampler utilizing the University of Washington rapid bioassessment protocols. Initial sampling reveals that benthic fauna are neither diverse nor plentiful. The most numerous fauna are pollution tolerant species. The sampling scheme consists of a control reach upstream of the revegetation project and three samples bracketing the revegetation area. Three sample sites within the revegetation area are generally exposed with little canopy cover. The stream bottom is sandy with portions of muck and some gravel. Most debris in the stream is woody debris less than 2 centimeters in diameter. Eaton Creek is spring fed and is reported to have relatively stable flow throughout the year. Dissolved oxygen, pH, and temperature data were collected concurrent with insect sampling. Dissolved oxygen and pH were tested at each station using Hach field test kits. Temperature was collected with a thermometer held midstream for 3 minutes. Thurston County Environmental Health also has an ambient monitoring station on Eaton Creek and sampling days are coordinated for cross-referencing the Hach kit information with laboratory analyses.

Managing Great Blue Herons in South Puget Sound

Donald Norman
Toxicology Task Force
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The primary focus of research on Great Blue Herons in Puget Sound has been on contaminant monitoring and little information is available on population dynamics. Recent life history information compiled by Robert Butler at the Canadian Wildlife Service however, can be used to address local management issues. I will present some of the background on the population biology that can be used to outline research issues to be investigated in south Puget Sound to provide long-term protection of herons and better integrate this information into planning decisions being made in the region.

The primary local need is for monitoring of all of the major colonies, because colonies shift and do abandon sites on a regular basis. I will present some of the basic techniques to be used to monitor colony sites. In addition to the focus upon the nesting area, the need to locate alternative nesting and seasonal foraging areas are critical for long-term management of herons. This information will be addressed so that local volunteers can begin to collect this information.

The major research questions for the South Puget Sound area include locating and describing overwintering habitat, and measuring the forage quality of summer estuarine feeding areas. Research in British Columbia has shown that both juveniles and females must shift to upland areas in the fall to meet their energetic needs. Evaluation of the available upland habitat and its carrying capacity for small rodents (the primary winter prey item) may be an important population limiting factor. In summer, the need to evaluate the prey base at colonial feeding areas could provide interesting comparisons to the well documented dominance in the prey base of shiner perch (*Cymatogaster aggregata*) at eelgrass bed foraging areas. Because of the lack of major eelgrass beds in South Puget Sound, there may be a lack of shiner perch in the diet, and therefore a nutritional constraint on growth of the chicks or quality of molt in the females.

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TFW Watershed Analysis: Assessing Cumulative effects of Forestry on the Mashel River

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Preliminary Needs Assessment for the South Puget Sound Water Quality Management Area

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Recent Evolution of Nisqually Glacier, Mount Rainier

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Carolyn Driedger has been observing glaciers on Mount Rainier for much of the last 17 years. She works at the U.S. Geological Survey's

Cascade Volcano Observatory and has a special interest in glacier/volcano interactions . Her most recent work includes a studies of debris flows caused by glacial recession at Mount Rainier and Mount Hood.

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Barbara Samora has been working in the National Park Service for the past 18 years in Yosemite National Park, North Atlantic Regional Office, Cape Cod National Seashore, and has been a Natural Resource Specialist at Mount Rainier National Park for the past eight years. Barbara is responsible for park-wide aquatic resources and air quality management, inventories, monitoring, and research. Barbara also coordinates geologic studies in the park and works cooperatively with staff at the U.S. Geologic Survey, state and local agencies and academic institutions on geologic and water resource related projects being conducted in the park. Through cooperative efforts with the Nisqually River Council, Nisqually Tribe, and U.S. Geologic Survey, Barbara initiated the National Park Service monitoring of surface elevations on the Nisqually Glacier in 1991 after the monitoring program was discontinued by USGS in 1985.

Barbara has a B.S. in Natural Resources Management from the University of New Hampshire, and Humboldt State University and graduate work in aquatic ecology and natural resources management.

Water Quality Monitoring to Address Nonpoint Pollution Problems

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McAllister Creek Monitoring and Debris Analysis

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The Nitrogen Stand Dynamics and Growth Response from the use of Biosolids in Forest Stands

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Mark Grey is a researcher and Ph.D. candidate at the University of Washington's College of Forest Resources. He holds a B.A. in English from Eastern Washington University and a M.S. in Forest Ecosystem Analysis from the University of Washington. His work includes the management of operational-scale biosolids applications at Pack Forest as well as participation in several studies examining the use of organic wastes such as biosolids and various types of compost. His current work includes a comprehensive examination of biosolids nitrogen dynamics in western and eastern Washington as part of forest and agricultural land application projects. Before embarking on his M.S. and Ph.D. work, Mr. Grey worked for six years in the environmental consulting profession in the Seattle area.

Movement and Migration Patterns of Terrestrial Adult Northwestern Salamanders (*Ambystoma gracile*)

Ms Angela Stringer
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I received two BAs from the University of California at Santa Cruz in 1985 in Environmental Studies (Agroecology) and in Language Studies (Chinese). I received a MS from the University of Washington, College of Forest Resources in 1993 in Wildlife Science. My thesis work was on the effects of nitrogen fertilization on powerline rights-of-way plant and small mammal communities. Currently I am a PhD student, also at the

University of Washington in Wildlife Science, working on movement patterns and habitat use of Northwestern Salamanders. I am also involved in research on amphibian distribution patterns in managed forest landscapes.

The Forest Ecosystem Study: An experiment to Develop Late Seral Habitat

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Dr. Andrew Carey is Principal Research Biologist and Leader of the Ecological Foundations of Biodivirsity Research Team. He has conducted research on forest ecosystems in the Pacific Northwest since 1982, both as a scientist and a coordinator of old-growth and spotted owl related research. Currently his primary research centers on conservation of biodivirsity in managed forests. His academic background is in forestry, wildlife management, epidemiology, and zoology. Dr. Carey earned his B.S. in forestry and wildlife and his M.S. in wildlife management at Virginia Tech. His Ph.D. in zoology and entomology was awarded by Colorado State University in 1978. Dr, Carey has published scores of technical papers on subjects ranging from rabies to spring bird communities. Dr. Cary and his wife, Regine, are avid telemark skiers and white water rafting enthusiasts.

Suzanne Wilson is a wildlife biologist on the Ecological Foundations of Biodivirsity Team. She is the lead biologist for small mammal studies. She has been at the Pacific Northwest Research Station since 1992. Previously she worked on field studies in Vermont, Wyoming, and South America. She graduated from the University of Vermont in 1990 with a B.S. I wildlife biology. Suzanne is a girl scout leader and a sailor.

David Thysell is a botanist and mycologist for the Ecological Foundations of Biodivirsity Team. He has been with the Pacific Northwest Research Station since 1993 after having been a Forest Service district botanist in southern Oregon. His research focuses on vegetative and fungal community relationships. His studies also include plant and fungal responses to management activities. His academic background is in botany, plant ecology, and mycology at the University of Idaho. David is co-chair of the South Sound Native Plant Society and well as a songwriter and musician.

Todd Wilson is the research coordinator for the Ecological Foundations of Biodivirsity Team. He has been with the Pacific Northwest Research Station since 1991. A native of Washington, Todd has worked in the Coast Range of Oregon and the north Cascades and Puget Trough regions of Washington. Currently, Todd's research focus is on the ecology of the Northern Flying Squirrel, weasels, and forest ecology. Todd received his B.S. in wildlife biology from Washington State University in 1988. Todd is an avid gardener, hunter, and birdwatcher.

Natural Urban Corridors

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My interest in this topic is the result of both personal inclination and the practice of architecture. Involvement in growth management issues in Pierce County for the last several years point out the great disparity between views and a some what narrow vision the public has on what is possible. The best results in any undertaking are achieved through consensus. An issue as broadly based as environmental management must identify that which a consensus can be built on and to offer a vision that allows diverse interests the chance to produce its own interpretation. The corridor idea is an attempt to present such a vision.

Phalaris arundinacea L.: Invasive Grass Species on the Nisqually Delta

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Alexander R. Cobb

First year student at The Evergreen State College. Attended Sleepy Hollow High School in Tarrytown, New York. Interested in biomechanics, botany, and ecology.

Michael W. Spadafora

Second year student at The Evergreen State College. Interests include climax forest ecosystems and permaculture.

Matthew J. Fontaine.

First year student at The Evergreen State College. Attended Lander Valley High School, Lander, Wyoming. Research interests include ecology, medicine, and public health.

Jacob S. Hendrickson.

First year student at The Evergreen State College. Attended Ballard High School in Seattle, Washington. Interested in restorative ecology.

This research was performed as a part of the integrated studies program Humans and Nature in the Pacific Northwest at The Evergreen State College.

Dr. Kathryn H. Burgess
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Kathryn H. Burgess is Visiting Faculty in Environmental Studies at The Evergreen State College. She earned her A.B. in Biology (1983) at Dartmouth College; and her A.M. (1985) and Ph.D. in Biology (1991) at Harvard University. She held a Postdoctoral Fellowship at the Center for Insect Science, University of Arizona. Kathryn is Past Director of the National Youth Science Camp, West Virginia. Her research is in plant and insect ecology and evolution, particularly in the ecology of flower-feeding and the evolution and molecular phytogenetics of the Heliothinae (Lepidoptera: Noctuidae).

Nisqually Delta Oceanography and Plankton Populations

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Jim Strong received his BA in Chemistry at Southwestern College at Memphis (now Rhodes College). After military service he attended graduate school at the University of Tennessee earning an MS in analytical and organic chemistry. He entered the teaching profession at Kellogg Community College, Battle Creek, Michigan. While at Butler, he established a water quality lab which supported the county’s water quality program and introduced limnology as a regular part of the college curriculum. He spent a sabbatical year studying mining technology at Pikeville College in Pikeville, Kentucky. He moved into industrial research and development within the steel industry as a researcher for Heckett, Division of Harsco Corporation, and was appointed Manager of Environmental Quality control for that company. He returned to teaching in 1984 at SPCC. He has been involved in two research projects dealing with the Nisqually Delta.

Ms Mary Lou Peltier
Saint Martin’s College
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Mary Lou Pettier earned her M.A. in Biology from Immaculate Heart College in Los Angeles and has been an assistant professor of biology at Saint Martin's College for six years. She teaches Marine Biology, Ecology, Advanced Ecology, Invertebrate Zoology, Genetics, Microbiology, General Biology for majors and non-majors, and Environmental Science for non-majors. Mary Lou is also moderator of the SMC Biology Club/Beta Beta Beta National Biological Honor Society and will be SMC Faculty President for the 1995-1996 school year. Prior to this, she taught biology and chemistry at South Puget Sound Community College. She has also been involved with the Budd-Deschutes Project GREEN water quality monitoring project in this area since its beginning three years ago.

Potential Benefits of a Co-managed Fishery

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Monitoring Benthic Invertebrates to Protect Water Resources

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Leska Fore is a statistician at the University of Washington. Her position is funded by outside research grants from state and federal agencies. She graduated from Brown University with a B.A. in biology in 1983. She received her M. Sc. in 1992 in biometry from the University of Washington. Between undergraduate and graduate studies she studied coral reef ecology at the Smithsonian Tropical Research Institute in Panama and worked with dolphins and chimpanzees on language-acquisition projects.

She is working with James Karr, Director of the Institute for Environmental Studies, to develop and test indices used to evaluate freshwater resources. In particular, she is interested in the underlying statistical properties of the index of biotic integrity (IBI) and its conceptual clones. Currently she is working with Karr to modify the IBI for use with macroinvertebrates collected from Northwestern streams.

Response of Benthic Invertebrates Along a Revegetated Portion of Eaton Creek

Mr. Chris Regan

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Chris received his B.S. in biology with a minor in chemistry from Western Washington University in 1993. In his final year he focused on wetland ecology, plant ecology, and aquatic entomology. He has volunteered extensively with the Thurston County Stream Team program as an environmental educator teaching macroinvertebrate monitoring. He is currently employed with the Washington Parks and Recreation Commission.

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Managing Great Blue Herons in South Puget Sound

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Mr. Norman earned his MS from Huxley College, Western Washington University in wildlife toxicology working on herons and contaminants, and has many years of working on herons in Puget Sound, setting up long-term monitoring. He is currently working on the foraging of herons in eelgrass beds, and would like to start a project to study where herons feed in the South Sound. Toxicology Task Force is a partnership with two other wildlife involved in both toxicology and wildlife projects, including a contract with the Nature Conservancy to perform a neotropical migrant bird survey at McChord AFB. He has also studied herons in 1994 at Fort Lewis.