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A Brief History of Forest Hydrology in British Columbia

Dave Toews and Eugene Hetherington

Editor's note: This article synthesizes material from a chapter prepared for a compendium on B.C. forest hydrology and watershed management. It highlights turning points, initiatives, and events that have influenced the development of forest hydrology in British Columbia for the past 35 years.

To better understand how to protect watershed values while harvesting timber, a major body of knowledge in forest hydrology and watershed management has developed in British Columbia during the past 35 years. Inevitable conflicts among land managers regarding harvest rates and methods of logging and road building led to forest hydrology studies, with a need for co-operation between industry and government obvious from the start.

1960s

In the 1960s—a time of growing environmental awareness—the forest industry in British Columbia expanded rapidly, with primary roads being built into many untouched watersheds. Observers documented poor water protection practices: machinery working in stream channels, substandard roads and culverts, muddy water, landslides, and extensive skid trail disturbance. To protect streams, directives known as "P" clauses, which included prohibitions against operating machinery within stream channels and depositing material into streams, were introduced.

As forest hydrology research in British Columbia did not exist then, research from elsewhere was used to answer local questions. The first attempt to establish a B.C. watershed study that we know of was the Genesee Creek project (1968–1972), on a remote, salmon-rich stream flowing into Owikeno Lake near Rivers Inlet. This unpublished study was discontinued due to the expense of working in a remote location and the impracticality of logging much of the upland watershed.

Walt Jeffrey, who was hired by the Faculty of Forestry at the University of British Columbia (UBC) in 1966, is credited with initiating research in forest hydrology in the province. He set up research studies, encouraged others to do so, and supported land managers in applying the results. He also recruited Dr. Bert Goodell, who continued the research and teaching following Jeffrey's untimely death in 1969. The richest legacy of this period was the training of graduate students who have carried on the work in forest hydrology in British Columbia and across Canada.

Continued on page 2

Inside this issue:

History of Forest Hydrology in B.C.

A Framework for Effective Watershed Monitoring

Introduction to Salt Dilution Gauging for Streamflow Measurement - Part 2

Construction of a Mariotte Bottle

Profile: Dr. Markus Weiler

Upper Penticton Creek: How Forest Harvesting Affects Water Quantity and Quality

A Paradigm Shift In Watershed Restoration

Low Flows in Snowmelt-dominated Watersheds

Update

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Continued from page 1

1970s

The first major watershed study in British Columbia began in 1970. The Carnation Creek project on Vancouver Island is the longest term and most highly published watershed study in the province (155 citations listed in Hartman and Scrivener [1990], and at least 50 since then).

A second important study, started in 1972, was the Slim–Tumuch project east of Prince George. One of the main findings of this study was that most of the logging-related sediment that entered streams came from a single source of lacustrine material—a result that may have been avoided by locating the road elsewhere (Brownlee *et al.* 1988).

A historic conflict in 1979 arose in the Queen Charlotte Islands in association with the approval of logging in the Riley Creek watershed, an area particularly prone to landslides (Donnelly and Martin 1980). At first, the federal Department of Fisheries and Oceans did not object and the B.C. Forest Service issued a cutting permit. Fisheries reconsidered its stance following a significant storm in the fall of 1978 that resulted in landslides. Fisheries personnel notified the forest licensee that unless logging was suspended, the forest company would be charged under the *Fisheries Act*. When the company continued to log after notification, a company official was charged with obstruction of justice and fallers were arrested. A major impasse resulted and senior politicians including the premier, the federal Minister of Fisheries, and the prime minister became involved. Finally, all parties agreed that the area could be logged if it could be done safely. A steep portion of the block directly above a tributary stream was deleted from the cutting permit and the road system was deactivated immediately after logging.

The incident at Riley Creek shaped forest hydrology and fish/forestry research in British Columbia. It led to the formation of the Fish/Forestry Interaction Program (FFIP) that culminated in a final symposium 15 years later, as well as the associated publication of the influential *Carnation Creek and Queen Charlotte Islands Fish/Forestry Workshop: Applying 20 years of Coastal Research to Management Solutions* (Land Management Handbook 41; Hogan *et al.* [editors] 1998).

E. Hetherington

Logging on Carnation Creek floodplain, 1976.

Also in the 1970s, awareness of the effects of large woody debris in streams and the importance of the structure of stream channels increased. Scientists learned that, in addition to the traditional forest hydrology topics of quantity, regime, and quality of water, there was a need to consider channel and debris stability. It became apparent that forest harvesting adjacent to channels could affect the long-term stability of streams, even when there was no instream activity.

Another intense topic of discussion was the effect of logging on rain-on-snow events on the Coast. A study in the Queen Charlotte Islands outlined the theoretical impacts of logging on peak flow (Toews and Wilford 1978); its recommendation that harvesting be limited to one-third of a watershed within a 25-year period was controversial. The debate led to related studies in the Queen Charlotte Islands, as well as a study by Beaudry and Golding (1987) in the Vancouver area.

1980s

By the 1980s, projects established earlier were producing results and science-based watershed management policies were evolving. Carnation Creek started yielding significant findings, which were presented at major workshops in 1981 (Hartman [editor] 1982) and 1987 (Chamberlin [editor] 1988). In Carnation Creek, complex relationships between biological and hydrologic parameters such as stream temperature, streamwater nutrients, and channel stability came to be better understood. A workshop in 1983 led to the development and implementation of the *Coastal Fisheries Forestry Guidelines* that were subsequently refined in a second edition (B.C. Ministry of Forests *et al.* 1988). The guidelines were agreed to by both industry and government, and implemented with an intensive training program.


E. Hetherington

Gordon Hartman leading a tour along the upper Carnation Creek channel.

By the mid-1980s, the B.C. Forest Service had hired research hydrologists in five of six forest regions; the Ministry of Environment and forest companies were also hiring specialized staff with interests in hydrology. New programs were set up to broaden the geographical scope of research in the province. Common concerns included mass wasting, surface erosion and sediment from roads, snow hydrology and rate-of-cut, fish/forestry interactions, and the effectiveness of constraints on forest management. Hetherington (1987) published a useful synthesis of the Canadian literature on many of these issues.


E. Hetherington

Charles Scrivener sampling gravel. Carnation Creek, February 1984.

For most of these technical problems, it has been possible to translate research findings into practice. The rate-of-cut issue has been an exception. Is it necessary to regulate the rate-of-cut on a watershed basis? A workbook for coastal watersheds (Wilford 1987) illustrated some of the difficulties of combining various impacts in a watershed into a single analysis. The trials of this method were useful in promoting further discussion regarding the appropriate nature of a cumulative effects model.

Meanwhile, the FFIP in the Queen Charlotte Islands presented initial findings in a workshop in 1986, including an overall emphasis on slope and channel stability and associated fish habitat impacts in a geomorphologically active environment. Results expanded the forest hydrology knowledge base and were used to revise the *Coastal Fisheries Forestry Guidelines*.

Continued on page 4

Continued from page 3

1990s

To reflect a sub-boreal environment, the Department of Fisheries and Oceans established another fish/forestry/hydrology watershed study in the Stuart–Takla area north of Prince George (MacDonald [editor] 1994). As the use of technology grew, various attempts were made to develop or calibrate computer simulation models that could assess the effects of forest management scenarios on streamflow, including the HSPF model at Carnation Creek, the UBC Watershed Model at Upper Penticton Creek, and the WRENSS model in the Okanagan. The UBC Forestry Faculty has recently calibrated the Distributed Hydrology Soil Vegetation Model (DHSVM) using data from three southern B.C. watersheds.

A crucial event in the development of logging guidelines in British Columbia occurred in the early 1990s when an alliance of environmental groups, First Nations, and private individuals came together to protest continued logging in the Clayoquot Sound area on the outer coast. In response, the government selected a group of independent scientists to study the issue. In 1995, the Scientific Panel for Sustainable Forestry in Clayoquot Sound recommended that logging continue, but on a very limited scale and under stringent guidelines. The transferability of these report recommendations to other regions of the province has not been tested.

While a great deal has been accomplished in British Columbia since the mid-1960s in forest hydrology and watershed management, much remains to be learned.

Of major importance in forest policy was the introduction in 1994 of the B.C. government *Forest Practices Code* and of Forest Renewal BC (FRBC), an initiative aimed at rehabilitating B.C. watersheds. Previous decades of research paved the way for the preparation of *Forest Practices Code* guidebooks and the development of procedures for the Watershed Renewal Program of FRBC. An additional legacy of FRBC was the establishment of two endowed chairs in forest hydrology at UBC and two at Okanagan University College.

The *Forest Practices Code* was intended to specify precisely how activities were to take place in the forest. The coastal and interior watershed assessment guidebooks (B.C. Ministry of Forests 1999; B.C. Ministry of Forests and BC Environment 1995a, 1995b) were prepared and hundreds of watersheds throughout the province analyzed (Carver and Teti 1998).

2000s

The forestry professionals who produced the guidebooks clearly saw the many gaps and shortcomings in applied forest hydrology and geomorphology research in British Columbia. With the need to verify information in the guidebooks, a number of procedures were begun in the late 1990s. A workshop in the Interior brought together people conducting assessments with those applying the results. The proceedings *Watershed Assessment in the Southern Interior of British Columbia* were published in 2001 (Toews and Chatwin [editors] 2001).

In 2001, the B.C. government replaced the *Forest Practices Code* with a new results-based approach that specifies broad overall results for the forest industry. It allows licensees considerable latitude in achieving those results, provided environmental standards are maintained. The research question is: What measurements can be used reliably to determine watershed condition on an operational scale? Basic to implementing the new strategy will be a sound understanding of watershed science in a geographically diverse province.

In summary, while a great deal has been accomplished in British Columbia since the mid-1960s through research, practice, education, and policy development in forest hydrology and watershed management, much remains to be learned.

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A Framework for Effective Watershed Monitoring

Dave Wilford and Richard Lalonde

The Bulkley Land and Resource Management Plan (LRMP) requires that monitoring be undertaken to ensure that water and fish habitat objectives are met (Bulkley Valley Community Resources Board and Interagency Planning Team 1998). An interagency/licensee committee (see Acknowledgements) was asked to develop a monitoring plan. This was a major task, given 68 watersheds with diverse hydrology, geomorphology, and aquatic resources within a 7620 km^2 timber supply area (TSA). The committee recognized that each watershed needed to be reviewed individually to identify values that would be sensitive to forestry-induced watershed changes. Also, the committee reviewed existing approaches, such as watershed assessments (B.C. Ministry of Forests and BC Environment 1999) and watershed classification (Cheong 1996), and discussed the challenge with hydrologists and geomorphologists. The conclusion was that we needed to create a process-based, watershed overview approach to identify appropriate parameters. The committee also recognized that it would be impossible to individually examine each watershed, so a simple approach to ranking watersheds, based on past/proposed forest harvesting and aquatic values was adopted. We ranked all 68 watersheds and identified appropriate monitoring approaches in 29 watersheds over five weeks. This article details our approach to watershed monitoring.

We ranked all 68 watersheds and identified appropriate monitoring approaches in 29 watersheds over five weeks.

The Framework

Our approach had two components: ranking the watersheds and identifying suitable parameters and appropriate spatial sampling scale (e.g., site, tributary stream, multiple locations on main stream).

Ranking the Watersheds

Given time and financial constraints, we developed a ranking system to ensure watersheds with high aquatic values were examined and received monitoring decisions. Community watersheds, key fish-producing watersheds, and watersheds with red- or blue-listed fish species were rated as having high aquatic values. Watersheds rated moderate had limited fish species and numbers of fish in a regional context. Watersheds with low aquatic values had few or no fish present. All watersheds were then ranked according to the percentage of watershed area with past and proposed forest harvesting: low potential of risk to aquatic resources was less than 20%, moderate risk was 20–30%, and high risk was greater than 30%. The values and potential risks were numerically ranked (Table 1) to produce an overall priority ranking for each watershed. The controlling factor in the numerical

Continued on page 6