Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Watershed Evaluation of Beneficial Management Practices (WEBs)

Black Brook

New Brunswick

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Alberta
Government of Saskatchewan
Manitoba
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Québec
Newfoundland Labrador
Nova Scotia / Nouvelle-Écosse
New Nouveau Brunswick
Prince Edward Island
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Northwest Territories
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Canada

Ducks Unlimited Canada
Canards Illimités Canada

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.

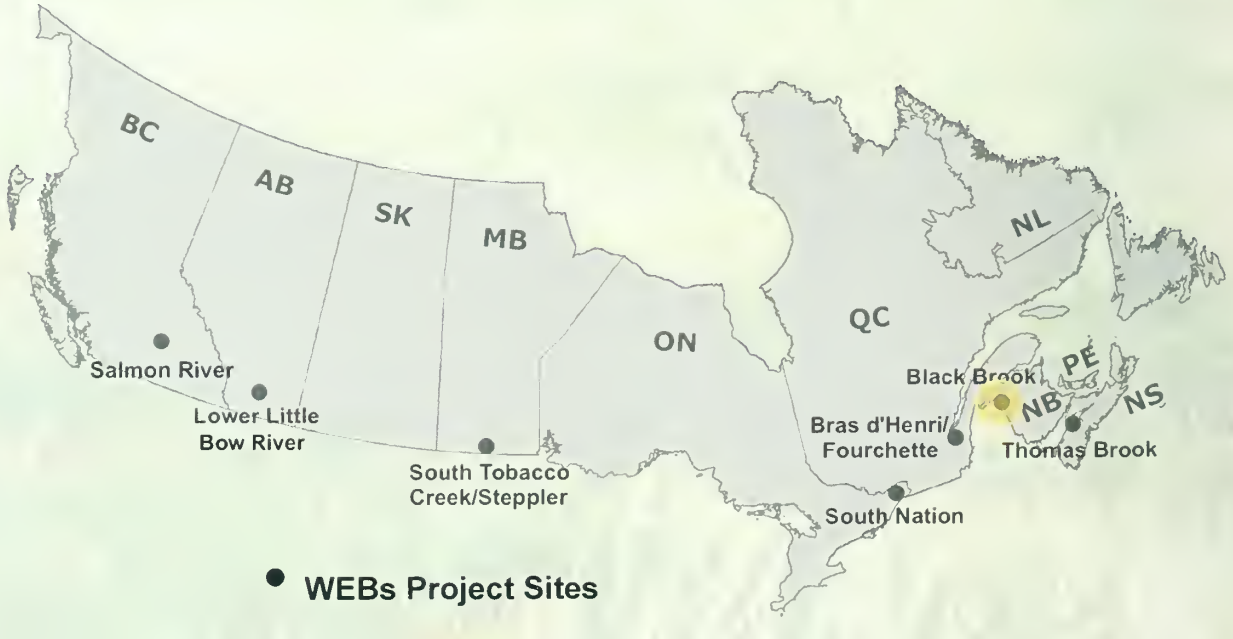
The long-term history of conditions and trends is generally well understood at each of the seven WEBs watersheds, due to past activities and data collection by local watershed associations and multi-agency teams. It is anticipated that these sites will continue as long-term benchmarks for watershed health.

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.

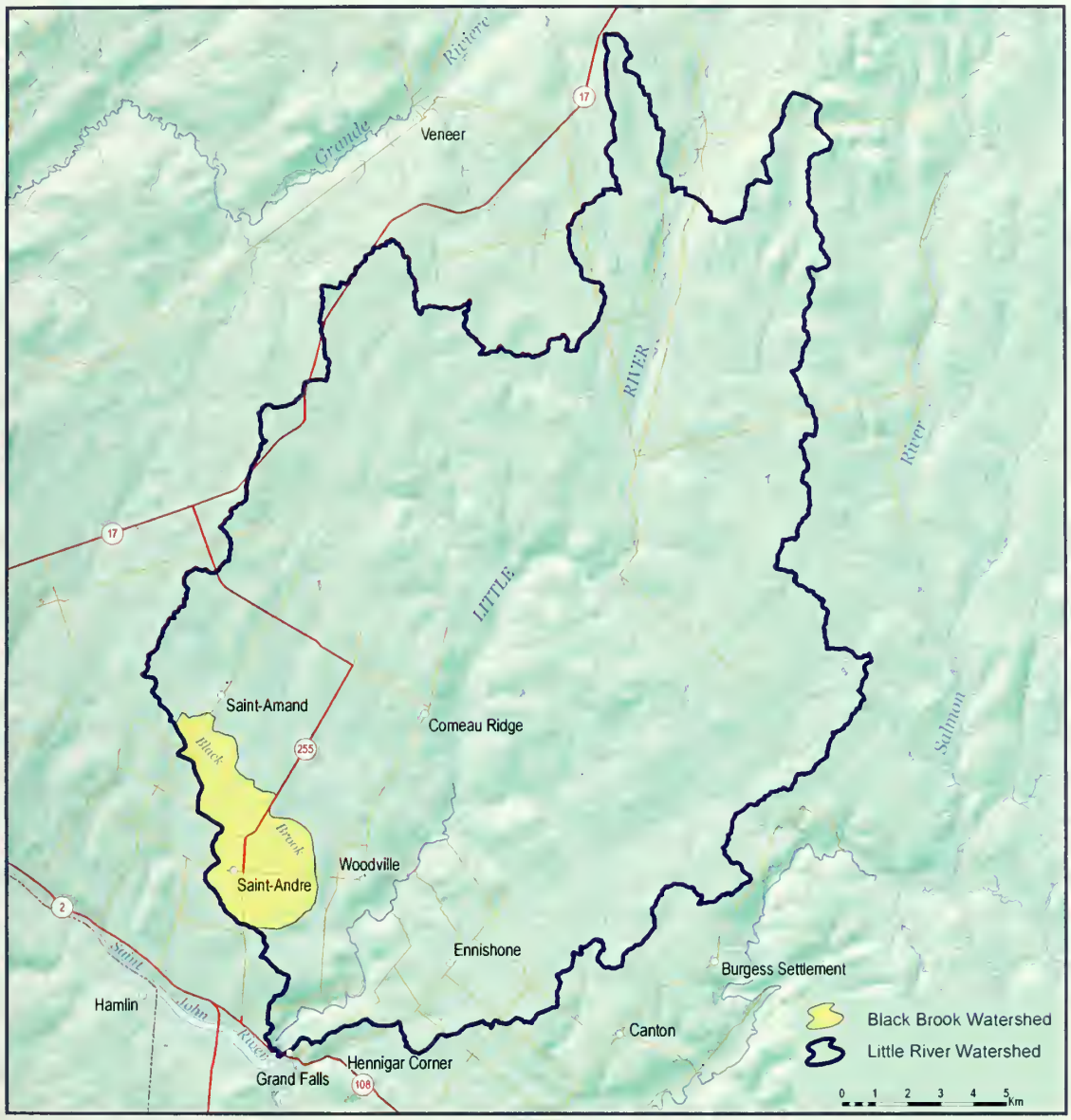
Integrated modelling is underway at the South Tobacco Creek and Bras d'Henri sites. This component incorporates hydrologic, environmental, economic and producer behavioural aspects into a multi-faceted decision tool at the micro-watershed and larger watershed scale. Models are being validated using actual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



● **WEBs Project Sites**

Black Brook Watershed

The 1,450-hectare Black Brook Watershed is located within the greater (340-square-kilometre) Little River Watershed, north of Grand Falls, in northwestern New Brunswick.



The watershed is located within the province's potato-growing region which is prone to some of the most serious water erosion in Canada. Eroded soils in this area contribute excessive amounts of sediment and nutrients to surface waters. Landscapes in the Black Brook Watershed are dominated by soils that have developed on coarse to fine-textured dense, compact glacial till. The topography is rolling with slopes generally ranging from two to nine per cent, but with some slope segments in excess of 15 per cent.

Agricultural land constitutes approximately 65 per cent of the land base, with the remainder either forested or under urban and residential development. The major crop is potato, in rotation with grain, peas and hay for forage. Half the agricultural land is annually under potato production. Average precipitation is 1,134 millimetres, of which slightly more than one-quarter falls as snow.

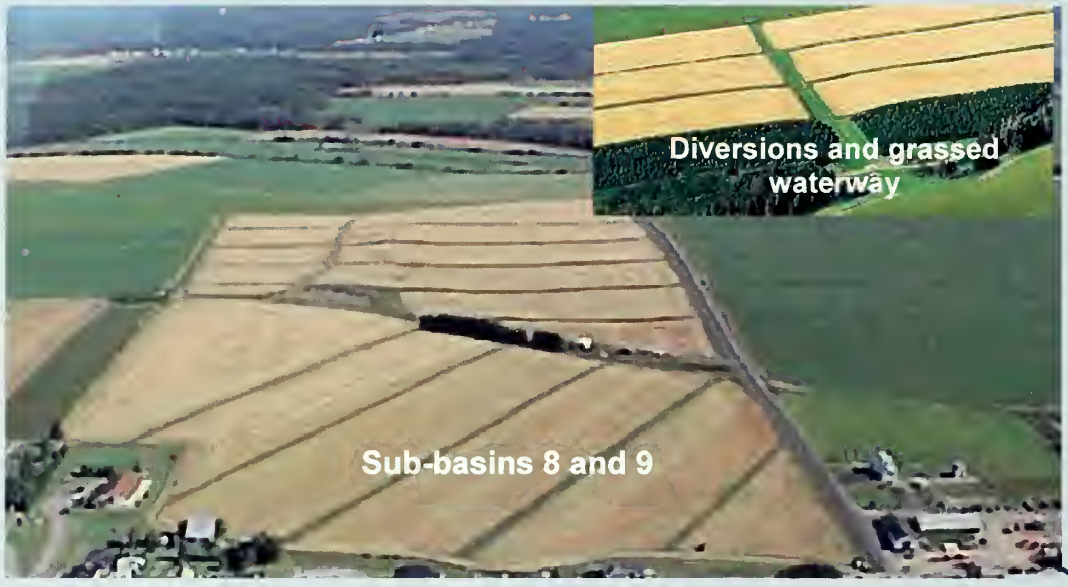
The Black Brook Watershed was established as an experimental watershed in 1990. Since that time, researchers have been investigating the impacts of intensive potato production on surface water quality, thus providing the existing WEBs study with a wealth of pre-BMP benchmark data for comparison. The physical resources of the watershed have been characterized in detail, including information on soils, topography, climate, land use, and surface water flow and quality. An existing network of permanent gauging and sampling stations allows for continuous monitoring of stream discharge and water quality in the sub-basins and outlet of the Black Brook Watershed.

The impact of agriculture on water yield and quality is being monitored on nine sub-basins with varying intensities of agricultural land use.

Beneficial Management Practices at

Two BMPs are being assessed within the Black Brook Watershed.

Diversions and grassed waterways



The effectiveness of variable-grade diversions and grassed waterway systems (established between 1994 and 2003) for upland erosion control are being evaluated. Sub-basin 9 comprises 101 hectares and sub-basin 8 comprises 200 hectares. Most of the agricultural lands in these sub-basins are protected by diversions and grassed waterways, which are maintained and upgraded on a regular basis.

Terraces are a popular soil conservation measure in potato-producing areas such as Prince Edward Island and New Brunswick. A diversion terrace can reduce soil loss to an acceptable level when the slope length of a field is greater than the accepted limit for agronomic measures (crop rotation, conservation tillage etc.). A tolerable level of six tonnes per hectare/year has been selected for New Brunswick. Terraces break up long slopes into a series of shorter ones. Each terrace intercepts runoff from the area above it and diverts it into a grassed waterway.

A grassed waterway is a permanently vegetated channel designed to move surface water across farmland without causing erosion. The waterways are typically constructed in natural depressions in the field, where water would naturally flow and collect. The grass in the channel slows the water flow and protects the soil from erosion. Waterways are usually graded to further control the speed of the runoff. Large flows of water can be carried this way, yet the waterways are not so deep as to impede heavy farm machinery.

Grassed waterways often drain into open ditches or streams that have stable, non-erosive outlets to prevent scouring—the abrasion of the sides and bottom—of stream channels. Rock chute spillways or vertical-grade control structures can safely convey the runoff to the outlet.

Since 1994, the area under diversions and grassed waterways within the Black Brook Watershed has tripled.

e Black Brook Watershed

In addition to these two main BMPs, the integrated effects of various soil and water conservation practices are being assessed within the Black Brook Watershed. These practices include crop rotation, green manure, stone crushing (as opposed to picking), conservation/reduced tillage, nutrient management, cross-slope farming and strip cropping.

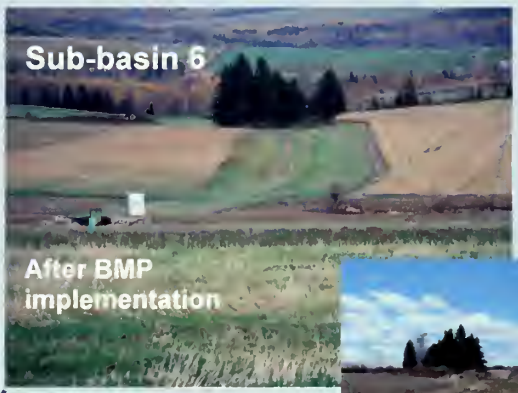
Historical data sets on surface water quality for the pre-soil conservation years (1992-1994) are being compared to post-soil conservation data (from 2005 onwards).

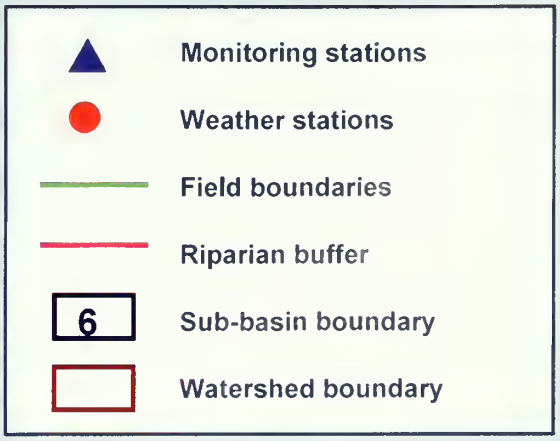
Vegetated riparian zones

In agricultural land, a riparian buffer is a permanently vegetated strip of land next to a body of water. They are designed to improve water quality by preventing runoff, contaminated by nutrients and sediment, from reaching the watercourse. Riparian buffers can also enhance the riparian area by providing habitat for wildlife and by stabilizing the river or stream bank.

In the Black Brook WEBs project, the effectiveness of vegetated (grassed) riparian buffer zone interceptor fields in filtering sediment and nutrients is being evaluated at the sub-basin level.

Seven hundred and seventy metres of riparian buffer zones have been established in sub-basin 6. These buffers are typically 15 metres wide on either side of a grassed waterway.





Monitoring Techniques

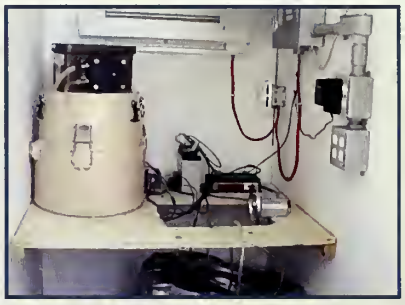
Water quality and quantity within the Black Brook Watershed are monitored at nine surface water stations. These stations consist of weirs equipped with stilling wells and automated stage height monitoring and water samplers. The locations of these monitoring stations are marked on the BMP map on the preceding pages.

Samples are typically taken automatically every 72 hours. Should the stage height increase by five centimetres or more, indicating a hydrograph event, additional samples are taken to reflect changes in water quality.

Proportional stream flow water sampling is being used to collect data on stream discharge, water temperature, water electrical conductivity, pH, sediment concentration, and nutrient (nitrogen, phosphorus, potassium, calcium, magnesium) concentrations.

Samples taken from the outlet (Ms1) in particular, will indicate the effectiveness of the implemented BMPs in improving water quality over the entire Black Brook Watershed.

Edge-of-field measurements are used to monitor the effectiveness of the riparian buffers in sub-basin 6.Two fields on either side of the waterway—one with an up-and-down slope cultivation and the other with contour cultivation—have been instrumented.



Picture above: Monitoring station at Ms6

Picture left: Typical auto sampler and data logger

The waterway has a 15-metre wide buffer on each side. Surface runoff before entering the buffer and at 15 metres within the buffer is diverted to a trapezoidal flume/ pressure transducer system which is used to monitor flow rates and collect water samples.

Also in sub-basin 6, suction lysimeters, installed at 30 and 60 centimetre soil depths, collect soil water samples for nutrient analysis.

Microbial source tracking was carried out between 2003 and 2006 at both the Little River Watershed and the Black Brook Watershed. Samples were taken on a bi-weekly basis from gauging stations Ms1, Ms2 and Ms4, in collaboration with Health Canada.

In addition, Environment Canada's National Water Research Institute is undertaking an impact study on the effects of agricultural production on aquatic ecosystems.

Pesticide monitoring is also being undertaken jointly with Environment Canada as part of the Pesticide Science Fund Project. This involves weekly sampling at the Black Brook Watershed outlet, and sequential sampling of storm runoff events in sub-basins 1 and 9 of the Black Brook Watershed, as well as at weir 12 of the Little River Watershed.

Five auto-weather stations monitor air temperature and precipitation. These are indicated on the BMP map on the preceding pages.

Pictures from left to right: Water sampler, modified for pesticide residues, at Ms1; trapezoidal flume/pressure transducer in sub-basin 6; water samples taken for the microbial source tracking initiative; weather station at W2

In addition to the collection of physical data, GIS technology is used to provide information about other parameters affecting the transport of contaminants. Spatial GIS layers of the watershed have been constructed.

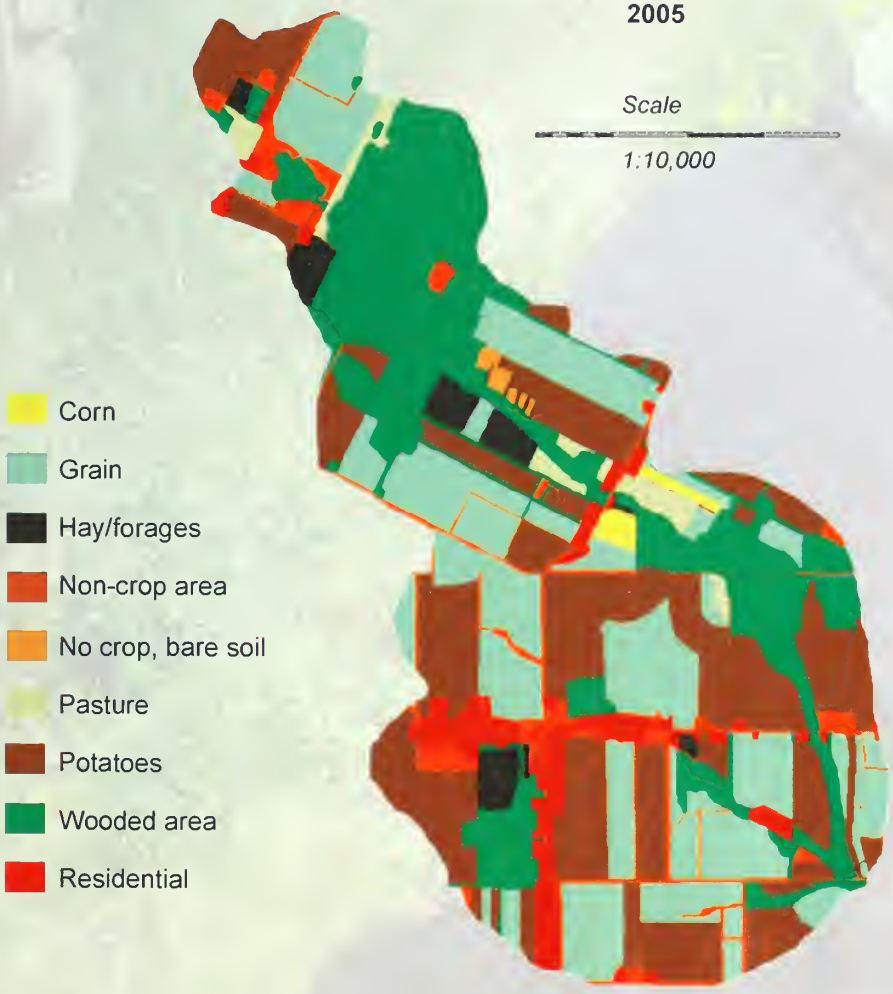
As part of the WEBs **modelling** component, A GIS-based soil loss and sediment yield model known as Sediment Delivery Distribution (SEDD, University of New Brunswick) will assess the field-level effectiveness of the diversion terrace/ grassed waterway systems. The Riparian Ecosystem Management Model (REMM, United States Department of Agriculture) is used to assess the effectiveness of the vegetated riparian zones.

The outputs from these two models will then feed into the Soil and Water Assessment Tool (SWAT) to characterize watershed processes under base conditions and to examine water quality benefits of BMPs. This model has been calibrated successfully at the project site.

In addition to water quality monitoring and hydrologic modelling, the Black Brook WEBs project includes a detailed **land-use assessment** (see below), that will form part of an extensive economic assessment of the relative costs and benefits of BMP implementation.

Intensive soil sampling helps to determine soil characteristics within the watershed

Land use in the Black Brook Watershed 2005



The economic assessment has three components. The first examines the on-farm data set for the Black Brook Watershed. The on-farm data gathered since 1991 was examined for changes in soil conservation practices, nutrient management, tillage and crop rotations.

Next, a comprehensive potato quality and yield survey was undertaken, and soil samples are being analyzed for nutrient composition and overall soil health. A correlation is being developed between crop yield and soil health. As crop yields directly influence potential farm income, any yield improvement can be calculated in fiscal terms, and an economic value can be assigned to any BMP that improves soil quality.

Finally, a whole farm enterprise analysis will be carried out to determine whether farmers in the Black Brook Watershed can afford to implement the suggested BMPs, as well as to determine public support for this initiative.

WEBs studies will lead to a greater understanding of the ecology of the Black Brook 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 budget totals more than $16 million.

Other participating partners in the Black Brook WEBs project include: Eastern Canada Soil and Water Conservation Centre, Fisheries and Oceans Canada, Environment Canada, Health Canada, New Brunswick Department of Agriculture and Aquaculture, New Brunswick Department of Environment, University of New Brunswick, Potatoes New Brunswick and cooperating landowners/producers.

Further Information

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