Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Watershed Evaluation of Beneficial Management Practices

WEBs

Towards Enhanced Agricultural Landscape Planning

Four-Year Review (2004/5 - 2007/8)

Executive Summary

Ducks Unlimited Canada
Conserving Canada's Wetlands

Canada

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Executive Summary

The Watershed Evaluation of Beneficial Management Practices (WEBs) project was initiated in April 2004 to assess the environmental and economic performance of selected agricultural beneficial management practices (BMPs) at seven small watersheds across Canada. Under the *Agriculture Policy Framework* (APF), Agriculture and Agri-Food Canada (AAFC) has been the main funding agency, with Ducks Unlimited Canada as a key funding partner. Over 40 other federal, provincial, municipal, academic and non-governmental organizations are also partners in the project. This report is a summary of the project's first four years (April 2004 – March 2008).

The need to validate the performance of selected BMPs in a watershed setting was a primary reason for initiating WEBs—with informing future policy and programming decision making as a desired end result. The costs and environmental benefits of

The primary focus in WEBs has been on water quality, although other environmental parameters—such as riparian health—have also been considered at many sites.

BMPs have seldom been measured beyond small plot and field experiments. Few of these practices have been evaluated at the watershed scale where the combined

WEBs project site location map (2004/5 - 2007/8)

effects of soils, topography and land use may significantly alter anticipated results.

WEBs has contributed improved knowledge regarding the value of agricultural BMPs. It is one of the first studies in Canada to assess both the environmental and economic performance of BMPs at a watershed scale. Innovative, interdisciplinary research at the seven WEBs watershed sites is bringing us a step closer to achieving improved water quality in agricultural landscapes. WEBs also maintains a close working relationship with the Conservation Effects Assessment Project (CEAP) of the United States Department of Agriculture (USDA), providing a partnership for the exchange of information and lessons learned between projects having similar objectives.

BMP evaluation strategy

Each of the WEBs watershed studies includes the following components: *biophysical evaluations* to measure the impact of BMPs on environmental factors such as water quality; *economic assessments* to examine the costs and benefits of implementing BMPs; and *hydrologic modelling* of landscape interactions and their relationship with BMPs in order to scale up results to the next-level watershed, to work towards providing a regional perspective on larger watershed issues. At two of the WEBs watershed sites *integrated modelling* pilot studies are underway to combine biophysical, economic and hydrologic considerations into a decision-support tool for long-term watershed planning.

WEBs BMPs implemented by watershed (2004/5 - 2007/8)

	WEBs BMPs	Salmon River	Lower Little Bow River	South Tobacco Creek/ Steppler	South Nation	Bras d'Henri and Fourchette	Black Brook	Thomas Brook
Riparian	Cattle exclusion fencing (and off-stream watering)	✓	✓		✓			✓
	Off-stream watering without fencing		✓					
	Grazed versus mechanical harvesting			✓				
In-field	Manure management		✓			✓		✓
	Zero versus conventional tillage			✓				
	Crop rotation					✓		
	Perennial cover		✓	✓				
	Reduced herbicide use					✓		

	WEBs BMPs	Salmon River	Lower Little Bow River	South Tobacco Creek/ Steppler	South Nation	Bras d'Henri and Fourchette	Black Brook	Thomas Brook
Runoff	Diversion terraces and grassed waterways						✓	
	Storm water diversion (farmyard runoff)							✓
	Holding pond (cattle containment runoff)			✓				
	Small reservoirs			✓				
	Buffer strips		✓				✓	
	Suite of surface runoff control measures					✓		
Drainage	Controlled tile drainage				✓			

*WEBs is not designed as a test of BMP effect across differing watershed conditions**

** It is important to note that comparing the effect of individual BMPs across multiple watersheds and/or the assessment of any one BMP under a wide range of different watershed conditions is beyond the initial scope of WEBs.*

The paired watershed design at the South Tobacco Creek Watershed allows for a clearer indication of BMP effect.

WEBs has applied a suite of BMPs at each of its seven watershed sites (approximately 300–2,500 hectares in size). These BMPs were selected to match the unique conditions of each watershed and as a result, the suite of BMPs from one site does not directly correspond to that of another. WEBs is not meant to be a comparison of individual BMP effects across a wide range of landscape and watershed conditions. This would be a very different experiment, beyond the scope of WEBs.

WEBs is primarily focused on water quality, which is often a reflection of other environmental impacts such as soil and air quality and biodiversity. However, in many cases, additional environmental parameters such as soil or riparian health or the composition of aquatic invertebrates are being examined.

Where available, field data collected from within the WEBs watersheds were used in the economics and modelling studies. In other cases, literature values were initially used, to be augmented with field data when it became available. The incorporation of additional field

data will complement literature values, and will strengthen the level of confidence in model outputs and overall conclusions from WEBs.

Initial four-year findings

All seven WEBs sites have reported specific scientific findings and many useful and interesting outcomes have been observed. Individual sites vary in their ability to report results because the time required to establish initial monitoring regimes, collect baseline data, implement BMPs, and launch associated studies has been different for each location. As a result, some sites have only two to three years of post-BMP data and most have no more than two years of economics and modelling results. Because these experiments are conducted at the watershed scale where long-term data are required to account for spatial and temporal variability, it is still early to be drawing firm conclusions. Nevertheless, WEBs has accomplished much towards better understanding the environmental and economic performance of its implemented BMPs.

WEBs has made significant progress towards understanding the performance of specific BMPs within the watersheds where they were tested. This provides a foundation from which to further understand the broader applicability of these BMPs within a specific regional context. WEBs has also gained valuable insights into the challenges involved in unravelling the on-farm and off-farm economics of BMP adoption. And progress has been made in validating hydrologic models using results from field-tested BMPs. This provides a scientifically-sound basis for broader application of these models to other BMPs and landscape conditions, and will eventually lead to wider ecosystem comparisons. And WEBs has successfully begun to integrate biophysical and economic findings to permit the interpretation and application of WEBs results for broader planning purposes. While much remains to be done, the initial steps are promising.

Biophysical results

More than half of the BMP tests conducted in WEBs (13 out of 22) have shown the clear potential to reduce contaminant loading to surface waters. Although in many cases, the degree of this effectiveness has yet to be quantified. Some findings are mixed, wherein certain water quality parameters are improving while others remain inconclusive or may even be negative. Improvements to one parameter may come at the expense of degradation to another. In some cases, while BMP effects were uncertain for water quality, they were positive for other environmental indicators such as riparian health or aquatic invertebrate populations. Much has been learned within WEBs about the interaction of landscape processes and BMP effect. While the contribution that individual BMPs make to edge-of-field or in-stream loadings is often evident, the cumulative effect of multiple BMPs on water quality can be difficult to detect downstream at the watershed outlet. Conversely, in some watersheds having a complex mixture of small fields and small landscape parcel sizes, the watershed outlet may be the only point at which BMP effect can be detected—and that only as a cumulative response.

Economic results

The WEBs economics component has assessed the on-farm costs of BMP application and begun to evaluate the potential on-farm and off-farm benefits of applying the selected BMPs. WEBs economists used a variety of economic models and tools best suited to the unique circumstances of each watershed. Most of the BMPs studied have high implementation and/or maintenance costs. About 75 percent of the BMPs have some on-farm revenue potential, whereby limited monetary benefits (such as marginally-increased yields or cattle weight gain) may partially offset the cost of BMP implementation. Nevertheless, thus far, the net change to farm income has been generally negative. One clear exception is the controlled tile drainage BMP in the South Nation Watershed where corn and soybean yield

increases will pay for BMP installation costs within three or four years. Additional BMPs may yet prove to be viable on-farm, but these have yet to be identified. Many of the BMPs studied may have off-farm (public) benefits and a limited number of public benefit studies have been initiated under WEBs. As results from WEBs biophysical monitoring become increasingly available, site economists will integrate these data to improve confidence in their methods and results.

Hydrologic modelling results

Hydrologic modelling at the WEBs project sites complements the biophysical and economic assessments. This activity involves the use of enhanced computer models to increase understanding of background conditions and watershed processes, while facilitating the scaling-up of information on BMP impacts to the next-level watershed to provide a regional perspective on larger watershed issues. The Soil and Water Assessment Tool (SWAT) is the primary hydrologic model used in most WEBs watersheds. Model calibration was

Credit: P. Lafrance, INRS

Economic analyses conducted in WEBs will provide producers with credible estimates of the on-farm costs and benefits of BMPs so they can make informed choices about implementing them.

WEBs modellers have adapted SWAT to better suit Canadian conditions.

initiated for most watersheds—often using literature review values for initial input data. Some modelling components were modified to better suit Canadian climatic conditions and to accommodate specific BMPs. Most projections suggest a long-term reduction in sediment and nutrient loading, but these results require further evaluation using WEBs field data. Further work is required to obtain consistent results at the sub-watershed level.

Integrated modelling results

Two integrated modelling pilot projects are underway at the South Tobacco Creek (MB) and the Bras d'Henri (QC) watershed sites. Extensive hydrologic assessments were conducted on these two sites in order to model the water quality benefits of applied BMPs. Because economic data were more readily available at these sites, economic assessments were generally more detailed than in the other WEBs watersheds. Economic models were used to estimate costs for specific BMPs and combinations of BMPs, at the farm and watershed level. A farm behaviour model and/or farm surveys were used to develop scenarios for BMP adoption. Significant progress has been made towards incorporating hydrologic, on-farm economic and other factors into these integrated models. A prototype platform has been largely completed for each of the pilot watersheds. The interface that allows the exchange of information between the hydrologic and economic models has been partially completed and will be a valuable tool for researchers and conservation managers. WEBs biophysical and economic data will be incorporated into these integrated models.

Research, policy and programming implications

Through providing enhanced knowledge regarding the environmental and economic performance of BMPs, WEBs is demonstrating its applicability to policy and program development. However, WEBs has only just begun to explore what its findings might mean to research, policy and programming interests.

It is essential that dialogue amongst these interest groups continue in order to maximize the relevance of WEBs results.

Incentives and comparisons

Only one BMP studied in WEBs (controlled tile drainage) has thus far clearly proven to be economically viable at the farm level. This BMP also appears to provide off-farm (public) benefits. Partly on the strength of this WEBs research, the local conservation group and the provincial government have included this practice as a BMP eligible for limited cost sharing—thereby clarifying that information regarding on-farm and off-farm effects is relevant and valued towards achieving policy and programming objectives.

It is understood that additional BMPs will likely prove to be economically viable, but their on-farm or off-farm benefits have yet to be quantified within WEBs. In the absence of such evidence, BMPs that cannot demonstrate on-farm economic or at least environmental viability, seem unlikely to be implemented or sustained without financial or regulatory incentive. Those BMPs providing largely off-farm benefits will probably need similar encouragement.

Although WEBs was not designed to compare BMP effects across differing watershed conditions, some BMPs have been applied within more than one watershed and comparisons are bound to be made. A preliminary assessment of possible multi-site results has been undertaken in relation to selected BMP findings. While biophysical and/or economic results for these BMPs were sometimes similar across watersheds, findings were by no means uniform.

Watershed signals and concepts

Despite it being too early to draw watershed-scale conclusions, a number of additional research, policy and programming signals are evident from WEBs. These can be illustrated in specific examples from each of the seven watersheds. Such concepts relate to: the need to clarify assumed versus proven BMP

benefit; isolating the impact and applicability of local versus regional effects; capitalizing on the value of historic data sets; and the value of coupling biophysical and economic findings. Also included are: the need to better quantify underlying watershed processes; the uncertainty behind applying short-term findings; interpretation issues underlying the complexity of small field/small landscape parcel interactions; and the challenges associated with attempting to scale up results to larger watershed levels.

Targeting and scaling-Up

The policy and programming applicability of WEBs research will be further enhanced by linking what is known about the environmental performance of BMPs to producers' on-farm economic and non-economic motivations. An opportunity exists to use WEBs experience to date in order to design and invoke a pre-screening mechanism by which to identify those BMPs which are most likely to have a significant on-farm benefit versus those having primarily an off-farm benefit—and to focus

An integrated modelling approach is needed to better understand and predict the costs, benefits and environmental impacts of applying BMPs over increasingly large areas and longer time periods.

investigative resources towards quantifying probable effects. As well, the targeting of certain BMPs to specific areas of a watershed to achieve desired water quality results may well prove cost effective from a programming perspective.

Efforts will continue towards scaling up biophysical, economic and modelling conclusions to the sub-watershed or watershed level. This may be done through expanded biophysical, economic and hydrologic analysis, and through further integrating these research components.

Other key achievements

WEBs is a multidisciplinary project, comprised of experts in agricultural, biophysical and watershed research; economics; hydrology; and modelling. WEBs has fostered productive partnerships with many agencies and departments. The collaboration of individuals with the diversity of skills resulting from these partnerships is one of the project's greatest strengths.

WEBs continues to distribute a wide range of communications products to inform others about its findings. These products include: multiple presentations at workshops and conferences; an increasing number of

published papers in peer-reviewed journals; newspaper and magazine articles; watershed pamphlets and fact sheets; an up-to-date website; and annual reports. In addition, WEBs hosts watershed tours and holds an Annual Technical Workshop—all to provide a greater understanding of the concepts and factors underlying BMP performance.

Next steps

Because the necessary infrastructure and partnerships are in place, WEBs is well-positioned to continue innovative long-term watershed research across Canada. More time is needed for adequate data collection and analysis. The ongoing research will strengthen initial findings while the addition of new sites will address landscape and data gaps.

Plans for the next phase of WEBs include:

- building on current WEBs successes by continuing the current monitoring regime, while incorporating modifications and enhancements
- strengthening the national network of watershed-scale laboratories by adding new sites to address identified landscape gaps

- responding to emerging watershed-specific problems through an innovative studies component that complements longer-term WEBs objectives

WEBs will continue to demonstrate that a collaborative initiative can accomplish much more than a single discipline. As the study continues under *Growing Forward*, it will lead to a greater understanding of BMPs and landscape processes. This will ultimately result in improved water quality and more effective agri-environmental stewardship. Meeting these goals will strengthen Canada's reputation as a leader in sustainable agriculture while contributing to a better quality of life for all.

For further information

Contact webs@agr.gc.ca or visit the WEBs website at www.agr.gc.ca/webs