Watershed Evaluation of Beneficial Management Practices (WEBs)

Study yields key insights into BMP performance

The **Watershed Evaluation of Beneficial Management Practices (WEBs)** program is assessing the environmental and economic performance of agricultural beneficial management practices (BMPs) at nine small watersheds across Canada (Figure 1). Agriculture and Agri-Food Canada (AAFC) launched WEBs in 2004, and the program is currently funded under AAFC's *Growing Forward* initiative.

Research is conducted in partnership with over 70 government, academic and other agencies. Program findings are helping researchers and agri-environmental policy and programming experts to understand how BMPs perform and interact with land and water.

WEBs released a report* of initial findings which summarized the biophysical, economic and modelling results from the first four years of the program (2004-2008). At the time, WEBs had seven watershed sites. The Pipestone Creek (Sask.) and Souris River (P.E.I.) watershed sites were added in 2009.

This fact sheet largely centres on the *biophysical* (environmental) findings from that report and demonstrates through case study examples how WEBs is obtaining valuable results in five key areas of significance to decision makers at all levels.

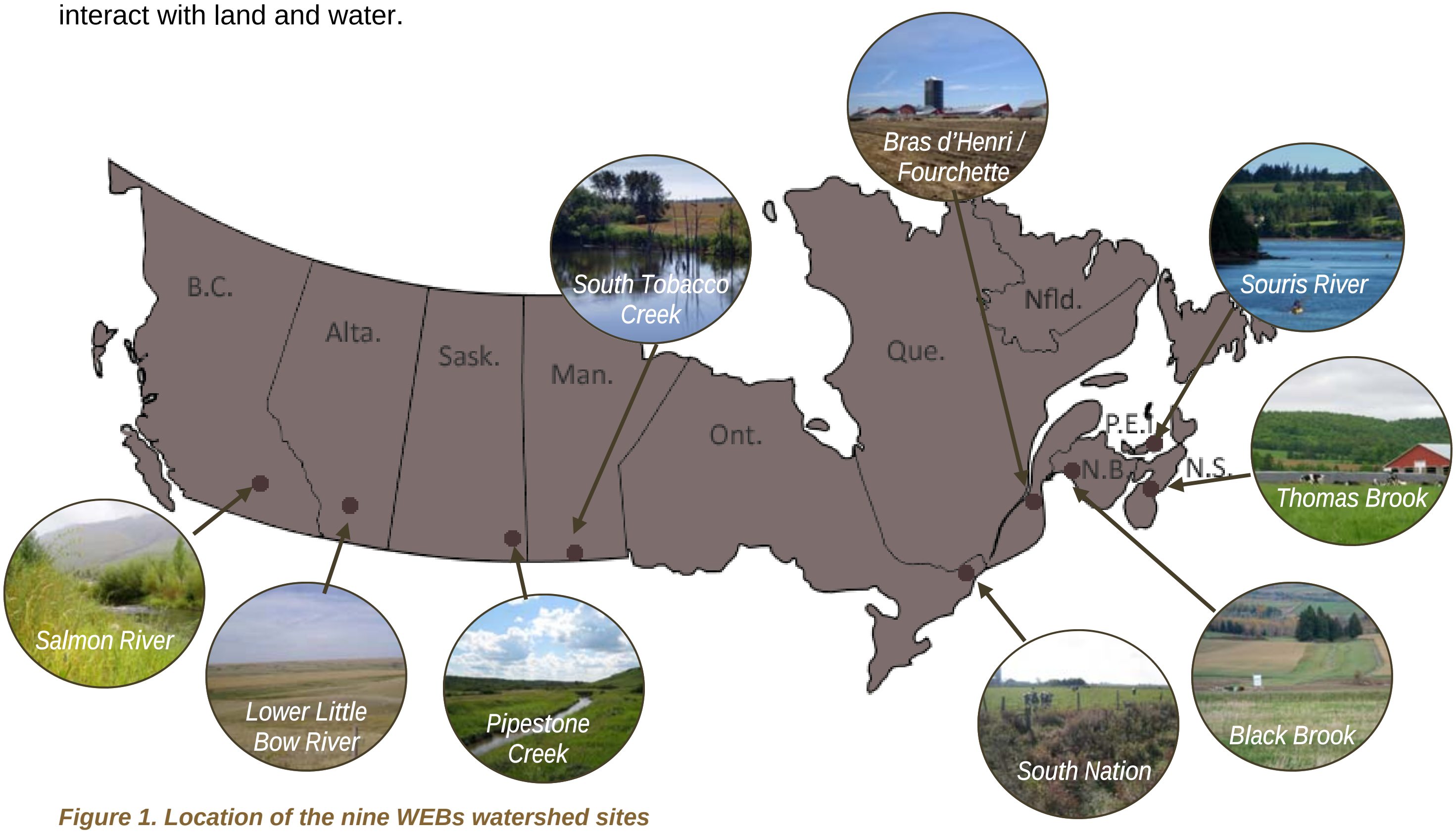


Figure 1. Location of the nine WEBs watershed sites

*Stuart, V., D.B. Harker, T. Scott, and R.L. Clearwater (eds). 2010. *Watershed Evaluation of Beneficial Management Practices (WEBs): Towards Enhanced Agricultural Landscape Planning - Four-Year Review (2004/5 - 2007/8). Agriculture and Agri-Food Canada (AAFC)*, Ottawa, Ont. 138 pp.

What has WEBs learned about the performance of BMPs?

WEBs has reported on specific scientific findings, and many useful and interesting outcomes have been observed. Individual sites have varied in the time required to establish monitoring regimes, collect baseline data, implement BMPs and launch associated studies. As a result, some sites had only limited post-BMP data at the time of reporting.

WEBs biophysical findings overall can be briefly summarized in terms of:

- Positive environmental trends
- Mixed findings and trade-offs
- Water chemistry versus other indicators
- Edge-of-field and watershed results
- Landscape interactions

Positive environmental trends

Certain BMPs have shown positive trends in relation to water quality and/or other environmental indicators. More than half of the BMP tests conducted to date have been found to reduce the contamination of surface waters by nutrients or sediment. WEBs researchers continue to study and quantify the nature of this reduction.

A key example is the South Nation Watershed in Ontario (Case study 1), where the controlled tile drainage BMP has significantly reduced nutrient loads in receiving surface water, while providing producers with a modest economic gain.

Case study 1: South Nation Watershed (Ont.) Controlled tile drainage improves water quality and yields

An example of a win-win BMP is the practice of controlled tile drainage (CTD) being studied in the South Nation Watershed. CTD involves placing a structure at the head of tile drain outlets in order to raise the water table and retain water and nutrients in the field during the growing season. Water quality findings showed that this practice significantly reduced nutrient losses to surface water, both at the edge of individual fields and at the watershed outlet.

Furthermore, CTD increased crop yields by an average of 3% for corn and 4% for soybeans. Given that the structures have a lifespan of at least 25 years, this BMP has the potential to pay for itself in as little as four to five years.

Due in part to the research conducted under WEBs, controlled tile drainage has been included as a BMP eligible for cost sharing under the Canada-Ontario Farm Stewardship Program. South Nation Conservation Authority and the City of Ottawa (under the Rural Clean Water Program) are offering an incentive to producers as well.

Mixed findings and trade-offs

Some findings are mixed—certain water quality parameters are improving while others remain inconclusive or may even be deteriorating. As well, improvements to one parameter may come at the expense of degradation to another. Few BMPs have no trade-offs.

For example, the use of diversion terraces and grassed waterways appears to have reduced surface runoff and soil erosion losses in the Black Brook Watershed in New Brunswick. However, because the terraces are holding runoff for longer periods, the water may be percolating through the soil and contributing excess nutrients to local groundwater—as evidenced by increasing nutrient concentrations within the base flow of nearby streams.

Another example of a trade-off comes from research into conservation tillage within the South Tobacco Creek Watershed in Manitoba (Case study 2).

Water chemistry versus other indicators

In some cases, while BMP effects were uncertain for water chemistry, they were positive for other environmental indicators such as riparian health or aquatic invertebrate populations. An example of this is the cattle exclusion fencing BMP in the Salmon River Watershed in British Columbia (Case study 3). In this watershed, a positive change in one environmental indicator did not necessarily guarantee a change in the other.

Case study 2: South Tobacco Creek Watershed (Man.) Conservation tillage trade-offs

A comparison of conservation tillage and conventional tillage at the South Tobacco Creek Watershed has yielded some interesting findings. Under a zero tillage-like form of conservation tillage, sediment and total nitrogen (N) export were reduced by an average of 65% and 69% per year respectively. However, total phosphorus (P) export was actually 12% greater—a factor that researchers have attributed to the release of dissolved P from crop residues during freeze-thaw events, as well as P that accumulates near the soil surface under conservation tillage systems.

These results demonstrate that although conservation tillage can effectively reduce sediment and sediment-bound nutrient export from fields, it may not reduce the export of dissolved P resulting from snowmelt runoff. In these situations, it might be necessary to implement additional management practices (such as intermittent tillage) to reduce the accumulation of dissolved P at or near the soil surface.

These findings may be applied to other landscapes having a cold semi-arid climate where snowmelt runoff makes up a significant portion of the yearly runoff volume.

Case study 3: Salmon River Watershed (B.C.) Water chemistry versus other indicators

A study at the Salmon River Watershed found that cattle exclusion fencing of a riparian area resulted in a significant reduction in E. coli and fine sediment contamination of river water. Fencing also had a positive impact on other environmental indicators such as riparian vegetation and aquatic invertebrates.

However, monitoring within this watershed has been unable to show simultaneous improvements in water chemistry resulting from cattle exclusion fencing.

Edge-of-field and watershed results

While the contributions that individual BMPs make at the edge-of-field or to in-stream loadings are often evident, the cumulative effect of multiple BMPs on water quality can be difficult to detect at the watershed outlet. This may be because the size of the receiving stream renders changes in water quality difficult to determine.

Conversely, some watersheds, such as the Thomas Brook Watershed in Nova Scotia (Case study 4), have a complex mixture of small streams, small fields and variable landscape features, such that assessing BMP performance at the edge-of-field may be difficult. In this watershed, the outlet may be the only point at which the impact of BMPs can be effectively measured.

Landscape interactions

Much has been learned about the various landscape factors (e.g. soil texture) and processes (e.g. freeze-thaw effects) that can affect BMP performance. For example, an improved understanding of the effect of soil type on BMPs within the Bras d'Henri Watershed in Quebec (Case study 5) has allowed researchers to better interpret water quality results and other biophysical findings. This knowledge will benefit future BMP evaluations, both within and beyond this watershed.

Case study 4: Thomas Brook Watershed (N.S.)
Effect of small field parcels

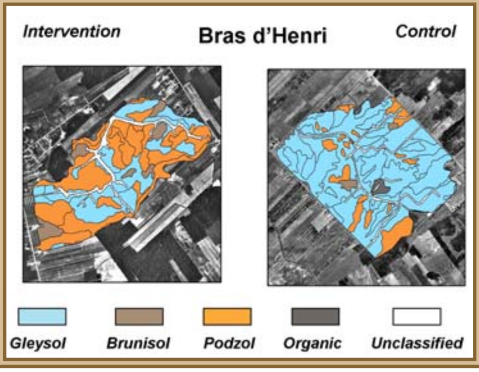
It is generally most effective to test for both individual BMP effect within the watershed (edge-of-field) and for the cumulative impact of all implemented BMPs at the watershed outlet. This approach has been difficult to apply within the Thomas Brook Watershed, where field parcels are very small, the crop mix varies greatly (from cereals to forages to cash crops) and the watershed is interlaced with sub-streams and riparian areas.

In such cases, monitoring at the watershed outlet may be the only practical method of measuring overall BMP effect.

Case study 5: Bras d'Henri Watershed (Que.)
Learning about landscape processes

Two paired micro-watersheds are being studied within the Bras d'Henri Watershed. These watersheds were chosen after a comparison of available hydrology, soils and land-use information. A very detailed soil survey conducted through WEBs later determined that the soils of these 'twin' watersheds were actually very different (see soil map below). The dominance of podzols (coarse-textured soils) in the intervention (BMP-altered) watershed made it far more prone to N leaching than the control watershed. But as these podzols also have a high P-sorption capacity, this led to much lower P concentrations at the outlet when compared to the control watershed. Both of these factors helped to explain the unexpected performance of the BMPs.

This information has allowed researchers to better interpret water quality results, and has led to new research and scientific findings on relationships between soil variability and BMP performance.



WEBs includes a significant economics component to determine the on-farm and off-farm benefits and costs of BMP adoption.

Other components studied within WEBs

Economic impact of BMPs

WEBs has been conducting detailed studies into the financial impact of BMPs on producers. Knowing the benefits and costs of different practices can help determine whether or not producers are likely to require financial incentives, such as cost-sharing, before implementing BMPs. WEBs socio-economic research is examining what factors motivate producers to adopt certain practices. Much of the research to date has focused on identifying private benefits to the farm operation, and project economists are now exploring the public benefits that BMPs can provide to society at large.

Modelling in WEBs

WEBs field data, along with climate, soil, land-use and other data are input into computer models to simulate the hydrology of each watershed. These models can then run 'what if' scenarios to predict how BMPs might perform under different conditions, or to determine the optimum mix or placement of BMPs to ensure maximum water quality and other benefits.

The Soil and Water Assessment Tool (SWAT) is the primary hydrologic model used in most WEBs watersheds. Some modelling components have been modified to better suit Canadian climatic conditions and to accommodate specific BMPs. Coined CanSWAT, this adapted model has valuable applications within Canada as well as regions within the U.S. where the dominant hydrology is driven by snowmelt runoff.

WEBs modellers are creating a refined model to better account for Canadian climatic conditions such as snowmelt, frozen soils and other factors.

In order to apply WEBs findings on a regional basis, individual watershed results are being scaled up (extrapolated) to larger watershed areas. Additionally, at two WEBs pilot locations—the South Tobacco Creek Watershed in Manitoba and the Bras d'Henri Watershed in Quebec—*integrated modelling* is combining hydrologic models with economic considerations. These integrated models will act as decision-support tools to allow land-use planners to examine the cost effectiveness and environmental impact of various BMP scenarios.

The valuable information WEBs provides about BMP performance on the landscape will ultimately help producers and policy makers to make the best decisions about where and how these practices should be applied.

More information

Visit www.agr.gc.ca/webs or contact WEBs at webs@agr.gc.ca.

AAFC No. 11638E
Aussi offert en français sous le titre *Évaluation des pratiques de gestion bénéfiques à l'échelle des bassins hydrographiques (EPBH) : Des études révèlent des renseignements clés sur le rendement des PGB*