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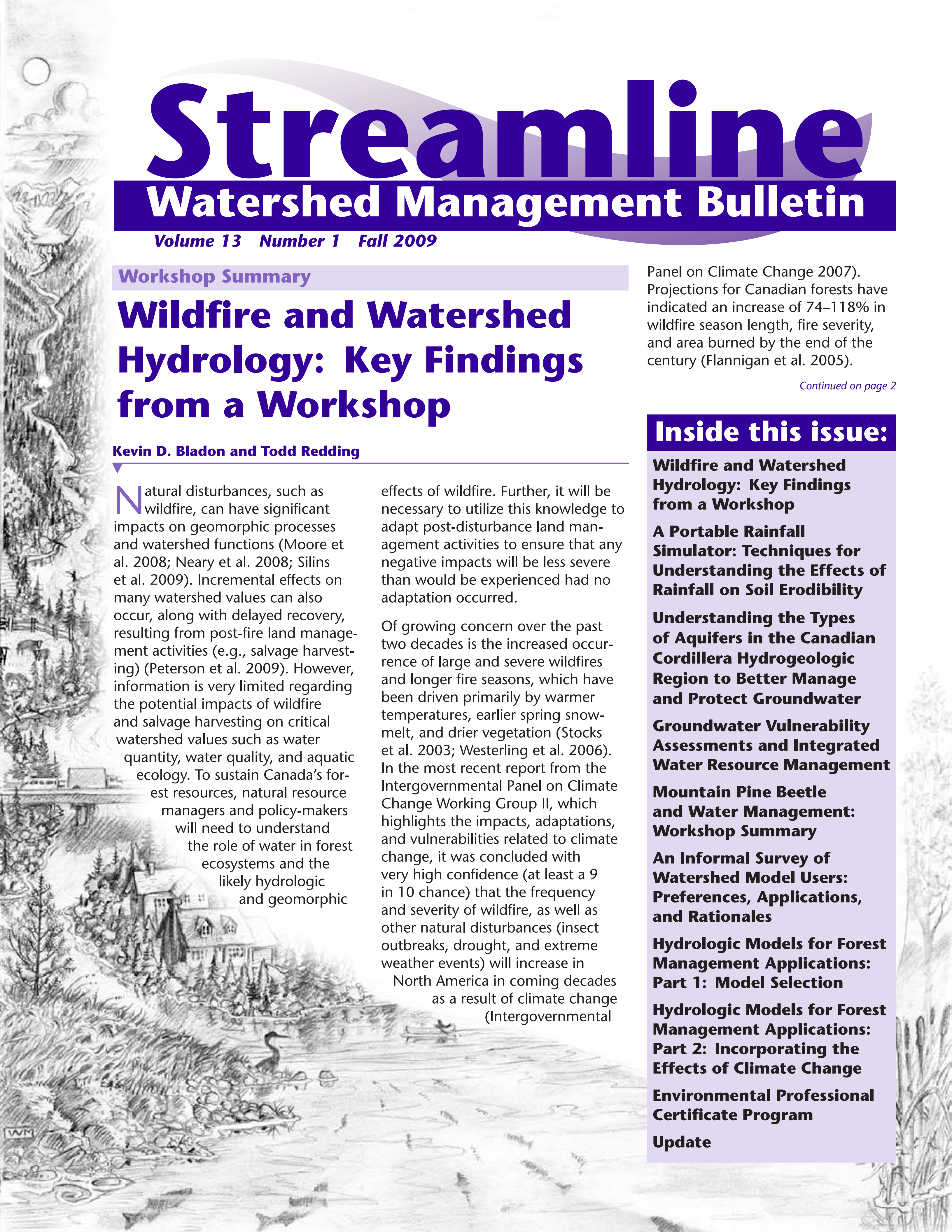

Workshop Summary

Wildfire and Watershed Hydrology: Key Findings from a Workshop

Kevin D. Bladon and Todd Redding

Natural disturbances, such as wildfire, can have significant impacts on geomorphic processes and watershed functions (Moore et al. 2008; Neary et al. 2008; Silins et al. 2009). Incremental effects on many watershed values can also occur, along with delayed recovery, resulting from post-fire land management activities (e.g., salvage harvesting) (Peterson et al. 2009). However, information is very limited regarding the potential impacts of wildfire and salvage harvesting on critical watershed values such as water quantity, water quality, and aquatic ecology. To sustain Canada's forest resources, natural resource managers and policy-makers will need to understand the role of water in forest ecosystems and the likely hydrologic and geomorphic effects of wildfire. Further, it will be necessary to utilize this knowledge to adapt post-disturbance land management activities to ensure that any negative impacts will be less severe than would be experienced had no adaptation occurred.

Of growing concern over the past two decades is the increased occurrence of large and severe wildfires and longer fire seasons, which have been driven primarily by warmer temperatures, earlier spring snowmelt, and drier vegetation (Stocks et al. 2003; Westerling et al. 2006). In the most recent report from the Intergovernmental Panel on Climate Change Working Group II, which highlights the impacts, adaptations, and vulnerabilities related to climate change, it was concluded with very high confidence (at least a 9 in 10 chance) that the frequency and severity of wildfire, as well as other natural disturbances (insect outbreaks, drought, and extreme weather events) will increase in North America in coming decades as a result of climate change (Intergovernmental Panel on Climate Change 2007). Projections for Canadian forests have indicated an increase of 74–118% in wildfire season length, fire severity, and area burned by the end of the century (Flannigan et al. 2005).

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Supporting Sustainable Natural Resource Management Decisions

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Results from two recent needs assessments were indicative of the growing concern over the potential hydrologic and geomorphic effects of wildfire. Respondents from the forest industry, provincial and federal governments, First Nations, academia, natural resource consulting, and community stewardship groups agreed that improved knowledge and quantification of the hydrologic and geomorphic impacts of natural disturbance was a top priority (Redding and Nickurak 2008; Redding et al. 2008). In response to the needs assessments, a recent workshop entitled "Wildfire and Watershed Hydrology" was hosted by FORREX in Kelowna, BC, on June 3–4, 2009. The intent of this workshop was to present preliminary and final results of ongoing and recently completed research projects on the hydrologic and geomorphic effects of wildfire. Its primary goal was to provide new information to assist decision making and to provide feedback to researchers that would help refine research plans and interpretation of results. A secondary goal was to provide participants with a forum for discussion and sharing of ideas to help deal with the challenges associated with shifting natural disturbance regimes.

Key Findings from Workshop Presentations

The technical presentations during the workshop provided results from wildfire research in British Columbia, Alberta, and the United States, highlighting the state of knowledge on many topics and identifying gaps in our understanding of the potential effects of wildfire and post-fire salvage harvesting on aquatic systems. Additionally, several presentations focused on post-fire treatment options, ecohydrologic effects of wildfire, and the potential downstream implications. The key findings from these presentations are summarized below.

- The occurrence and severity of wildfire is a function of many natural factors, including fuel availability, temperature, humidity, precipitation, wind, lightning strikes, and anthropogenic factors. Climate change can affect most of these natural factors and therefore influence the wildfire season across a range of temporal and spatial scales. Thus, in some regions (e.g., British Columbia's Southern Interior), increased wildfire frequency, severity, and area burned are projected to increase over the coming decades.
- Natural disturbances that cause the loss of forest cover can result in reduced precipitation interception losses and increased snow accumulation amounts, but with high inter-annual variability. Snowmelt and ablation rates may also increase after disturbance due to increased net radiation.

The intent of this workshop was to present preliminary and final results of ongoing and recently completed research projects on the hydrologic and geomorphic effects of wildfire.

- Reduced transpiration rates can result in increased soil moisture following wildfire and post-fire salvage harvesting.
- Peak flow and annual water yield responses to wildfire are likely to be watershed-specific. In the short to medium term, water yields typically increase following natural disturbances that cause mortality of the overstorey vegetation. Peak flow magnitudes generally increase following wildfire, but may also decrease due to desynchronization of snowmelt across the watershed. The onset of the melt period and the timing of peak flow may occur up to 2–3 weeks earlier in burned watersheds. The rate of recovery varies widely and is primarily influenced by the local climate regime and post-disturbance vegetation.

- Where wildfire causes tree mortality in the riparian zone, the loss of root cohesion can reduce stream bank strength and have important implications for channel morphology (e.g., channel widening). Soil erosion and debris flow risk is often, but not always, increased after wildfire. Increased risk has been linked to the potential for high-intensity rainstorms or rapid snowmelt on water-repellent (hydrophobic) soils, as well as the legacy of forest operations (e.g., roads, landings, skid trails).
- The volume of in-stream wood loading may increase after wildfire, with important long-term implications for channel morphology and the creation of aquatic habitat.
- Given the variety of ways in which wildfire can influence watershed geomorphic processes (surface runoff and erosion, debris flows, loss of bank strength, increased wood loading), and the fact that these processes operate over a range of time scales and lags, geomorphic response to wildfires is complex and contingent on the sequence of post-fire weather events and hydrologic response.
- A well co-ordinated, rapid assessment of the risk of post-fire erosion, as exemplified by the US Burned Area Emergency Response (BAER) teams in Australia, can provide land managers with the knowledge necessary to understand the risks to water resources and infrastructure and to evaluate treatment options.
- The use of mulching treatments (e.g., wood chips and straw mulch) can be effective in reducing the risk of erosion and sediment production from burned hillslopes, but timing of application and consideration of mulch quality (e.g., minimize potential for weed seeds) are critical to the success of these treatments.
- Water-repellent soils do not appear to have an effect on forest tree regeneration.
- Following wildfire, numerous changes in water quality are possible, with variable rates of recovery. Potential effects include increased turbidity, nutrients (e.g., nitrogen and phosphorus), dissolved organic carbon, heavy metals (e.g., mercury), and temperature. All of these parameters can be negatively influenced by salvage-harvesting activities.
- Even small changes in water quality can have significant impacts on aquatic ecology, resulting in greater algal production, increased aquatic invertebrate abundance, and shifts in invertebrate community structure.
- Wildfire-related changes in water quality present several public health protection challenges for water purveyors and can potentially increase the risks for drinking water treatment. Thus, appropriate protection of source waters is often a more effective and less expensive option to ensure high-quality drinking water, as compared with increased treatment levels.

Despite the recent research efforts, many unknowns still exist regarding the effects of wildfire and post-fire salvage harvesting on water quantity and quality.

The culmination of the workshop was a panel discussion, during which five professionals engaged the audience in a discussion on where and when to salvage harvest or use other land management options (e.g., do nothing). The primary topics of this discussion included the following.

- Despite much recent work, there is still uncertainty about the effects of various natural disturbances (e.g., wildfire and mountain pine beetle) and the potential incremental effects of salvage harvesting on a range of water values.
- However, it was agreed that salvage logging can potentially increase watershed risks. These risks need to be considered and weighed against various watershed values when making any post-disturbance land management decisions.
- The current economics and jurisdictional authority of the forest industry are challenging and, in most cases, prohibitive to the use of many other post-disturbance management options (e.g., mulching treatments).
- From the perspective of the water purveyors, the potential incremental challenges for water treatment that may be created by post-disturbance land management require greater consideration.

Information Needs

A number of continuing information needs were identified. Despite the recent research efforts, many unknowns still exist regarding the effects of wildfire and post-fire salvage harvesting on water quantity and quality. Some of the more specific information needs identified included:

- A demand for more watershed- or basin-scale research on the hydrologic and geomorphic effects of wildfire and post-fire salvage harvesting.
- More research focused on addressing shifts in the hydrologic regime (both timing and quantity) due to wildfire and post-fire salvage harvesting.
- A high level of uncertainty persists regarding how long it will take for water quality and quantity in disturbed (wildfire and post-fire salvage-harvested) watersheds to return to pre-disturbance levels (hydrologic recovery).
- As a result of the high variability from previous studies, the actual effects that wildfire and salvage harvesting will have on water quality remain unclear.

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- Further research focused on the ecological implications of disturbance at both the watershed and landscape scales.
- More information on the fate and transformation of chemicals from wildfire runoff and the implications for drinking water treatability.
- Testing and developing risk assessment and post-fire rehabilitation tools should continue to be a priority.
- Researchers, and water supply and treatment professionals, should communicate more regularly to enhance the value of study results. For example, water quality data are not always collected or reported in ways that are meaningful for water treatment professionals.

Workshop Evaluation

A post-workshop evaluation (completed by 61% of participants) indicated that 92% of respondents increased their knowledge of the key hydrologic processes affected by wildfire and related salvage harvesting by attending the event. Further, 98% of respondents said that their expectations for the workshop were met. Most respondents noted that the knowledge gained from the workshop could be directly used to assist land management decision making and/or to support policy development. Overall, the workshop was rated as 'excellent' by 66% of respondents, with the remaining 34% rating the workshop as "good."

Additional Information

The workshop handbook with two-page summaries from each presenter is available at: ***www.forrex.org/program/water/PDFs/Workshops/Wildfire_Handout.pdf***

The workshop evaluation summary is available at: ***www.forrex.org/program/water/PDFs/Workshops/Wildfire_Watershed_Hydrology.pdf***

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