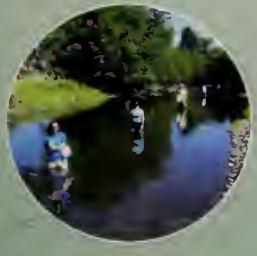
Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Watershed Evaluation of Beneficial Management Practices (WEBs)

Salmon River

British Columbia



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The Watershed Evaluation of Beneficial Management Practices (WEBs)

is a national project led by Agriculture and Agri-Food Canada (AAFC), with Ducks Unlimited Canada a key funding partner. Designed to measure the performance of selected agricultural beneficial management practices (BMPs) at a watershed scale, the project studies the impact of BMPs on water quality in seven micro-watersheds across Canada. Each site includes an on-farm economic assessment and a hydrologic modelling component, with integrated modelling occurring at two of the sites. WEBs was initiated in 2004 and will run to March 31, 2008.

The WEBs project has stimulated the formation of a network of living laboratories across Canada, bringing together hydrologists, economists, modellers and agri-environmental experts from government, academia and non-government organizations. The result is high quality applied research and exceptional opportunities for future collaboration in areas of common interest.

Beneficial management practices are science-based farming activities designed to help minimize potential environmental impacts such as sediment and nutrient runoff into water bodies. Prior to WEBs, the effectiveness of individual BMPs was evaluated largely on test plots or at a small field scale, with results extrapolated through modelling to the watershed scale. WEBs was created to address limitations to these evaluation methods by applying a suite of BMPs and studying their economic impact and effect on water quality at the micro-watershed level (i.e. approximately 300 hectares). The suites of BMPs have been specifically tailored to the unique conditions of each watershed.

The long-term history of conditions and trends is generally well understood at each of the seven WEBs watersheds, due to past activities and data collection by local watershed associations and multi-agency teams. It is anticipated that these sites will continue as long-term benchmarks for watershed health.

Environmental evaluations are being conducted through a range of validation techniques to determine the impact of individual and suites of BMPs on water quality at each watershed. Methods employed include historic benchmarking, paired watersheds, upstream and down-stream monitoring, and edge-of-field testing. All studies have been designed with in-field assessments, intended to yield scientifically valid and publishable results at the end of the project.

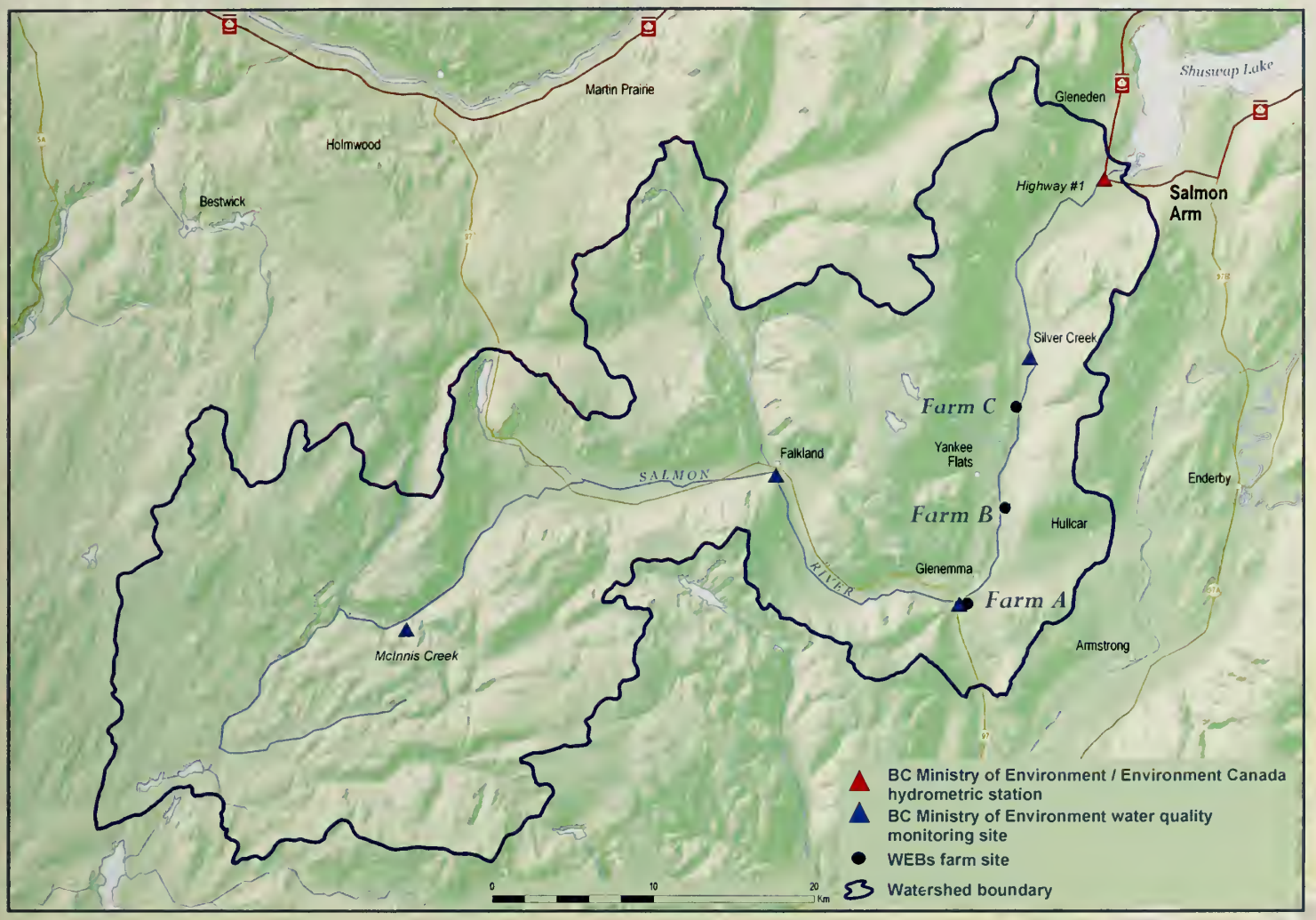
On-farm economic assessments are being conducted at all WEBs watersheds, using approaches that are best suited to the unique circumstances of each site. Through the development of economic models and impact assessment tools, economists will be able to determine the costs and benefits of BMP implementation scenarios. The socio-economic factors that might affect producers' decisions to adopt BMPs are also being examined.

Hydrologic modelling is being conducted at each WEBs site in order to characterize watershed processes under baseline conditions and to examine the water quality benefits of BMP implementation. In most cases, models based on the Soil and Water Assessment Tool (SWAT) are being used to evaluate the impact of different BMP scenarios. These models are being modified to suit Canadian climatic conditions and to accommodate specific BMPs. The South Tobacco Creek, Bras d'Henri and Black Brook watershed sites are particularly well advanced in the process.

Integrated modelling is underway at the South Tobacco Creek and Bras d'Henri sites. This component incorporates hydrologic, environmental, economic and producer behavioural aspects into a multi-faceted decision tool at the micro-watershed and larger watershed scale. Models are being validated using actual watershed data, as opposed to data extrapolated from other studies.

Salmon River Watershed

The Salmon River, located in the southeastern region of the Fraser River Basin, drains into the Shuswap Lake in British Columbia's drier interior. The river is approximately 120 kilometres long and drains a 1,500-square-kilometre area through the Thompson River which is part of the Fraser drainage basin. Peak stream flows occur from April through June (due to snow melt), with low flows occurring from late summer through the winter.



Forest harvesting, agriculture and urban development have steadily increased within the Salmon River Valley. Of the approximately 325 farms within the watershed, beef ranching, dairy farming, and forage crop production are the most common agricultural activities. However, agriculture in the area has diversified and the basin now features livestock such as emus and llamas, and crops such as orchard fruit, ginseng and Christmas trees.

The beef and dairy cattle farms use irrigation water from the Salmon River to produce forage for winter feeding as the growing season has a severe water deficit. Beef cattle from ranches in the watershed typically graze in the forested upland range from late spring to early fall. Cattle spend the winter adjacent to the river, where they are fed and where calving takes place. In many areas, cattle have direct access to the river and the riparian area.

Riparian areas are negatively impacted by cattle from trampling vegetation and streambanks when concentrated adjacent to the river.

Contamination from nutrients, fecal bacteria and other materials in the Salmon River occurs through surface runoff, groundwater seepage, soil erosion, sedimentation, and from direct cattle access to the river. Proper fencing, off-stream water supply and controlled cattle access to the river reduces the impact of livestock in the riparian area.

Water quality data have been collected for over 25 years in the Salmon River Watershed. Data indicate that water quality challenges continue and that conditions are not improving as rapidly as anticipated. Current water quality does not fully support all the designated water uses in the watershed and is compromising water use and impacting the valuable salmon fishery.

The WEBs project at Salmon River focuses mainly on the effects of implementing off-stream watering for cattle, restricting livestock access to the river, and creating riparian buffers at three cow/calf beef operations along the river.

Beneficial Management Practices

Two BMPs are being assessed on three farms within the Salmon River Watershed.

Restricted livestock access

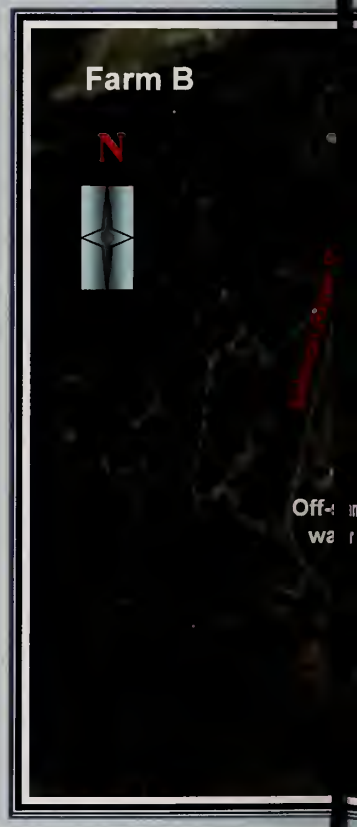
At the outset of the Salmon River WEBs project, cattle exclusion fencing was established between the upstream and midstream locations at each farm, with direct cattle access to the stream between the midstream and downstream locations. Cattle were encouraged to avoid the river in the unfenced stretches through the placement of off-stream watering systems.

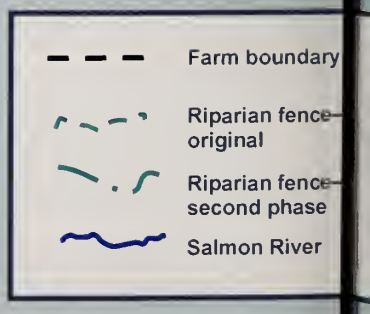
At Farm B, limited access to the river has been retained at two points (see picture at right and map of Farm B), as a half-measure until all fencing and off-stream waterers have been installed.

At Farm C, the fencing for the whole length of the farm along the stream was completed in the spring of 2006, for total cattle exclusion from the river.

At Farm A, one of the banks is on First Nations land and was not fenced to exclude cattle, and this has resulted in excessive cattle grazing and riparian impacts from the mid- to downstream section in the summer of 2007. The entire length of the farm was fenced on the farm side in 2007. Fencing was planned for the First Nations side in the winter of 2007/08.

The areas between the fencing and the river act as riparian buffer zones which can improve water quality by trapping sediments and nutrients before they reach the river. These buffers have been enhanced in some places, through the stabilization of the banks with rocks (see picture at right) and the planting of native trees and shrubs.





t the Salmon River Watershed

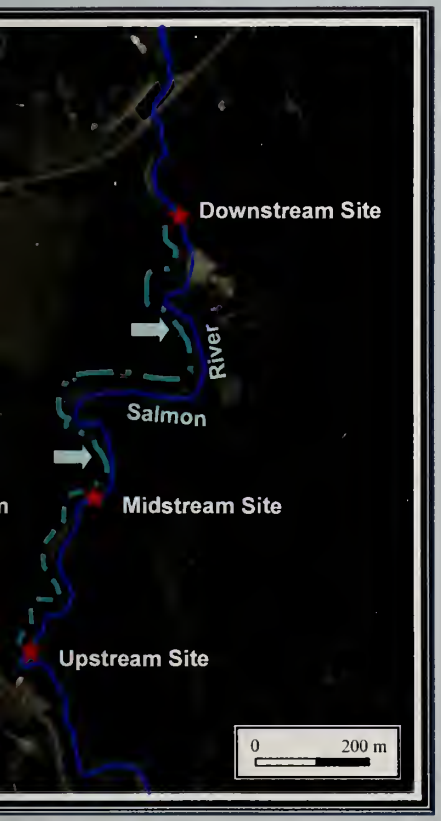
Off-stream watering

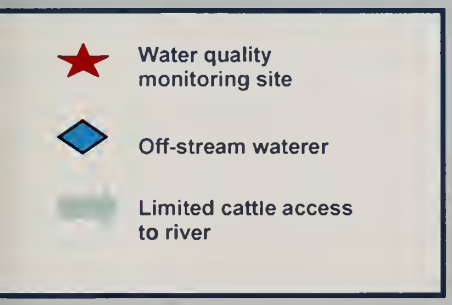
Prior to the installation of an off-stream water supply, cattle had direct access to the river for water. Direct access has caused a deterioration in water quality through direct fecal deposition, and has led to trampling and over-grazing of the river bank.

Off-stream watering systems have been installed in winter-feeding areas at all three farm sites. Initially these waterers were installed away from unfenced portions of the river, to encourage the cattle to avoid using the river as a source of drinking water. All three farm sites will have the riparian areas completely fenced by the end of March 2008, the end of the current phase of WEBs. River water quality is being evaluated before and after BMP implementation.

Cattle drinking from a trough at Farm A

Earth-heated waterers help to maintain a year-round water supply at Farm C





Monitoring Techniques

Water quality and quantity within the Salmon River Watershed are monitored at 10 sites (as pictured on the preceding pages) to determine the impacts of restricting livestock access. Each farm site has three sampling sites—upstream, midstream and downstream. Water quality parameters measured include: total, dissolved and soluble reactive phosphorus (P); total nitrate, nitrite and ammonia nitrogen (N); total and dissolved carbon (C); and thermotolerant coliform and *E. coli*. The tenth sampling site is monitored jointly by Environment Canada and the BC Ministry of Environment, and is located at the mouth of the Salmon River, near Salmon Arm. This site serves as a reference point for the watershed. Four additional water quality monitoring sites, monitored by the BC Ministry of Environment, are located throughout the length of the watershed (as marked on the map on page 2). These help to model water quality by measuring the water quality parameters described above.

A YSI Sonde installed in the stream at each farm sampling location measures conductivity, turbidity and temperature on an hourly basis. An AquaRod situated at each midstream site measures and records stream depths every hour. Turbidity, total suspended solids (TSS) and conductivity analyses are also measured in the laboratory using water samples taken in the field to compare and standardize field equipment. Piezometers have been installed to measure **groundwater quality** at additional farm sites.

Picture above: Winter sampling

Picture left: AAFC technician testing water quality samples for bacterial analysis at the AAFC lab in Kamloops

Nutrient and fecal bacterial sampling is carried out by taking water samples in clean, sterilized bottles. Manual samples are obtained on a bi-weekly basis between October and May and monthly from May to September. Sampling is conducted more frequently during runoff events in early spring. Water samples are placed in coolers with ice immediately after sampling and are taken to the AAFC laboratory in Kamloops to determine fecal bacterial numbers and the water chemistry samples are shipped to the University of Victoria within 24 hours. The sampling regime is synchronized with the beef cattle activity in the watershed, with more sampling when the cattle are near the stream between late fall and early spring. During the remainder of the year, cattle are grazing the forested uplands in the watershed and sampling intensity is reduced. Additional samples are being collected for microbial source tracking.

Sediment is collected using a sediment sampler developed by Bruce Roddan, a technician at AAFC's Kamloops Range Research Station, for the collection of cumulative samples over designated time periods. The sampler is made of a large-diameter closed PVC pipe with a small-diameter intake and outlet that allows water to flow through at a slow rate so that sediments are continuously deposited in a collector. The sampler is regularly emptied into a large pail and sent to the AAFC laboratory for processing. A sub-sample of the sediment slurry is taken to determine the fecal bacterial concentration, and the remainder is dried and weighed to determine sediment load. The sediment is separated into different size fractions and then pulverized to determine C and N levels. The effect that sediments have on stream water quality is also being studied through streambed sediment sampling.

Pictures from left to right: John Vivian measuring stream flow, Environment Canada hydrograph by Salmon Arm, AAFC soils technician Bruce Roddan empties the sediment sampler that he designed for the Salmon River WEBs project, drilling piezometers

Riparian vegetation is being monitored using the Greenline Method, designed by the U.S. Department of Interior and the Bureau of Land Management. Vegetative communities have been identified and described along 100-metre transects upstream (fenced) and down-stream (unfenced) of the midstream location along the riparian greenline on both sides of the stream. Photo-points (see picture at right) have been taken at 20-metre intervals along the riparian greenline. These permanent photo-points are marked using metal spikes and GPS, and will be revisited to observe vegetative change over the next few years.

Photo-point monitoring site for vegetation assessment

A **bio-monitoring study** is being conducted to determine whether benthic macro-invertebrate community dynamics are being negatively impacted by land-use activities such as agriculture. Multivariate analysis is being performed to determine what factors are controlling macro-invertebrate communities along the river, and whether increasing the width of the riparian zone alters these communities. Twenty-two sites in the Salmon River Watershed are used in this study, which encompasses farms of varying agricultural intensity and some pristine reference sites.

In addition to water quality monitoring, the Salmon River WEBs project includes a detailed **land-use assessment** (see below). This land-use information forms part of an extensive project assessing the relative costs and benefits of BMP implementation and conducting water quality modelling. An economic evaluation of the BMPs is being conducted for a typical beef production system in BC, and is incorporating a number of farm sites within the Salmon River Watershed. Economic information concerning the impacts of BMPs on farm businesses in the area, as well as the general benefits to society, are being evaluated using a consensus research method. This data will be fed into a model farm, representative of the Salmon River area, and will be used to evaluate the economic impact of the BMPs being applied. The BC Cattlemen's Association has assisted in promoting WEBs and identifying rancher participants. The BC Ministry of Agriculture and Lands assisted with data gathering and funding.

A hydrologic model, based on the Soil and Water Assessment Tool (SWAT), has been utilized to predict the quantity and timing of the river's discharge and water quality, in response to climate and land use respectively. SWAT has been successfully calibrated for this project site.

Land use of the Salmon River (2003)

- Cattle farm
- Forage
- Forest
- Low density Forest
- Lakes and streams
- Livestock farm (non-cattle)
- Pasture
- Tree farm
- Vegetable farm

WEBs studies will lead to a greater understanding of the ecology of the Salmon River Watershed, thus bringing us a step closer to achieving improved water quality and a clearer picture of the value of BMPs for agriculture and the environment.

Methods and findings from this study may one day be applicable to larger watersheds and contribute to a better quality of life for more Canadians.

Project Partners

WEBs is a multidisciplinary project led by Agriculture and Agri-Food Canada, with Ducks Unlimited Canada a key funding partner. Various other provincial and federal government departments, universities, and conservation groups are also providing valuable cash and in-kind contributions. The support of local producers and watershed associations has greatly contributed to the project's success. The project's overall national budget totals more than $16 million.

Other participating partners in the Salmon River WEBs project include: the Salmon River Watershed Roundtable, the University of Victoria, Environment Canada, British Columbia Ministry of Agriculture and Lands, British Columbia Ministry of Environment, the University of Victoria, the Okanagan College (Salmon Arm campus), and the cooperating landowners/producers.

Further Information

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