Streamline
Watershed Management Bulletin

Volume 11 Number 1 Fall 2007

Riparian Management in Headwater Catchments: Translating Science into Management – Meeting Summary

Erland A. MacIsaac, R.D. (Dan) Moore, and John S. Richardson

Forest harvesting can influence many aspects of stream environments and watershed functioning, with potentially negative influences on water quality and aquatic ecology. The most common approach to protect stream environments is to retain forested buffer strips. However, this strategy incurs economic costs due to the reduction of area available for harvest, and can complicate operations such as yarding. Consequently, the retention of forested buffer strips, particularly along headwater streams, has been associated with ongoing debate and controversy.

Many jurisdictions throughout North America do not require treed buffers along headwater streams, which are often defined in relation to size and (or) lack of fish presence (e.g., Lee *et al.* 2004).

In response to these controversies, a group of scientists organized a symposium on *Small Stream Channels and their Riparian Zones: Their Form, Function and Ecological Importance in a Watershed Context* in February 2002. This symposium and an associated workshop resulted in special issues of the *Canadian Journal of Forest Research* (Moore and Richardson 2003), and the *Journal of the American Water Resources Association* (Moore 2005). The general consensus at the 2002 meeting was that there was insufficient knowledge of the functioning of small streams and their responses to forest harvesting to guide riparian management in headwater areas.

Since the 2002 meeting, a range of projects focused on headwater streams and their response to alternative riparian treatments has been conducted, particularly in British Columbia and the US Pacific Northwest. For example, in British Columbia, provincial forest research initiatives funded various research projects focused on small streams, while in the United States, the Oregon Headwaters Research Cooperative funded a series of projects and meetings (Danehy and Ice 2007). To provide a forum for presentation and discussion of these emerging research results and their implications for riparian management, a conference was held February 19–21, 2007, at the University of British Columbia, titled *Riparian Management in Headwa-*

Continued on page 2

Inside this issue:

Published by:
FORREX Forest Research Extension Partnership
Suite 702, 235 1st Avenue
Kamloops, BC V2C 3J4

Project Manager:
Todd Redding
Tel: (250) 807-9516

Distribution/Mailing List:
Gord Austin
Tel: (250) 371-3923

Technical review committee:
T. Redding, R.D. Moore, R. Pike

Technical reviewers this issue:
K. Bennett, G. Butt, S. Chatwin, D. Ferguson, M. Geertsema, T. Giles, R. Guthrie, D. Hogan, M. Jakob, R.D. Moore, R. Pike, T. Redding, M. Wise

Publication and Web Site Support:
Satnam Brar, Julie Schooling

Graphic Layout: **SigZag Design**

Editing: **Ros Penty**

Cover Illustration: **William McAusland**
McAusland Studios, Kamloops, B.C.

Streamline is a refereed publication published twice a year by FORREX. All articles published in Streamline are technically reviewed to ensure that we extend reliable and technically sound information to our readers. Content published in Streamline is intended to provide general information and should not be relied upon as legal advice or legal opinion. Streamline content reflects the opinions and conclusions of the contributing author(s), not those of FORREX, our editorial staff, or our funding partners.

This publication is funded in part by the British Columbia Ministry of Forests and Range through the Forest Investment Account – Forest Science Program, the BC Ministry of Environment with funds from the Mountain Pine Beetle Program, and the USDA Forest Service.

ISSN 1705-5989
Printed in Canada

Printed on recycled paper

http://www.forrex.org/streamline

FORREX
Supporting Sustainable Natural Resource Management Decisions

Continued from page 1

ter Catchments: Translating Science into Management. The conference was co-sponsored by the University of British Columbia, Fisheries and Oceans Canada, Natural Resources Canada (Canadian Forest Service), BC Ministry of Forests and Range, and BC Ministry of Environment. The conference drew over 200 participants from throughout North America and as far away as New Zealand. These scientists, forest and aquatic resource professionals, and non-government organizations reviewed the state of headwater riparian management science in the Pacific Northwest.

The meeting began on February 19 with a field trip to Malcolm Knapp Research Forest. There, participants learned about and discussed results from a project funded by Forest Renewal BC and Forest Investment Account (BC), titled "Ecology and management of riparian–stream ecosystems: A large scale experiment using alternative stream side management techniques." On February 20 and 21, oral and poster presentations highlighted recent research results from a range of sites, including the sub-boreal, Southern Interior, and south coastal regions of British Columbia, and the Cascades and Coast Ranges of Washington State and Oregon. Researchers working in the boreal forest zone of Ontario and the southeast United States came to compare and contrast the research results from their headwater studies. These studies used various study designs, including synoptic (retrospective) surveys, large- and small-scale designed field experiments, and computer simulations.

Scientists, forest and aquatic resource professionals, and non-government organizations reviewed the state of headwater riparian management science in the Pacific Northwest.

The meeting closed with a panel discussion, which provided an opportunity to reflect upon and debate the implications of recent research on the challenges associated with riparian management in headwater catchments. Panel members included:

- Dr. Rhett Jackson, Associate Professor, Warnell School of Forest Resources, University of Georgia
- Dr. David Kreutzweiser, Research Scientist, Canadian Forest Service
- Mr. Bill Beese, Forest Ecologist, Western Forest Products
- Dr. Kate Sullivan, Director of Research and Development, Scotia Pacific

The panelists' comments and follow-up commentary from the audience covered a range of issues. Some key points emerged from the panel discussion.

Study design: While designed experiments with replicated treatments and pre- and post-treatment measurements are statistically the most rigorous approach for research, they are often challenging to implement in practice and apply in large-scale adaptive management experiments. Operational constraints often mean that treatments are not executed according to the original study design, and replication can be difficult, given the dramatic variability in streams and the often inaccurate representation of headwater streams on maps. Alternative experimental designs such as case studies or synoptic surveys should not be completely discounted as means to generate useful scientific knowledge because of lower statistical or inferential rigour. There is also a shortage of long-term studies (5 years) looking at long-term changes and recovery processes in headwater systems.

Windthrow: In several experiments discussed at the conference, windthrow reduced canopy cover below that intended by the experimental design. While it complicates the analysis, windthrow is a common disturbance element in riparian management, and its influence needs to be considered. As such, treatments may be better represented by gradients in physical variables (e.g., of reductions in canopy cover) rather than discrete factors such as buffer width. Windthrow is a key issue for the design of riparian buffers on small streams; it is likely to occur and windthrown trees still have ecological functions. In addition, we need to apply our existing knowledge of operational methods for increasing the wind-firmness of buffers, such as pre-logging riparian treatments and pruning, and to test these strategies in research trials.

Significance of effects: At many study sites, changes in physical variables, such as water temperature, were near the limits of detectability, especially given the low statistical power associated with the typically short periods of pre- and post-treatment observations and the large spatial and temporal variability within and among headwater streams. This situation regularly leads to the challenges of Type II errors (not detecting a real difference because of the lack of sufficient replication). Beyond the difficulties in establishing statistical significance are the challenges in assessing the ecological significance of changes to the stream-riparian environment. Are the often small changes in physical or biological conditions ecologically significant or within the range of natural variability? Do the type and size of headwater stream matter? Determining the magnitude of changes in physical and biological components of a stream that are acceptable to stakeholders is fundamental to deciding the level of riparian protection required on headwater streams.

Process models: Except for some intensively studied research sites, there is incomplete information on how changes in the physical environments of streams and riparian zones translate into biological and ecological effects. The best approach may be to develop and apply process simulation models to link physical and ecological processes and predict cumulative, large-scale spatial and future temporal changes. For example, the effects of riparian management on large woody debris recruitment—and the subsequent changes in physical habitat and structure within streams—can only be assessed with models that can simulate processes and predict conditions over decadal and longer time scales.

Developing scientifically defensible indicators allows forest managers to demonstrate the sustainability of any forest and riparian practices in headwater areas.

Indicators: How to measure the "ecosystem health" of headwater systems is unclear due to the lack of well-understood indicators or indicator species in headwater streams and riparian areas. Developing scientifically defensible indicators allows forest managers to demonstrate the sustainability of any forest and riparian practices in headwater areas.

Downstream effects: Headwater streams export water, energy, and materials to downstream aquatic habitats (Wipfli *et al.* 2007), but our understanding of these processes is incomplete. In particular, how do disturbances from forestry activities affect these processes, how do they propagate downstream, and how do we best mitigate the effects?

Climate change: The need to consider the confounding effects of climate change on headwater riparian management was frequently expressed. Stream temperatures and hydrology will change, as will winds and insects that may affect blowdown and impact riparian buffers. However, current climate models are poor at predicting localized and seasonal climate changes. It was suggested that headwater systems remain as intact and resilient as possible to buffer and allow adaptation to climate change.

State of knowledge: Although there was consensus that our state of knowledge has grown considerably since the 2002 conference, there was no consensus on the effectiveness of recommended best management practices (BMPs) in headwater systems. Some participants voiced caution over our lack of knowledge of the long-term, cumulative effects of forest harvesting on headwater ecosystems, the extrapolation from site-specific studies to the landscape level, the limited ecoregional extent of the studies to date, and the potential importance of considering species at risk and population connectivity. Others believe we have enough research to translate the science into sound management practices and get on with adaptive management trials. It was suggested that differences in opinion about the state of knowledge may stem from the lack of agreed-upon objectives or benchmarks against which we can assess the significance of ecological effects. For example, it is unclear what ecosystem components we need to protect and how much protection is enough or too much. How much change in a headwater ecosystem is acceptable to stakeholders? Another important short-term goal is a meta-analysis of the currently available science to determine quantitatively the scope and limits of our knowledge of head-

Continued on page 4

Continued from page 3

water ecosystem processes and our ability to assess the risks of management activities on stream and riparian resources.

Operational forestry: An important challenge is getting the forestry sector to buy in to recommendations for BMPs in headwater areas. Education, tax incentives, and (or) carbon credits were discussed as ways to encourage retention of riparian forest in headwater areas.

Summary

The conference successfully pulled together much of the existing and emerging science on headwater riparian management and provided a forum for scientists, resource managers, and other stakeholders to discuss the implications for sustainable forest management. It also identified many significant knowledge gaps and challenges that need to be considered when translating the science into management actions in headwater forests.

There is a need to identify and clarify the key ecological changes associated with harvesting in headwater systems and agree on methods to measure the changes, the relevant space and time scales for monitoring, and the identification of acceptable thresholds. More specifically, to advance the sustainable management of headwater forests, it will be necessary to:

1. define clear and quantifiable objectives for riparian management, as the existing primary objectives in most jurisdictions only identify protection of fish and drinking water quality, which are not relevant in many headwater systems;
2. propose alternative management strategies to meet these objectives; and
3. develop a research plan for testing the management strategies.

Research plans will need to consider both physical and biological responses and their interactions, downstream propagation of disturbances, and post-disturbance recovery. The last two considerations are necessary for extrapolating from sites to landscapes. In addition, research plans should integrate field monitoring and process models.

Despite the knowledge gaps, a solid foundation currently exists to propose partial answers to the question of how to balance the protection of headwaters with sustainable forest management. For example, retention of some level of merchantable riparian forest is clearly required to provide shade and maintain inputs of organic matter, both litter and large woody debris. The important challenges lie in determining how much retention is required, in what spatial pattern, and on which particular stream reaches, as well as how to address windthrow. Recognizing that there is considerable uncertainty in the current state of knowledge, it will be important to adopt an iterative approach to setting BMPs. As new information accumulates from ongoing research and evaluation of proposed BMPs, revisions to forest management practices around headwaters will be needed (i.e., adaptive management).

The conference program and abstracts are available at *http://faculty.forestry.ubc.ca/richardson/RiparianManagementConference/ConferenceProgram.pdf*

Acknowledgements

We gratefully acknowledge financial support from our sponsoring agencies mentioned in the article. Devon Knight Events provided excellent conference organization and ensured a high-quality experience for participants. We especially thank the panel members, who helped integrate the rich set of research results and apply them to the challenge of riparian management along headwater streams.

For further information, contact:

Erland A. MacIsaac
Head, Fish–Forestry Research Program
Fisheries and Oceans Canada
School of Resource and Environmental Management
Simon Fraser University
Burnaby, BC V5A 1S6
Tel: (604) 986-1695
Email: macisaace@pac.dfo-mpo.gc.ca

R.D. (Dan) Moore
Professor
Departments of Geography and Forest Resources Management
University of British Columbia
Vancouver, BC V6T 1Z4
Tel: (604) 822-3538
Email: rdmoore@geog.ubc.ca

John S. Richardson
Professor
Aquatic and Riparian Area Ecology
Department of Forest Sciences
University of British Columbia
Vancouver, BC V6T 1Z4
Tel: (604) 822-6586
Email: john.richardson@ubc.ca

References

Danehy, R.J. and G.G. Ice. 2007. Introduction to special issue on headwater streams. Forest Science 52:101–103.

Lee, P., C. Smyth, and S. Boutin. 2004. Quantitative review of riparian buffer width guidelines from Canada and the United States. Journal of Environmental Management 70:165–180.

Moore, R.D. 2005. Small stream channels and their riparian zones in forested catchments of the Pacific Northwest: Introduction. Journal of the American Water Resources Association 41:759–761.

Moore, R.D. and J.S. Richardson. 2003. Progress in understanding the structure, function and ecological significance of small stream channels and their riparian zones. Canadian Journal of Forest Research 33:1349–1351.

Wipfli, M.S., J.S. Richardson, and R.J. Naiman. 2007. Ecological linkages between headwaters and downstream ecosystems: Transport of organic matter, invertebrates, and wood down headwater channels. Journal of the American Water Resources Association 43:72–85.