URBAN ECOLOGY & CONSERVATION SYMPOSIUM

Sharing More Data, Making More Connections

Organized by the
Urban Ecosystem Research Consortium (UERC)

Held at
Smith Memorial Center Ballroom, Portland State University
Portland, Oregon, USA
January 28, 2005

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About the
Urban Ecosystem Research Consortium (UERC)

Mission Statement
To advance the state of the science of urban ecosystems and improve our understanding of them, with a focus on the Portland-Vancouver metropolitan region, by fostering communication and collaboration among researchers, managers and citizens at academic institutions, public agencies, local governments, non-profit organizations, and other interested groups.

Primary UERC activities include:
- Organizing annual Urban Ecology and Conservation symposia
- Coordinating working group meetings
- Maintaining a contact list for networking
- Providing a web site to enable access to UERC-related information
- Hosting a listserv for participants to communicate

Advocacy Statement
The role of the UERC is not to provide a political or advocacy platform, but to offer a forum for professionals to exchange information regarding urban ecology and its application to resource planning and management.

Peer Review Group
One of our UERC participants, Amber Keyser, established a peer review group in 2004. Meetings are held every other month and provide a supportive and friendly place for people to discuss research ideas, study designs and in-progress projects. The purpose of these meetings is to improve the quality of research, facilitate collaboration, and further connect us as a community of colleagues. If you are interested in participating, either to present ideas for discussion or to serve as a peer reviewer, please contact:

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Listserve
Join the listserv hosted by Oregon State University to exchange information and receive notices about upcoming events by subscribing at lists.oregonstate.edu/mailman/listinfo/urban-erc.

Find Out More
For more information about the UERC and to find out how you can get involved, please visit the web site hosted by Portland State University at www.esr.pdx.edu/uerc or contact a steering committee member.

UERC Steering Committee

The steering committee oversees UERC activities and organizes the Urban Ecology and Conservation symposia. Currently, the steering committee is composed of 10 individuals representing academic institutions, government agencies, and non-profit organizations. This diverse representation allows us to reach into many important sectors of the natural resources community in the Portland-Vancouver metropolitan area. If you are interested in joining this committee, please get in touch with any of the members listed below.

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2005 Symposium Agenda

8:00	Registration & Morning Social	
9:00	Welcome & Introduction - *Mike Houck*	
9:10	**Keynote Address** - *Why Cities Matter: Conserving Biodiversity To Create Livable Cities & Regions* John Fregonese - Fregonese Calthorpe & Associates	
Planning & Data	*Moderator: Alan Yeakley*	
9:40	Chris Prescott	The Role of Portland in Regional Recovery Planning Efforts
9:50	Claire Puchy & Dawn Uchiyama	Integrated Watershed Management in Portland, Oregon
10:00	Audrey Hatch	Comprehensive Wildlife Conservation Strategy for Oregon: Statewide Perspective and Urban Focus
10:10	Jill Ory	Creation of a Stream Enhancement Geodatabase
10:20	Amin Wahab & Eugene Lampi	Water Quality Monitoring in Portland's Fanno and Tryon Creeks
10:30	Q & A	
10:40	Break - *Raffle at 10:55*	
Human Dimensions	*Moderator: Noelwah Netusil*	
11:00	Kelli Larson	Residents' Attitudes toward Water Resource Protection in the Johnson Creek Watershed of Metropolitan Portland, Oregon
11:10	Marion Dresner	Changes in Students' Ecological Thinking Resulting from Ecological Science Projects as Represented by Ecological Models
11:20	Daryl Houtman	Quantifying and Valuing Ecosystem Services in Lents Neighborhood, Portland, Oregon
11:30	Alison Smith	Outreach Methodology for Landscape Scale Invasive Plant Species Control
11:40	Jennifer Budhabhatti	Cooper Mountain: Developing a Public-Use Plan to Protect Natural Resources
11:50	Q & A	
12:00	Lunch Break - *Raffle at 12:55*	
1:00	**Keynote Address** - *Connecting the Dots: Cities & Rivers, A Willamette Valley Vision* Steve Gordon - Lane Council of Governments	
Wildlife in the Region	*Moderator: Jennifer Budhabhatti*	
1:30	Deb Scrivens & Terry Kem	Cybertracking on Cooper Mountain
1:40	Laura Roberts	Amphibian Distribution in Parks and Greenspaces of the Portland, Oregon Metropolitan Area: A Multiple Scale Investigation
1:50	Lori Hennings & Michael Cole	Baseline Assessment of Macroinvertebrate Communities in and Adjacent to the Damascus Area Urban Growth Boundary Expansion, Oregon
2:00	Al Smith	Return of Native Freshwater Mussels to Smith-Bybee Lakes
2:10	Chad Smith	Baseline and Post Project Fish Monitoring for the City of Portland's Endangered Species Act Program
2:20	Trevor Massey & Robin Hertert	Birds on the Edge: Surveying Bird Populations on Portland's Willamette Bluffs
2:30	Q & A	
2:40	Break - *Raffle at 2:55*	
Flora & Non-Natives	*Moderator: Kelli Larson*	
3:00	Alan Yeakley	Riparian Buffer Losses following Development in Three Oregon Cities from 1990 to 2002
3:10	Noah Jenkins	Effects Of Managed Flooding on Shoreline Vegetation Communities in a Pacific Northwest Wildlife Preserve
3:20	Nancy Broshot	Changes in Forest Structure in Forest Park Between 1993 and 2003
3:30	Jan Curry	Goodbye Reed Canarygrass/Blackberry Jungle! Hello Restored Wetland/Upland Habitat
3:40	Sandy Diedrich	Decenial Monitoring of the Forest Park Ivy Removal Project
3:50	Kevin Martin	Using LiDAR and Multispectral Imagery to Map Canopy Heights in Tryon Creek Watershed
4:00	Kyle Strauss	Ecologic and Economic Considerations for Landscape Scale English Ivy Control
4:10	Q & A	
4:20	Wrap Up - *Lori Hennings*	
4:30-6:30	Poster Session & Evening Social	

Poster Presentations

Katelin Alldritt, Camille Graves, Sopheap Kuch, and Julie Smith	A Comparison of Wetland Vegetation at the Sandy River Delta from 2003-2004
Andrew Arnsberg, Ian Waite, Frank Rinella, and Steve Sobieszczyk	Assessment of Aquatic Biological Communities Along a Gradient of Urbanization
Neil Bell	Evaluation of *Ceanothus* and *Cistus* for Western Oregon Landscapes
Matthew Brennan	Adaptive Management at a Stream Rehabilitation Site in Dallas, Oregon
Joshua Caplan and Alan Yeakley	Patterns of Himalayan Blackberry Distribution, Abundance, and Vigor in Portland Parks
Samual Chan, Tara Nierenberg, and Derek Godwin	Oregon State University's Master Watershed Stewards Program for the Portland Metro Area
Heejun Chang and Michael Boeder	Multivariate Analysis of Water Quality in the Tualatin River basin
Sandra Diedrich	Ivy Removal Project Field Investigations Applied to Removal Protocol and Control Methods
Michelle Hollis	Relationships between Land Use and Water Quality in and Near the Damascus Urban Growth Boundary (UGB) Expansion Area
Terry Kem	Mapping Mammal Presence and Behavior with Cybertracking Technology
Trevor Massey, Robin Hertert, Esther Lev, Dennis O'Connor, and Daniel Senffner	Open Meadow Students Restoring Wetlands and Planning for the Future
Danny O'Keefe and Patricia Thompson	The Songbird Foundation Urban Habitat Campaign: Urban Habitat is For the Birds
Frank Opila and Pat Willis	Water Quality Monitoring, Education and Partnership Project
Michael Pence, Kent Kirkpatrick, and Lisa Hamerlynck	Developing Methods for Rapid Assessment of Natural Open Spaces
Kendra Petersen-Morgan	Assessment of Riparian Restoration Projects Conducted in Partnership with the Johnson Creek Watershed Council
Walter Shriner and Michael Jones	Conducting Ecological Research in a Classroom Setting: A Case Study
Walter Shriner, Marty Mitchell, Kathryn Holleran and Joan Caldwell	A Watershed Approach to Natural Resources Technician Education
Jeffery Smith	Geonomics: Shift Taxes to Augment Habitat
Sarah Smith and Michael Murphy	The Demography of Spotted Towhees in Portland's Urban Greenspaces
Wendy Stevens and Marion Dresner	Research on Monitoring of Urban Biodiversity with Non-Specialists: Outcomes for Conservation and Science Education
Cynthia Studebaker	Fish Habitat Restoration Projects in Portland
Dan Sullivan	Compost: A Tool for Sustainable Landscapes
Bob Van Dyk, Deke Gundersen, Jocelyn Brown, Katie Garcia, Tara Rott, and Mackenzie Zirk	Lower Gales Creek Restoration Project

Keynote Speakers

Opening Keynote Address

Why Cities Matter: Conserving Biodiversity To Create Livable Cities & Regions

John Fregonese
Fregonese Calthorpe & Associates, Portland, Oregon

John Fregonese has been a planner for 25 years. He has earned the rare reputation of being able both to create an energizing vision for communities and to develop solutions to urban problems. He makes planning interesting, relevant and understandable to the average person. As a result, his projects tend to garner strong public input and support.

John is well known for his work in Portland where he directed Metro's Region 2040 growth management program. The Region 2040 plan has earned many national awards. Since co-founding Fregonese-Calthorpe in 1997, John and his colleagues have engaged in some of the most nationally significant metropolitan planning projects in recent decades. John was a key consultant in the *Envision Utah* process and a lead consultant for *Chicago Metropolis*. He is currently engaged in developing regional plans in Austin, Texas as well as Southern California, a massive region of 38,000 square miles and 17 million people.

Luncheon Keynote Address

Connecting the Dots: Cities & Rivers, A Willamette Valley Vision

Steve Gordon
Lane Council of Governments

Steve Gordon retired from his position as Program Manager at the Lane Council of Governments in Eugene, Oregon in 2003 and currently consults on natural resources projects. Steve coordinated the Eugene-Springfield metropolitan region comprehensive plan in the early 1980's. Steve has written extensively on wetlands, growth management and rural community issues, and has served on several state committees dealing with public facilities, economic development, wetlands and other natural resources.

Steve is a regionally and nationally recognized leader in planning and wetland protection, having received the Oregon Chapter of the American Planning Association's award for *Distinguished Leadership by a Professional Planner* and the Environmental Law Institute and Environmental Protection Agency *National Wetlands Protection Award*. In 2003, The Nature Conservancy of Oregon bestowed on Steve and the City of Eugene its *Conservation Leadership Award* for lifetime achievement in partnering on the West Eugene Wetlands project. In 2004, the Eugene City Club honored him with its *Turtle Award*, given to leaders who stick their necks out on community projects. He is currently working on a book focusing on dragonflies of the Eugene-Springfield area.

Abstracts Submitted

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A Comparison of Wetland Vegetation at the Sandy River Delta from 2003-2004

The wetland site adjacent to I-84 in the Sandy River Delta (SRD) is an area undergoing a restoration project by the United States Forest Service (USFS). Portland State University students collected data in the summer months of 2003 and 2004 as part of a partnership with the USFS. Our goal was to determine the effectiveness of the wetland restoration by identifying plant species and estimating percent coverage. The data collection methodology relied on a linear transect across the wetland in a West to East direction. At ten meter intervals, the percent coverage of each plant species was recorded in each one meter squared plot. Overall vegetation coverage from 2003 to 2004 was illustrated by an increase in native, non-native, and obligate plant coverage. The Simpson diversity index decreased from 2003 to 2004 from 7.06 to 5.86, respectively. However, the average diversity index from per plot increased from 2003 to 2004 from 2.56 to 3.22, respectively. The species richness increased from 30 to 31 species, which contrasted with a higher increase in average species richness per plot from 4.97 to 6.50, correspondingly. An influence on the data was a wetter summer in 2003 than 2004. Based on this study, the status of the wetland at the SRD is improving. The inconclusiveness of the data was due to the small collection time frame. This initial stage of analysis contributes to what hopes to be a long term study on the restoration process of the SRD.

Keywords: Conservation biology, Habitat restoration
Time Period: 2003 - 2004
Geographic Location: Sandy River Delta, confluence of Sandy River and Columbia River, Troutdale
Partners and Sponsors: Robin Dobson, U.S. Forest Service

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Assessment of Aquatic Biological Communities Along a Gradient of Urbanization

From late 2003 through summer 2004, the U.S. Geological Survey's National Water Quality Program sampled 28 streams within the Willamette Basin to investigate effects of urbanization on aquatic biology, habitat, and water chemistry. The 28 watersheds fall along an urban land use gradient index (0 to 100, lowest to highest) based on land use and census data. Watershed areas range from 5 to 37 square miles and contain greater than 30 percent of the Willamette Valley ecoregion. Ten streams were sampled for water chemistry six times during study period. The other 18 streams were sampled twice for water chemistry—once during high sustained flow, and once during summer low flow. Aquatic biology and habitat were assessed at all 28 sites during summer 2004. The data will be analyzed to determine relationships to the urban gradient index and for possible detection of threshold responses. Preliminary results indicate that 57 percent of the most urbanized streams contained nonnative fish species, but only 43 percent contained salmonids. Conversely, nonnative fish species were present in 14 percent of the least urbanized streams, whereas salmonids were present in 79 percent of these streams.

Keywords: Animal ecology, Land use planning, Water quality
Time Period: Late 2003 - Summer 2004
Geographic Location: Willamette River Basin

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Evaluation of *Ceanothus* and *Cistus* for Western Oregon Landscapes

Both *Ceanothus* and *Cistus* are genera of principally evergreen shrubs, native to the western U.S. and the Mediterranean basin, respectively. Both genera are sparingly cultivated in the Pacific Northwest, being represented by only a few taxa of the many that exist in cultivation elsewhere. Their principal ornamental characteristics are that they are evergreen, and very showy when in bloom, and so are popular landscape shrubs. However, originating as they do in Mediterranean climates, these shrubs also display superb drought tolerance, as well as tolerance of poor soil typical of many home sites and streetscapes. Many *Ceanothus* are also nitrogen-fixing. The goal of our research on these genera was to gather as many taxa as possible, and trial them for PNW conditions in an outdoor, replicated field trial. The best-adapted varieties could then be recommended for use in challenging landscape sites such as highway banks, parking lots and other hot, dry locations where water and fertilizer applications are not available or desired. A collection of *Ceanothus* has been trialed in this manner at the Oregon Garden. Forty five taxa were planted in a replicated trial in 2001. The plants were watered in their first year and have received no supplemental water since the establishment year. Data collected on the plants includes size and flowering times. A similar trial of 110 taxa of *Cistus* was established at NWREC in June 2004 and will be evaluated in a similar way. Results will be made available to nurseries, landscapers and other natural resource professionals.

Keywords: Plant ecology, Sustainable development, Water quality
Time Period: 2001 - 2007
Geographic Location: The Oregon Garden, Silverton; North Willamette Research and Extension Center, Aurora
Partners and Sponsors: The Oregon Garden, OSU North Willamette Research and Extension Center (NWREC)

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Adaptive Management at a Stream Rehabilitation Site in Dallas, Oregon

The Rickreall Creek rehabilitation project at Delbert Hunter Arboretum in Dallas, Oregon was developed to reduce the risk of vertical streambanks to public safety, halt and potentially reverse progressive channel downcutting, diminish flood and erosion hazards, and improve aquatic and riparian habitat. The project consisted of bank regrading to increase flood conveyance and reduce velocity of instream flows, construction of two "complex" engineered log jam grade control structures (utilizing concrete "log" key members) to direct flow and trap bedload alluvium, and increasing the diversity of physical habitat to allow development of a variety of aquatic and riparian habitats. The project was constructed in the summer of 2003. During the winter of 2003/2004, an ice storm caused unusually high woody debris loading in Rickreall Creek, and led to the development of a debris jam on the upstream grade control structure. During this same period, the right bank at this structure experienced scouring flows, leading to the formation of a side channel around the grade control structure. Measures were taken to ensure that the side channel did not migrate further away from the stream and threaten nearby residences. During summer 2004, adaptive management measures were taken to further stabilize banks near the grade control structures, and to revise the upstream grade control structure to allow passage of transient woody debris in the center of the channel. The unplanned, newly-formed side channel was determined to be a benefit to the system, which has relatively low channel diversity in the project reach.

Keywords: Habitat restoration, Hydrology, Land/watershed management,
Time Period: August 2003 - Present
Geographic Location: 400 foot reach of Rickreall Creek in Dallas, Oregon
Partners and Sponsors: City of Dallas, Rickreall Watershed Council, Pacific Water Resources

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Changes in Forest Structure in Forest Park Between 1993 and 2003

In 1993, I began a study of forest structure in Forest Park. In this study, three, 250 meter square quadrats were randomly located at 25 sites in Forest Park and the Ancient Forest Preserve. All trees within each quadrat were identified to species and the dbh (diameter at breast height) was measured. Data were recollected in 2003 at the same sites. Data were analyzed using ANOVA and Bonferroni/Dunn using section of the park as the independent variable. Data between years were compared using paired t-tests. In 1993 and 2003, there were significantly fewer western red cedars and western hemlocks at sites closer to downtown Portland. In both years, there were significantly fewer shade tolerant species of saplings and young trees at sites closer to the city. I also found significantly fewer trees in the park in 2003 than in 1993. In no section did I find an increase in the density of saplings or young trees of any species. This suggests that tree regeneration is not occurring in Forest Park. My findings suggest that urbanization is interfering with normal successional processes at more urban sites. In addition, I found significantly higher tree mortality in 2003 than in 1993 for all tree species in Forest Park. The combination of decreased recruitment and increased mortality poses potential problems for management of the park.

Keywords: Conservation biology, Plant ecology
Time Period: Summer 1993 and Summer 2003
Geographic Location: Forest Park in Portland Oregon and the Ancient Forest Preserve in Multnomah County
Partners and Sponsors: Portland Parks and Recreation, Portland State University (1993) and Linfield College (2003)

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Cooper Mountain: Developing a Public-Use Plan to Protect Natural Resources

Cooper Mountain is a 260 acre site owned by Metro and located west of Tigard in the southwest corner of Washington County, Oregon. Its south-west exposure and thin soils have led to a mosaic of oak-madrone habitat, prairies and mixed-conifer vegetation. The oak-madrone habitat, prairies and associated wildlife are unique in the Willamette Valley, because 80% of the 20% available habitat is in private ownership. The site will soon be open to the public. To prepare for this event, Metro inventoried and mapped its natural resources including wildlife, rare and threatened plants, wetlands, soils and geologic features. Metro developed a public use plan based on natural resource information, a recreation need assessment, feedback from its steering committee and public open houses. Three public-use alternatives were generated through this process and comments were sought from the steering committee and the public on its natural resource values and public-use perspective. A final draft alternative was chosen based on public opinion. Research and public opinion showed that dogs and biking are detrimental to the habitat; they would, therefore, not be allowed on site. Only low impact uses such as hiking and limited horse back riding would be allowed. Over 50% of existing demand trails would be closed and restored. Best management practices will be used to build trails and other public infrastructure.

Keywords: Conservation biology, Environmental social sciences, Habitat restoration, Land use planning, Land/watershed management, Wildlife biology
Time Period: January 2004 - August 2005
Geographic Location: Cooper Mountain, west of Tigard in the south-west corner of Washington County, Oregon
Partners and Sponsors: Washington County and Tualatin Hills Parks and Recreation

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Patterns of Himalayan Blackberry Distribution, Abundance, and Vigor in Portland Parks

This study was a first step in identifying the factors contributing to human-modified plant communities' susceptibility to blackberry invasion; we sought to determine what environmental factors influence blackberry's distribution, abundance, and reproductive potential in Portland natural areas. Soils in which blackberry patches were growing had coarser textures than typical for their soil units, highlighting the role of anthropogenic soil alteration in blackberry invasion. Patch area per hectare decreased with the amount of competing vegetation surrounding patches, but increased with soil clay content. Patch height increased with soil fertility but decreased with soil density and canopy cover. Reproductive output increased with soil fertility but decreased with canopy cover and the diversity of the surrounding vegetation. These data show that both light and soil fertility influence the level of blackberry's invasion at a site, and suggest that an analysis of the environmental and anthropogenic influences on light and soil fertility (e.g., forest fragmentation and soil alteration) will allow us to estimate a site's invasibility. Our next steps are to perform an expanded study in which we will determine if more human modified plant communities are more invasible, and the relative contributions of environmental and anthropogenic factors to their invasibility level. We will also determine which factors contribute to the cost effectiveness of controlling blackberry in urban natural areas.

Keywords: Land/watershed management, Plant ecology
Partners and Sponsors: Portland Parks and Recreation
Publication: Caplan, J.S. and J.A. Yeakley. In review. Himalayan Blackberry (*Rubus armeniacus*) Tolerance and Vigor Response to Photic and Edaphic Conditions in Western Oregon. Northwest Science.

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Oregon State University's Master Watershed Stewards Program for the Portland Metro Area

Many residents in the Portland Metro area are familiar with "master" programs offered by the OSU Extension Service: Master Gardeners, Master Food Preservers, and Master Woodland Managers. With special training provided by the OSU Extension Service, these people serve as rich resources for their communities. OSU Watershed Extension is applying this successful model to educate Master Watershed Stewards (MWS) to serve the Portland metro communities. MWS Stewards are certified after completing an eight module course covering watershed principles and management and a project with assistance from OSU Watershed Extension, resource agencies or watershed councils. MWS Stewards become local contacts on watershed issues for their communities. MWS curriculum entails a series of eight interrelated topics (usually 18 classroom hours and 28 field hours) that provide comprehensive watershed education at an introductory level. Enrollment is open to watershed groups, landowners, agricultural producers, conservation districts, nursery growers, foresters, planners, teachers, urban residents and other interested groups and individuals. Each topic combines watershed principles and practices and touches individual and links between forestry, aquatic, agriculture, and urban land uses. Current introductory topics in the MWS Program include: Introduction/Project Planning; Watershed and Stream Processes; Riparian Area Functions and Management; Salmonid Biology; Stream Assessment and Restoration; Water Quality Monitoring; Wetland Evaluation and Enhancement; Soils, Erosion, and Conservation; and Working Together to Create Successful Groups. Additional topics and advanced trainings are made available based on local needs.

Keywords: Environmental education, Land/watershed management, Water quality
Time period: Program for the metro areas started in 2003 and will be offered again during the spring of 2005.
Geographic Location: Portland metro area

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Multivariate Analysis of Water Quality in the Tualatin River basin

The Clean Water Services of Washington County has been collecting various water quality parameters in the Tualatin River basin since 1980. Using these data, we analyzed spatial variations of selected water quality parameters in the Tualatin River and its major tributaries. We used multivariate statistics and Geographic Information Systems (GIS) for data analysis. We used GIS to analyze land cover characteristics at the sub-basin scale and at the riparian buffer scale. There was a striking variance in land cover from an upstream sub-basin to a downstream sub-basin at both scales. We grouped six sub-basins into three groups – urban, mixed, rural basins. The Kruskal-Wallis test was used to determine mean differences among the three groups. Most water quality parameters exhibited statistically significant differences. To further explain observed variance in water quality, we used principal component analysis (PCA) for each group. PCA identified different water quality parameters as major components in each group, suggesting that different processes are involved in explaining water quality variability in an urban-rural gradient of the Tualatin River basin.

Keywords: Hydrology; Land/watershed management, Water quality
Time Period: 1980 - 2003
Geographic Location: Tualatin River, Washington and Clackamas Counties and City of Portland
Partners and Sponsors: Clean Water Services, Portland State University Faculty Enhancement Grant

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Columbia River Suspended Sediment Monitoring

For the past two winter/spring seasons we have measured physical properties of suspended material in the Columbia River. Efforts center on maintaining a laser in-situ scattering transmissometer (LISST) at the Portland General Electric (Beaver Army Terminal) pier at river mile 53 on the Columbia River. The LISST-floc uses forward scattering of laser light to determine volume concentration of suspended matter in 32 log spaced size bins extending from 7 to 1500 microns. Supporting measurements include mass concentration of total suspended solids, fixed/volatile ratio, settling velocity, and scanning electron microscopy. The USGS maintains transmissometers and an acoustic Doppler current profiler, which records intensity of acoustic return, at Beaver. Collected data, in addition to its usefulness in determining sediment export by the Columbia River, has facilitated several findings. As expected, concentrations of the finest material changes little with the phase of the tide, whereas concentration of larger material positively correlates with magnitude of tidal current velocities. However, peak concentration of the largest material occurs not during, but following peak flow velocity. We hypothesize aggregation processes govern its behavior. Comparison of mass and volume concentrations with measured settling velocities support the fractal nature of aggregates. The Beaver site offers a prime location for methodological development of suspended sediment monitoring. We look toward applying methods developed there to lower flow, more traditionally urban fluvial environments and more interdisciplinary environmental studies.

Keywords: Geology, Water quality
Time Period: Winter & Spring, 2003 - 2005
Partners and Sponsors: U.S. Army Corps of Engineers, NOAA Fisheries

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Stem Injection of Glyphosate Herbicide for Controlling Japanese and Giant Knotweed

Because Japanese and giant knotweed (*Polygonum cuspidatum* and *P. sachalinense* respectively) are capable of forming dense monocultures and permanently displacing native species in riparian and flood plain habitats, they represent a major threat to the function of riparian areas and floodplains throughout the Pacific Northwest. Since 2000, The Nature Conservancy (TNC) has been conducting knotweed control experiments and has engaged in a landscape-level control project in the Sandy River watershed. Earlier TNC studies focused on testing manual treatment and a variety of foliar and cut-stem type herbicide applications. Although several treatment combinations provided significant levels of control, each required multiple years to achieve eradication. Here, we present the 1st year results of a controlled experiment and associated uncontrolled landscape scale control program testing direct stem injection of the herbicide glyphosate done in partnership with Metro's knotweed control program on the Clackamas River. We injected knotweed stems with different volumes of glyphosate in July or September 2003 (1.5, 3 or 5 ml of herbicide concentrate, with or without supplemental foliar spray, n = 6) and measured stem number reduction of each patch in summer 2004. Stem injection provided approximately 90% control, with surviving canes much reduced in vigor. Glyphosate volume, supplemental spraying, and application timing and the percentage of stems injected had only minor effects. Data from the landscape scale treatment program largely confirm the results of the small scale experiment. One year after treatment there is no apparent difference between patches treated with 3ml versus 5ml of herbicide.

Keywords: Habitat restoration, Land/watershed management, Plant ecology
Time Period: July 2003 - October 2004
Geographic Location: Sandy River watershed and Clackamas River riparian areas, Multnomah and Clackamas counties
Partners and Sponsors: U.S. Fish and Wildlife Service, Oregon Watershed Enhancement Board, Bureau of Land Management, Sandy River Basin Watershed Council, National Fish and Wildlife Foundation, Northwest Service Academy
Publications: Controlling Knotweed in the Pacific Northwest: tncweeds.ucdavis.edu

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Goodbye Reed Canarygrass/Blackberry Jungle! Hello Restored Wetland/Upland Habitat

Who're you gonna call when the place is a reed canarygrass, concrete and blackberry jungle? Jackson Bottom Wetlands Preserve connected with the Natural Resources Conservation Service (NRCS) for grant funding involving research to study invasive reed canarygrass and to convert a section of reed canarygrass and blackberry into a native landscape which would have high educational value. These five acres of land surround the year-old Wetlands Education Center near the middle of the Tualatin River at the edge of Hillsboro. The result after two years is that there are nine demonstration areas for public education and recreation. One is the reed canarygrass research area for ongoing education and restoration. The other demonstration areas include a pollinator garden, a sensory trail, landscaping for home and business, three vegetated bioswales, a stormwater creek model with soil bioengineering, a reptile garden, a native tree arboretum (upland/wetland), and a bulb garden. Ten interpretive signs and two brochures were developed to explain the project and teach the general public about what we learned. Many school children and community visitors come for hikes and education programs about plants, wildlife habitat, and water quality. This project studied and removed invasive plants and created restored areas now available for environmental education about how native plants are used for wildlife habitat and water management.

Keywords: Habitat restoration, Plant ecology, Environmental education
Time Period: January 2002 - December 2004
Geographic location: Jackson Bottom Wetland Preserve in Hillsboro, floodplain of the Tualatin River
Partners: Natural Resources Conservation Service, Clean Water Services, Waste Management, Cascade Education Corps, AmeriCorps, Fisher Farms, Portland State University, Dennis O'Connor Restoration Services, Photodonation, Washington Co. Sheriff's Department inmate program

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Decenial Monitoring of the Forest Park Ivy Removal Project

The Decennial Monitoring project combined a specific assessment of more than 90 work sites with other project documentation to produce findings and conclusions regarding the effectiveness of work performed and recommendations for future strategies and priorities. The specific assessment examined sites ranging from less than an acre to more than 25 acres where *Hedera helix* had been removed manually over a ten year period by both volunteers and paid youth crews. The monitoring was conducted within a seven week period in the summer of 2003 by a team of college interns and high school youth using a format and protocol developed internally in consultation with research professionals. The preliminary results were then compared to condition and activity documentation for each work site during the winter of 2003-2004 with follow-up field visits conducted for more than 30 sites in the spring and summer of 2004. Findings and recommendations taken from the database illustrate both successes and shortcomings in achieving measurable and/or sustainable habitat restoration. They also indicate priorities and strategies for future project planning. The requirements necessary for and the educational value of such projects are also demonstrated. The report concludes that specific priorities are essential: stop seed production, save the canopy, and eliminate isolated infestations while overall reducing biomass otherwise. The report also concludes that the method of removal is a secondary consideration to strategic priorities. Further, the report concludes that education is a major benefit of volunteer participation while recommending specific types of volunteer removal activities for greatest efficiency.

Keywords: Environmental education, Environmental policy, Habitat restoration
Time Period: 1993 - 2004
Geographic Location: Forest Park, Portland, Oregon
Publications: Ivy Removal Project: Decenial Monitoring Report

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Ivy Removal Project Field Investigations Applied to Removal Protocol and Control Methods

The Ivy Removal Project has conducted numerous field investigations and test plot projects in order to improve its protocol and attract research into the variables affecting control of the invasive plant species *Hedera helix*. Two are presented on this poster to illustrate the importance of investigating specific questions in order to develop control protocol that is efficient and effective. Each proceeded as an inquiry project rather than as a research project in order to manage each investigation within the dynamic context of a community based project and its programmatic components. These questions were: 1) Does pulled ivy or ivy removed from trees need to be removed from the site in order to prevent re-growth? 2) How often do ivy flowers need to be deadheaded in one growing season in order to stop berry and seed production? Each question has been answered by conducting a high school student led project to establish test plots, collect data, perform data analysis, and develop conclusions supported by the test plot protocol and the data generated. Test plot results indicate that re-growth of ivy at a work site is most likely from residual roots that re-sprout or from germinated seeds than from re-rooted vines. The second question was investigated over a multi-year period: mature Hedera helix needs deadheading only once between October 1st and February 1st to control the production of drupes. The poster illustrates the test plot protocol, the data collected, and the results.

Keywords: Environmental education, Environmental policy, Habitat restoration
Time Period: 2001-2003; 1999-2003
Geographic Location: Forest Park, Portland, Oregon
Partners and Sponsors: Linfield College, Portland State University

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Changes in Students' Ecological Thinking Resulting from Ecological Science Projects as Represented by Ecological Models

What do students learn through work on field projects that is unique to ecology? Systems thinking and the concept of change over time are two important ecological ways of thinking and knowing, also important for public understanding about ecological processes. Systems thinking can be measured using models of ecosystems generated by students. Changes in complexity of representations of student thinking as they progress through a study can be traced. Two groups of high school students at Sandy High School were involved in a pilot study involving the use of student generated ecosystem models. Students designed a model of ecosystem components before engaging in a two-week field research project comparing diversity of invertebrates under two different environmental conditions. After their field study, students were asked again to generate ecosystem models. Ecosystem models were scored according to the number of correct links, number of both biotic and abiotic components used, and overall understanding of multiple interactions. Most students showed considerably more sophistication in the design of their second models. This assessment procedure will be tested on undergraduate students this winter before and after engaging in ecosystem field studies.

Keywords: Conservation biology, Environmental education
Time Period: Summer and fall 2004
Geographic Location: Sandy, Clackamas County
Partners and Sponsors: Byron Ball (teacher), Sandy High School and Dr. Andy Moldenke, Oregon State University
Publication: Forthcoming

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Captive rearing and endangered butterfly recovery: Three captive environments and implications for propagation programs

Loss of habitat due to the rapid encroachment of urban development has had a strong negative effect on many species of native insects. The Fender's blue *(Icaricia icarioides fenderi)* is an endangered butterfly surviving in remnants of upland prairie in Oregon's Willamette Valley. Because Fender's blue populations are scarce and those that remain are rapidly declining, recovery strategies for this butterfly are likely to require population augmentation and reintroduction for long-term viability. Unfortunately, effects of captive rearing are largely unknown for butterflies. In order to investigate these possible effects in the context of endangered butterflies, we initiated research on Puget blue (*I. i. blackmorei*), a closely related surrogate species, with the goal of applying this knowledge to develop the most appropriate and least detrimental protocol possible for the Fender's blue. Larvae collected from 48 females were weighed and split into three treatment groups for larval diapause, each experiencing unique environmental conditions throughout diapause. Initial analyses reveal that although no significant differences were detected in development time and sex ratio between treatments, weights at both pupation and adult eclosure were significantly different between treatments. Additional analyses of morphology and behavior are underway to further quantify treatment effects. Overall, these results suggest that though captive rearing is an important tool for the recovery of endangered butterflies, direct short-term effects of captive rearing are important and merit further study.

Keywords: Animal ecology, Conservation biology, Wildlife biology
Time Period: 2003 - 2005
Geographic Location: Scatter Creek Wildlife Area, Thurston County, WA
Partners and Sponsors: American Zoo and Aquarium Association, Oregon Zoo, Washington Department of Fish and Wildlife

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Clark County Critical Areas Ordinances Update Project

Washington's Growth Management Act (GMA) requires local jurisdictions to designate and protect critical areas, defined as wetlands, flood hazard areas, critical fish and wildlife habitat, geologic hazard areas and critical aquifer recharge areas. GMA further requires that the ordinances be reviewed periodically reviewed and updated, and that any updates be based on best available science. The county is in the process of working with state agencies, stakeholders and other interest groups, and the public to determine what changes need to be made to ordinances to reflect the latest science. It is anticipated that most of the needed changes will be to the habitat and wetlands ordinances because of the amount of new information that has been generated and because of efforts to recover endangered fish species.

Keywords: Land use planning, Environmental policy, Environmental education
Time Period: January 2004 - Summer 2005
Geographic Location: Clark County, Washington
Partners and Sponsors: Washington Department of Community, Trade, and Economic Development
Publications: Updates to Clark County Code Title 40, the county's unified development code, and critical areas data layers in the county's GIS.

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Fish Communities of Urban Streams: Insights on Gear Bias from Non-Standard Fish Sampling Methods

Fish collection during and after stream segment dewatering and lethal toxic events reveals fish community structure that can differ considerably from the results of standard electrofishing in the same reaches of Portland area streams. These unique sampling opportunities approximate a total census of all fish in a reach. Comparison with other sampling techniques highlights the limitations and biases of standard fish collection methods. Sampling gear and techniques designed to minimize harm to individual fish and their populations are effective for some species and life stages, but may miss or underestimate others.

Keywords: Fisheries
Time Period: 2002 - 2004
Geographic Location: Portland metropolitan area

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The Effect of Riparian Vegetation on Heavy Metal Concentrations in an Urban Stream

In urban areas, heavy metals are important in surface water quality degradation. Riparian areas may play a key role in controlling anthropogenic metal loading. I hypothesized that riparian zones may reduce the input of dissolved metals to streams, by reducing surface runoff, by increasing the amount of organic matter with which metals can bind, and by direct vegetative uptake of metals. I predicted that concentrations of zinc (Zn), copper (Cu), and lead (Pb) in shallow groundwater would increase with decreasing adjacent riparian buffer width. I selected an urbanizing stream, Johnson Creek, for a study site. Johnson Creek flows through various land uses in southeast Portland, OR, providing an opportunity for comparison between heavily vegetated and unbuffered sections. I installed shallow groundwater wells at six sites along Johnson Creek: three lined with <40m of vegetation and three with vegetation buffers ≥200m wide. From September until May, I collected weekly samples of the shallow groundwater and surface water at each site, and analyzed seven of those samples for Zn, Cu, and Pb concentrations by inductively-coupled plasma mass spectrometry (IC-PMS). Metal concentrations at buffered and unbuffered sites were not significantly different. I conclude that the most important factors affecting metal concentrations were stream flow and subsurface adsorption/desorption processes, and that local, small-scale riparian buffer conditions did not exert significant control over local stream water metal concentrations. My results suggest that examining cumulative effects of riparian buffers on a watershed scale may be more important in determining metal concentrations than local riparian width.

Keywords: Land/watershed management, Water quality
Time Period: September 2003 - May 2004
Geographic Location: Johnson Creek, Portland

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Comprehensive Wildlife Conservation Strategy for Oregon: Statewide Perspective and Urban Focus

The Oregon Department of Fish and Wildlife is preparing a Comprehensive Wildlife Conservation Strategy (Conservation Strategy) to provide a non-regulatory, statewide approach to species and habitat conservation in Oregon. Each state accepting USFWS state wildlife grant funds must prepare a comprehensive strategy that accomplishes the following objectives: identifies species of greatest conservation need and their habitats; describes the limiting factors facing these species and habitats; describes priority research and survey efforts, identifies partnerships and collaborative opportunities, proposes monitoring plans, and involves meaningful public participation. The Strategy synthesizes reliable, science-based, peer-reviewed information on Oregon's natural resources, and provides a proactive framework for conservation that could reduce the risk of further threatened and endangered species listings. We present our framework for identifying species and habitats of greatest conservation need, and discuss the information in the context of cooperative solutions and voluntary approaches identified. One focus will be conservation needs and actions identified for Oregon's urban areas. Overall, the Strategy will help ensure the sustainability of Oregon's terrestrial and aquatic ecosystems and the economies that rely on them.

Keywords: Conservation biology, Sustainable development
Time Period: 2004 - 2005; monitoring is ongoing
Geographic Location: Statewide (Oregon), with a focus on the Portland area

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Damascus/Boring Urban Growth Expansion Area Concept Planning

In 2003, the greater Portland area's Urban Growth Boundary (UGB) expanded by more than 12,000 acres in the Damascus-Boring area, the single largest expansion of the UGB since its establishment. This area is expected to develop over the next 20 years with approximately 25,000 residences, a town center and 1,657 acres of employment land. In 2003, Metro characterized macroinvertebrate and physical habitat conditions in 40 stream reaches within and adjacent to the expansion area and investigated the effects of forested buffers within the study area on macroinvertebrate community conditions. The four larger tributary systems, Rock, Richardson, Noyer, and NF Deep creeks, showed longitudinal trends of improving benthic conditions from upstream to downstream. In 2004, Clackamas County and Metro, in partnership with local cities and citizen groups, began the concept planning process required before urban development can occur. The study area's size and relatively undeveloped condition present a prime opportunity to integrate natural resources, transportation infrastructure, public facilities and land use. Natural resources provide the foundation for each concept plan. Concept plan development includes: Core Values/Images: A public involvement process to identify core values of the community (completed). Plan Alternatives: Involves compiling background data, developing goals and principles, and a Concept Development Workshop to identify concept plan alternatives (completed). Analysis of Alternatives: Each of the alternative concepts will be analyzed, looking closely at the transportation impacts and the impact on the natural resources (in process). A decision on the Recommended Concept is expected for the end of 2005.

Keywords: Land use planning, Land/watershed management, Sustainable development
Time Period: 2003 - 2005
Geographic Location: Clackamas County

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Relationships between Land Use and Water Quality in and Near the Damascus Urban Growth Boundary (UGB) Expansion Area

Urbanization of watersheds can considerably alter water chemistry and physical habitat conditions, leading to a decline in biological integrity. The use of benthic macroinvertebrates as indicators of surface water quality has become a consistent and widely accepted measure of stream condition. Through a partnership with Metro, previously collected bioassessment data using benthic macroinvertebrates will be examined for 40 stream reaches within and adjacent to the 12,000-acre Urban Growth Boundary (UGB) expansion area near Damascus, Oregon to determine if correlations exist between land use and water quality. GIS will be utilized for land use/land cover analysis to explore the relationship between land use and water quality at multiple spatial scales. Linear regression and correlation analysis will be employed to examine the association between physiochemical variables and macroinvertebrate metrics so that optimal correlations between water quality and land use can be determined. Factors of collinearity will be minimized and multivariate ordination will be used to statistically relate specific land use categories to macroinvertebrate metrics. The information will be used to increase Metro and its partners' ability to make informed planning decisions to minimize development impacts on streams within the Damascus UGB expansion area.

Keywords: Water quality, Land use planning, Land/watershed management
Time Period: October 2004 - June 2005
Geographic Location: Tributary streams to Clackamas River and Johnson Creek in/near Damascus UGB expansion area
Partners and Sponsors: Lori Hennings, Metro

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Effects Of Managed Flooding on Shoreline Vegetation Communities in a Pacific Northwest Wildlife Preserve

Water level management efforts in the Smith and Bybee Lakes Wildlife Area (SBL), an 800 ha preserve in the Columbia Slough area of North Portland, Oregon, include using a newly-established water control structure to suppress invasive reed canarygrass (*Phalaris arundinacea* L.) by flooding during spring and early summer growth periods. We sought to determine: (a) the present extent and distribution of reed canarygrass at SBL, particularly on lands that will be affected by the change in water regime; (b) the effectiveness of the change in water level at suppressing reed canarygrass; and (c) the effects of the change in water level on other plant species distributions. Prior to seasonal flooding during the dry season in autumn 2003, we established 30 vegetation transects at SBL. These transects were distributed randomly throughout SBL, placed perpendicularly to the shorelines of the wetlands. Measurement of vegetation was conducted using the line intercept method at 10 cm intervals. Our baseline measurements showed that reed canarygrass averaged 49% cover in the shoreline areas of SBL. This invasive plant had a strong impact on plant diversity; nonparametric statistical correlation of reed canarygrass cover with Shannon diversity yielded a Spearman's rho value of -0.77 ($P<0.05$). Measurements of reed canarygrass stands during the 2004 growing season indicated a reduction in mid-season shoot growth and alteration of growth habit for inundated patches as compared to upland stands; both results were correlated with water depth. Monitoring in autumn 2004 showed that reed canarygrass cover had decreased to 45% on average, while cover for important native taxa had increased.

Keywords: Habitat restoration, Plant ecology
Time Period: October 2003 - November 2004
Geographic Location: Smith and Bybee Lakes, Portland, Oregon
Partners and Sponsors: Metro, U.S. Environmental Protection Agency

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Mapping Mammal Presence and Behavior with Cybertracking Technology

Metro Regional Parks and Greenspaces began a public master planning process for Cooper Mountain in 2003. To aid in making decisions about where to site trails and other infrastructure for the new public park, a volunteer team of local animal tracking experts was recruited to use Cyber Tracker technology. The team's goal was to gather data on the presence or absence of mammal species and determine their use of the site. The City of Wilsonville through HDR Engineering, Inc. hired Terry Kem to use cybertracking technology to map mammal presence and movement. The information was taken into consideration for the city's plans for building Boeckman Road connector project. The methods used for both projects was reading animal track and sign. To input field data into the Cybertracker program, data were recorded into Palm Pilots connected to hand held GPS units and then downloaded into a personal computer. The program queried data, projected data onto local maps and aerial photographs, and exported data into GIS software. Terry Kem of Deerdance was the data manager.

Keywords: Land use planning, Animal ecology
Time Period: 2003 - 2004
Geographic Location: Cooper Mountain, Washington County
Partners and Sponsors: Metro Regional Parks and Greenspaces, Deerdance

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It Ain't the Fish…It's the People

Water quality is not just about fish…it's about understanding people and human behavior. We are given titles such as Conservation Specialists or Watershed Coordinators but in reality, we are People Managers. We can't begin to manage our natural resources if we can't manage people. Improving water quality can best occur by affecting changes in landowner behavior that will result in positive changes to the landscape itself through implementation of best management practices. Clackamas County ranks second in the state in gross farm sales and supports such intensive and diverse operations as nursery, Christmas trees, timber, berries, pasture, livestock, horses and numerous small farm enterprises. Collectively, these landuses along with recreation, fishing and tourism, place increasing demands on our waterways, making water quality protection a critical component when managing for multiple uses. Many landowners have a desire to improve the resource value of their land, conserve water, reduce pesticide use and enhance fish and wildlife habitat. However, they are more likely to do so through a better understanding of the bureaucratic process and access to technical assistance or cost-share incentives in lieu of regulatory action. As the "Switzerland" of agencies, the Soil and Water Conservation District plays a crucial role in TMDL implementation by bridging the knowledge gap between the landowner and the agency regulators. This approach provides landowners with a partnership "buy in," to voluntarily develop conservation farm plans and install conservation practices that address State agricultural water quality management plan goals and local resource concerns.

Keywords: Economics, Land/watershed management, Water quality
Time Period: 2003 - 2004
Geographic Location: Clackamas County
Partners and Sponsors: Oregon Department of Agriculture, Natural Resources Conservation Service, Oregon Watershed Enhancement Board

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Ecologic and Economic Considerations for Landscape Scale English Ivy Control

English ivy's capacity to grow in full shade, form monocultures on the forest floor and to kill even mature trees makes it one of the most pressing threats to long term forest health in the four County Area. In our opinion, this Oregon State B-listed noxious weed threatens nearly all conserved forests of the lowland Pacific Northwest. Over the past four years The Nature Conservancy (TNC) and others have conducted experiments, field trials and economic analyses to determine the cost and efficacy of manual and herbicide based control of English ivy. The TNC studies specifically compare winter applications of triclopyr and glyphosate based herbicides with (mostly) fall and winter manual removal by volunteers and AmeriCorps type work crews. Both methods proved effective at reducing English ivy 90% or more with a single treatment, although both typically require multiple treatments to attain full control (defined here as less than 2% absolute cover 1 year after treatment). Early data suggest that with no supplemental planting, herbicide treatment may delay, but does not prevent the reestablishment of native plants. In our model, even modest supplemental planting overwhelms the differences in recovery rate we observed. The cost of manual treatment is estimated to be at least 1000% that of herbicide treatment. Our results suggest that a region wide program based on manual removal is unlikely to result in protection of meaningful, landscape scale habitat. A specific integrated approach is suggested with guidelines for herbicide use.

Keywords: Economics, Environmental policy, Habitat restoration
Time Period: 2000 - 2004
Geographic Location: Portland Metropolitan Area, especially Camassia Natural Area
Partners and Sponsors: Partially funded by grants from the USFWS Metro Area Restoration and Conservation Program and supported by partnerships with the Northwest Service Academy of the AmeriCorps and the Multnomah Youth Corps
Publications: Controlling English Ivy in the Pacific Northwest. The Nature Conservancy Wildland Weeds Website: tncweeds.ucdavis.edu/moredocs/hedhel02.pdf

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Residents' Attitudes toward Water Resource Protection in the Johnson Creek Watershed of Metropolitan Portland, Oregon

The research questions for this project are: (1) To what degree do residents of metropolitan Portland support/oppose various aspects of water resources protection? (2) What factors explain residents' attitudes? and, (3) How do attitudes vary between participants and non-participants of place-based groups (watershed councils and neighborhood associations)? Preliminary interviews and a mail questionnaire were the primary data collection methods, and both qualitative and quantitative analyses were conducted. Four unique aspects of attitudes toward water resource protection were evaluated – *general* importance, support/opposition to *government*, *regulations*, and *economic* measures – in addition to an *overall* index comprising these dimensions. Substantial support exists for water resource protection with regard to general values, education and restoration, specific types of regulations, and funding mechanisms that make the polluter pay. Opposition is greatest toward funding mechanisms such as taxes, efforts of businesses and the regional and federal government, and regulations in general. Significant factors explaining attitudes about water resource protection are broad beliefs about the environment and political matters, perceptions, recreational use, and place attachment. The relationship between distance to waterways and attitudes is complex and non-linear. People who report living close to water exhibit greater support financially and for regulations than those far away, yet people with water on/bordering their property oppose regulations more than those who live close. Watershed council participants are more supportive than non-participants on all attitudinal dimensions except generally expressed importance, while neighborhood association participants are more supportive economically. Findings from this research have important implications for environmental protection and public involvement in decision-making.

Keywords: Environmental social sciences, Land/watershed management, Environmental policy/planning
Time Period: 2002 - 2004. Interviews since 2002. Survey implemented in February 2004.
Geographic location: Johnson Creek watershed, southeast metropolitan Portland, Oregon
Partners and sponsors: Project funded by a National Science Foundation grant. Collaborators who have participated in this project include: government agencies, Johnson Creek Watershed Council, neighborhood association personnel, and fellow researchers.
Publications: Executive summary and policy recommendations available upon request. Peer-reviewed publications forthcoming. Contact author for more information.

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Urban Ecology Laboratories: Policy and Permit System for Research in Portland Parks

Portland Parks and Recreation's (PP&R) Research in Parks Policy encourages the use of parkland for academic and applied research on topics relating to urban ecology, especially projects with direct applicability to park management. A standardized permit system and research tracking database have been established. The permit system features a brief application form and requires annual status reports and a copy of final reports or publications. A single point of contact for all research applications facilitates research in multiple park sites. The permit system will help protect parkland by minimizing research impacts and ensure that future management will take advantage of research findings. The database of ongoing and previous research will allow searching by topic or park site for related research. Where appropriate, PP&R may offer support such as assistance with site selection, photos, maps, and City GIS information. PP&R's research policy and tools may serve as a model for a standardized system for permitting and tracking research on public land in the region.

Keywords: Land/watershed management
Geographic Location: City of Portland managed parkland

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Outreach Methodology for Landscape Scale Invasive Plant Species Control

The Nature Conservancy is leading a multi-partner project to rid the Sandy River watershed of the invasive plant Japanese knotweed. The project began following the 1996 floods when knotweed was found on The Nature Conservancy property in the Sandy River gorge. Removing knotweed on the property was a short-term solution, due to the fact that seasonal fluctuations in the river would send new sources of knotweed downstream; in turn, reestablishing plant populations. The sustainable solution is to reach out to private landowners upstream to manage knotweed on those properties and eradicate knotweed from the Sandy River riparian system. As part of an integrated approach to successfully achieve project goals, including enhancing community invasive species awareness, access to potential knotweed infestations, and increasing volunteer participation, we undertook an aggressive outreach effort that targeted community members in a variety of ways. Through direct personal contact, media exposure, public speaking events, volunteer recruitment, and restoration projects, we have helped shape and gain both recognition and active support for knotweed and invasive species control in the Sandy River watershed and other regions. We now have 331 cooperating private properties allowing The Nature Conservancy to access and manage knotweed infestations on their land.

Keywords: Environmental education, Habitat restoration, Land/watershed management
Time Period: 2000 - 2004
Geographic Location: Sandy River watershed from Troutdale to Zig Zag, Oregon
Partners and Sponsors: Partially funded by grants from the Oregon Watershed Enhancement Board, Oregon Department of Agriculture, Bureau of Land Management, U.S. Fish and Wildlife Service/Metro (Greenspaces Program) and the Northwest Service Academy AmeriCorps program.
Publications: Sandy River Riparian Habitat Protection Project Report 2000-2003: TNC Field Office in Oregon

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Using LiDAR and Multispectral Imagery to Map Canopy Heights in Tryon Creek Watershed

The City of Portland Bureau of Planning has been collaborating with the Bureau of Environmental Services on several remote sensing projects. In 2003 we completed a 1-meter multispectral imagery classification exercise to identify vegetation, water bodies, impervious surfaces and bare soil throughout the City. The overall classification accuracy is 89.3%. In March of 2004, the Bureau of Environmental Services funded a pilot "Light Distance and Ranging" (LiDAR) mission for Portland's Tryon Creek watershed. LiDAR is an aerial platform that produces highly accurate elevation information for specific point locations – in the case of Tryon Creek watershed approximately one elevation point every 3 feet (with approximately 27,000,000 points in the 12.65 square mile project area). LiDAR points are classified as either surface (i.e., bare earth returns) or non-surface points representing features such as vegetation, vehicles, and buildings (i.e., first-returns). The surface and non-surface returns were compared to derive the height of non-surface features. Non-surface points were then delineated into canopy and non-canopy features using the multispectral imagery classification as reference. The result is a map of canopy heights throughout the watershed, one on which pockets of older, larger trees can be identified. These data will help inform the current watershed planning efforts and the development of resource protection strategies for the Tryon Creek watershed. The results of this pilot project will also help determine whether Portland funds future LiDAR missions.

Keywords: Land use planning, Land/watershed management
Time Period: June 2002 - October 2004
Geographic Location: Tryon Creek watershed, City of Portland
Partners and Sponsors: City of Portland, Bureau of Environmental Services

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Birds on the Edge: Surveying Bird Populations on Portland's Willamette Bluffs

In three of the last four fire seasons, urban wildfires have occurred on the Willamette Bluffs (Portland, Oregon), the Willamette River's riparian zone in which our school is located. Before the fires the bluff habitat was largely covered with the invasive species like Himalayan blackberry and English ivy. After the fires, the City's Bureau of Environmental Services reseeded the bluff and planted it with native trees and shrubs. The Willamette Bluffs system includes over 230-acres of critical habitat for migrant and resident birds located in the densely populated urban area. The Bluffs' flyway provides historic resting and nesting habitat for migratory songbirds, many of which the U.S. Geological Service describes as having "significant trends" of declining numbers. Students in the CRUE program are assessing how the fires and restoration efforts have impacted bird distribution and usage of the bluff. The students have mapped pre and post burn habitats, conducted vegetation surveys, and implemented point-count bird surveys along North Portland's Willamette Bluff. Additionally, they are also contributing baseline data to Portland's Urban Migratory Bird Treaty initiative, and building a website about birding opportunities on the bluff. Their presentation will cover the methods and initial findings of the multi-year study.

Keywords: Environmental education, Habitat restoration, Wildlife biology
Time Period: 2004 - 2005
Location: Willamette Bluff, North Portland
Partners: Bureau of Environmental Services, Toyota Motor Sales, USA, Inc., National Science Teachers Association, U.S. Fish and Wildlife Service/Metro (Greenspaces Program), Portland Audubon, Portland Parks and Recreation

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Open Meadow Students Restoring Wetlands and Planning for the Future

Design Course - Students in Open Meadow Alternative School's CRUE program have teamed with the Wetlands Conservancy, the city of Tualatin, and Clean Water Services to design a wetland mitigation and restoration plan for the Nyberg Creek Wetland in Tualatin. After surveying the topography, vegetation, water features, and the soils, the students worked with a wetland scientist and a landscape architect to generate three-dimensional, scaled drawings of plans for restoration. The wetland is a likely site of future mitigation, and the plans are meant to be a conceptual design for that mitigation.

Cedar Mill Wetland Restoration - Working along side wetland scientist, students from the CRUE program were responsible for writing and implementing a wetland restoration plan at different sites within a 14 acre wetland in Beaverton. Students inventoried their sites, designed invasive species removal and native species planting plans, as well as identified maintenance and monitoring strategies for their sites. Then students then got down and dirty to implement their plans and improve the habitat of the wetland.

Keywords: Environmental education, Habitat restoration, Wildlife biology
Time Period: 2004 - 2005
Location: Nyberg Creek Wetland, Tualatin and Cedar Mill Wetland, Beaverton
Partners: The Wetlands Conservancy, The Bill Healy Foundation, Dennis O'Conner, City of Tualatin, Clean Water Services

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Quantifying and Valuing Ecosystem Services in Lents Neighborhood, Portland, Oregon

Ecosystems provide society with a range of beneficial goods or services collectively known as ecosystem services. In the Pacific Northwest ecosystems provide numerous services including; water supply, precipitation interception and storage, water purification and erosion control among others. Beginning in June, 2003, the City of Portland hired the combine consultant team of David Evans and Associates and Eco Northwest to develop and test a two-part ecosystem services analysis tool. Part 1 of the analysis involved the use of multiple biophysical models to estimate a projects' ability to improve conditions in the watershed. Part 2 of the analysis applies economic valuation methods to the estimated improvements from part 1 to illustrate a project's return on investment or potential economic value. The Johnson Creek Watershed Planning Group's current and ongoing work to provide flood abatement through the use of expanded wetland detentions was used as a case study to develop and test this tool. In addition to flood management objectives, the study focused on five services including; water quality and salmonid habitat improvements, carbon sequestration and air pollutant removal, recreation and property improvements. Portions of each of these services were valued. Results indicate that using a natural or ecosystems approach to better manage flooding in Lents Neighborhood would provide more than $30,000,000 in economic value to the public over a 100-year timeframe directly resulting from floodplain function improvements and riparian restoration. A single-objective approach that would not involve additional ecosystem service enhancements is estimated to yield less than half the return.

Keywords: Economics, Environmental policy, Land use planning
Time Period: Summer 2003 - Present
Geographic Location: Southeast Portland, Johnson Creek Watershed
Partners & Sponsors: Johnson Creek Watershed Planning, David Evans & Associates, EcoNorthwest

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The Songbird Foundation Urban Habitat Campaign: Urban Habitat is For the Birds

The Songbird Foundation is a non-profit 501(c)(3) organization founded in 1997 to preserve songbirds and their habitat by educating and motivating people in making sustainable choices. The Foundation promotes awareness of the decline of migratory and resident songbirds resulting from non-sustainable agriculture and development practices locally and throughout the Americas, particularly coffee plantations. Foundation practices are anchored in many sources of data summarizing and demonstrating declines in neotropical migrants (i.e., 2002 Seattle Audubon Society Report by EDAW, Inc., U.S. Fish and Wildlife Service and Smithsonian Migratory Bird Center). A role of the Songbird Foundation is to connect citizens with the local and world-wide effects of their personal choices and actions. The purpose of the Urban Habitat Campaign is to empower public entities and private citizens to reverse the loss of urban/suburban habitat and to create natural areas with habitat potential. The UHC is represented by members from local and state government agencies, NGO's, Seattle-based community organizations and private parties committed to urban habitat restoration and sustainability. The UHC is creating a website and media promotional campaign to be launched in early 2005 showcasing urban habitat restoration and preservation projects including location, design and plant resources. A searchable database of organizations and urban habitat projects, a calendar of related sustainable gardening events, live chats with local garden experts, downloadable resources, community forums and links to community resources will be central components of the website. The Songbird Foundation offers this as a tool for other regions to use for building a similar campaign. The Songbird Foundation website may be viewed at www.songbird.org.

Keywords: Environmental education, Habitat restoration, Sustainable development
Time Period: 1997 - Present
Geographic Location: Seattle, King County, Washington
Publications: In Your Own Backyard: A Guide to Maintaining Garden Habitat for Northwest Wildlife

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Water Quality Monitoring, Education and Partnership Project

The *Water Quality Monitoring, Education & Partnership Project* is a three-year project that provides a unique blend of technical water quality monitoring, public education, and collaboration among watershed stakeholders. Jackson Bottom Wetlands Preserve (JBWP), a 710-acre wetlands preserve on the floodplain of the Tualatin River, has two continuous water quality monitoring stations. One monitoring site is a nutrient-rich restored wetland pond; the other is in the Tualatin River. During the winter and spring rainy season, the river overflows onto the floodplain, including the wetland pond. JBWP provides the infrastructure for water quality monitoring, data delivery and watershed education. Each monitoring station takes hourly measurements of temperature, pH, dissolved oxygen, conductivity, turbidity (river only) and water level. The raw data are uploaded hourly to JBWP's web site www.jacksonbottom.org and are displayed both as tables and graphs. The web site also provides background information and observations on the water quality data. The partnership includes educational organizations, agencies using the data and watershed interest groups. Education includes formal education programs with elementary school groups, as well as informal settings with volunteers and the general public. Project support is provided for student science projects, from middle-school to graduate school. Opportunities exist for research, including how the wetland ecosystem and the river are interrelated. We are seeking additional education partners at all levels.

Keywords: Water quality, Environmental education, Land/watershed management
Time Period: June 2004 - 2007
Geographic Location: Jackson Bottom Wetlands Preserve, Hillsboro, Oregon and Tualatin River (monitoring at river mile 44.4), Washington County, Oregon
Partners and Sponsors: Clean Water Services, United States Geological Survey, Oregon Water Resources Department, Portland State University Environmental Sciences and Resources Program, Portland Community College Department of Engineering, Liberty HS, Tualatin River Watershed Council, Tualatin Basin Public Awareness Committee, Oregon Community Foundation (Tualatin Valley Water Quality Endowment Fund), Intel

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Creation of a Stream Enhancement Geodatabase

Clean Water Services is developing a geodatabase to track stream enhancement projects and allow for field-verified design of restoration projects in the field through the use of mobile-GIS technology. With regulatory tightening of monitoring requirements, the advent of hand-held GIS systems, and an increase in the number of stream enhancement projects Clean Water Services' is undertaking, we needed a means to track work, and increase efficiency. Now, staff takes the mobile device to project sites and walks project perimeters. The GPS tracks their position and creates a GIS polygon. Staff creates digital drawings depicting areas for invasive species removal, streambank revegetation, etc. Menus pop-up for selection of site-appropriate plant community types, invasive species presence, and even to record nutria behavior. The device is then synced onto an office computer, where the project design or monitoring information is automatically input into the larger GIS database. The larger geodatabase tracks nursery inventory and connects inventory to project designs. Project plant lists generated during the design phase are subtracted from nursery inventory. Labor and material costs are recorded and tied to projects. Queries generate growing contracts, planting plans, and project quotes. This geodatabase and mobile GIS allow Clean Water Services to maintain accurate records of enhancement work, plant inventory, costs, and hours of labor to conduct enhancements. As regulatory and fiscal environments tighten, this tracking helps justify and streamline work. As an added benefit, we maintain up-to-date GIS information compatible with our evolving GIS collection of data.

Keywords: Land/watershed management, Habitat restoration, Land use planning
Time Period: July 2004 - Present
Geographic Location: Tualatin River Watershed, Washington County, Oregon

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Defining Invasive Plant Species Spectral Signatures for Mapping of Metro Greenspaces

Metro began investigating hyperspectral imaging methods to quantify individual invasive plant species, plant community composition, and assist in mapping of areas to prioritize for restoration. The first step of this process involves testing a portable hand-held spectroradiometer to gather reflectance spectra of target species, which can later be used to select spectral bands for hyperspectral data collection flights over target natural spaces. Metro also completed a test design plan, species priority list based on testing sites, and a species seasonal attributes list, to help in defining key anatomical features of target species (such as flowering) which can aid in determining the best time of year to collect data from specific species. Effort also began on interspecies plant community assessment methods.

During the summer of 2004, spectral reflectance data (350-1000 nm) as well as GPS location data were collected on Himalayan Blackberry (*Rubus discolor*), Scotch Broom (*Cytisus scoparius*) and several other sample test species by using a commercial spectroradiometer (Analytical Spectral Devices Fieldspec Pro VNIR). Field operations and data collection methods were first defined in the field, then data collected on the target species. The data collected demonstrates differences between tested species over various parts of the visible and infrared spectrum, even within the short test period. Himalayan Blackberry (HB) leaf exhibits ~25% reflectance peak in the visible spectrum (near 550 nm) and 90-100% reflectance in the infrared (720-1000 nm). The berries and stem also exhibit unique signatures. Immature berries (red) have a visible reflectance peak of 25% near 640 nm and an infrared reflectance of 85-90% (800-900 nm). Mature blackberries have almost no reflectance in the visible and minimal in the infrared (5-10%). HB stem has very little reflectance (< 5%) in the visible with a peak near 640 nm and ~65% reflectance from 740-920 nm. Scotch Broom (SB) has less dramatic spectral features (in summer). Overall, reflectance was less than HB (<10% reflectance in visible, peak near 550 nm, ~20% reflectance in infrared broadband), probably due to SB's dark green stem and overall architecture. The data collected is the first step in building a local spectral signature library.

Keywords: Land/watershed management, Habitat restoration, Land use planning
Time Period: July 2004
Geographic Location: Metro Multnomah Channel and Cooper Mountain Metro properties
Partners and Sponsors: U.S. Fish and Wildlife Service/Metro (Greenspaces Program)

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Developing Methods for Rapid Assessment of Natural Open Spaces

Springbrook Park is a small natural open space (52 acres) in the Lake Oswego Park system. The pre-park acreage was logged, but has been left basically undisturbed since 1978, and is now a secondary growth forest. Due to its size, it is an ideal candidate to test technology enhanced park management methods. We conducted a rapid assessment of the remaining predominant succession trees (conifers) to begin understanding the natural inventory of the park. A backpack GPS unit (Trimble TSC1), compass, and tape measure were used to gather location, heading, and distance of trees. We collected data over winter in the absence of canopy to increase signal strength and accuracy from the GPS satellite constellation. One person collected GPS data on a central tree while simultaneously collecting compass heading and distance of nearby trees, and removing nearby invasive plants. 138 conifers (species undefined) were cataloged in approximately 15 hours of effort. GPS data reside in the Lake Oswego GIS system and ancillary data are available at www.22ndcentury.org. The rapid mapping data and methods can now be used to plan and coordinate further assessment of the park.

Keywords: Land/watershed management, Habitat restoration, Land use planning
Time Period: January - March 2004
Geographic Location: Springbrook Park, Lake Oswego

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Assessment of Riparian Restoration Projects Conducted in Partnership with the Johnson Creek Watershed Council

Since 1994, the Johnson Creek Watershed Council (JCWC) has been actively involved in protecting, enhancing and restoring the health and function of the Johnson Creek Watershed. Since their inception, the Watershed Council has partnered with local groups to create a watershed-wide restoration effort. This assessment project was developed in the Spring of 2004, to assist the Watershed Council in meeting their goal of tracking restoration projects and implementing a vegetative monitoring program. Over the past 10 years restoration project details have been recorded sporadically. One purpose of this project is to collect information from JCWC project partners to produce a database that will contain a detailed history, objective and outcome of each restoration site. Beginning in the Spring of 2005, vegetative monitoring will be conducted to determine plant survival rates, percent native vs. non-native vegetation and canopy cover. The data collected will be recorded and analyzed to determine the specific maintenance needs of each restoration project. Photo-point monitoring stations will be established and documented to be included as part of the long-term monitoring program. GPS will be utilized to map each site and the vegetative monitoring data will be entered into GIS to determine the level of maintenance required for each project. The information generated in this assessment will assist with future project selection and provide tools with which the council can reach their goals in an effective and efficient way, investing in the efforts of the past and continuing forward into the future.

Keywords: Land/watershed management, Plant ecology
Time Period: 2004 - 2005
Geographic Location: Johnson Creek Watershed, Clackamas and Multnomah County
Partners and Sponsors: Johnson Creek Watershed Council

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The Role of Portland in Regional Recovery Planning Efforts

The City of Portland is attempting to place its watershed restoration efforts within the context of regional recovery efforts. The City's restoration approach builds upon many key scientific findings and approaches from Columbia River Basin efforts. The City has in turn used elements of its scientific analyses to support regional planning efforts. One of the most significant products from this coordination to date has been the *Willamette Subbasin Plan*. This plan is part of a regional effort to direct actions to improve fish and wildlife populations throughout the Columbia Basin. The City contributed a number of products to this effort, including an extensive body of information on conditions in Portland watersheds; biological modeling to evaluate key limiting factors and their relative impact and priority; an inventory of existing protection and restoration programs and actions; and scientific restoration principles. The resulting plan provides a comprehensive documentation of conditions throughout the Willamette Basin and the actions needed to restore fish and wildlife and the habitat on which they depend. Biological analysis indicates that because of its position as gateway to the Willamette Basin, restoration of conditions in Portland is an important priority for fish recovery efforts throughout the basin. Lack of habitat complexity (e.g., lack of wood, bank modification), loss of key habitats (e.g., shallow water habitat) and chemical contamination were the most important local limiting factors identified in the analysis. Some of the approaches and tools used to address these factors will be described.

Keywords: Land/watershed management, Habitat restoration, Fisheries
Time Period: 2004
Partners and Sponsors: Willamette Restoration Initiative, Northwest Power and Conservation Council
Publication: *Willamette Subbasin Plan* (WRI 2004); www.nwcouncil.org/fw/subbasinplanning/willamette/plan/

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Integrated Watershed Management in Portland, Oregon

At the 2003 UERC Symposium, the City of Portland presented its draft *Framework for Integrated Management of Watershed Health*, describing its approach to improving ecological functions in its five urban watersheds. Following review by an Independent Science Team, stakeholders and the public, the City is now applying a revised *Framework*. This presentation provides an update on the City's approach, and describes how it is being applied in the Willamette Watershed. The *Framework* contains watershed health goals for hydrology, physical habitat, water quality and biological communities; provides scientific principles and guidelines; and describes the City's adaptive watershed management process of (1) planning, (2) characterizing, (3) establishing objectives and selecting protection and restoration actions, and (4) implementing and monitoring those actions. Portland's focus is on solving problems from a watershed function perspective, not one regulatory compliance issue at a time. It aims to bring all City bureaus' actions into alignment with the watershed health goals, while integrating other values (e.g., economic vitality) into decision-making. The City is applying the *Framework* at multiple scales, and encourages regional cooperation. The prevailing source of problems in the Willamette Watershed results from unmanaged stormwater from the high level of impervious area. The focus is therefore on treating and infiltrating stormwater to protect and restore areas currently providing natural function. By subwatershed (drainage areas of no more than a few square miles), the City has identified maintenance, outreach, protection, policy, revegetation, stormwater and stream enhancement actions to be implemented by many existing City programs.

Keywords: Land/watershed management, Habitat restoration
Time Period: Update covers 2003 - 2005
Publication: City of Portland, Oregon. March 2004 Public Review Draft *Framework for Integrated Management of Watershed Health.*

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Assessing Juvenile Salmonid Habitat Use in the Lower Willamette River

In response to Endangered Species Act listings of multiple salmonid stocks found in the lower Willamette River, the City of Portland initiated a multi-year investigation to evaluate relationships between salmon juvenile and other fish communities to bank treatments and nearshore developments. We quantified available habitat in the study area from the confluence to the Columbia River to the Willamette Falls and assessed salmon abundances associated with specific bank treatment and nearshore development types by season. Bio-telemetry, beach seining and boat electrofishing methodologies were used to determine migration, movements, and habitat association of juvenile salmonids (*Oncorhynchus* spp.) and resident fish. Important findings from the study include:

- Yearling salmonids (115 mm and greater) appear not to be associated with nearshore areas. Exceptions include coho preferencs for beaches and rock outcrops (and avoiding riprap), Chinook catch rates higher at off-channel sites in spring/winter, all salmonid species avoided seawalls and steelhead avoided riprap sites. Subyearling Chinook (30-115 mm) used beaches extensively (90% of all salmonid catches).
- Yearling salmonids showed short residence times in the lower River for Chinook and steelhead. Coho yearlings showed relatively long residence times. Residence times for yearling salmonids were affected by flows, temperature, date/season and fork length.
- Subyearling Chinook salmon were abundant in the lower River year round with peaks from November through June/July.
- Resident predators (smallmouth bass, Largemouth bass, Northern pikeminnow, walleye) were highly associated with nearshore habitats, exhibiting seasonal preferences for riprap, rock outcrop and pilings. Findings show that predators "over-utilize" pilings. Overall, predator densities in the lower River were low.

Keywords: Fisheries
Time Period: 2000 - 2004
Geographic Location: Lower Willamette River (north of Willamette Falls)
Partners and Sponsors: Oregon Department of Fish and Wildlife, Portland Development Commission
Publication: Annual summaries for 2000/01 and 2001/02 available at www.fish.ci.portland.or.us

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Amphibian Distribution in Parks and Greenspaces of the Portland, Oregon Metropolitan Area: A Multiple Scale Investigation

Loss of biodiversity due to habitat fragmentation is an ongoing problem in the world today. With growing human population and increasing urbanization, it is a necessity to conduct studies on wildlife occurring in urban areas. Currently there is a deficit of research investigating amphibians in urban environments. My objectives were to describe amphibian species richness and abundance and relate patterns of variation to variables at three increasingly large spatial scales; 1) local microenvironmental (i.e., trap location), (2) macrohabitat/patch (i.e., park or greenspace), and 3) landscape (surrounding park and greenspaces). A total of 10 species were detected in 17 parks and greenspaces within the Portland, Oregon Metropolitan area. Amphibian distribution was highly nested with fragmentation resistant species, *Ensatina eschscholtzi*, being most common. Amphibian species richness was most influenced by variables within the macrohabitat/patch scale, and was highest at sites with more tall shrub density, a northeastern facing direction, increased proximity to other forest fragments, and where soils were warmer and dryer. Alternately, amphibian abundance was highly associated with microenvironment scale variables, which described sites with decreased leaf litter/increased soil cover, less moss and fine woody debris with moist cool soils. Although found to be insignificant in this study, landscape scale variables may in fact play an integral role in local population persistence as it relates to a species abilities to recolonize fragments following local extinction and to migrate to aquatic breeding sites.

Keywords: Animal ecology, Conservation biology, Wildlife biology
Time Period: 2001 - 2004
Partners and Sponsors: U.S. Fish and Wildlife Service/Metro (Greenspaces Program)

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Restoring Habitat for an Endangered Butterfly

Restoring areas that function as habitat for rare species is a significant conservation challenge. The Fender's blue butterfly (*Icaricia icarioides fenderi*) survives in remnant prairies in Oregon's Willamette Valley. Designing and implementing restoration strategies for the Fender's blue requires a collaboration between scientists and land managers to test if the best available science can succeed in restoring critical prairie habitat in Oregon's urban areas. We investigate prairie restoration for the Fender's blue at The Nature Conservancy's Willow Creek Natural Area in Eugene, Oregon. Previous studies indicate Fender's blue requires key patch level resources, larval hostplant and adult nectar resources, and critical landscape level attributes, minimum patch size and connectivity. Restoration of Fender's blue habitat is limited by availability of seed from larval hostplants, the threatened species Kincaid's lupine (*Lupinus sulphureous kincaidii*). Therefore we test if establishing critical nectar sources adjacent to the existing Fender's blue habitat will functionally increase patch size and thereby enhance the Fender's blue population. Restoration work was begun in Fall 2003. In Spring 2005 we will monitor the butterfly's response to restoration by tracking flight behavior and butterfly density. In addition, we will conduct vegetation surveys to evaluate actual nectar densities in the context of seed application rates and plug survivorship. Our behavioral approach links on-the-ground restoration action to population dynamics of an endangered species, a linkage rarely made in the restoration or conservation literature and one that has the potential to greatly aid in planning restoration strategies for endangered grassland species.

Keywords: Conservation biology, Habitat restoration
Time Period: 2003 - 2005
Geographic Location: Willow Corner, Willow Creek Nature Conservancy Preserve, City of Eugene
Partners and Sponsors: The Nature Conservancy, U.S. Fish and Wildlife Foundation, Budweiser Conservation Scholarship

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Captive Rearing Protocols for At-Risk Butterflies

Population supplementation via captive breeding is a common recommendation in recovery strategies for federally listed butterflies as well as numerous other endangered species. Unfortunately, captive rearing protocols are poorly developed for many at-risk species. We investigated methods to propagate the Fender's blue butterfly (*Icaricia icarioides fenderi*), an endangered butterfly in the Willamette Valley. Protocols to captively rear butterflies like Fender's blue which diapause as larvae have proved particularly challenging. To minimize potential impact of research on the Fender's blue butterfly, we worked with a surrogate species, the Puget blue butterfly (*I. i. blackmorei).* We explored different egg collection methods with the objectives of minimizing time in captivity and releasing of ovipositing females back to the wild. In total we collected 1879 eggs from 46 Puget blue females. We collaborated with the Oregon Zoo to examine environmental conditions in which to feed and house the larvae during initial instar stages and through diapause. Larvae were split into separate cohort groups, each experiencing different environments. After diapause, larvae were returned to their host plant (*Lupinus albicaulis*) to continue development. Survivorship from egg to pre-diapause larvae varied between treatment studies and had an overall survivorship of 67%. Of concern, significant loss occurred between post-diapause larvae and emergence as adults, with only 20% surviving these transitions, suggesting further study is needed to determine causes of mortality.

Keywords: Animal ecology, Conservation biology
Time Period: 2003 - Present
Geographic Location: Scatter Creek Wildlife Area, Thurston County, Washington

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Restoring Willamette Valley Upland Prairie for the Fender's Blue Butterfly: Observations from a 9-Year Experiment

Willamette Valley prairies are one of the most endangered habitats in the United States. With less than ½% of habitat remaining, and little of that in pristine condition, restoration of this native habitat is essential if this ecotype and the species that depend on it are going to survive. Two species endangered by limited Willamette Valley prairies are the Fender's blue butterfly (*Icaricia icarioides fenderi*) and its primary larval hostplant, (*Lupinus sulphureus kincaidii*). Recovery of these species will require restoration of the upland prairies, yet restoration methods for these prairies are in their infancy. To address this need, experiments at two sites in Eugene, Oregon were begun in 1995 and have been monitored yearly since then. These experiments focus on establishing critical resources for the Fender's blue, larval hostplant and adult nectar resources, and the native prairie community that is essential in maintaining these resources. Experiments suggest that 1) some treatments, especially solarization, are more likely to lead to establishment of important prairie plants, 2) site differences will substantially influence restoration outcome, and 3) long-term monitoring is critical to assessing the outcome of restoration attempts because we continue to see surprises during almost every year of monitoring.

Keywords: Conservation biology, Habitat restoration
Time Period: 1995 - Present
Geographic Location: The Nature Conservancy's Willow Creek Preserve and West Eugene Wetlands area, Eugene, Oregon
Partners and Sponsors: Bureau of Land Management, West Eugene Wetlands which is a partnership that includes City of Eugene, The Nature Conservancy, U.S. Army Corps of Engineers, Oregon Youth Corps, Bureau of Land Management, U.S. Fish and Wildlife Service and McKenzie River Trust
Publications:

Schultz, C.B. 2001. Restoring resources for an endangered butterfly. Journal of Applied Ecology 38: 1007-1019.

Schultz, C.B. 1997. Planting butterfly seeds: An experiment in restoring habitat for the Fender's blue butterfly. Pages 88-98 *in* T. Kaye, A. Liston, et al. (eds). Conservation and Management of Native Plants and Fungi. Native Plant Society of Oregon, Corvallis, Oregon.

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Cybertracking on Cooper Mountain

Metro Regional Parks and Greenspaces began a public master planning process for Cooper Mountain in 2003. To aid in making decisions about where to site trails and other infrastructure for the new public park, a volunteer team of local animal tracking experts was recruited to use Cyber Tracker technology. The teams goal was to gather data on the presence or absence of mammal species and determine their use of the site. The method used was reading animal track and sign. To input field data into the Cybertracker program data were recorded into Palm Pilots connected to hand held GPS units and then downloaded into a personal computer. The program queried data, projected them onto local maps and aerial photographs, and exported them into GIS software. Terry Kem of Deerdance was the data manager. The site was divided into six sections, and each section was assigned to a tracking team. Six teams of trackers collected field data monthly, generally spending 3 to 6 hours per visit. A total of 4758 data points were recorded in a one year period. A total 20 mammal species were recorded, representing 8 families of mammals. Species of interest that were recorded included Western Gray Squirrel, black bear and bobcat. A total of 267 volunteer hours have been logged for the project so far, and the project is ongoing. The project will continue after park infrastructure is built to record any changes in wildlife patterns of use on the site.

Keywords: Land use planning, Animal ecology
Time Period: 2003 - 2004
Geographic Location: Cooper Mountain, Washington County
Partners and Sponsors: Metro Regional Parks and Greenspaces, Deerdance

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A Watershed Approach to Natural Resources Technician Education

With the assistance of the National Science Foundation the faculty of Mt. Hood Community College have been developing a curriculum for educating natural resources technicians. The Natural Resources Technology Program is designed to develop broadly trained graduates who can work productively for public agencies and private companies. During the last four years we, as faculty, have focused on two main objectives: 1) developing a contextual learning environment that is based at the watershed level, and 2) developing effective techniques for ensuring that key skills and abilities are properly sequenced throughout the curriculum. We have found that the process of incorporating the watershed context in our courses has resulted in a more integrated curriculum with the desirable result of graduates who possess a deeper understanding of the challenges faced by resource managers. Our efforts to sequence key skills and abilities has led to a technique for evaluating when material is presented and making adjustments to course content more dynamic. By evaluating when material is "introduced", "practiced" and "applied" we have been able to create a curriculum that maximizes the students' ability to master the techniques needed to be effective employees. An added benefit from the process is that both full-time and adjunct faculty better understand the overall curriculum. Thus, both students and faculty see their courses not as separate experiences, but as part of a greater whole.

Keywords: Environmental education, Land/watershed management
Time Period: Ongoing
Geographic Location: Gresham, Troutdale, Multnomah County, Watersheds: Fairview Creek, Beaver Creek, Latourell Creek
Partners and Sponsors: National Science Foundation NSF-ATE#0101646
Publication: Guidelines for Developing a Watershed Learning Environment to Educate Natural Resources Technicians, July 2004 (available at conference or by contacting authors)

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Conducting Ecological Research in a Classroom Setting: A Case Study

In the Natural Resources Technology Program at Mt. Hood Community College we take a variety of courses designed to prepare us to participate in biological research with public agencies and private contractors. Part of this training involves learning the techniques needed to collect high quality data. Here we describe a research project we completed as part of two courses during Fall Quarter 2004--F240: Natural Resources Ecology and FW252: Mammals. The objective of this research was to get real-world experience in conducting a biological assessment. Our field site was the mixed forest community that exists behind the Mt. Hood Community College campus. The forest consists of an upland areas and riparian zones on both the east and west sides of Beaver Creek. We conducted vegetation analyses, trapped for small mammals, and evaluated physical conditions. We worked with land managers (Metro, MHCC) to collect baseline data that may be useful in determining management outcomes. Our reports are available upon request.

Keywords: Animal ecology, Environmental education, Plant ecology
Time Period: October - December 2004
Geographic Location: East Multnomah County, Gresham, Troutdale, Beavercreek Watershed
Publication: Available upon request

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Return of Native Freshwater Mussels to Smith-Bybee Lakes

In the fall of 2001, Smith and Bybee lakes in North Portland, Oregon virtually dried up. Populations of three species of native freshwater mussels perished. In surveys that year, I found only the shells of freshly dead mussels (scavenged by birds) from very large, old individuals. I found no live mussels or shells of juvenile or young mussels. In the fall of 2004, low lake levels allowed me to re-survey for mussels. I found small live mussels and shells from two of the three species found in 2001 (*Anodonta oregonensis* [Oregon floater], *A. californiensis* [California floater]). The range of sizes (total length) for each species did not overlap between 2001 and 2004. My conclusion was that these two species had re-colonized the lakes. Both species of mussels are obligate parasites on the gills of fish at the larval stage (glochidia) of their life history. The primary purpose of this adaptation is for dispersal, since adult mussels move very little in their lifetime. In 2001, all carp, the dominant fish species in both lakes, died. The dense carp population had likely suppressed successful mussel reproduction for a number of years by disturbing the bottom substrate and/or eating the tiny juvenile mussels that settled after release from the gills of fish. In 2004, the carp were far less numerous and the water turbidity was much lower. These new mussel populations should remain if the lakes retain some water year-around and the carp population stays at a reduced level.

Keywords: Animal ecology, Conservation biology
Time Period: 2001 and 2004
Geographic Location: Smith-Bybee Lakes in North Portland

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Baseline and Post Project Fish Monitoring for the City of Portland's Endangered Species Act Program

The City's Endangered Species Act Program has been conducting baseline fish monitoring in City streams since 1999. To meet growing regulatory requirements and public values, the ESA Program developed a fish monitoring program that focuses in four areas: baseline fish monitoring, post project monitoring, fish salvage monitoring and research. Baseline fish monitoring is conducted to document fish presence/absence and distribution at sites where proposed instream projects are expected to occur within the next three to five years. Surveys are conducted before construction begins to assess existing fish community structure. Pre-monitoring data provides important baseline biological data that can be useful for project planning and assisting with permitting requirements. Post project monitoring is conducted after construction activities are completed to evaluate project success and fish response. Fish salvage is required for projects occurring instream and is required for a number of federal and state permits, e.g., Corps Section 404 in consultation with NOAA Fisheries. Research data are collected where they are determined to be useful for a variety of reasons including: assessing the success of newly restored floodplain, off-channel site or bioengineered bank treatment. Also, research is being conducted to evaluate and confirm resident and anadromous life history strategies of naturally spawning populations that have been documented from previous studies in several of the City's watersheds. The combination of pre- and post- project fish monitoring gives the City the ability to evaluate the success and failure of implemented projects to meet growing regulatory standards and public values to be "fish-friendly". Results from the baseline monitoring are showing that juvenile salmonids are utilizing many of the City's waterways such as Kelley Creek (coho), Johnson Creek at Tideman-Johnson Park (chinook), in Tryon Creek State Park (rainbow/steelhead), and Arnold Creek (rainbow/steelhead).

Keywords: Fisheries, Land/watershed management
Time Period: 1999 - Present
Geographic location: Willamette River, City of Portland

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Geonomics: Shift Taxes to Augment Habitat

Cars take lots of land that otherwise could be habitat. To urge cars to relinquish some territory, try charging their drivers rent. Government could convert its property tax to a site value tax, shifting this levy off buildings plus land, onto the value of the location alone. Then owners who use land efficiently would save. Conversely, owners of parking lots, strip malls, and big box stores, and speculators withholding land from use would pay more. They would be motivated to lose their asphalt aprons or vacant lots and put their parcels to better use. Some owners, to minimize paying rent, would trim their lots, providing strips for bike paths and wildlife corridors. Many individual landowners want to maximize return from every square inch of their holdings. But where a metro region is overbuilt (border-to-border streets and buildings), there the overall land value is lowered. Parks and open space (habitat for other species) raise the value of turf around their periphery. Applications to build in Manhattan's Central Park are denied because building in there would lose New York City tax revenue. Many environmental groups endorse this geonomic tax shift. Some jurisdictions apply it. Wherever used, de-taxing buildings while recovering land rents has benefited both people and planet. In Oregon last session, sponsors from both major parties introduced a bill to permit localities to shift their property tax. A similar bill is likely to be introduced in 2005. To help Oregon align tax policy with efficient land use, get in touch.

Keywords: Economics, Land use planning, Sustainable development
Publications: *Geonomics: Recovery of Site-Rents for Urban Density* Forthcoming by the American Planners Association. Presently posted by the Boston Society of Architects of the AIA: www.architects.org/shaping_communities/index.cfm?doc_id=116

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The Demography of Spotted Towhees in Portland's Urban Greenspaces

During the spring and summer of 2004, I began a study of the demography of Spotted Towhees in urban greenspaces in Portland, Oregon. I am working in six urban forest fragments of various sizes in the Tryon Creek watershed of SW Portland. The goals of my study are (1) to determine the source-sink dynamics of towhees in these urban parks, (2) to characterize the age structure and turn-over rate in various sized parks, and (3) to determine the primary predators of towhee nests in urban areas. After my first year of analysis I have found interesting differences in nesting height between first and second breeding attempts, and a significant increase in nest predation from the first to the second breeding attempt. High nest predation rates coupled with relatively few re-sightings of fledglings suggests that these urban populations of towhees may have negative population growth rates, and that these populations may not be sustainable. Research in subsequent years will focus on quantifying juvenile and adult survival rate and characterizing nest predators in these urban greenspaces.

Keywords: Animal ecology, Conservation biology, Wildlife biology
Time Period: April 2004 - Present
Geographic Location: Portland, Oregon
Partners and Sponsors: U.S. Fish and Wildlife Service/Metro (Greenspaces Program)

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Research on Monitoring of Urban Biodiversity with Non-Specialists: Outcomes for Conservation and Science Education

This poster reports on the pilot year of the Conservation of Urban Biodiversity (CURB) Project, where academics, resource professionals, teachers, high school and undergraduate students work together to address research and monitoring an aspect of Portland's biodiversity. This project explores a model of connecting urban biodiversity conservation needs with the needs of urban high school and undergraduate science students. Goals of this project are to provide relevant, valid and reliable data to resource managers; to improve student's cognitive and affective outcomes towards science, conservation and their local community; and to improve the connections between school and community. This poster presents the CURB model, results from the pilot year of the project and the research design testing for conservation and education outcomes over the next two years.

Keywords: Conservation biology, Environmental education, Plant ecology
Time Period: Pilot project: Fall 2003 - Spring 2004, Proposed research: 2004 - 2006
Geographic Location: Within the Portland Urban Growth Boundary
Partners and Sponsors: Portland Public Schools, PSU Environmental Science and Resources Program, NSF Center for Learning and Teaching - West, Portland Parks and Recreation Natural Resources Department, Metro Parks and Greenspaces

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Living on the Land: Stewardship for Small Acreages

Land in the West has fragmented into smaller parcels under development pressure to accommodate increasing populations. New residents on these parcels possess limited knowledge about managing the land. Extension, Natural Resource Conservation Service (NCRS), and Conservation District members from eight Western states developed an outreach curriculum to provide small acreage landowners information on inventorying resources, setting goals, soils, water, managing animals, pastures, and manure that enables them to manage their land in an environmentally sensitive manner. Seventeen additional resource professionals reviewed the materials before finalization. The curriculum, available on CD, comprises five modules with 15 lessons, an instructor's guide, lesson plans, handouts, PowerPoint presentations, pre- and post-tests, and suggestions where localized information should be substituted. (See www.animalrangeextension.montana.edu/LoL/home.htm). A key strength is the program's adaptability to local audiences. After initially training 47 resource professionals, close to 1000 CDs were distributed. Parts of the program have been used extensively by Conservation Districts, NRCS, Extension, and others throughout the West. The entire curriculum has been used in Idaho and Washington. Anecdotal evidence in Clark County, WA suggests that following participation in the course, landowners make significant changes to their management practices (e.g., maintaining septic tanks, protecting wellheads, diverting runoff from animal manure). An evaluation of participants (100%) from the first two full-length courses (Fall 2003 and spring 2004) will be conducted and analyzed during Fall 2004 to determine what changes participants effected based on what they learned. This workshop will present an overview of the LOL program and the impacts based on this survey.

Keywords: Environmental education, Land/watershed management
Time Period: 2003 - 2004
Geographic Location: Clark County, Washington
Partners and Sponsors: Clark County Clean Water Program and Clark Conservation District

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Fish Habitat Restoration Projects in Portland

The City of Portland offers spawning and rearing habitat to native fish communities in accessible eastside and westside tributaries and it provides important rearing and refuge habitat in mainstem areas of the lower Willamette River and Columbia Slough watershed. These areas provide unique habitat uses that are characterized by the unique geomorphic attributes specific to each area. In addition to the natural features and processes, different urban, or non-natural forms (and processes) affect available habitat and its suitability and use. The combination of these natural and non-natural influences are an integral part of how any aquatic habitat restoration project is designed in the City. This poster will highlight several aquatic habitat enhancement projects that the City has either implemented and/or is planning. Each of these projects are expected to provide direct benefit to native salmon populations as well as to other native fish communities by improving the habitats upon which they depend. For example, one project may be more suited to improve spawning and rearing habitat, while another may be more suitable for improving overwintering and refuge habitat.

Keywords: Fisheries, Habitat restoration, Hydrology, Watershed management
Time Period: 2004
Geographic Location: City of Portland: Johnson Creek, Kelley Creek, Columbia Slough, and Tryon Creek

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Compost: A Tool for Sustainable Landscapes

Composts, produced from yard waste or manures can be used as a mulch or soil amendment to improve soil quality. Together with collaborators at WSU-Puyallup, we are initiating a project to monitor changes in soil quality, plant performance in compost-amended or mulched soils. The overall objective is to obtain reliable, science-based information to guide recommendations for organic matter amendment of planting beds in urban areas. Experiments will be structured to evaluate plant response under a minimal irrigation regime. Experiments will be conducted on soils typical of the glaciated Puget Sound region (compacted glacial till) and on soils with high clay content found in the Willamette Valley. Key questions to be evaluated include: Does compost amendment or mulching affect the quantity of water available to plants in mid-summer under minimal irrigation? What changes in soil quality can be measured? Is soil and plant response similar for different composted organic materials? Is there a measurable benefit from repeated compost applications, or is most of the benefit obtained from a single high-rate compost application during landscape construction or renovation? We will report progress made to date in addressing these questions.

Keywords: Soil science, Sustainable development
Time Period: Future experiments being planned
Geographic Location: Willamette Valley, Oregon and Puget Sound, Washington
Publication: Bell, N., D.M. Sullivan, L.J. Brewer, and J. Hart. 2003. Improving garden soils with organic matter. EC 1561. Oregon State University Extension Service. Corvallis, Oregon.

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Lower Gales Creek Restoration Project

The Gales Creek riparian area is currently degraded by invasive species, a lack of riparian vegetation, and garbage. The area serves as important habitat for fish and wildlife species and is a high priority area for restoration due to the following: 1) The area received the highest score from Metro in the Goal 5 habitat analysis; 2) Steelhead listed under the Endangered Species Act use Gales Creek; 3) The Tualatin River Watershed Council's watershed analysis identified this as a key area for restoration; 4) Gales Creek is on the 303(d) list for temperature, dissolved oxygen, and bacteria; 5) The area lies within the proposed Wapato National Wildlife Refuge. We present an overview of a multi-year project to restore and enhance riparian habitat on the banks of lower Gales Creek. The aim of this project is to create a restoration plan and implement a program of activities focused on restoration and enhancement of the area. Key partners include Pacific University, Clean Water Services, Metro, the City of Forest Grove, and private landowners. Information presented here describes the existing natural conditions; the role of public policy in shaping the funding and goals of the project; the role of the project as an educational laboratory (including research projects that will be designed into the overall project); and role of the various project partners in design, implementation, and long-term monitoring.

Keywords: Habitat restoration, Environmental education, Environmental policy
Time Period: 2003-2007
Geographic Location: Lower Gales Creek, Tualatin River Watershed. R3W, T1S, Sec 7
Partners and Sponsors: Pacific University, Clean Water Services, Metro, Private landowners

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Water Quality Monitoring in Portland's Fanno and Tryon Creeks

The City of Portland - Bureau of Environmental Services' (BES) monitoring program for Fanno Creek and Tryon Creek includes the following:

- *Fixed-Station Water Quality Monitoring*: BES has monitored the water quality of Fanno Creek and its tributaries since 1989. Sites are monitored monthly and three sites weekly during the TMDL compliance period. One location is monitored on Tryon Creek.
- *Temperature Monitoring*: BES has maintained continuous temperature recorders during the summer (May - October) since 1998 at two locations in Fanno Creek and one location in Tryon Creek.
- *Flow Monitoring*: The U.S. Geological Survey through a cooperative agreement with BES has maintained a streamflow gages on Fanno Creek since 1989 and Tryon Creek since 2001.
- *NPDES Stormwater Monitoring*: BES has maintained a stormwater sampling site in Fanno Creek at SW 56th Avenue since 1991. A total of 27 storm events have been monitored.
- *Fanno-Tryon Storm Monitoring Project*: To characterize pollutant loads from different land uses, four stormwater sampling sites were established in the Fanno and Tryon Creek watersheds. Four storms were sampled between 2001 and 2002.

The water quality monitoring program has five basic objectives:

- Determination of water quality conditions for compliance with water quality standards, criteria, TMDL limits, and support of beneficial uses;
- Determination of general temporal trends in environmental conditions;
- Determination of the effectiveness of specific environmental management activities and initiatives;
- The understanding of pollutant sources and the relationship between land uses and water quality; and
- Compliance with regulatory requirements for monitoring and reporting

Keywords: Water quality
Time Period: 1989 - 2004
Geographic Location: Fanno and Tryon Creeks, Portland
Partners and Sponsors: United States Geological Survey

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ASR (Aquifer Storage and Recovery): A Municipal Water Supply Enhancement Technique Utilizing Off-Peak Groundwater Replenishment

ASR is a proven technique to enhance existing sources of surface water supply for municipal drinking water. With ever increasing population, the City of Beaverton must balance appropriate conservation measures with ongoing evaluations of source options, and, when justified, development of additional sources. Since 1999, Beaverton has used ASR, a groundwater storage technology, to augment peak season water supply. Beaverton's ASR involves injecting treated drinking water into natural underground basalt formations (aquifers), where it is stored for later use. Surface water is injected during the winter months, when it is plentiful and customer demand is low, then is pumped from the aquifer into the City's distribution water mains during the summer peak season when potable water demand increases. ASR was developed in Beaverton to increase water supply by 6 million gallons per day in the summer without an increase in surface water withdrawn from the Tualatin River. The City has realized cost savings from ASR in the form of postponed purchase of expensive water supply components – stored surface water behind impoundment dams, water treatment plant and transmission line (conveyance) capacity. Using ASR, less surface water is removed from the Tualatin River in the summer, which is a benefit to fish, other aquatic life, and riparian zones. ASR does not deplete groundwater resources, since the amount extracted is nearly the same as was injected into the ground as storage. ASR can reduce mining of the aquifer by conventional extraction of native groundwater, therefore, acting as a groundwater replenishment system.

Keywords: Water quality, Geology, Economics
Time Period: 1999 - 2004
Geographic Location: Tualatin River basin, Cooper Mountain-Bull Mountain Critical Groundwater Area, Washington County
Publications: Reports which can be found at:
www.portlandonline.com/shared/cfm/image.cfm?id=54782
www.ci.beaverton.or.us/departments/engineering/eng_drinkwaterprg.html#WaterQualityReport

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Riparian Buffer Losses following Development in Three Oregon Cities from 1990 to 2002

Riparian vegetation buffer loss was investigated for three cities (Hillsboro, Portland, Oregon City) with contrasting local regulatory controls in urbanizing northwest Oregon. On the municipality level, regulatory controls in Portland included a system of environmental zoning for riparian area protection, while regulatory controls on development in riparian areas in Hillsboro and Oregon City were less stringent. Digital aerial photographs covering buffer areas within 200 m of all permanent streams for these cities were digitized at three points in time (1990, 1997 and 2002) using criteria including minimum inter-patch distance of 5 m for adjacent classes and minimum patch area of 20 m^2. Cover classes were divided into vegetation areas adjacent to stream and total, as well as woody and unmanaged vegetation areas. Results for the 12 year period showed larger losses for unmanaged adjacent vegetation 100 m from stream for Hillsboro and Oregon City (≥1.5 percent/year) than for Portland (<1 percent/year). For adjacent tree vegetation within a 100 m buffer width, again Hillsboro and Oregon City had higher rates of loss (>1 percent/year), while Portland lost trees in the 100 m buffer at a lower rate (<1 percent/year). Despite increased regulatory controls imposed during the 1990s, the rate of buffer loss did not slow during the latter period (1997-2002) of the study. These results also demonstrate that vegetated riparian buffers continue to be lost due to development in growing Oregon municipalities regardless of the level of regulatory protection.

Keywords: Conservation biology, Land/watershed management, Sustainable development
Time Period: 1990 - 2002
Geographic Location: Hillsboro, Portland, and Oregon City
Publications:

Ozawa, C.P., and Yeakley, J.A. 2004. Keeping the green edge: Stream Corridor Protection in the Portland Metropolitan Region. Pages 257-279 in C.P. Ozawa (ed). The Portland Edge: Challenges in Growing Communities. Island Press, Washington, D.C.

Yeakley, J.A., C.P. Ozawa, and A.M. Hook. In press. Changes in Riparian Vegetation Buffers in Response to Development in Three Oregon Cities. In: Aguirre-Bravo, Celedonio, et al. (eds). 2004. Monitoring Science and Technology Symposium: Unifying Knowledge for Sustainability in the Western Hemisphere; 2004 September 20-24; Denver, CO. Proceedings RMRS-P-000. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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KEYWORD INDEX