

# Short History of Marmot Creek Experimental Watershed: People, Places and Things Done

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# Abstract

## Short History of Marmot Creek Experimental Watershed: People, Places and Things Done

The Marmot Creek Experimental Watershed which was one of the earliest if not the first long term paired-basin study in Canada designed to assess the effects of forest cover manipulation on water flows. This paper describes events leading to the start of Marmot Creek project, persons and agencies involved in the project and a legacy of continued hydrological research, education and watershed management in Western Canada.

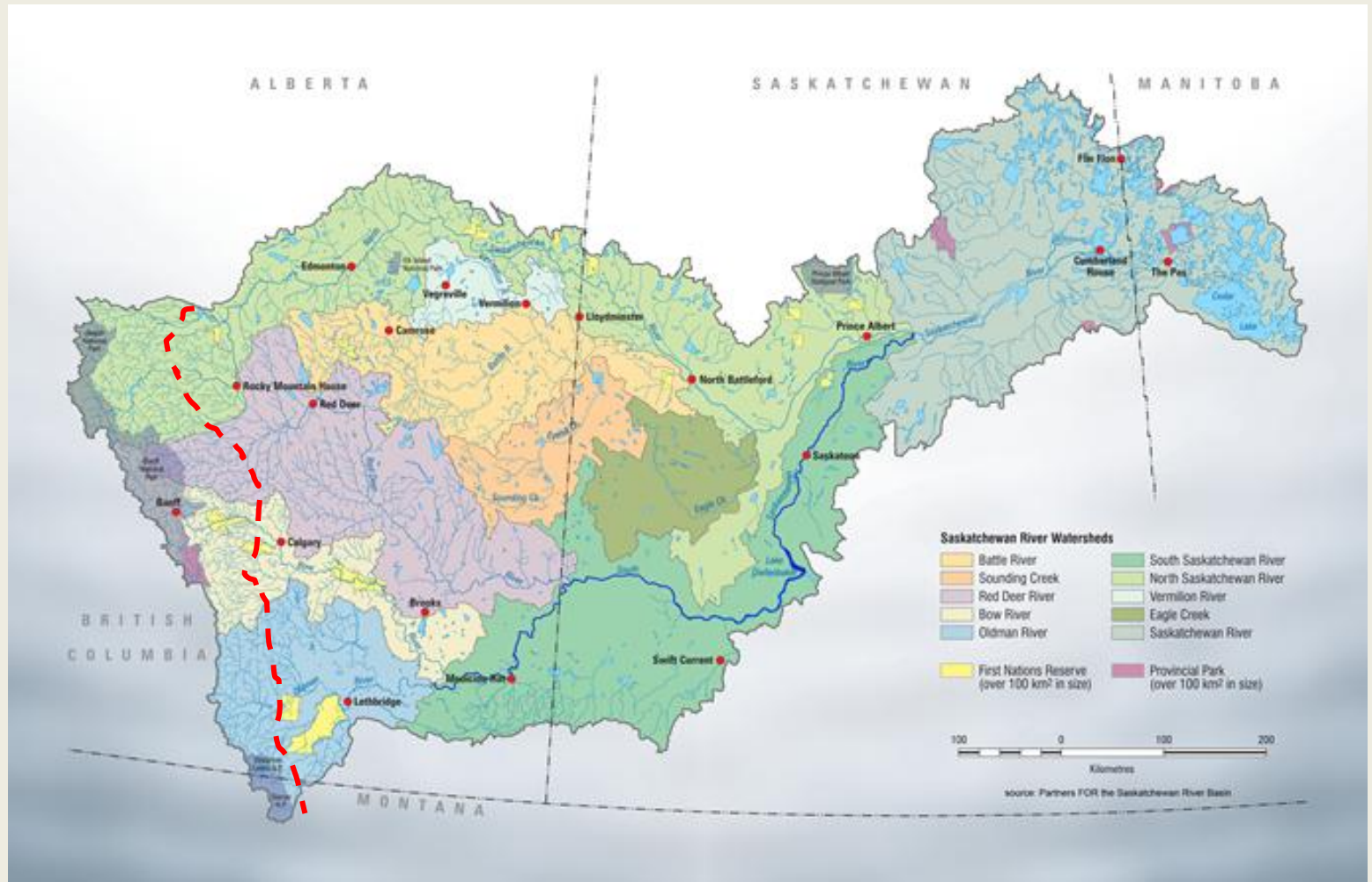
# Background....

- The East Slopes of the Rockies are a primary source of water for the prairie provinces..
- Extensive forest fires in the mid 1930s burned large areas of the East Slopes...
- Significant flooding following the fires raised concerns for the protection of the East Slopes
- Following World War II the Eastern Rockies Conservation Board (ERCB) was created in 1947 by federal-provincial legislation

# ERCB ... Mandate

- The ERCB was to..
  - Plan, advise, direct, supervise and carry out the following:
    - Construct, operate, and maintain projects, and facilities for the protection of the forest of the area from
      - Fires, insects, disease and other damage
    - And manage these “...forests to obtain the greatest flow of water in the Saskatchewan River and its tributaries.”
    - The ERCB was terminated in 1973. The research and management programs (Marmot, Streeter) continued with little change until 1988 when the Marmot Creek Experimental Watershed program was terminated by the Alberta Government with the advent of the Winter Olympics and anticipated expansion of the Nakiska Ski complex into the watershed. Water Survey of Canada continued monitoring flow at the main stem weir.

# Forest Conservation Area



# East Slopes Watershed Research Program

- Two experimental watersheds were established
  - To carry out forest manipulation treatments with the objective to improve water yield
  - The first basin was Marmot Creek, located west of Calgary in the front range of the Rocky Mountains
  - The second was Streeter Creek in the Porcupine Hills south of Calgary and west of Claresholm.
  - A third basin was started but later canceled because of budget constraints

Marmot Creek: its objective was to conduct forest cover manipulation treatments in subalpine spruce-fir forest with the objective of improving water yield (Jeffery 1965).

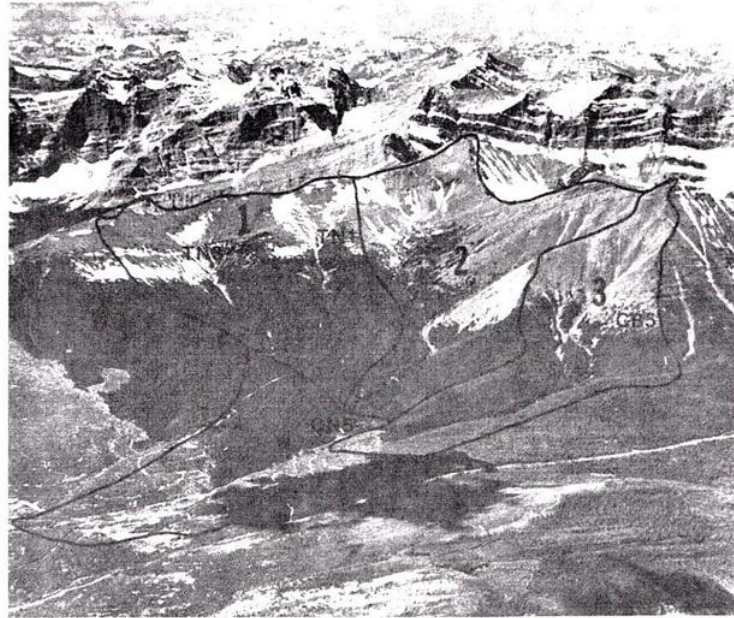


Figure 2. The three subbasins of the Marmot experimental watershed. Those with stream gauges are: 1) Twin, 2) Middle, and 3) Cabin. The area where the three streams join (4) is designated as confluence. The alphanumeric symbols indicate the location of the climatological stations that are currently in operation.



Figure 7. View of West Streeter subbasin in February 1977, the first winter after treatment. This photo illustrates the loss of snow from the large, exposed clearings, which the small patch clear-cuts were designed to correct. The black object in many of the patch cuts is the residue from clearing that was piled but not fully burned.

Research at Streeter Creek, was to study the hydrologic effects of converting aspen forest to grassland (Jeffery 1965).

# Program Structure-Personnel

- **Water Survey of Canada (Dennis Davis)** – hydrometric structures, collection, processing and archiving of data for Marmot and Streeter basins
- **Meteorological Branch, Department of Transport (Donald Storr, Av Mann, Jim Bruce)** – design and implementation of meteorological networks, collection, processing and archiving of data
- **Research Council of Alberta (Roy Stevenson, Bob Green)** – groundwater instrumentation, monitoring, processing and archiving of data for Marmot and Streeter basins
- **Department of Fisheries and Forestry (CFS today): (Walt Jeffery, Charlie Stanton, Teja Singh, Robert Swanson, Douglas Golding, Richard Rothwell, Richard Harlan, Gerry Beke, Graham Hillman, Pierre Bernier):** description of vegetation, soils, design of forest manipulation treatments, and snow hydrology
- **Alberta Forest Service (AB Environment – Sustainable Resource Development today): (Ed Wyldman):** access development in and to basins
- **Calgary Power** – provision of electrical power to Marmot Creek



# Marmot Research.....

- Besides the planned forest manipulation treatments considerable process based research was done in Marmot....
- The following is a short list of some of the studies done at Marmot and Streeter

## Sample of research projects at Marmot and Streeter Basins...

- Beke, G. J. (1969): Soils of three experimental watersheds in Alberta and their hydrologic significance, Ph. D. thesis, Univ. of Alberta, Dep. Soil Sci., Edmonton, 456 p.
- Golding, D.L. (1970): Computer mapping of the Marmot Creek snowpack and the influence of topographic and forest-stand variables on the pack, Proc. 3rd Forest Microclimate Symp., Can. Forest. Serv., Alberta, Calgary, Alberta, pp. 76-83.
- Harlan, R. L. (1969): Soil-water freezing, snow accumulation, and ablation in Marmot Creek experimental watershed, Alberta, Canada. Proc. 37th Anzi. Meeting, Western Snow Conf. 275-289.
- Storr D., Tomlain, Cork H. F., Munn R.E. 1970. An Energy Budget Study Above the Forest Canopy at Marmot Creek, Alberta 1967. Water Resources Research vol.6 issue 3 705-716.
- Stevenson, D .R . (1 967): Geological and groundwater investigations in the Marmot Creek experimental basin of southwestern Alberta, Canada. M. Sc. thesis, Univ. of Alberta, Dep. Geol. Edmonton, 106 p.
- Storr, D. (1968): An estimate of snow evaporation potential in Marmot basin, Pap. presented at Nat. Workshop Seminar on Snow Hydrology, Univ. of New Brunswick, Fredericton, 7 p.
- Munn, R.E. and D. Storr (1967): Meteorological studies in the Marmot Creek.
- Kirby, C. L., and R. T. Ogilvie. 1969. The forests of Marmot Creek Watershed Research Basin. Environ. Can., Can. Forest Serv. Pub.1259. 37 p
- Singh T. 1976. Yields of Dissolved solids from Aspen Grassland and Spruce-fir Forests in Southwestern Alberta. Journal of Range Management 29(5) September 1976.
- R.H. Swanson, D.L. Golding, R.L. Rothwell, and P. Y. Bernier. Hydrologic Effects of Clear Cutting at Marmot Creek and Streeter Watersheds, Alberta. Information Report NOR-X-278 Northern Forestry Centre, Canadian Forestry Service 1986
- Storr, D. 1972. Estimating effective net radiation for a mountainous Watershed. Boundary Layer Meteorology Vol. Issue 1 pp 3-14

# Forest Hydrology and Other Basin Studies

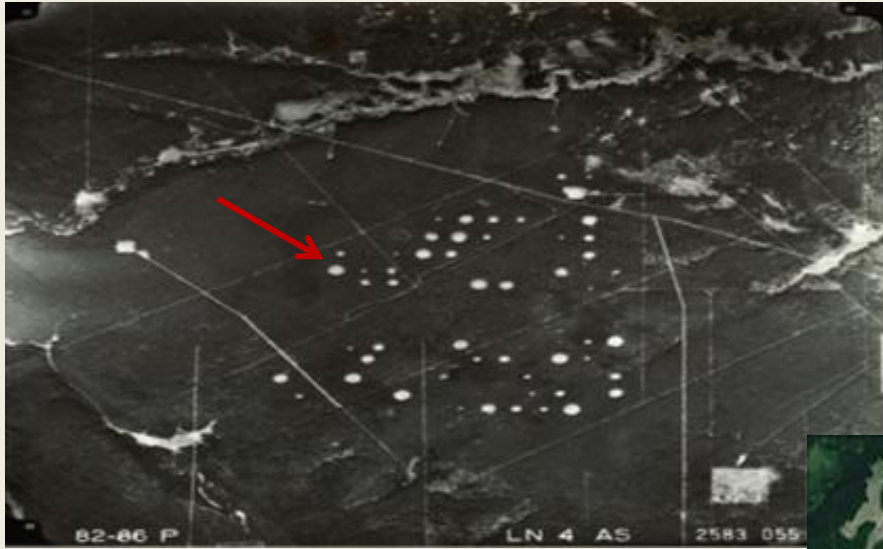
- Following Marmot and Streeter basins there were a number of other experimental watersheds established in Canada.
  - Tri-Creeks Basin (Alberta Forest Service)
  - Spring Creek (Alberta)
  - Carnation Creek BC (BC Ministry Forest and others)
  - Turkey Lakes Ont (Canadian Forest Service)
  - Montmorency Forest Que (U. Laval)
  - Model Forest Program
  - International Hydrologic Decade

# Studies Allied with Marmot

**D. L. Golding and R. H. Swanson (1986) Snow distribution patterns in clearings and adjacent forest** *Water Resources Research* Volume 22, Issue 13, pages 1931–1940.

**Abstract:** Snow accumulation patterns were determined for clearings and adjacent forest at Marmot Creek experimental watershed and James River, Alberta. At maximum accumulation snow water equivalent (SWE) was greater in clearings than in forest whether clearings were large, as in 8- to 13-ha blocks where SWE averaged 20% more than in the forest, or small as in the  $\frac{1}{4}$  to 6-H (height) diameter circular clearings where SWE was 13–45% greater than in the forest. SWE was 42 to 52% less in north than in south sectors of 2–6 H clearings. These differences increased with clearing size and time since beginning of accumulation period and are caused by snow ablation (melt and evaporation), a function of direct solar radiation reaching the snowpack. In such situations the snow that has accumulated on the ground cannot be considered a measure of the snow that has actually fallen there. For water balances and hydrologic modeling, snow measurements in partially cleared watersheds must be adjusted for temporal and spatial factors specific to the watershed.

# James River Study



1986



TODAY

# Hinton- Edson Study

Swanson, R . H . and G . R. Hillman . 1 9 7 7 . Predicted increased water yield after clear-cutting verified in west-central Alberta . Fish . Environ. Can . ; Can . For . Serv . , North . For . Res . Cent . Inf . Rep . NOR-X- 198 .

## ABSTRACT

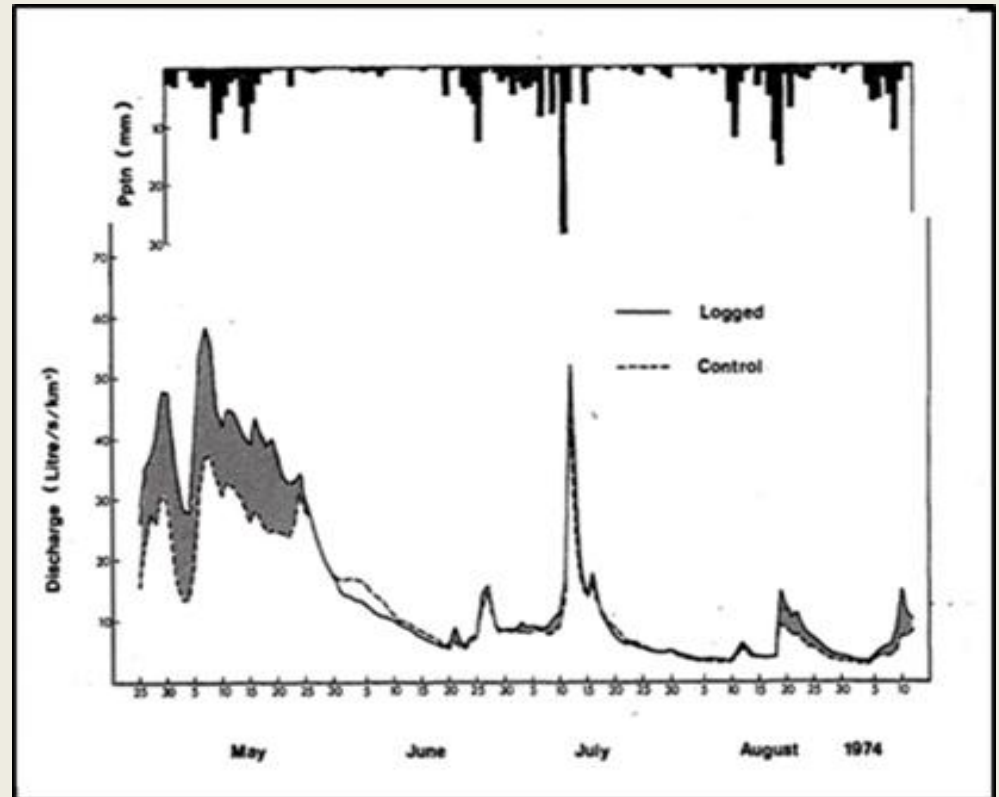
The effects of clear-cutting on the North West Pulp and Power Company Ltd . lease near Hinton, Alberta on water yield were predicted to be (1) an increase in streamflow during the snowmelt freshet , ( 2 ) an annual yield increase of 20- 30% , ( 3 ) an increase in storm flow peak magnitude of four to five times , and (4) a longevity of more than 30 years before these effects begin to diminish . These predictions were made using an informal model that states that the change in water yield resulting from forest harvest may be inferred from the alterations in stand structure , density , and arrangement that occur during harvesting which produce predictable changes in the interception, transpiration , snow accumulation , and snowmelt processes that in turn affect generated runoff . Validity of the predictions was tested by statistically comparing water yield from nine logged and nine unlogged catchments on the lease . **Results were (1) 59% more streamflow during the snowmelt freshet , ( 2 ) 27% greater yield over the gauged season (April 25-September 15) , and (3) an increase in storm peaks of 1-1/2 to two times . Since the first two effects confirmed the predictions , and the average harvest age is 10 years, longevity will likely be as predicted also .**

Predicted increased water yield after clear-cutting verified in west-central Alberta



R.H. Swanson and G.R. Hillman

Composite hydrograph of the 9 logged and control watersheds

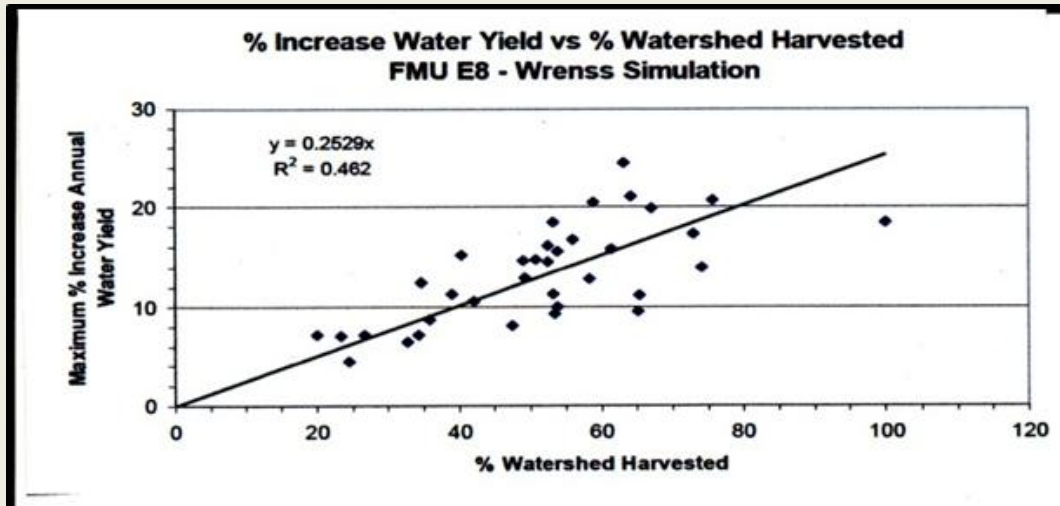
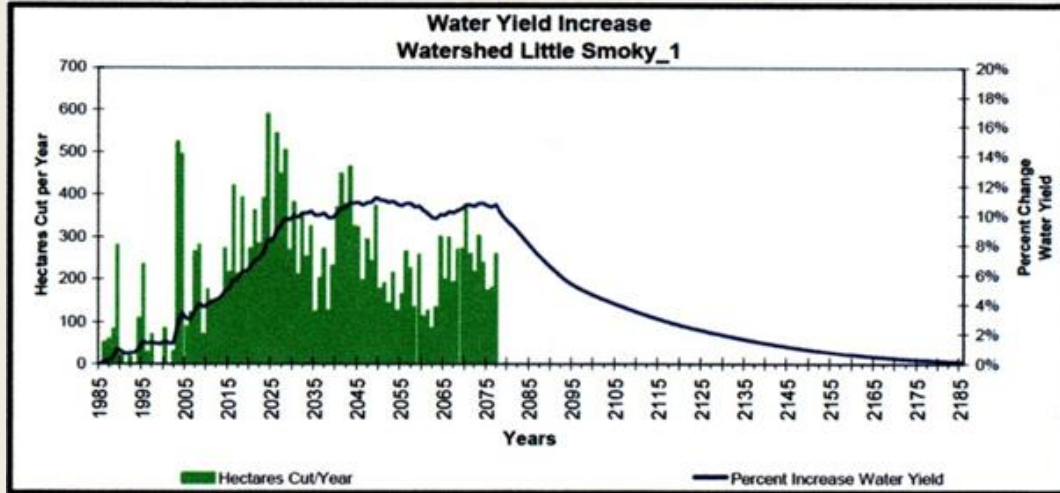
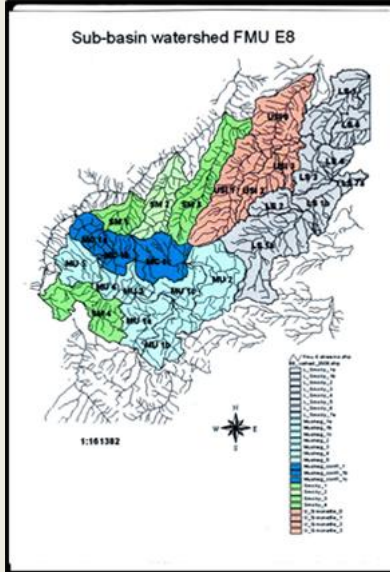


# WRENSS Model

- The original Wrenss model was developed by the U.S.F.S. as an operational tool to assess the hydrological effects of forest harvesting (Troendle and Leaf 1980)
  - Wrenss = Water resource evaluation nonpoint silvicultural sources
- Bob Swanson adapted the model to Alberta conditions and produced a lap top version.
- The model is relatively simple in concept with modest data requirements making it easy to use
- Outputs from Wrenss-Alberta include: increase in annual/seasonal water yield, increase in maximum annual daily flows for recurrence intervals of 5, 10, 20, 50, and 100 years, equivalent clear-cut area and hydrologic recovery. It has been used along with another more simplified version (ECA-AB Silins 2003) in Alberta

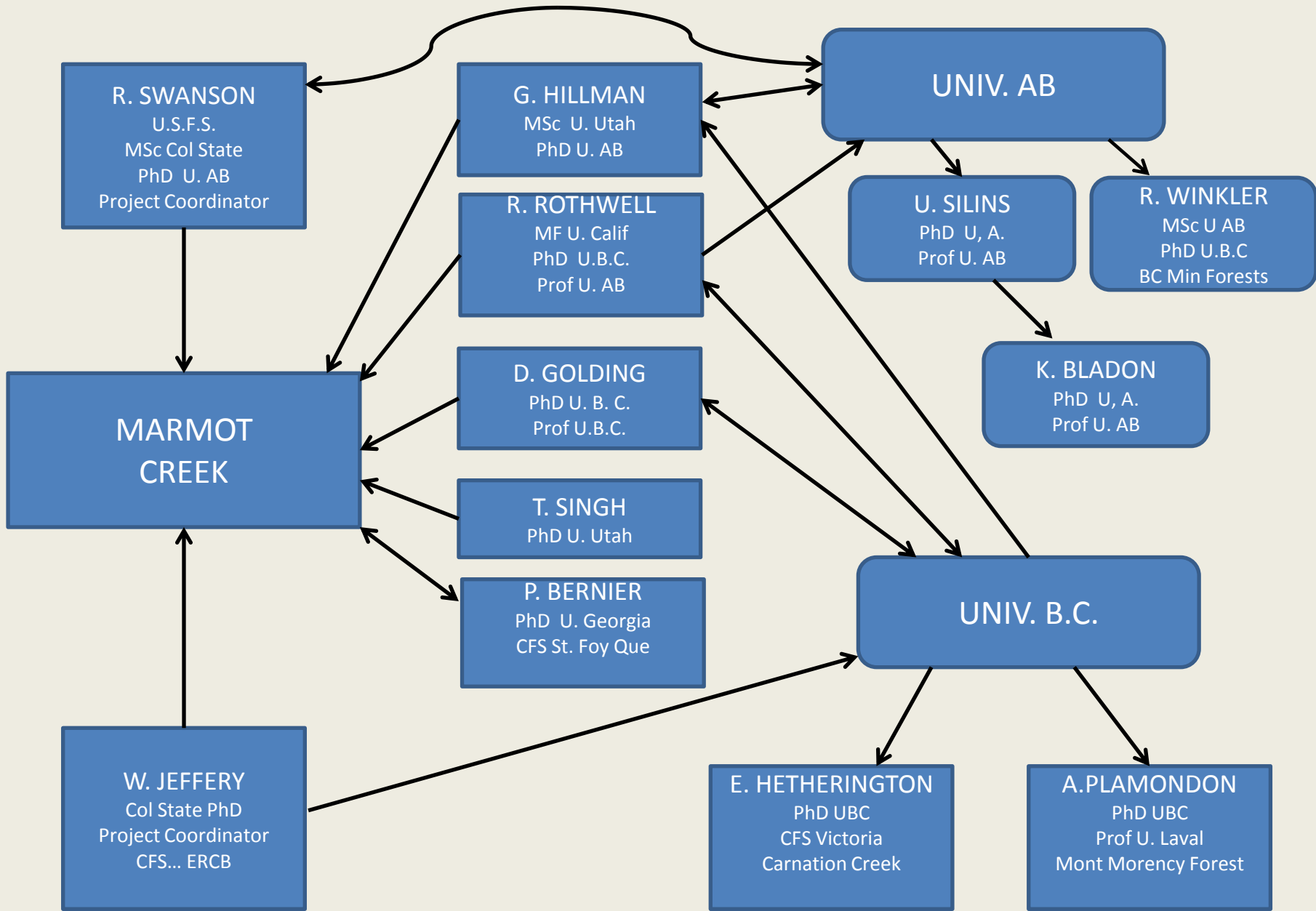


# Wrenss Output



# Value of Experimental Basins

- Besides serving as:
  - Outdoor laboratories for the study of hydrologic processes, and the..
  - Testing place for models and theories
  - Experimental basins...are “classrooms” for the education and training of scientists and hydrologists...



# Conclusions

- The Marmot project was the start of forest hydrology in western Canada
- It left us with a legacy of continued research to better understand the hydrology and sustainable management of forested lands.
- Long term projects like Marmot provide data and insight for scientists and managers which are essential to understanding the hydrology of natural systems.
- Experimental basins like Marmot are outdoor laboratories where different scientific disciplines can meet and interact.
- They also contribute to the education and training of students and researchers