WASHINGTON STATE
FOREST PRACTICES
ADAPTIVE MANAGEMENT PROGRAM
SCIENCE CONFERENCE

Cooperative Monitoring
Evaluation & Research

WEDNESDAY, February 11, 2015
8:00 A.M. to 4:30 P.M.
&
THURSDAY, February 12, 2015
8:30 A.M. to 3:30 P.M.
OB2 Auditorium, DSHS Building
Olympia, Washington

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Washington State Forest Practice
Adaptive Management Program
Acknowledgements

A special Thank-you to all of the scientist who will be presenting at the 2015 CMER Science Conference. In addition, our sincerer gratitude to the support staff that have planned the conference proceedings.

CMER Science Conference Coordinator:
Patti Shramek

Cooperative Monitoring Evaluation and Research Committee (CMER):
Committee members both voting and participating attendees.

CMER Co-Chairs: Todd Baldwin (Kalispel Tribe) and Mark Hicks (Ecology)
Previous Co-Chairs: Sally Butts, Craig Hansen, Terry Jackson, Doug Martin, Chris Mendoza, Timothy Quinn, Nancy Sturhan
CMER Coordinator: Patti Shramek

CMER Scientific Advisory Groups (SAG)
SAG attendees which includes caucus members, the public, and contractors, who are participating or have served on these committees. This list is exceptionally long.

SAG Co-Chairs:

- WetSAG: Debbie Kay & Harry Bell
- SAGE: KodiJo Jaspers & Joel Adams
- UPSAG: Isabelle Sarikhan
- RSAG: Joe Murray
- LWAG: Marc Hayes & AJ Kroll
- SRSAG: Mark Hicks & Chris Mendoza

Technical Writing & Implementation Groups (Pilot - TWIGS):
Scientist & CMER/AMP staff who have provided their expertise to the following projects: Eastside Type N Riparian Effectiveness, Westside Type F Riparian Prescription Effectiveness, Roads Effectiveness Best Management Practices, Unstable Slopes, Criteria, Forested Wetland Effectiveness

Timber Fish and Wildlife Policy (Policy):
Caucus committee members, the public, and contractors who are participating or have served on the committee.
Policy Co-Chairs: Stephen Bernath (Ecology) & Adrian Miller (Olympic Resource Mgmt.)

Forest Practices Board Members:
Aaron Everett (Chair), Heather Ballash, Kirk Cook, Brent Davies, Bob Guenther, David Herrera, Tom Laurie, Bill Little, Carmen Smith, Dave Somers, Court Stanley, Joe Stohr, Paula Swedeen

CMER Staff:

Leah Beckett, Ash Roorbach, Dave Schuett-Hames Greg Stewart, **and Past Staff:** Jenelle Black, Steve McConnell, George McFadden, Myla McGowan, Robert Palmquist, Allen Pleus, Mary Raines, Amy Seiders, and Devin Smith

Adaptive Management Staff:

Hans Berge, Howard Haemmerle, Amy Kurtenbach, Patti Shramek, **and Past Staff:** Darin Cramer, Linda Heckel, Dawn Hitchens, Jim Hotvedt, Jeff McNaughten, Theresa Miskovic

University of Washington Editor and Staff

Coordinating Independent Scientific Peer Review.

Tribes:

NWIFC, UCUT, Chehalis, Colville, Hoh, Jamestown, Kalispel, Lower Elwha, Lummi, Makah, Nisqually, Nooksack, Port Gamble, Puyallup, Quileute, Quinault, Sauk-Suiattle, Shoalwater, Skokomish, Spokane, Squaxin Island, Stillaquamish, Suquamish, Swinomish, Tulalip, Upper Skagit, Yakama

Washington Conservation Caucus:

Audubon Washington, Conservation Northwest, The Mountaineers, Olympic Forest Coalition, Pacific Rivers Council, Sierra Club, Washington Environmental Council, Washington Forest Law Center and Wild Fish Conservancy.

Small Landowner Office:

Washington Farm Forestry Association, Participating Washington State Private Landowners

Large Landowner Caucus:

Washington Forest Protection Association, Participating Washington State Private Landowners

County Government:

Washington State Association of Counties

Washington State Government:

Department of Fish and Wildlife, Department of Ecology, Department of Natural Resources

Federal Government:

National Marine Fisheries Service, US Fish and Wildlife Service, Environmental Protection Agency, US Forest Service

Without question, stakeholders have been missed in this list of acknowledgements. The science and policy decisions cannot be made without the cooperation, participation, and dedication of all stakeholders, landowners, and the support of the citizens of Washington State.

PROGRAM CONTENTS

CONFERENCE AGENDA
Wednesday, February 11, 2015
Type N Experimental Buffer Treatment Study – Hard Rock

Time	Presentation	Presenter
8:00 to 8:15 a.m.	Welcome and Introduction	Peter Goldmark, Commissioner of Public Lands
8:15 to 8:35	Headwaters Amphibians – Background and study need	Tim Quinn, Washington Department of Fish and Wildlife
8:35 to 8:55	Type N Buffer Treatment on Hard Rock Substrates, Introduction to Study	Aimee McIntyre, Washington Department of Fish and Wildlife
8:55 to 9:20	Synthesis of Results	Marc Hayes, Washington Department of Fish and Wildlife
9:20 to 9:40	Riparian Stand Mortality and Wood Recruitment	Dave Schuett-Hames, CMER Staff, Northwest Indian Fisheries Commission
9:40 to 9:55	Woody Debris Loading	Eric Lund Washington Department of Fish & Wildlife
9:55 to 10:10	Break	
10:10 to 10:35	Water Temperature and Shade	Bill Ehinger, Washington Department of Ecology
10:35 to 10:50	Discharge	Greg Stewart, CMER Staff, Norwest Indian Fisheries Commission
10:50 to 11:10	Nutrient and Suspended Sediment Exports	Bill Ehinger, Washington Department of Ecology
11:10 to 11:25	Sediment Processes	Greg Stewart, CMER Staff, Northwest Indian Fisheries Commission
11:25 to 12:00 p.m.	Panel Discussion and Questions	All
12:00 P.M. to 1:00	Lunch	

Time	Presentation	Presenter
1:00 to 1:20	Channel Characteristics	Eric Lund, Washington Department of Fish and Wildlife
1:20 to 1:35	Litterfall Input and Instream Detritus Export	Stephanie Estrella, Washington Department of Ecology
1:35 to 1:50	Periphyton	Eric Lund, Washington Department of Fish and Wildlife
1:50 to 2:10	Macroinvertebrates Export	Stephanie Estrella, Washington Department of Ecology
2:10 to 2:35	Stream Associated Amphibians	Aimee McIntyre, Washington Department of Fish and Wildlife
2:35 to 2:50	Break	
2:50 to 3:05	Fish	Jason Walter, Weyerhaeuser
3:05 to 3:20	Trophic Pathways	Bob Bilby, Weyerhaeuser
3:20 to 3:45	Synthesis	Marc Hayes, Washington Department of Fish and Wildlife
3:45 to 4:30	Panel Discussion and Questions	All
4:30 p.m.	**ADJOURN**	

CONFERENCE AGENDA
Thursday, February 12, 2015

Time	Presentation	Presenter
8:30 to 8:45 A.M.	Second Day Introduction	Mark Hicks & Todd Baldwin, CMER Co-chairs
8:45 to 9:15	Literature Synthesis on Wetlands	Dr. Paul Adamus, Principal Investigator
9:15 to 9:45	Strategy for Researching Wetlands	Dr. Paul Adamus, Principal Investigator
9:45 to 10:00	Break	
10:00 to 10:30	Eastern Washington Type N Forest Hydrology Study	Dan Miller, Principal Investigator
10:30 to 11:00	Effectiveness of Riparian Management Prescriptions in Protecting and Maintaining Shade and Temperature	Eddie Cupp, Principal Investigator
11:00 to 11:30	Eastern Washington Riparian Assessment Project (EWRAP)	Ash Roorbach, CMER Staff, Northwest Indian Fisheries Commission
11:30 to 1:00 P.M.	Lunch	
1:00 to 1:30	Stream-Associated Amphibian Response to Manipulation of Forest Canopy Shading	Dr. James MacCracken, Principal Investigator
1:30 to 2:00	Breeding Bird Response to Riparian Buffer Width	Scott Pearson, Washington Department of Fish and Wildlife
2:00 to 2:15	Break	
2:15 to 2:45	Riparian Hardwood Conversion Study	Ash Roorbach, CMER Staff, Northwest Indian Fisheries Commission
2:45 to 3:30	Final Questions & Answers	All
3:30 p.m.	**ADJOURN**	

COOPERATIVE MONITORING EVALUATION & RESEARCH COMMITTEE BACKGROUND

The Cooperative, Monitoring, Evaluation and Research Committee (CMER) was established by the Washington State Forest Practices Board to help evaluate the effectiveness of the Washington Forest Practices Rules. CMER is made up of members representing State agencies (Washington Departments of Natural Resources, Fish and Wildlife and Ecology), Federal agencies (U.S. Fish and Wildlife Service and National Marine Fisheries Service), Washington Tribes, Washington Counties, industrial and small forest landowners and environmental organizations.

There are currently five scientific advisory groups under CMER. The scientific advisory groups (SAGs) develop scientific research and monitoring studies based on CMER direction and priority research questions pertaining to riparian and aquatic resources originally identified in the Forests and Fish Report, and later incorporated into the CMER Work Plan. These research questions evolve over time as new information is gathered and synthesized. Once developed, the SAGs bring forward studies for CMER's review and approval. Most study designs and completed research and monitoring reports undergo independent scientific peer review prior to final approval. The SAGs are as follows:

Landscape and Wildlife Advisory Group (LWAG)
Riparian Scientific Advisory Group (RSAG)
Scientific Advisory Group Eastside (SAGE)
Soft Rock Scientific Advisory Group (SRSAG)
Upslope Processes Scientific Advisory Group (UPSAG)
Wetlands Scientific Advisory Group (WETSAG)
Technical Writing Implementation Groups (TWIGS)

CMER holds regular monthly meetings attended by CMER members, SAG co-chairs, and other interested parties. SAGs meet on a monthly basis.

Completed CMER research is forwarded to a Forest and Fish Policy Committee, also made up of members representing the stakeholder groups indentified in the first paragraph. As with CMER, they meet monthly to consider CMER studies, other forest practices issues and make recommendations to the Washington Forest Practices Board. The Washington Forest Practices Board is an independent state agency, chaired by the Commissioner of Public Lands or designee, which sets minimum standards for forest practices.

The current Washington Forest Practices Rules were implemented in 1999 and formally adopted in 2001. On June 5, 2006, the Rules pertaining to riparian and aquatic resources were recognized in a federally approved Habitat Conservation Plan for a 50-year term. The Washington Forest Practices Habitat Conservation Plan includes approximately 9.3 million acres of non-federal, non-tribal forest land in Washington that falls within the jurisdiction of the Washington Forest Practices Rules and Washington Forest Practices Act.

RELEVANT WEBSITES

Washington State Department of Natural Resources:
http://www.dnr.wa.gov/Pages/default.aspx

Forest Practices Adaptive Management Program (CMER):
http://www.dnr.wa.gov/BusinessPermits/Topics/FPAdaptiveManagementProgram/Pages/fp_am_program.aspx

Forest Practices Division:
http://www.dnr.wa.gov/BusinessPermits/ForestPractices/Pages/Home.aspx

Forest Practices Habitat Conservation Plan:
http://www.dnr.wa.gov/BusinessPermits/Topics/ForestPracticesHCP/Pages/fp_hcp.aspx

Washington State Department of Fish and Wildlife:
http://www.wdfw.wa.gov/

Washington State Department of Ecology:
http://www.ecy.wa.gov/

Washington Forest Protection Association:
http://www.wfpa.org/

Washington Farm Forestry Association:
http://www.wafarmforestry.com/

Northwest Indian Fisheries Commission:
http://www.nwifc.org/

Upper Columbia United Tribes:
http://www.ucut.org/

Columbia River Inter-Tribal Fish Commission:
http://www.critfc.org/

Washington State Association of Counties:
http://www.wacounties.org/wsac/

Washington Forest Law Center:
http://www.wflc.org/

U.S. Fish and Wildlife Service – Pacific Region:
http://www.fws.gov/pacific/

National Marine Fisheries Service – Northwest Regional Office:
http://www.nwr.noaa.gov/

REFRESHMENT/SNACK/LUNCH OPTIONS

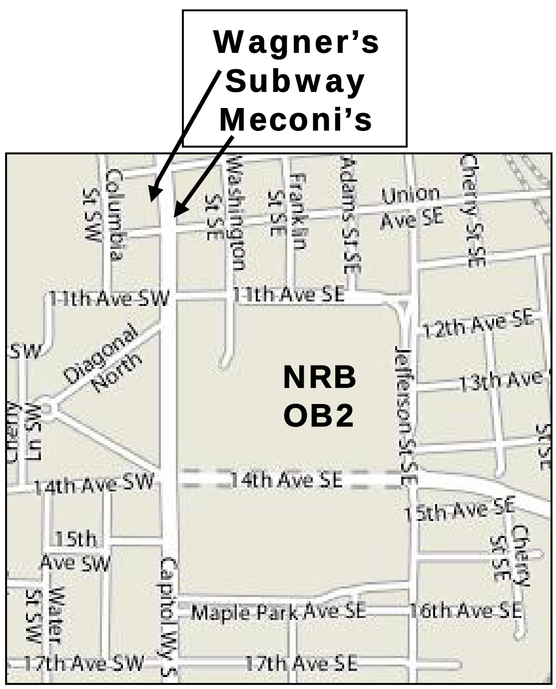
OB2 Cafeteria, Service Level
Sandwiches, soups, salad bar, grill items, and daily specials.

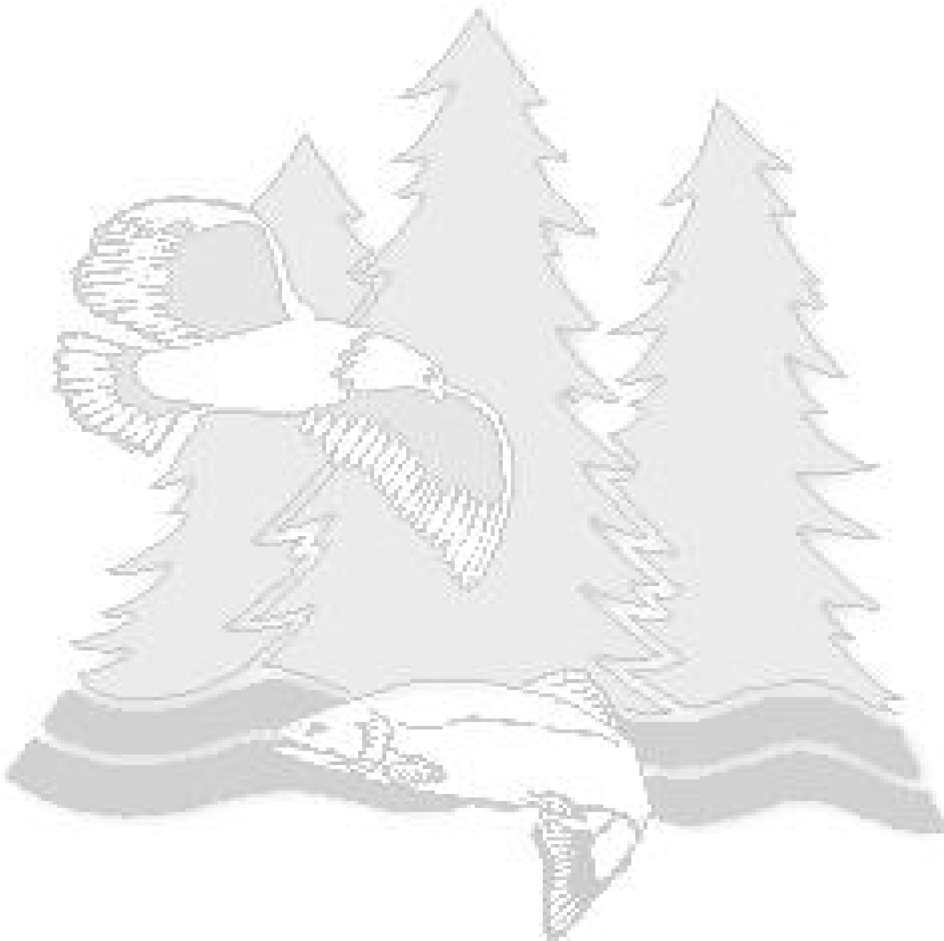
Natural Resources Building (NRB) Cafeteria, Lobby Level, Building Adjacent to OB2
Sandwiches, soups, salad bar, grill items, and daily specials.

Meconi's Italian Subs - Corner of Union Avenue and Capitol Way South
Sub sandwiches, salads, and soups.

Wagner's European Bakery - Near Corner of Union Avenue and Capitol Way South
Sandwiches, soups, salads, and bakery goods.

Subway - Near Corner of Union Avenue and Capitol Way South
Sub sandwiches, salads, and wraps.





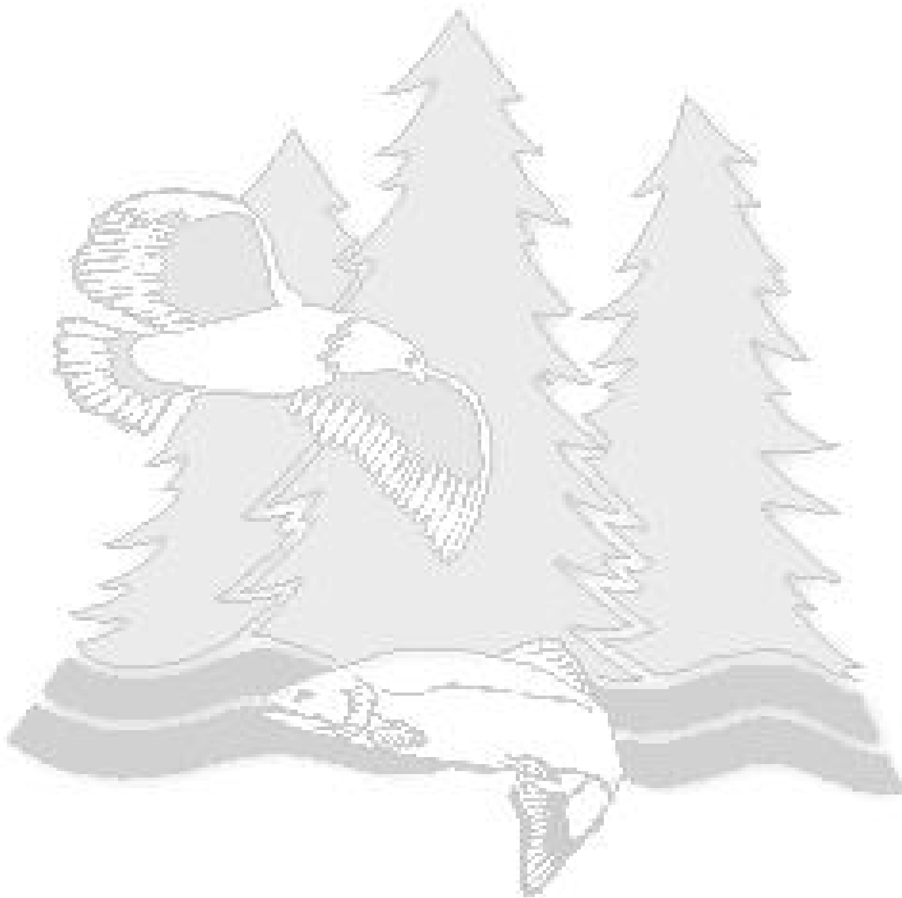
ABSTRACTS

HEADWATER AMPHIBIANS AND FOREST AND FISH: A MARRIAGE OF SCIENTIFIC CONVENIENCE

Presenter: Timothy Quinn, Washington Department of Fish and Wildlife
Marc Hayes, Washington Department of Fish and Wildlife

The conceptual genesis of the Type N study began in 1998 as the Timber Fish and Wildlife (TFW) Community began discussing foundational elements of what would ultimately become the Forest and Fish Agreement (FFA). Early FFA discussions followed the path first blazed in 1986 with the original TFW agreement, i.e., stakeholders would honor multiple resource values, adaptive management, and a forum for forthright discussion and consensus-based decision making. As policy makers quickly agreed on the major questions, they also took the opportunity presented them to address other less obvious natural resource issues. In late 1998, TFW policy makers posed a question to an *ad hoc* CMER wildlife committee: “What other species/issues, closely tied to riparian habitat, should be addressed in this agreement and why?” For two years, the Wildlife committee wrestled with the question, conducted analyses, and finally proposed a forest management approach for headwater streams that ultimately included ESA coverage for obligate stream-associated amphibians. Thus, what started strictly as a forest and fish-related agreement became FFA with the amphibians silent but covered. The *ad hoc* wildlife committee argued that headwater stream dynamics were largely unstudied, and headwater stream amphibians, considered at relatively high risk based on their perceived association with old forests, would benefit from knowledge gained through adaptive management associated with the FFA. Policy agreed and here we are 15 years later.

NOTES

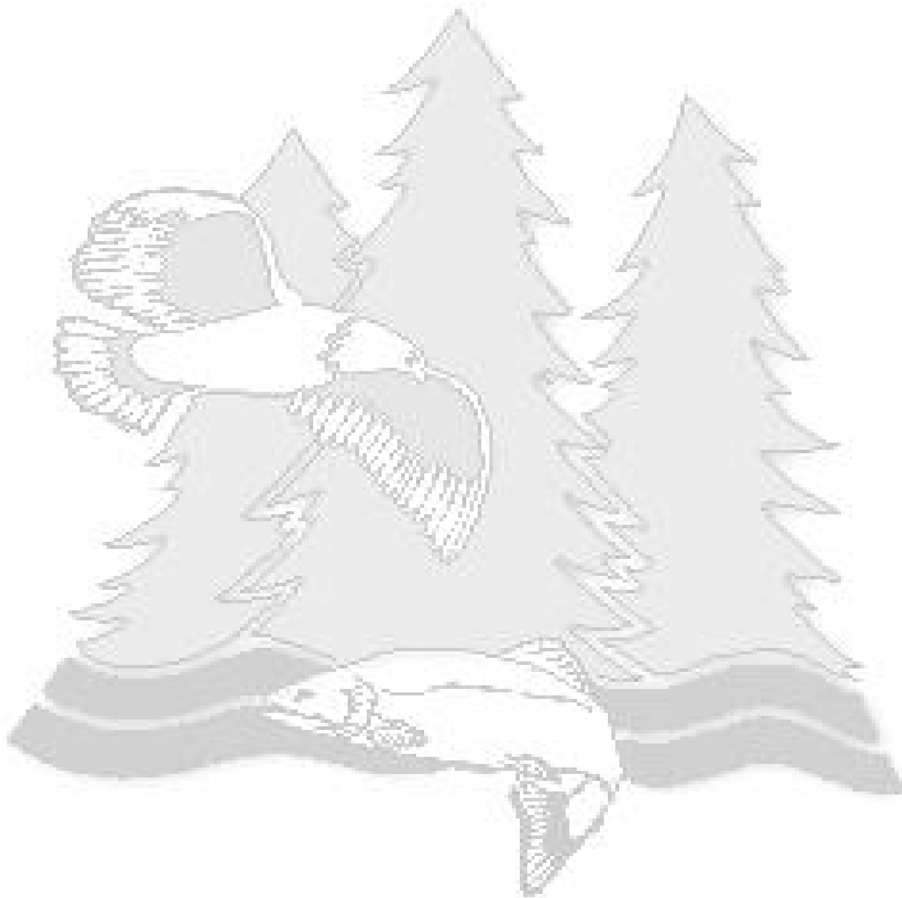


TYPE N EXPERIMENTAL BUFFER TREATMENT STUDY ON HARD ROCK SUBSTRATES: INTRODUCTION AND STUDY DESIGN

Presenter: Aimee McIntyre, Washington Department of Fish and Wildlife
Marc Hayes, Washington Department of Fish and Wildlife

The Type N Experimental Buffer Treatment Study is a landscape-level experiment designed to evaluate the effectiveness of the current RMZ rules for non-fish bearing (Type N) streams on hard rock substrates in western Washington. The experimental units, which consisted of 17 non-fish bearing basins structured in a BACI design, included six reference (unharvested) basins and 11 basins in which one of three treatments was applied: 1) the current Forest Practices riparian buffer prescription (n = 3), 2) a buffer shorter (0%) than the current prescription (n = 4) and 3) a buffer longer (100%) than the current prescription (n = 4). We measured five categories of physical (water temperature, discharge, nutrient export, sediment, channel characteristics, water temperature) and eight categories of biotic (riparian vegetation, wood, litterfall, detritus, periphyton, macroinvertebrates, amphibians, fish) variables to evaluate responses to treatments. Fish, detritus, discharge, litterfall, macroinvertebrates and sediment were measured in a subset of basins. We collected pre-treatment data in the three-year interval 2006-2008, treatments were applied in the interval late-2008 – early 2009, and post-treatment data were collected in the two-year interval 2009-2011.

NOTES



TYPE N EXPERIMENTAL BUFFER TREATMENT STUDY ON HARD ROCK SUBSTRATES: SYNTHESIS OF RESULTS

Presenter: Marc Hayes, Washington Department of Fish and Wildlife
Timothy Quinn, Washington Department of Fish and Wildlife

This synthesis summarizes the early post-harvest results of the Type N Experimental Buffer Treatment Study, a landscape-level Forests and Fish adaptive management study designed to determine the effectiveness of buffer prescriptions for non-fish bearing streams on hard rock substrates in western Washington. This study used basin-scale experimental units embedded in a BACI design that bracketed treatments with a shorter (0%) and longer (100%) riparian buffer than the current Forest Practices prescription. Results of this study revealed a mix of expected and unexpected biotic (amphibians, fish, litterfall and detritus, macroinvertebrates, periphyton, wood, vegetation) and physical (discharge, nutrient export, sediment, water temperature) responses to treatments that help modernize our perspective on forest practices. Anticipated responses corroborated by the study included increases in water temperature, stream nitrogen concentration and export, runoff, buffer tree mortality, new wood in the first year post-harvest, small wood, and fine sediment, and decreases in litterfall, and shade. All these responses generally paralleled the gradient in the treatments. Other responses corroborated by this study included no difference in detritus exports, increases in collector-gatherer macroinvertebrates and decreases in predator macroinvertebrates across treatments, and constrained stream wetted and bankfull widths only in the 0% buffer treatment. Important unanticipated results were a) a general lack of change in amphibian densities across all treatments and b) no measureable change in sediment delivery to the stream or in suspended sediment export from the stream. The latter was also consistent with small response in total phosphorus export, and no response seen in periphyton, and macroinvertebrate scrapers and shredders. The few exceptions to the suite of these general patterns appear to be linked to site-specific conditions independent of experimental units.

NOTES

RIPARIAN STAND MORTALITY AND WOOD RECRUITMENT

Presenter: Dave Schuett-Hames, Northwest Indian Fisheries Commission
Ash Roorbach, Greg Stewart, Northwest Indian Fisheries Commission

We evaluated tree mortality rates and changes in riparian stands in response to buffering strategies on non-fish-bearing perennial (Type Np) streams in western Washington. The three strategies differ in the proportion of Type Np stream network buffered, including the 0% treatment (no buffers), the forest practice (FP) treatment (minimum of 50% buffered) and the 100% treatment (completely buffered). The 50-ft wide riparian management zones (RMZs) and perennial initiation point (PIP) buffers were sampled before, and two years after harvest at 17 sites grouped in blocks based on geographic location. General linear mixed effect models compared differences between the experimental treatments and unharvested reference sites.

Initially (2007), most riparian stands consisted of dense second-growth conifer, but trees/acre (TPA) and basal area/acre (BAPA) were lower and broadleaf trees were more abundant in the South Cascades block. A December 2007 storm (prior to harvest) generated hurricane-force winds in coastal southwest Washington, causing extensive mortality in two coastal blocks. The disturbance was patchy, increasing variability at impacted sites. Little pre-harvest mortality occurred elsewhere.

We observed differences in tree mortality between treatments two years after harvest. The highest mortality and greatest reductions in TPA and BAPA occurred at FP treatment sites. Post-harvest mortality in FP (buffered) RMZs was around 18% for TPA and BAPA, over twice the reference ($P \leq 0.05$) and 100% treatment ($P=0.07$) rates. There was little difference in the 100% treatment and reference rates ($P>0.9$). Mortality rates for FP treatment PIPs were eight times the reference rates ($P<0.01$) and over four times the reference rates ($P=0.07$ for %tree count and $P = 0.05$ for %BAPA) for 100% treatment PIPs. The FP versus 100% treatment PIP comparison had mixed results, with *P*-values of 0.04 for %tree count and 0.11 for %BAPA. The results corroborate Westside Type N Buffer Characteristics, Integrity and Function (BCIF) study findings of higher tree mortality in Forest Practice RMZs ($P=0.04$) and PIPs ($P=0.004$) compared to reference rates. Mean mortality rates for the BCIF PIP buffers were six times higher than the reference rates, similar to the eight-fold difference in this study.

Post-harvest stand conditions differed among experimental treatments due to harvest and subsequent mortality. Post-harvest BAPA was highest in the reference and 100% treatment RMZs and the distributions of plot values were similar. The combination of clear-cut reaches and buffer mortality in the FP treatment sites resulted in a lower range of BAPA values compared to the reference or 100% treatment sites. Forty percent of FP treatment RMZ plots were clear-cut, and BAPA values for most remaining buffer plots were below 150 ft^2 (34.5 m^2/ha). Additional monitoring over a longer timeframe will help address uncertainty about the effects of these initial differences in riparian stand condition on riparian stand development and riparian functions over time.

NOTES

WOODY DEBRIS LOADING

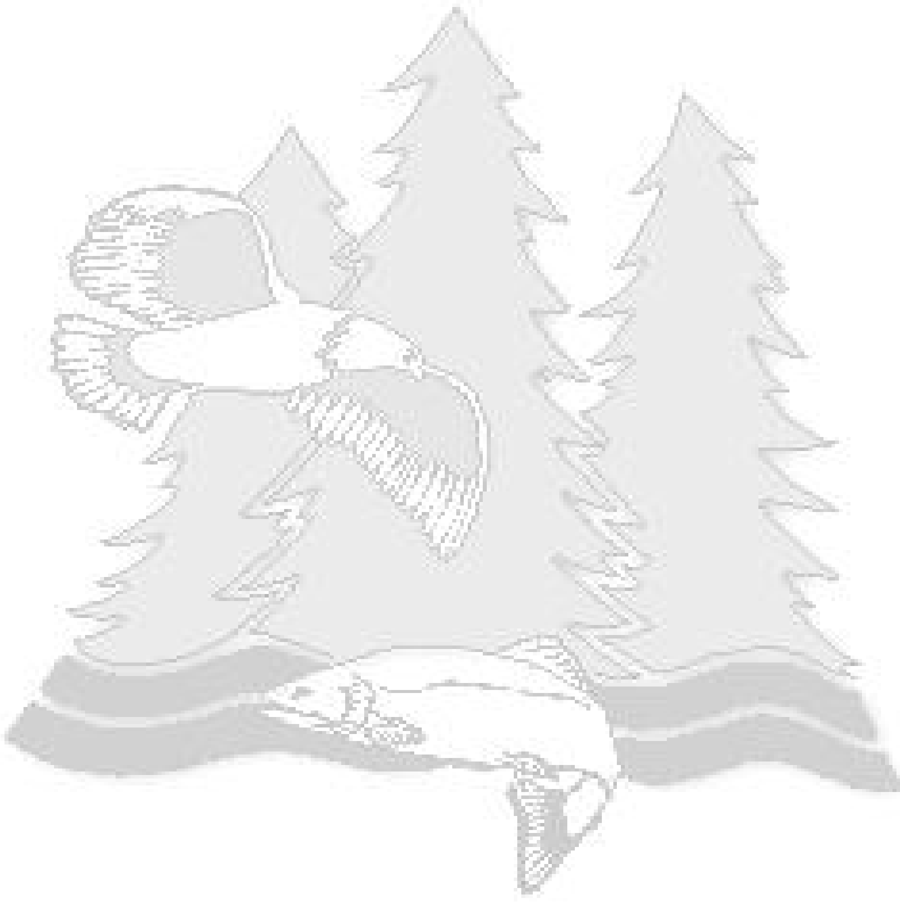
Presenter: Eric Lund, Washington Department of Fish and Wildlife
Dave Schuett-Hames, Northwest Indian Fisheries Commission
Aimee McIntyre, Washington Department of Fish and Wildlife

We evaluated changes in wood recruitment rates and instream wood loading and cover in response to alternative riparian buffer treatments that varied by proportion of the Type Np stream network buffered, including the 0% treatment (no buffers), forest practice rule (FP) treatment (minimum 50% buffered) and 100% treatment (completely buffered). Sampling occurred before and two years after harvest. Tree fall and large wood recruitment to the channel were sampled at riparian stand plots established in the 50-ft wide riparian management zones (RMZs) and perennial initiation point (PIP) buffers as described in Chapter 5. We calculated the percent cover of new wood at each site as the average cover of all 10-m sampling intervals throughout the Type Np stream network. We recorded the diameter class and function of all wood pieces within the bankfull channel that were >2cm in diameter and calculated the frequency of both small woody debris pieces (SWD; ≥ 2 to 10cm diameter) and large woody debris (LWD; >10cm diameter) by site. General linear mixed effect models were used to compare differences among treatments and with unharvested reference sites.

In the two years following harvest, mean tree fall calculated as percent of standing trees was highest in FP (buffered) RMZs (16.4%), lower in 100% treatment RMZs (5.6%) and lowest in reference RMZs (3.0%). The pattern was similar for PIPs. The P-values for the FP (buffered) vs. reference comparison were ≤ 0.02 for both RMZs and PIPs. For the 100% treatment vs. reference comparisons, P=0.34 for RMZs and P=0.03 for PIPs. Mean post-harvest LWD recruitment volume was highest in the 100% treatment RMZs (nearly twice the reference rate) but was similar in the FP (buffered) and reference RMZs. The P-values for these comparisons were > 0.10. Mean LWD recruitment volume was 30 times greater in the 100% treatment PIPs than the reference PIPs (P=0.04), 18 times the reference rate in the FP (buffered) PIPs (P=0.08). Tree fall and LWD recruitment were very low at 0% treatment sites because few riparian trees remained.

Newly recruited wood cover in the first post-harvest year increased as the length of the riparian buffer decreased. The proportion of the stream length covered by new wood in the first post-harvest year was greatest in the 0% treatment (35% of stream length covered), followed by the FP (32%) and 100% (17%) treatments and reference (4%), respectively. Our estimates for numbers of LWD loading in the post-harvest period were 70%, 60% and 70% greater in the 100%, FP and 0% treatments, respectively, than for the reference, however we found no differences among harvest treatments. SWD accounted for 80% of all wood by count. The number of SWD pieces in the post-harvest period were greater for the FP and 0% treatments than for the reference (P = 0.04 and P < 0.0001, respectively), and greater for the 0% treatment than the FP and 100% treatments (P = 0.04 and < 0.01, respectively).

NOTES

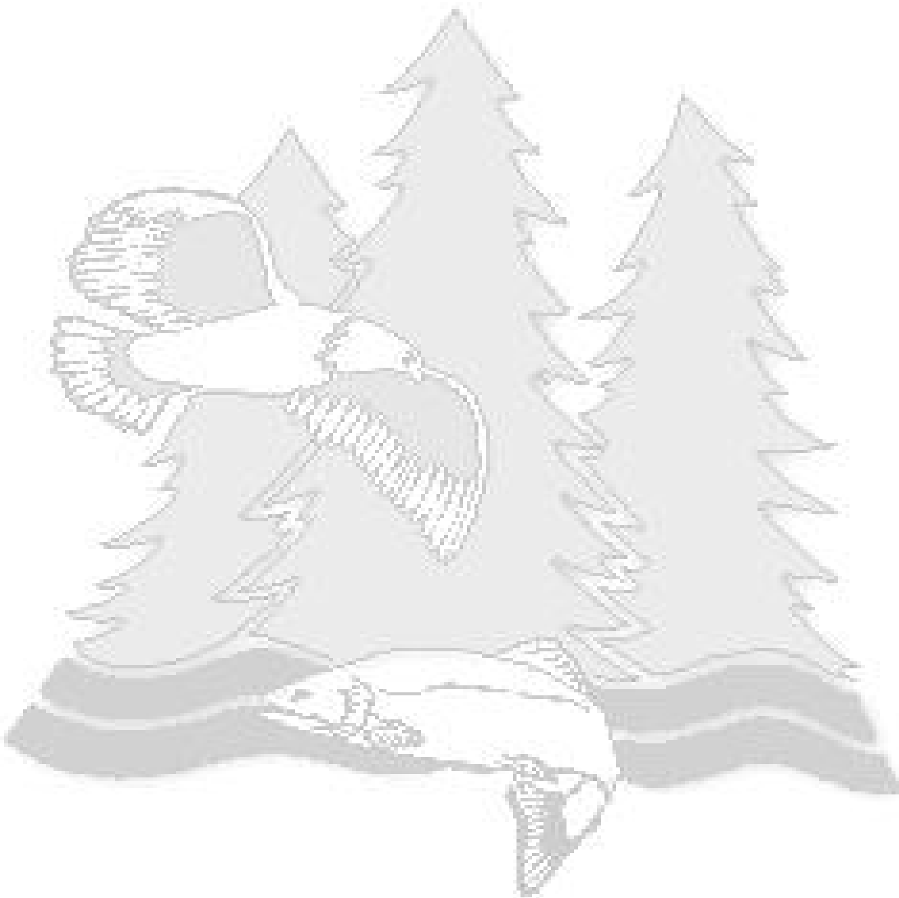


STREAM TEMPERATURE AND SHADE

Presenter: William Ehinger, Washington Department of Ecology
Stephanie Estrella, Charlotte Milling, Washington Department of Ecology
Greg Stewart, Northwest Indian Fisheries Commission

We measured stream temperature and riparian cover at multiple locations in 17 headwater streams in southwest Washington and the western Olympic peninsula from October 2006-September 2011 in order to estimate changes in temperature and cover following timber harvest using three different riparian buffer strategies. The four experimental treatments were: a no harvest reference, 100% of perennial stream buffered with a minimum 50 feet width no-harvest zone (100%), at least 50% of the stream buffered as above (FP), and 0% of the stream length buffered (0%). Riparian cover, measured with a densiometer at 1-m and at the water surface decreased <10% in the 100% treatment, 20-40% in the FP treatment, and >50% in the 0% treatment. Understory vegetation and woody debris provided a substantial amount of cover in the 0% sites and in the harvested portion of the FP sites. Summer 7-day average maximum daily stream temperature increased by approximately 1°C in the 100% and FP treatments and by 3°C in the 0% treatments. Stream temperature was still elevated in the second year post-harvest but, in general, was lower than in the first year post-harvest.

NOTES



DISCHARGE

Presenter: Greg Stewart, Northwest Indian Fisheries Commission
William Ehinger, Washington Department of Ecology

We determined the relationship in water discharge between treatment and reference basins for three buffer treatments in two different blocks, and used that relationship to determine how discharge changed in response to forest harvest. Treatment basins differed in the length of stream buffered, and included an application of the current state Forest Practices buffer (FP treatment), a longer buffer (100% treatment) and no buffer (0% treatment) treatment. In the first two years following harvest, annual runoff increased in all treatment basins as a result of harvest, but the magnitude of change varied by season and return interval. As expected, total yield appeared to increase as a function of the proportion of basin harvested, with very little change seen where only 46% of the basin was harvested. Mean discharge increased in the FP and 0% treatments but not the 100% treatments. A frequency analysis showed that all treatments exhibited significant changes in magnitude/frequency of events over at least part of the frequency distribution. Base flows decreased in the 100% treatment, were largely unchanged in the FP harvest, and increased in the 0% treatments. Changes in annual peak flows were generally not statistically significant, but most basins did exhibit a significant increase in the frequency/magnitude of the 30-day event. The frequency analysis findings are consistent with the previous estimates of mean discharge, but highlight the importance of examining the entire distribution of flows especially when evaluating potential ecological impacts.

NOTES

NUTRIENT AND SUSPENDED SEDIMENT EXPORT

Presenter: William Ehinger, Washington Department of Ecology
Stephanie Estrella, Washington Department of Ecology

We measured stream flow, turbidity, and concentrations of nutrients (nitrogen and phosphorus) and suspended sediment in eight headwater sites in southwest Washington and the western Olympic peninsula from October 2006-September 2011 in order to estimate changes in export following timber harvest using three different buffer treatments. The four experimental treatments were: a no harvest reference, 100% of perennial stream buffered with a minimum 50 feet width no-harvest zone, at least 50% of the stream buffered as above, and 0% of the stream length buffered.

We found greater variability in pre-harvest N concentration and export among the study sites than expected. Despite the pre-harvest variability, the response of N-export to harvest was consistent with post-harvest increases in the export of total-N ranging from 7-358% and in nitrate-N ranging from 13-327% across all sites. Although the differences between the 100% and FP treatments and the difference between the FP and 0% treatments were not significant ($P < 0.05$), the relative magnitude of the change is in line with our expectations of increased N export correlated with the increase in runoff which, in turn, was correlated with the proportion of the watershed harvested.

In contrast to nitrogen, total-P concentration did not change in a consistent way post-harvest. Total-P export increased post-harvest in all treatments ranging from 21-50%. However this is likely a function of increased runoff because very little bank disturbance was observed in any of the sites and there was little opportunity for the input of sediment to the channel.

We saw little change in turbidity after harvest. Over 90% of the individual turbidity values were < 1.4 NTUs with most being near zero. As a result we saw little evidence of increased suspended sediment export following harvest.

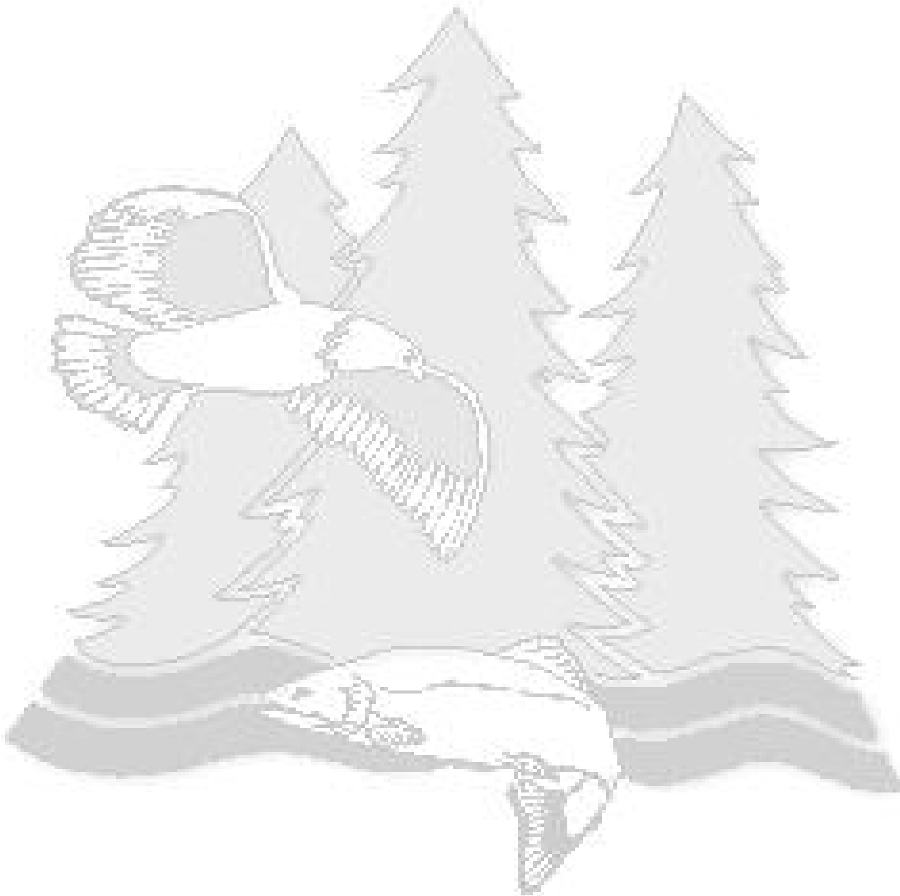
NOTES

SEDIMENT PROCESSES

Presenter: Greg Stewart, Northwest Indian Fisheries Commission
William Ehinger, Washington Department of Ecology
Dave Schuett-Hames, Northwest Indian Fisheries Commission
Aimee McIntyre, Eric Lund, Washington Department of Fish and Wildlife

We looked for gross changes in suspended sediment export and differences in sediment inputs from roads, bank erosion, and windthrow that could be used to explain hypothesized changes in amphibian density. Treatment basins differed in the length of stream buffered, and included an application of the current state Forest Practices buffer (FP treatment), a longer buffer (100% treatment) and no buffer (0% treatment) treatment. In the first two-years of harvest, we found little direct evidence of increased suspended sediment concentration or export resulting from the harvest treatments, nor did we find any obvious increase in sediment input to the stream from road sediment modeling or from field observations of windthrow and bank erosion.

NOTES

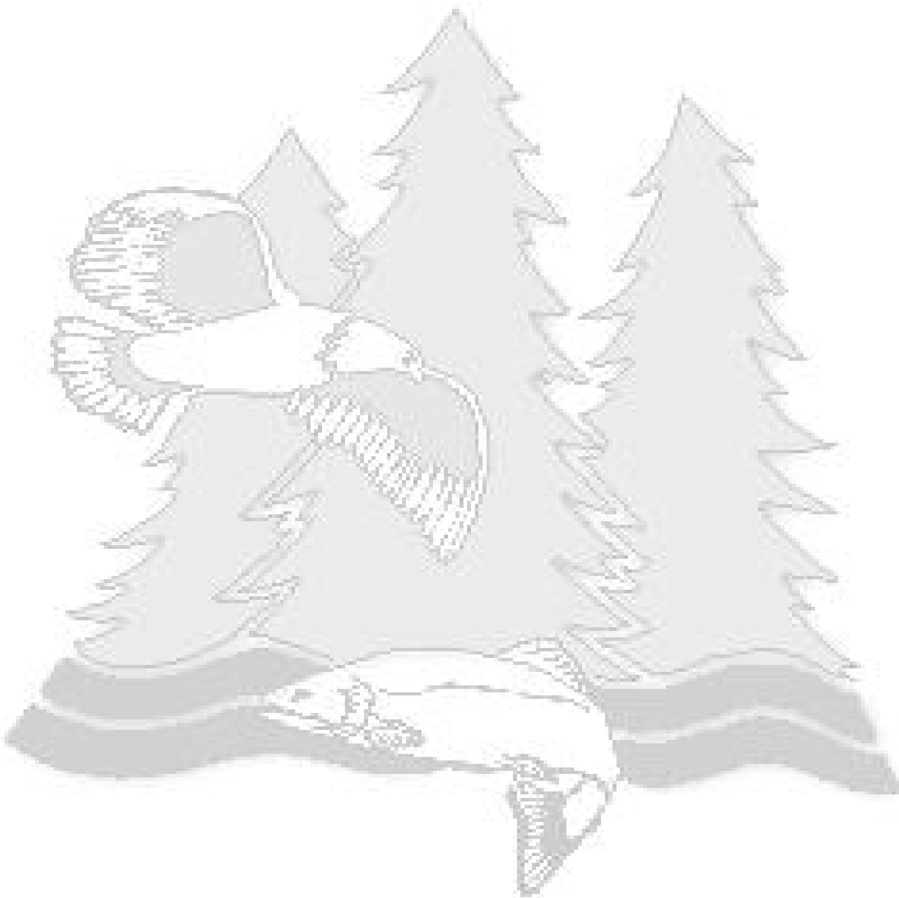


CHANNEL CHARACTERISTICS

Presenter: Eric Lund, Washington Department of Fish and Wildlife
Aimee McIntyre, Washington Department of Fish and Wildlife

We compared the response of headwater stream channels to clearcut timber harvest with three alternative riparian buffer treatments and reference sites that were not harvested during a five-year study period (2006-2010). Riparian buffer treatments varied by length of stream buffered and included an application of the current state Forest Practices buffer (FP treatment), and a longer (100% treatment) and shorter buffer (0% treatment).The response of headwater streams to timber harvest was evaluated using common stream channel metrics (e.g., stream wetted width, stream substrate, and channel unit composition and characteristics). Timber harvest in headwater basins resulted in an increase in the average pool length, regardless of buffer treatment. In the absence of a riparian buffer (0% treatment), stream wetted and bankfull widths were constrained compared to sites that included a riparian buffer (100% and FP) and references. We hypothesize that stream channels lacking a riparian buffer were constrained by the greater inputs of woody debris in the form of logging slash and the increased small wood loading that we observed in this treatment. A decrease in the length of stream buffered may also result in an increase in instream fine sediment and sand.

NOTES

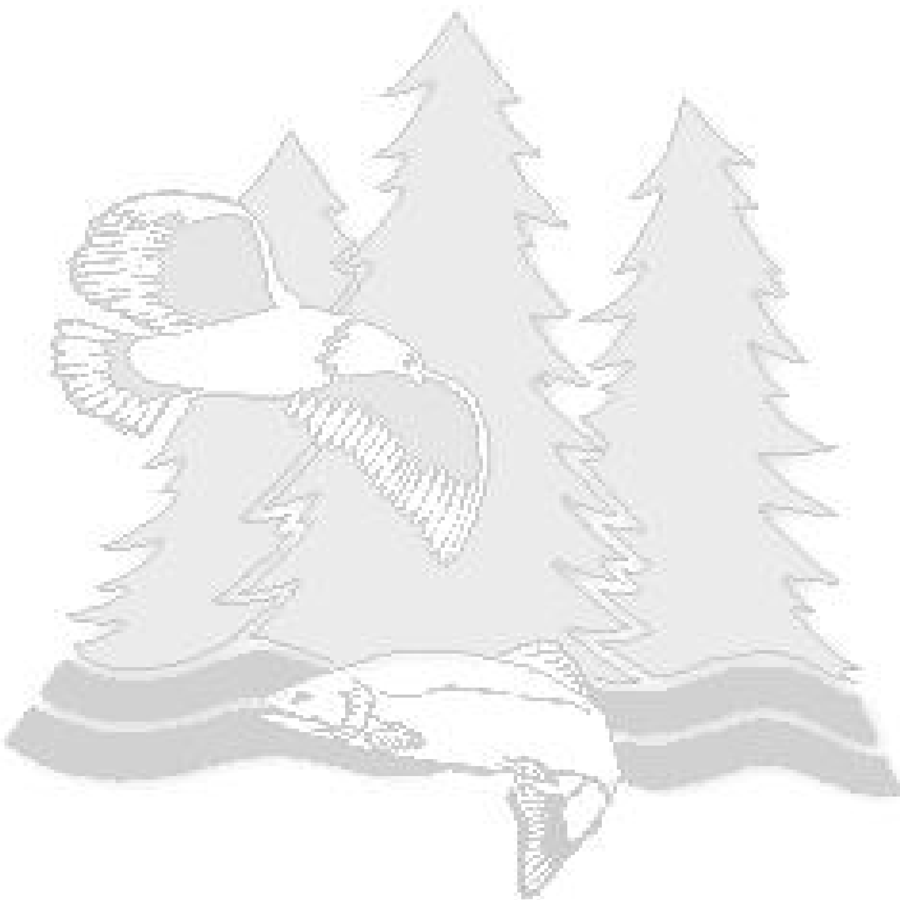


LITTERFALL INPUT AND INSTREAM DETRITUS EXPORT

Presenter: Stephanie Estrella, Washington Department of Ecology
William Ehinger, Charlotte Milling, Washington Department of Ecology

Headwater streams depend on organic matter inputs originating from outside the stream channel for their primary source of energy. Timber harvest in non-fish-bearing stream basins may alter the quantity, composition, and timing of these litterfall inputs, which may affect the quantity and composition of instream detritus and thus food availability to the aquatic biotic community. We assessed the response of litterfall input and detritus export from non-fish-bearing streams before and after timber harvest from study sites treated with the current Washington State Forest Practices buffer (FP treatment), a more extensive buffer (100% treatment), and no buffer (0% treatment) relative to unharvested reference sites. Litterfall was sampled continuously at four stations in each study site using paired litterfall traps. Samples were collected every six weeks and quantified in grams ash free dry weight (AFDW) per square meter per day. Detritus was collected in a drift net at the location of the hydrological monitoring equipment every six weeks, and export quantified in grams AFDW per day and per cubic meter of stream flow. Input of total and conifer litterfall decreased in the 0% treatment relative to the reference and relative to the 100% treatment ($P<0.05$). Deciduous litterfall decreased in the 0% treatment relative to the reference and relative to the 100% and FP treatments ($P<0.05$). There was no measurable change in detritus export ($P>0.05$) in the three treatments relative to the reference within the limitations of the study design and sampling methodology.

NOTES

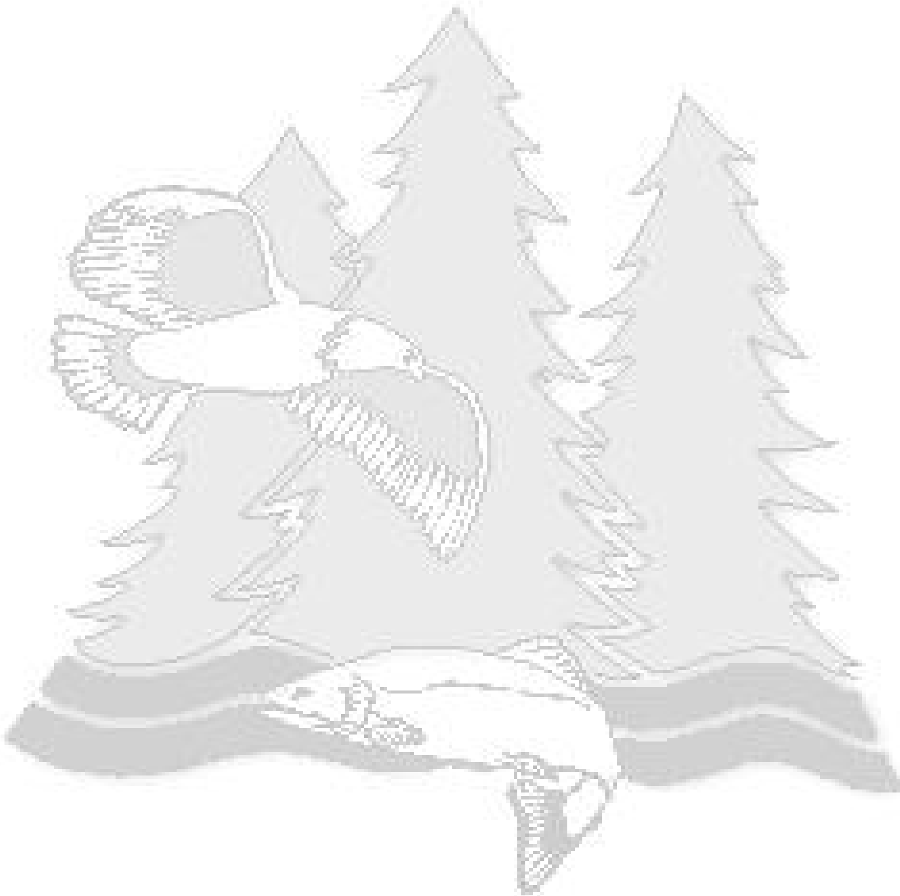


PERIPHYTON

Presenter: Eric Lund, Washington Department of Fish and Wildlife
Aimee McIntyre, Washington Department of Fish and Wildlife
Stephanie Estrella, William Ehinger, Washington Department of Ecology

We compared the response of periphyton biomass and chlorophyll *a* to clearcut harvest with three alternative riparian buffer treatments and reference sites that were not harvested during a five year study (2006 – 2010). Riparian buffer treatments varied by length of stream buffered and included an application of the current state Forest Practices buffer (FP treatment), a longer buffer (100% treatment) and no buffer (0% treatment). We collected periphyton samples from four pairs of unglazed, ceramic tiles installed at each study site over two, two-month sample periods each year: early summer (June and July) and late summer (August and September). Periphyton biomass did not differ by treatment following harvest ($P = 0.83$ and $P = 0.61$ for the early and late sample periods, respectively). Chlorophyll *a* also did not differ by treatment following harvest ($P = 0.14$ and $P = 0.75$ for the early and late sample periods, respectively). While we did observe post-harvest reductions in effective shade and canopy cover across all riparian buffer treatments, that reduction did not result in the increased periphyton biomass or chlorophyll *a* that we expected.

NOTES

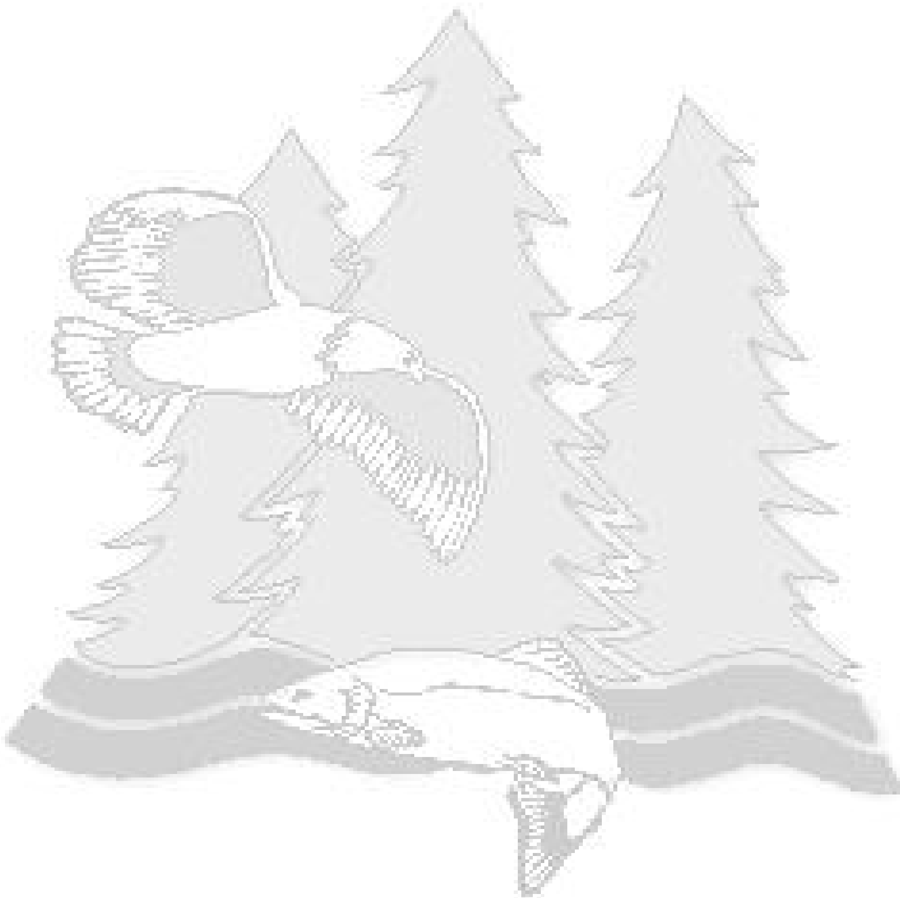


MACROINVERTEBRATE EXPORT

Presenter: Stephanie Estrella, Washington Department of Ecology
William Ehinger, Washington Department of Ecology

Headwater streams comprise a significant proportion of the landscape and macroinvertebrates exported from these stream networks serve as an important food source for downstream fish. Timber harvest in non-fish-bearing stream basins may reduce the number of macroinvertebrates exported from the basin or change the composition of the macroinvertebrate community through a decrease in organic matter inputs and increase in insolation and primary production. We assessed the response of macroinvertebrate export from non-fish-bearing streams before and after timber harvest from study sites treated with the current Washington State Forest Practices buffer (FP treatment), a more extensive buffer (100% treatment), and no buffer (0% treatment) relative to unharvested reference sites. Macroinvertebrates were collected in a drift net at the location of the hydrological monitoring equipment every six weeks and their export quantified in numbers and biomass per day and per cubic meter of stream flow. Export of total macroinvertebrates and most functional feeding groups, including Chironomidae, collector-filterers, omnivores, parasites, scrapers, and shredders, did not change in the treatments relative to the references following harvest ($P>0.05$). Collector-gatherer export in biomass per day increased after harvest in the 100%, FP, and 0% treatments relative to the reference ($P<0.05$), while collector-gatherer biomass per cubic meter of stream flow increased in the FP treatment relative to the reference ($P<0.05$). While collector-gatherer export in numbers per day and numbers per cubic meter of stream flow did not change after harvest ($P>0.05$), collector-gatherers consistently made up a substantial percentage of export in numbers and biomass. Predator export in numbers and biomass per day and per cubic meter of stream flow decreased in the 0% treatment relative to the reference ($P<0.05$). Baetidae export in biomass per cubic meter of stream flow increased in the 100%, FP, and 0% treatments relative to the reference ($P<0.05$). Despite these changes, there was no difference in collector-gatherer, predator, or Baetidae export between the treatments. Chironomidae and *Baetis* comprised much of the proportion of individuals exported, and *Baetis* of biomass exported. Wood inputs into the stream channels in the form of slash and windthrow created shade and depositional areas, which may have created habitat conditions favorable for collector-gatherer taxa. Persistence of taxa such as Chironomidae and *Baetis* likely resulted from their multivoltinism, and their ability to quickly adapt to disturbances and use available food sources. Although we observed some changes after harvest, there were no major reductions in macroinvertebrate export and no major shifts in community composition associated with the three buffer treatments relative to the unharvested references within the limitations of the study design and sampling methodology.

NOTES

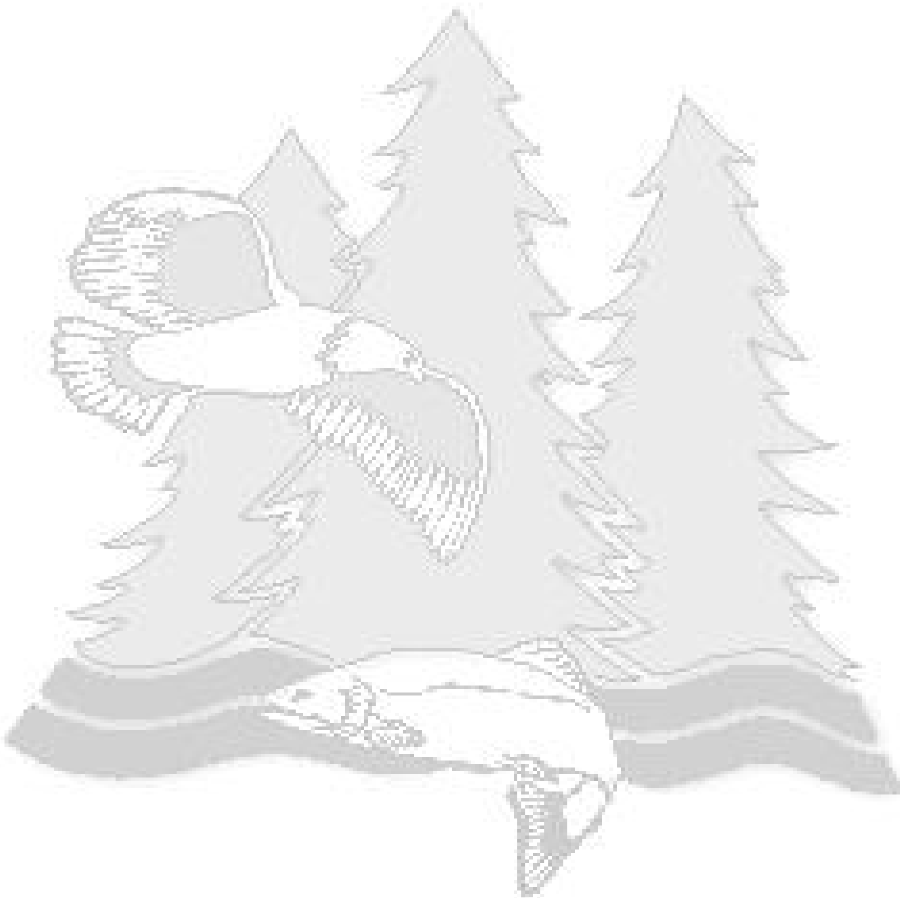


STREAM-ASSOCIATED AMPHIBIANS

Presenter: Aimee McIntyre, Washington Department of Fish and Wildlife

We compared the response of headwater stream-associated amphibians (Coastal Tailed Frog [*Ascaphus truei*], and torrent [*Rhyacotriton*] and giant [*Dicamptodon*] salamanders) to clearcut harvest with three alternative riparian buffer treatments and reference sites that were not harvested during a five year study (2006 – 2010). Riparian buffer treatments varied by length of stream buffered and included an application of the current state Forest Practices buffer, and a longer and shorter buffer. Stream-associated amphibians were not immediately extirpated from clearcut headwater streams, regardless of riparian buffer treatment. Treatment effects on linear density varied by genera and, for tailed frogs, by life stage. We estimated that the change in giant salamander linear density between the pre- and post-harvest period in the FP treatment was an 82% (95% CI: 55% to 93%) decrease relative to the reference. We estimated that the changes in Coastal Tailed Frog larval linear density between the pre- and post-harvest periods were 4.1 (95% CI: 1.6 to 10.0) and 8.2 (95% CI: 3.3 to 20.1) times greater in the 100% and FP treatments, respectively, than for the reference. We estimated that the change in post-metamorph Coastal Tailed Frog linear density in the 0% treatment was 5.5 (95% CI: 0.9 to 36.6) times greater than the reference. Finally, there was no clear evidence of a difference in response for torrent salamanders among treatments. We observed all focal amphibian species in areas lacking a riparian buffer, where logging slash accumulations were greatest. We did not detect a treatment effect on body condition for any species. We conclude that, overall, the current Forest Practice's buffer was effective in maintaining stream-associated amphibian populations, at least in the two years immediately after timber harvest.

NOTES

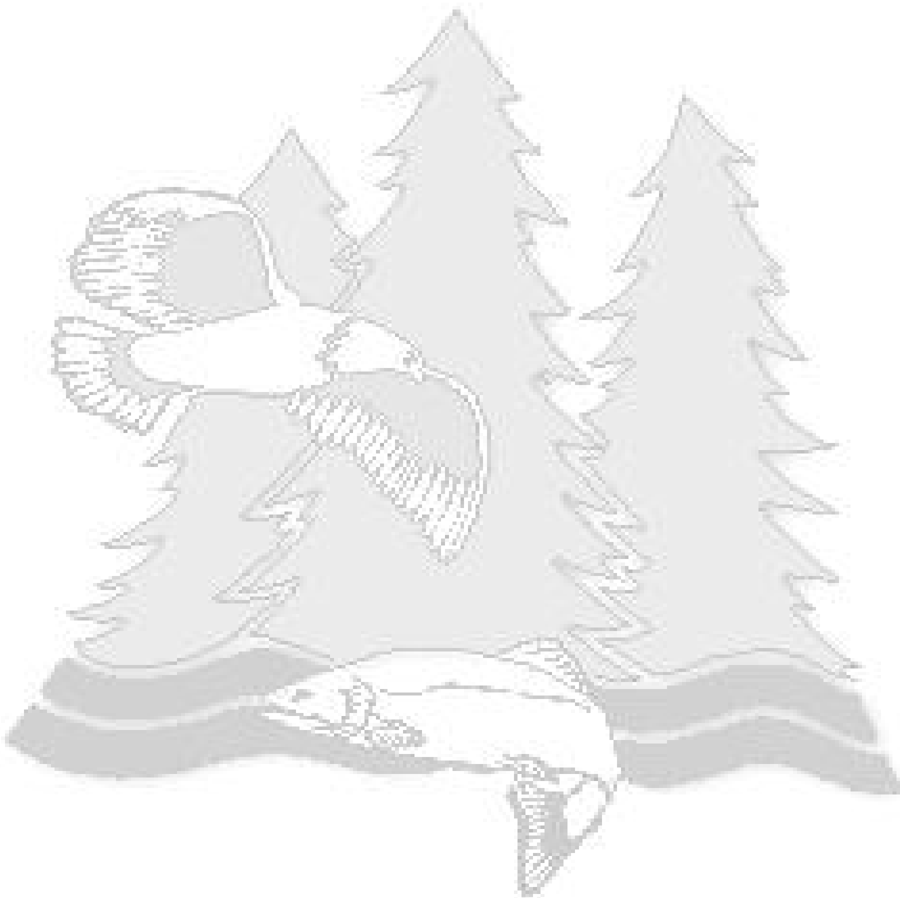


FISH

Presenter: Jason Walter, Weyerhaeuser NR
Brian Fransen, Jack Giovanini, Steve Duke, Robert Bilby, Graham Mackenzie, and Renata Tarosky, Weyerhaeuser NR.

Headwater streams comprise a significant proportion of the cumulative stream length in mountainous catchments, and are an important component to the ecology of lotic systems. These small streams provide critical habitat for fish such as coastal cutthroat trout, the species most often found at the upstream extent of fish distribution in western Washington. Few published studies exist characterizing these fish populations, or their sensitivity to modern timber harvest practices, and those that do report various conflicting responses. The original intent of the Type N Study was to include an evaluation of fish response in the stream segments immediately downstream from timber harvests treated with; current Washington Forest Practices buffers (FP treatment), more extensive buffers (100% treatment), or no buffers (0% treatment), relative to unharvested reference sites. For a variety of reasons, however, fourteen of the twenty Type N sites were dropped from the fish component of the study. Due to a resulting lack of replication, an evaluation of fish response to upstream timber harvest and different riparian buffer prescriptions was not possible. Instead, we modified our objectives to treat the remaining six sites as a case study, with the intent of characterizing the ecology of cutthroat trout and their habitats at the upstream extent of fish distribution. Fish and stream habitat data were collected twice annually (July and October) between 2006 and 2010. Cutthroat trout density and population structure were highly variable, both spatially and temporally, across sites, months, and years. Variability in fish abundance, however, did not appear to be correlated with physical stream habitat metrics such as gradient and percent pool area that were also variable across sites. Analysis of variance revealed that relative fish condition was consistently higher in July than October ($P < 0.001$). We found no relationship between relative fish condition and density. Consistently low recapture rates for PIT tagged fish over the course of the study provides strong evidence of a high level of fish emigration from and/or mortality within study reaches. The percent of PIT tagged fish that were recaptured during multiple surveys dropped exponentially through time with only 28.6%, 5.7%, 2.6%, and 0.6% of fish being recaptured one, two, three, and four times, respectively. A general linear model fit to size data from recaptured PIT tagged fish revealed that a log-linear relationship exists between specific growth and initial fish size ($P = 0.002$). For each additional one gram of initial weight, growth rate was reduced by 7.1%. We found no relationship between fish density and growth in either the July to October or the October to July interval. This work documents the relatively low abundance and growth of coastal cutthroat trout in stream reaches at the upstream extent of fish distribution. We found that these habitats tended to support lower densities of cutthroat trout than typically reported in the published literature for headwater basins as a whole, and that the fish in these habitats grew more slowly and were smaller on average with a lower condition factor than fish reported in these studies.

NOTES

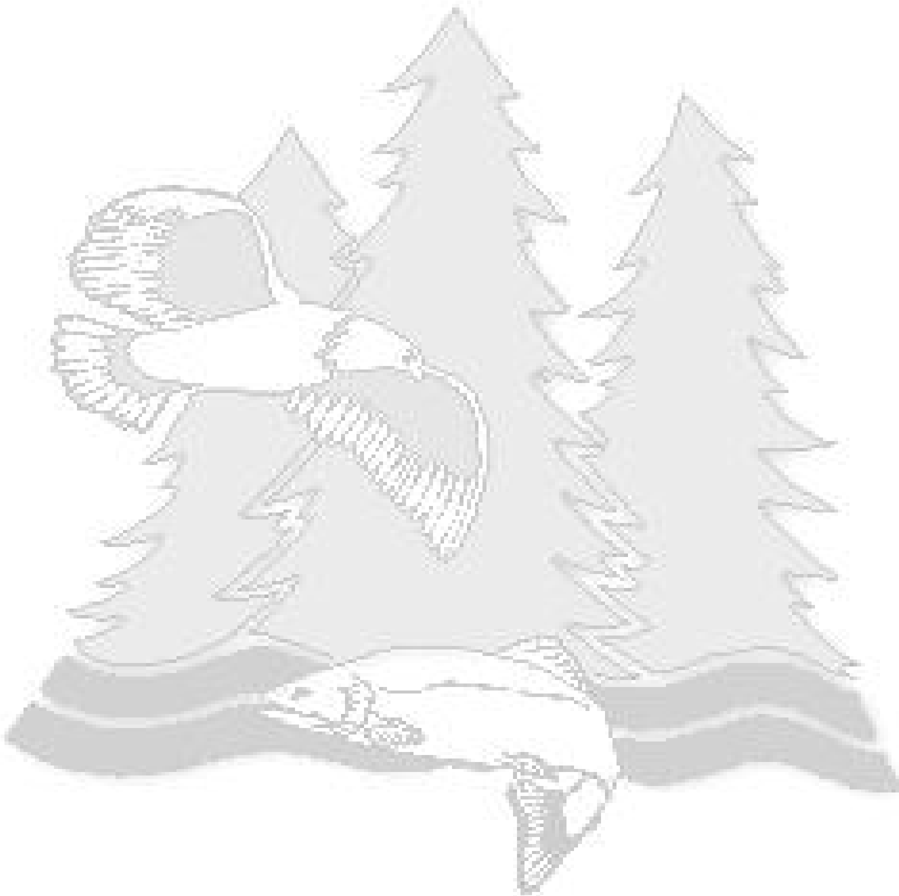


TROPHIC PATHWAYS

Presenter: Bob Bilby, Weyerhaeuser
Stephanie Estrella, Graham McKenzie, Washington Department of Ecology
Aimee McIntyre, Eric Lund, Washington Department of Fish and Wildlife

Canopy modification along forested streams has been associated with an increase in the contribution of algae to the trophic support of the system in numerous studies. However, the effect of canopy modification on food webs of very small, fishless streams has not been thoroughly evaluated. The Type N Study provided an opportunity to assess this question Stable isotopes have been used for more than 30 years to study food web dynamics. This technique is especially applicable to the question of shifts in trophic system organization due to canopy modification because the carbon (C) and nitrogen (N) isotopic signature of algae differs from that of terrestrially-derived organic matter. A post-harvest change in C and N stable isotope values for stream organic matter and biota would be expected if algae became a more significant source of energy. We sampled organic matter (leaf litter, periphyton and instream detritus), and invertebrates and amphibians to assess the trophic response in non-fish-bearing streams before and after timber harvest from study sites treated with the current Washington State Forest Practices buffer (FP treatment), a more extensive buffer (100% treatment), and no buffer (0% treatment) relative to unharvested reference sites. We found relatively few differences before and after harvest among treatment types. The responses we did observe were for N isotope ratios for gathering invertebrates and C isotope ratio for giant salamanders $\leq$ 50 mm. The cause of these changes, however, did not appear to be related to a change in the contribution of algae to the trophic support of the streams as no change in either C or N isotopic ratios was observed for periphyton or detritus, the two major food sources for primary consumers. The fact that substantial increases in light reaching the streams at some of the treatment sites after harvest did not generate a significant change in isotope ratios suggests that these very small streams are tightly coupled to the bordering terrestrial environment, even under conditions apparently conducive to instream plant growth.

NOTES



LITERATURE SYNTHESIS ON FOREST PRACTICES AND WETLANDS

Presenter: Paul Adamus, PhD, Oregon State University & Adamus Resource Assessment, Inc.

In the Pacific Northwest, considerable research has been done on the impacts of forest practices on *streams and riparian areas*. However, essentially none has been done on *wetlands*. This leaves a huge data gap, which contrasts with guidance in WAC 222. Rules associated with Washington's Forest Practice Standards Act explicitly caution against timber operations interfering with the ability of wetlands to maintain natural regimes of water flow, temperature, water quality, and habitat. This is necessary to achieve performance goals of the Forest Practices Habitat Conservation Plan.

In recent years, CMER work plans have noted this data gap and research need. However, for the research to be effective it must be well-focused. To help achieve that, CMER in 2011 contracted me to prepare an in-depth, updated synthesis of literature on wetlands and forest practices, emphasizing studies applicable to the Pacific Northwest. My synthesis was overseen by WetSAG, the Wetlands Scientific Advisory Group. It also was reviewed favorably by independent scientists. The 157-page report is available from my university web site:

http://people.oregonstate.edu/~adamusp/ForestPractices_Wetlands/

and will eventually be available from the CMER web site:

http://dnr.wa.gov/ResearchScience/WatershedWetlandsRiparianSciences/Pages/Home.aspx

The synthesis addresses the effects of tree removal, forest roads, and chemical applications. Its purposes included summarizing the current knowledge, identifying connections among themes, and highlighting research needs. I queried several databases, including Web of Science and Google Scholar, using a wide range of synonyms. The initial query identified about 4000 articles, but this was reduced to 135 by narrowing the search to papers relevant to the Pacific Northwest and to themes most relevant to forest practices. After reading those papers, I created an Excel database that allows users to sort the citations by wetland type, wetland function, forest practice, and state or region.

What I found is that there are literally no studies of wetlands and forest practices here in the Pacific Northwest. Most wetland research in this region has been done in urban or agricultural areas. Forest practices studies have focused on impacts to streams, riparian areas, and watersheds but not explicitly on wetlands. We do not even have a firm estimate of the number and area of wetlands where timber is harvested in or near a wetland, although Washington's reporting requirements are better than those of other states in the region.

Because of the lack of regional research on forest practices and wetlands, I could only speculate what impacts might occur. To do so, I constructed conceptual models and drew on a lifetime of experiences as wetland scientist. I cautiously extrapolated from studies in other regions and studies of riparian areas that may have included some wetlands, but did not explicitly mention them. I identified wildlife species most likely to depend on wetlands and summarized literature on their habitat requirements. With assistance from Washington DNR, we used GIS to overlay mapped wetlands with FPA permits.

NOTES

STRATEGY FOR RESEARCHING EFFECTS OF FOREST PRACTICES ON WETLANDS

Presenter: Paul Adamus, PhD, Oregon State University & Adamus Resource Assessment, Inc.

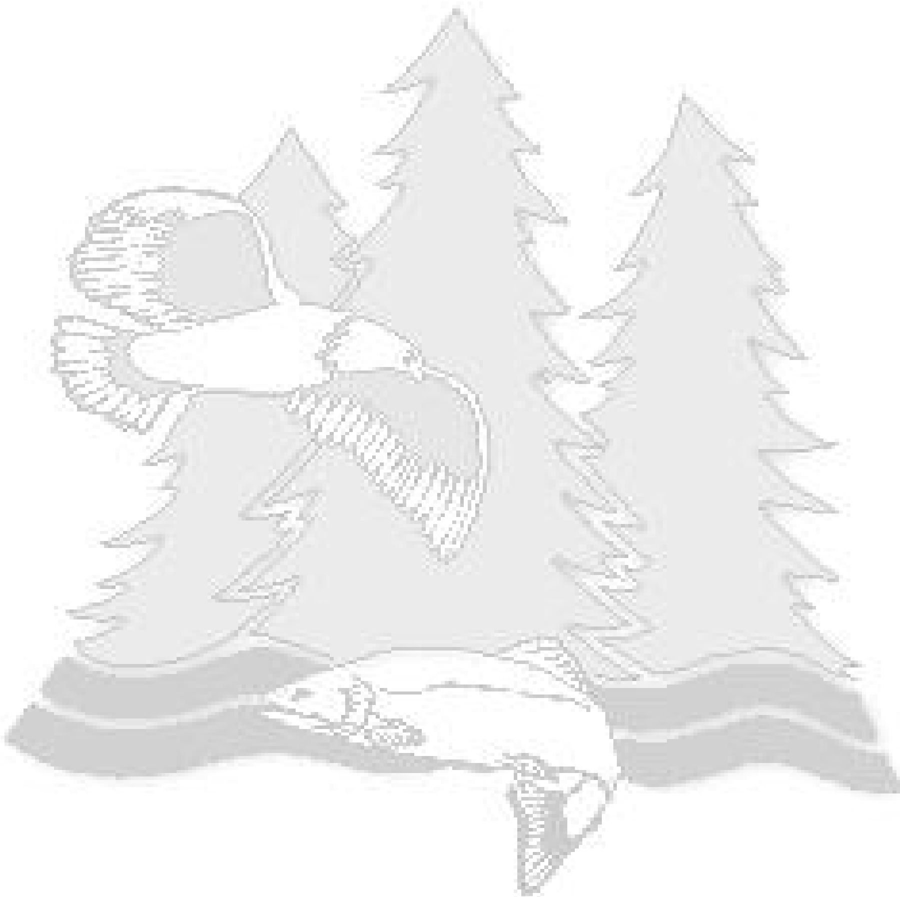
Despite considerable research done on the impacts of forest practices on streams and riparian areas, essentially none has been done on the effects on *wetlands* in the Pacific Northwest. This significant data gap contrasts with guidance in Washington's Forest Practice Standards Act that explicitly cautions against timber operations interfering with the ability of wetlands to maintain natural regimes of water flow, temperature, water quality, and habitat.

In recent years, CMER work plans have noted this data gap and research need. However, for the research to be effective it must be well-focused. The literature synthesis I described in my preceding presentation was key to focusing a re-organization and re-prioritization of research CMER had previously proposed for wetlands and forest practices. With the completed literature synthesis in their hands, the WetSAG worked with me to develop the follow-on Strategy for efficiently filling the most important data gaps I had identified. The 38-page Strategy is available from my university web site:
http://people.oregonstate.edu/~adamusp/ForestPractices_Wetlands/
and will eventually be available from the CMER web site:
http://dnr.wa.gov/ResearchScience/WatershedWetlandsRiparianSciences/Pages/Home.aspx

Under this Strategy, the first priority will be to research the effects of harvesting timber in forested wetlands -- a common occurrence especially in headwater areas of western Washington. The research will focus on harvest-related changes in groundwater levels and their expected effects on the functions of the harvested wetlands, as well as on the connectivity of those wetlands to streams. That, in turn, may impact stream temperature, fish access, peak flows, and other factors. A second project will center on impacts to wetland functions from harvests that occur outside of wetlands, and the degree to which existing WMZ specifications and other factors influence those impacts. A third project will examine the effects of forest roads on wetland functions and wetland connectivity to streams. In this presentation, I will describe in greater detail each of these projects and what they will measure.

These projects are strongly interrelated and thus, to the degree practical and appropriate, will benefit from sharing the same research sites and using similar protocols. However, this Strategy document was not intended to provide details about statistical design, research site selection, sampling schedule and equipment, and field protocols. Those will be described in a follow-up research plan for each project. The Strategy document describes each project in terms of specific research objectives, potential hypotheses, key covariates to consider, wetland functions and wetland types that it mainly addresses, linkage to the current CMER work plan, reasons why it was chosen, and expected outcomes. For each project, the Strategy also suggests broad performance targets that could be used to evaluate impact significance.

NOTES



EASTERN WASHINGTON TYPE N FOREST HYDROLOGY STUDY

Presenter: Dan Miller, M2 Environmental Consultants

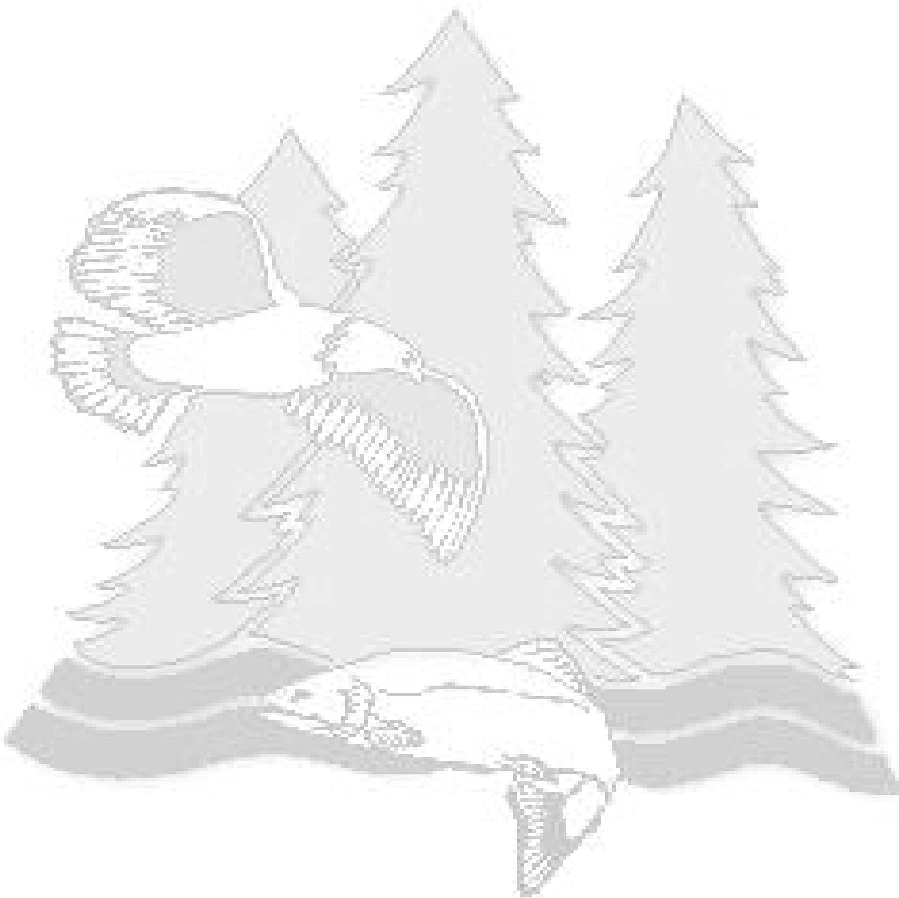
The Forest Hydrology study characterized the spatial distribution of headwater stream channels across forested lands of Eastern Washington, based on observations made at the end of the summer dry season (July 30 – September 20) in 2012. We examined three primary features of this distribution: 1) locations where channels exist, 2) locations where channels have surface water, and 3) locations where channels have evidence of bedload transport.

We used logistic regression to relate these observations to a small set of DEM- and GIS-derived attributes for 1) location in a channel network, 2) characteristics of the contributing area to that location, and 3) topography at that location. Validation of regression results show that these attributes serve well to characterize the spatial distribution of headwater channels across a representative sample of basins, with well-defined uncertainty for any individual basin. Using these results, predictions of channel length and the proportion of channel length that is perennial and exporting bedload were made for all headwater basins in forested regions of eastern Washington.

We then examined spatial connectivity of headwater channel networks. We found that the spatial frequency of discontinuities in channel type (e.g., from a dry channel to a wet channel) varies systematically with the modeled probability of channel type. From this, we estimated the probable length of a channel segment of contiguous type for any location in a channel network. We found that the type of channel connecting headwater areas to fish-bearing waters (e.g., a channel with flowing water, a dry channel, or no channel) varies systematically with the calculated channel length from the basin outlet. These results were used to calculate the probable type of channel connection to fish-bearing waters for all headwater basins in forested regions of eastern Washington.

These data and the derived statistical models provide an unprecedented look at the spatial distribution of headwater channels across a large region of diverse geology, geomorphology, and climate. Our results show that channel extent and network connectivity vary systematically with landscape controls resolvable with available GIS data, providing the ability to predict, with known levels of confidence, conditions in basins with no on-the-ground surveys. The methods explored here, and the relationships we found, can provide guidance and be used to generate testable hypotheses to better identify controls on headwater channel extent and variability in the spatial distribution of channels, both regionally and locally from basin to basin.

NOTES



EFFECTIVENESS OF RIPARIAN MANAGEMENT ZONE PRESCRIPTIONS IN PROTECTING AND MAINTAINING SHADE AND WATER TEMPERATURE IN FORESTED STREAMS OF EASTERN WASHINGTON

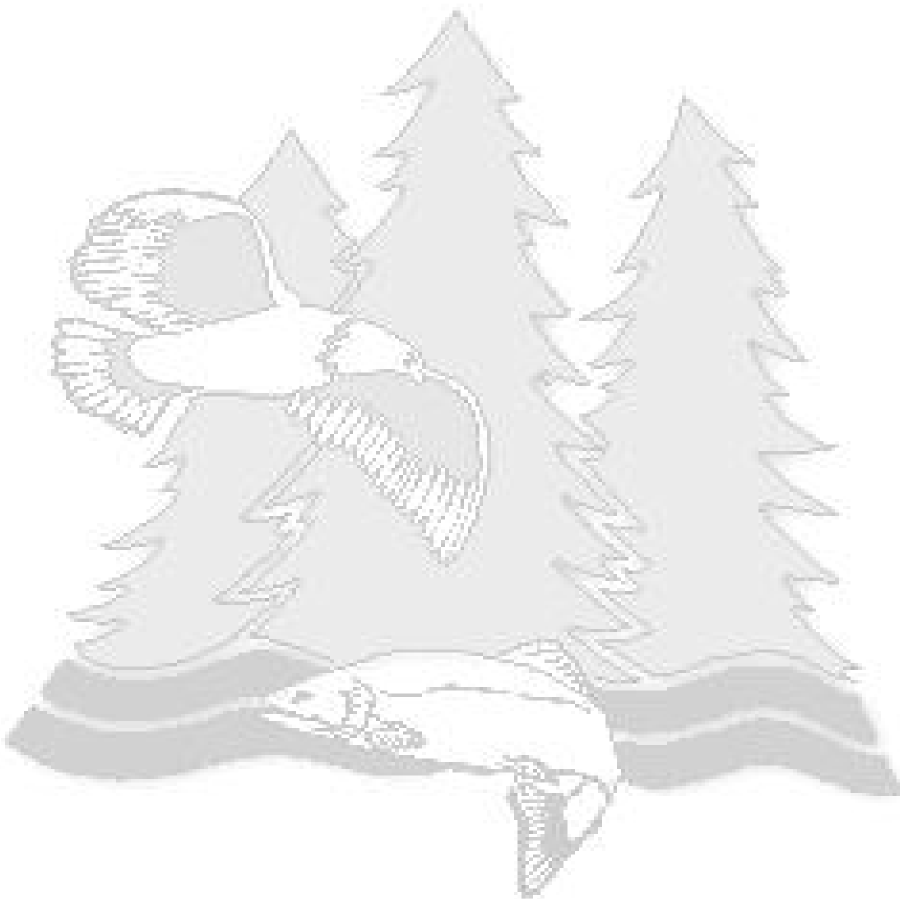
Presenter: Eddie Cupp, Terrapin Environmental

Riparian timber harvest prescriptions in Eastern Washington differ depending on whether or not a harvest unit is within the Bull Trout Habitat Overlay (BTO). When a harvest unit is located within the BTO, "all available shade" (ASR) must be retained within 75 feet of the stream. When a harvest unit is located outside the BTO, prescriptions fall under the standard rule (SR), which may allow for harvest of a portion of shade trees within 75 feet, depending on elevation and canopy cover existing prior to harvest. A replicated before-after-control-impact (BACI) study was used to test effectiveness of the ASR and SR riparian prescriptions for protection of shade and stream temperature. We examined the changes in shade and stream temperature response to timber harvest at 16 study reaches under the ASR and 14 under the SR prescriptions in eastern Washington over an eight year period (2003-2010). These changes were compared to stream temperature response of 30 no harvest reference reaches. We focused on shade and maximum daily stream temperature from July through mid-September. The ASR limited the mean decrease in shade to 1%, with a maximum decrease of 4%. Under the SR, shade was reduced by a mean of 4%, with a maximum decrease of 10%. No change in shade was detected in the no-harvest reference reaches.

Stream temperature response to riparian harvest treatments was evaluated by fitting pre-harvest calibration relationships between the upstream and downstream daily maximum temperatures in both treatment and reference reaches. A prediction equation for the temperature at the downstream end of a study reach was developed based upon the temperature at the upstream end. Differences in the observed and predicted temperatures were used to compute the daily maximum stream temperature response, referred to as $DMAX_{Response}$, in both treatment and reference reaches. We tested for prescription/shade rule effectiveness in protection of stream temperature by using the mean of $DMAX_{Response}$ computed for each sample season at each sample reach the first two years following harvest treatment as the dependent variable. Averaging the $DMAX_{Response}$ over a sample season removed the variability associated with temperature responses from shorter time periods, such as single days or individual weeks. Stream temperature responses evaluated in this analysis therefore reflect prolonged alterations in stream conditions. Estimates of post-harvest $DMAX_{Response}$ in reference reaches provide information on the stream temperature trajectories where no RMZ harvest treatment had occurred.

Following harvest, $DMAX_{Response}$ increased at SR sites relative to no-harvest reference reaches on average by 0.15 °C (95% CI= -0.01, 0.30). Likewise, $DMAX_{Response}$ increased at SR reaches relative to ASR reaches on average by 0.15 °C (95% CI= -0.03, 0.32). Harvest on ASR sites resulted in a decreased $DMAX_{Response}$ temperature of less than 0.01 (95% CI= -0.14, 0.14). The variability of $DMAX_{Response}$ observed in the no-harvest reference reaches set practical bounds on the magnitude of temperature changes that can reliably indicate a treatment response in our study. Changes in canopy closure, shade, and stand attributes following harvest did not account for the variations observed in stream temperature responses. Processes not directly related to riparian forest canopy alteration may be primarily responsible for the small variations observed in stream temperature following timber harvest.

NOTES



EASTERN WASHINGTON RIPARIAN ASSESSMENT PROJECT (EWRAP)

Presenter: Ash Roorbach, Northwest Indian Fisheries Commission
Dave Schuett-Hames, Greg Stewart, Northwest Indian Fisheries Commission

Riparian tree and understory data were collected at 102 randomly selected locations throughout eastern Washington to characterize current riparian forest conditions along fish bearing streams (Type F) in forest lands covered by Washington State's Forest Practices Habitat Conservation Plan. The study addresses 5 objectives, including determining the range and distribution of current riparian stand conditions, the relationships between site attributes and riparian stand characteristics, the relationships between stand characteristics and distance from stream, describing the frequency and distribution patterns of mortality, disease and insect effects, and describing management and other disturbances present in eastern Washington riparian stands.

Data were collected along transects perpendicular to the stream, extending 240 feet upslope from bankfull edge. Data were sorted into four zones based on regulation-defined Riparian Management Zones and distance from bankfull edge, including a Core Zone (CZ – immediately adjacent to the stream), Combined Inner and Outer Zone (IZ_OZ – immediately adjacent to and upslope of the Core Zone), Riparian Management Zone (RMZ – combined Core, Inner and Outer Zone), and non-Riparian Management Zone (non-RMZ – upslope of the RMZ boundary).

Overall mean density (TPA) in the RMZs was 190 trees per acre, with a mean basal area per acre (BAPA) of 122 square feet. Mean BAPA declined with distance from the stream – 137 square feet in the CZ, 115 square feet in the IZ_OZ, and 95 square feet in the non-RMZ. At the 90 locations below 4,000 feet elevation, mean density was 172 trees per acre; at the 12 locations above 4,000 feet elevation, mean density was 321 trees per acre. Mean density was higher in north facing bank slopes, 277 trees per acre, than in the other cardinal directions, all of which were below 190 trees per acre.

Disturbances, including roads, agriculture and evidence of recent tree removal or fire, were observed in 44 of the 102 RMZs. Mean BAPA was on average 35% less in RMZs with these disturbances than in sites without these disturbances. Disturbances were observed in 23 of the Core Zones, 42 of the combined Inner and Outer Zones, and in 57 of the non-Riparian Management Zone areas.

Washington State forest practices regulations categorize riparian areas along Type F streams into three Timber Habitat Types (THT), depending on elevation – Ponderosa Pine THT (≤2,500 ft.), Mixed-Conifer THT (2,500 – 5,000 ft.), and High Elevation THT (5,000+ ft.). When using tree data to key out and assign Forest Series to the RMZs, only 3 of the 38 sites located below 2,500 ft. elevation keyed out to the Ponderosa Pine THT.

NOTES

STREAM-ASSOCIATED AMPHIBIAN RESPONSE TO MANIPULATION OF FOREST CANOPY SHADING

Presenter: James G. MacCracken, Longview Timberlands
Marc P. Hayes, Julie A. Tyson, Washington Department of Fish and Wildlife,
Jennifer L. Stebbings, Longview Timberlands

We reduced vegetation cover along a 50-m reach of 25 headwater streams in northwest Oregon and western Washington. Vegetation removal began directly over the stream and moved outward until 0%, 30%, and 70% overhead cover was attained (hereafter; no-, low-, and intermediate-shade treatments). Each treated reach was paired to an upstream untreated reference reach where cover averaged 92–97%. Using a replicated BACI design, we documented pre- versus post-treatment changes in light levels, water temperature, biofilm, drift of detritus and macroinvertebrates, and the abundance, body condition, and growth rates of six stream associated amphibian species (one anuran and five salamanders). We used the results of mixed models analyses on effect sizes (treatment minus reference, $\alpha = 0.1$) as well as the relative magnitude of effect size (ES) changes (percentage change that exceeded the upper 90% confidence interval) from pre- to post-treatment periods to infer potentially important treatment effects. Treatments resulted in a roughly three-fold gradient ($P = 0.0001$) of photosynthetically active radiation at stream surfaces. At the greatest light levels, heterotrophic streams dominated by allochtonous inputs likely shifted toward autotrophy as revealed by increases in water temperatures ($P \leq 0.001$), 17-38% declines in stream detritus, and an increase in biofilm accumulation (P<0.1-0.01). At higher trophic levels, responses to treatments were inconsistent in direction and magnitude, likely due to site-specific factors. However, many response variables exhibited patterns that agreed with major predictions of the light:nutrient hypothesis: i.e., herbivore growth rates are maximized at moderate (low- and intermediate-shading) light levels. Specifically, drift of macroinvertebrate shredders declined by 43% (P = 0.001-0.001) in the no-shade treatment which was also accompanied by a decline in predators (14-26%). In addition, gathering collectors increased ($P \leq 0.01$) at low- and intermediate-shade levels. Further, the intermediate-shade level showed a 10-24% increase in scrapers and filtering collectors.

Captures of most amphibian species increased from pre- to post-treatment periods in all reaches, including references, implying year effects independent of treatments. However, ES estimates for giant salamanders (*Dicamptodon* spp.) increased 22-41% regardless of treatment levels. Cascade torrent salamanders (*Rhyacotrition cascadae*) and Olympic torrent salamanders (*R. olympicus*) increased pre- to post-treatment in intermediate-shade retention reaches (P <0.1-0.01) but declined for Olympic torrent salamanders in the low-shade reaches ((P <0.1-0.01). Moreover, tailed frogs (*Ascaphus truei*) showed a (1,263%) increase pre- to post- in the intermediate treatments.

Estimates of amphibian body condition exhibited few consistent patterns among treatments or taxa, but larval tailed frog and metamorphs had 143-520% increases in body condition estimates in the low-shade reaches. However, Cascade torrent salamander body condition declined in the low-shade reaches (P < 0.1-0.01). High variability generally characterized the other amphibian taxa or treatments across measured parameters. However, in stream enclosures, amphibian growth rates were highly variable but exhibited positive changes in 11 of 18 pre- to post-treatment combined species, life stage and treatment contrasts. In particular, tailed frog larvae showed 20-800% increases in growth rates in all treatments but only a significant increase in the no shade level (P <0.1-0.01). In contrast, tailed frog metamorphs showed decreases in growth rates in the no- and intermediate-shade treatments, but only significantly in the latter (P <0.1-0.01), and increased 800% in the low-shade treatment. Significant increases in torrent salamander growth rates were observed for Columbia and Olympic torrent salamanders in the no-shade reaches (P <0.1-0.001), and in the intermediate reaches for the Cascade torrent salamander (P <0.1-0.01). However, giant salamander growth test declined by 35-225% in across all treatments, but none of these changes were significant.

Amphibian responses were taxon-specific and varied among treatments and response variables, but our data imply that incorporating canopy openings similar in size (≈ 0.5 ha) and shade levels created with our intermediate treatments (70%) as part of riparian management may benefit stream amphibians as long as other potential stressors (fine sediment delivery or water temperature increases) do not result in negative impacts. Our basis for this suggestion is that the intermediate-shade treatment resulted in more positive responses than the other shade levels and had the smallest increase in water temperature. However, we caution that the variability observed in this study is likely to have its basis in site-specific differences that were not measured (e.g., groundwater inputs), which may have utility in understanding the variation in the responses that we observed. Hence we recommend that the benefits of creating canopy gaps in riparian forests should be further examined under an adaptive management framework.

NOTES

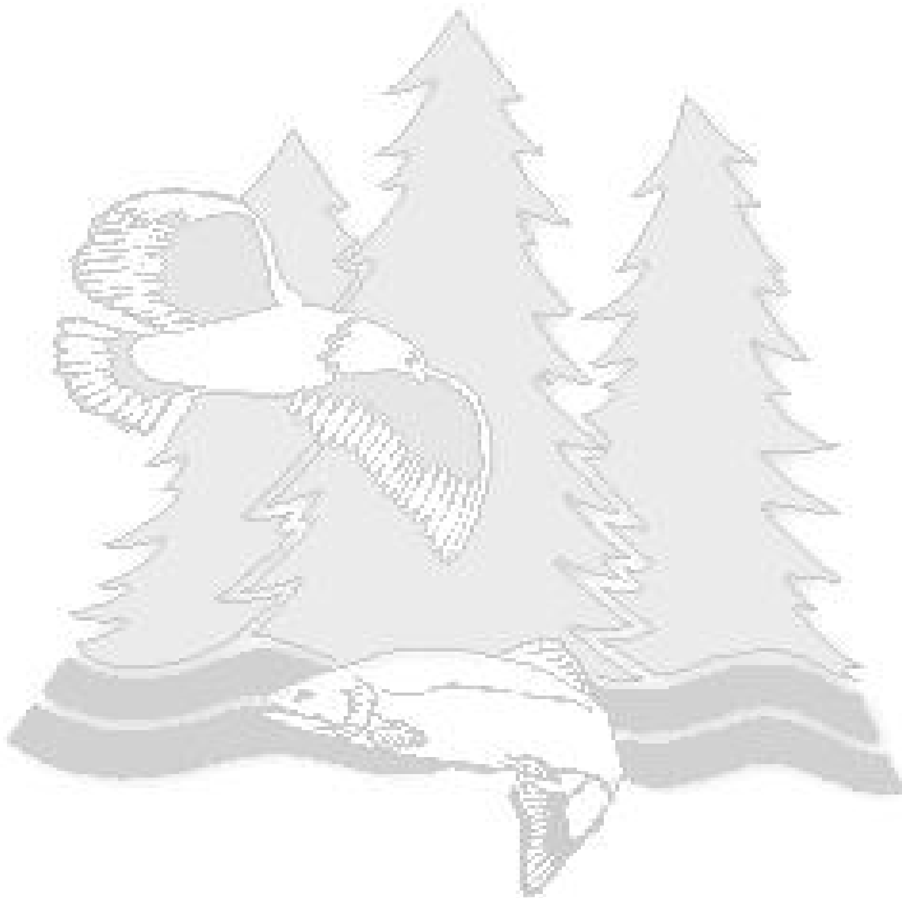
BREEDING BIRD RESPONSE TO RIPARIAN BUFFER WIDTH: 10 YEARS POST-HARVEST

Presenter: Scott F. Pearson, Washington Department of Fish and Wildlife
Jack Giovanini, Jay E. Jones, Andrew J. Kroll, Weyerhaeuser

We revisited the RMZ study sites 10 years post-harvest to examine longer-term bird assemblage responses to two riparian buffer treatments: 1) a relatively uniform width forested riparian buffer (~13 m) and 2) a wider and more variable width buffer (~30m), both created after clearcut harvest of the uplands adjacent to small streams in western Washington. Using the same Before-After-Control-Impact (BACI) experimental approach, we replicated bird counts within season to incorporate variation in the detection process across treatments and years, an aspect not included in the original RMZ study. We estimated effects of buffer treatments on species abundance and richness, local extinction (stand-level species loss) and species turnover, and species similarity between treatments. At the individual species level, we examined treatment effects on occupancy and abundance. Finally, we moved beyond our experiment and took advantage of the variability in buffer width both within and between the two treatments to examine the relative influence of vegetation (trees and shrubs) and buffer width on species occupancy and abundance.

Post-harvest, the average riparian buffer was 13 (±2.0 SE) and 29 m (±2.2 SE) on the narrow and wide treatment, respectively. Across all years [1993 (pre-treatment year), 1995-1996 (immediate post-harvest sample), and 2003-2004 (10 year post-harvest sample)] and treatments (control, wide and narrow buffer), 28 species were detected at least 10 times for a total of 2,064 detections. We found no treatment effect on total bird abundance. Both buffer treatments exhibited a similar 31-44% increase in mean species richness in the post-harvest years relative to their respective pre-harvest year, a pattern most evident 10 years post-harvest. In contrast, we found a 13-18% increase in species richness post-harvest on controls. When comparing the probability of species turnover between the pre-harvest year and either the two immediate post-harvest years or the two~10 year post-harvest years, turnover was much higher on both treatments (63-74%) relative to the controls (29%). Post-harvest, we found strong evidence (no overlap in 95% credible intervals) for an increase in site occupancy on treatments relative to the controls for approximately 29% and 100% of the species in the immediate post-harvest and the ~10 year post-harvest sample respectively. Occupancy increased for more species on the wider buffer treatment, but we found no clear evidence for a species-level decrease in occupancy on either treatment after harvest. Taking advantage of the existing variation in vegetation characteristics and buffer width among harvested sites and ignoring site treatment assignments (wide vs. narrow), our model predicts an increase of about 85 individual birds for every 5 m increase in buffer width (although the credible interval indicates a 16% probability of no/negative change). We found little influence of four habitat covariates on species occupancy or abundance. When assessing the relationship between buffer width and site level abundance of the four species associated with riparian habitats, Pacific-slope flycatcher (*Empidonax difficilis*), Pacific wren (*Troglodytes troglodytes*), American robin (*Turdus migratorius*), and black-throated gray warbler (*Dendroica nigrescens*), we found that narrow buffers (7-12 m) reduced overall bird abundance and that buffers 25-30 m or greater are needed to maintain riparian associates at pre-harvest levels. Our results suggest that local extinction does not occur even on the very narrow buffers that we examined, that buffer treatments increased species richness regardless of their width and that birds continued to colonize riparian buffers for up to 10 years post-harvest.

NOTES



Riparian Hardwood Conversion Study – Stand Structure and Economics

Ash Roorbach, Northwest Indian Fisheries Commission
Frank Brown, Pacific Rim Forest Management, LLC

Economic, silviculture, and vegetation data were collected at eight sites in western Washington to quantify costs and benefits of converting hardwood-dominated riparian stands to conifer-dominated. These hardwood conversions were added to adjacent upland harvest operations. Participating landowners used alternate plans with site-specific prescriptions rather than using hardwood conversion rules. All prescriptions were based on the following guidelines: permit cutting of all hardwood trees in the conversion areas, leaving a minimum 25-ft. wide no-cut buffer along the stream; leave all conifer in the riparian management zone (RMZ) core and inner zones as operationally feasible, and plant and maintain conifers to meet a minimum stocking target of 190 well-distributed, free-to-grow confer trees per acre. Operational and management decisions were left to landowner discretion though all relevant laws regulating activities in riparian areas still applied.

Silvicultural and economic data were collected using landowner surveys and field observations. Installation of 1/50th acre permanent fixed-radius plots set in a grid pattern of 60 ft. by 60 ft. provided sample coverage of approximately 20% of the conversion areas. Data collected in these plots quantified conifer and hardwood stocking and shrub response. Data collection also included a post-harvest 100 percent survey of the RMZs to estimate pre-harvest stand conditions and harvest volumes.

Data collected to date include 4 years of post-harvest regeneration data at seven of the conversion sites, and 3 years of post-harvest regeneration data at one of the conversion sites.

Site and Pre-harvest conditions
Combined RMZ core and inner zone areas at the locations ranged 3.3 to 9.9 acres. Areas actually converted to conifer were smaller, 1.1 to 3.6 acres, due to the 25' buffer leave tree requirement and other constraining features present in sites. Total basal area (conifer and hardwood combined) before harvest in the RMZ at the eight locations ranged 110 to 239 sq. ft. per acre. Red alder was the dominant species in the conversion areas of all locations, and when combined with other hardwood species accounted for 55 to 89 percent of the total basal area.

Harvest
Harvesting in the RMZ at the eight locations produced 10.3 to 25.7 thousand board feet per acre (net Scribner scale), with estimated net stumpage values ranging $3,129 to $8,488 per acre.

Reforestation and net hardwood conversion revenue Survival of planted conifers in the study ranged 34% to 96%, and varied by species, by site, and by year planted. Total live conifer stocking levels in the conversion areas at the eight locations ranged 204 to 994 trees per acre. However, the number of live conifers with whole terminal leaders above competing vegetation and hardwoods were considerably lower – 81 to 564 trees per acre. This is our most reliable estimate of trees with the best chance of future survival, recognizing that shrub, hardwood and animal browse rates vary between sites, as do ongoing landowner reforestation strategies. Hardwood trees in the conversion areas, at last measurement, ranged 66 to 2,839 trees per acre, while combined total cover of salmonberry, Himalayan blackberry and vine maple ranged 8 to 64%.

Reforestation costs through year 4 in the conversion areas ranged were $183 per acre to $1,034 per acre. Estimated net additional revenues from adding these hardwood conversions to upland harvests were $2,632 to $8,151 per acre, although additional silvicultural work will likely be needed at several of the sites to insure regeneration success (i.e. meeting the target of 190 free-to-grow conifer trees per acre).

It is too early to determine what the final free-to-grow stocking level will be at these sites, so another sampling event is scheduled for 2016.

Draft case study reports and a preliminary summary report on the study have been reviewed and approved by CMER. RSAG plans to continue communicating with landowners to track ongoing silvicultural work at the sites until the scheduled data collection revisit in 2016. The case studies and summary report will be updated and finalized after the 2016 data collection work.

NOTES