Long-term Watershed Research in Alberta

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The value of long-term data, as summarized by Stednick *et al*. (2004: p 279), is linked to watershed management needs: "Often the value of long-term [data] is not appreciated until those data are needed to respond to a management question—or, more often, a crisis." For scientists and practitioners to make informed recommendations and decisions, the impacts of land cover changes (e.g., forest harvesting, wildfire, and disease) in forested watersheds must be disentangled from inter-annual weather and climatic variability. Long-term, detailed datasets are required to predict the potential impact of future changes in climate and vegetation. The purpose of this special issue of *The Forestry Chronicle* is to present long-term watershed research studies (Fig. 1) that have provided useful information on regional hydrology that can then be used to make informed forest land-use and management decisions in Alberta. Although there have been many meaningful short-term studies that have advanced scientific and hydrologic knowledge, we focus on long-term watershed research (active for at least five years; Table 1) and summarize the available datasets, objectives of the research, principal results, and contact information.

The importance of long-term research sites for providing knowledge to guide watershed management are well understood in Alberta. In the 1960s, scientists in the provincial and federal governments initiated a long-term watershed research program to assess the hydrologic effects of land management in Alberta's forested headwaters (Jeffrey 1965). Experimental watersheds were instrumented in southern Alberta's Rocky Mountains with the objective of "evaluating and improving [watershed] management" by manipulating the land and forest, and observing the effects on water yield, hydrologic regime, and water quality (Jeffrey 1965: p 502). Results from these early hydrologic studies (e.g., Marmot Creek, Streeter Creek, Spring Creek, and Tri-Creeks) have provided important information on the hydrology, geomorphology, and ecology of the region. For example, results from experimental harvests in Marmot Creek indicate that it is possible to increase water yield through harvest procedures (Swanson *et al*. 1986). However, the optimal forest block size that maximizes water yield increases is too small given technological constraints and is not economical for commercial forest harvesting (Swanson *et al*. 1986). Research on suspended sediment in the Tri-Creeks Experimental Watershed showed that ensuring Best Management Practices (BMP) are being followed during harvest is critical in reducing the amount of sediment entering the stream (Jablonski 1986).

In the early 2000s, there was a renewed interest in long-term studies. New projects were initiated, including Forest Watershed & Riparian Disturbance (FORWARD), Southern Rockies Watershed Project (SRWP), and Hydrology, Ecology and Disturbance (HEAD), which have provided valuable hydrologic knowledge to assist land managers and local officials in managing forested landscapes. The SRWP has shown that salvage logging after severe wildfire should be well-planned and approached cautiously because it can potentially exaggerate the impacts on hydrology, water quality, and aquatic ecology more strongly than wildfire alone (Silins *et al*. 2016). The FORWARD project developed predictive tools for use in Millar Western's Detailed Forest Management Plan to forecast the effects of proposed forest management on streamflow and water

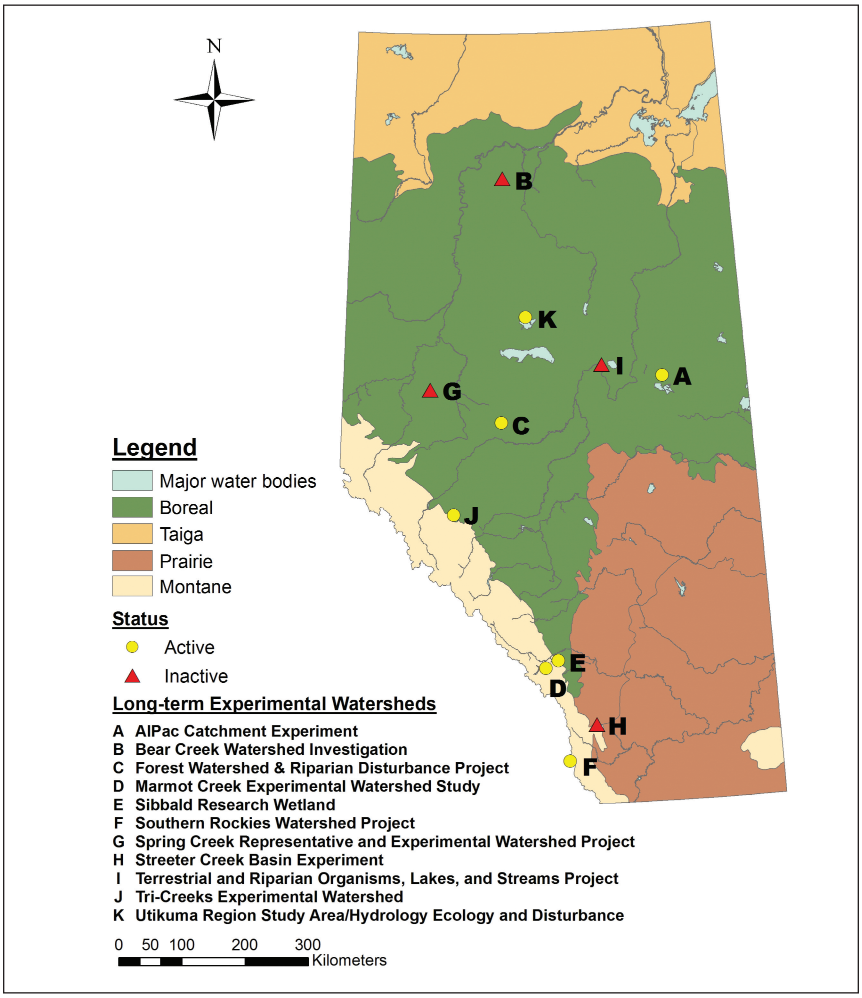

Fig. 1. Long-term watershed research sites in Alberta

quality (Prepas *et al.* 2008). HEAD developed conceptual and predictive models that can be used in hydrological risk assessments and watershed planning to improve BMPs and road construction (Petrone *et al.* 2016). In addition, researchers have revisited and re-established long-term sites that were decommissioned, capitalizing on previously available data, e.g., Marmot Creek (Pomeroy 2013) and Spring Creek (Swanson and Rothwell 2001).

Other important uses of long-term watershed studies and the resulting data include:

- Provision of an educational space and outdoor laboratory where students can learn from senior scientists and scientists can learn from each other through inter-disciplinary collaborations (Rothwell 2013);
- Improved hydrologic models through better understanding of hydrology and runoff processes, which then aids in improving BMPs and policies (Prepas *et al.* 2008, Donnelly *et al.* 2016);
- Knowledge of natural disturbances and their impacts on economics and society; e.g., wildfires have the potential to significantly impact drinking water treatment, depending on the extent and severity of fire and the type of treatment infrastructure (Emelko *et al.* 2011);

Table 1. Long-term watershed research projects summarized in this special issue

Project name	Lead agency	Duration	Current status
AlPac Catchment Experiment (ACE)	University of Alberta/Alberta Pacific Forest Industries Inc.	2005–present	Ongoing
Bear Creek Watershed Investigation	Alberta Government	1968–1973	Inactive
Forest Watershed and Riparian Disturbance (FORWARD)	Lakehead University	2001–present	Ongoing
Marmot Creek Experimental Watershed Study	Alberta/Canadian Government; University of Saskatchewan	1962–1987 2005–present	Ongoing
Sibbald Research Wetland	University of Saskatchewan	2006–present	Ongoing
Southern Rockies Watershed Project (SRWP)	University of Alberta	2004–present	Ongoing
Spring Creek Representative and Experimental Watershed	Alberta Government/Canadian Forest Service/Daishowa-Marubeni International Ltd.	1965–1987 1992–1999	Inactive
Streeter Creek Basin Experiment	Alberta/Canadian Government	1966–1986	Inactive
Terrestrial Organisms in Lakes and Streams (TROLS)	Lakehead University/ University of Alberta	1994–2000	Inactive
Tri-Creeks Experimental Watershed	Canadian Forest Service/Alberta Government/University of Alberta	1965–1987 2015–present	Ongoing
Utikuma Region Study Area (URSA): Hydrology, Ecology, and Disturbance of Boreal wetlands (HEAD)	University of Alberta	1999–present	Ongoing

- Information for the management of natural disturbances; e.g., beaver can control peatland form, hydrologic function, and the delivery of water and nutrients downstream in wetlands. Beaver management decisions regulate the extent of beaver impact (Westbrook 2016);
- Identification of the long-term economic impacts and environmental benefits of reclaimed mined areas in the oil sands (Petrone *et al.* 2016);
- Baseline data for flood frequency analysis and predictions of climate change impacts; e.g., Marmot Creek data and other hydrological and meteorological data can be used to improve flood prediction and provide better management and planning tools, which may prevent some of the economic or infrastructure impacts that can occur as a result of flooding (Pomeroy 2013);
- An opportunity to study the cumulative effects of multiple land-use changes and natural disturbances (Dubé *et al.* 2006); and,
- Knowledge regarding the recovery of hydrology, water quality, and aquatic ecosystem health after disturbances; e.g., initial monitoring four years after the Lost Creek wildfire suggested full hydrologic and water quality recovery; however, additional monitoring (four more years) showed clearly that many water quality variables (e.g., sediment, phosphorus) remained elevated and the system had not fully recovered (Bladon *et al.* 2012).

For these reasons, and others, long-term sites will likely play an important role in our understanding of watershed behavior and in influencing watershed management principles. Additional examples of valuable long-term hydrologic research in Canada can be found in HELP (2008) and Redding *et al.* (2010).

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