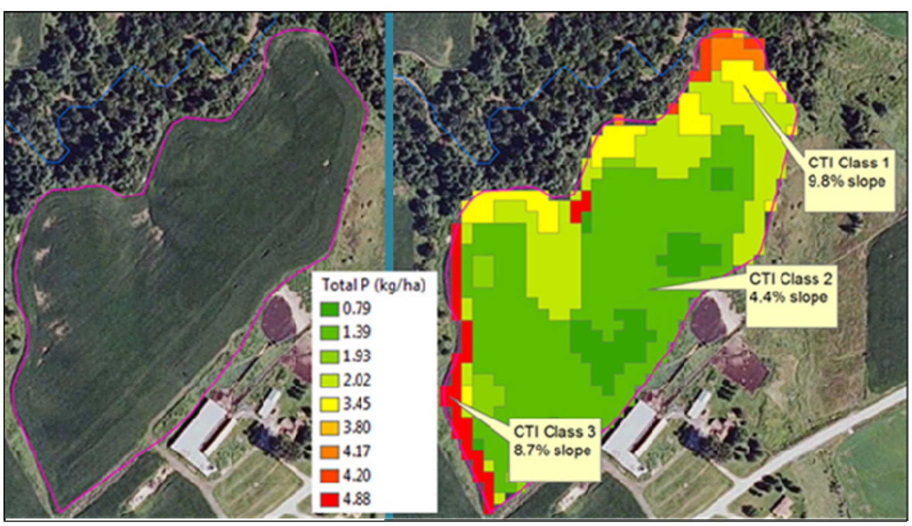
Targeting Conservation Practices to Critical Areas

It is widely believed that a small portion of the total land area of any given watershed is responsible for the majority of the pollutants exported during wet weather events. This portion of the watershed can be termed a "critical source area" (CSA). It follows that watershed management strategies could be more cost effective if treatments were targeted to these areas.

Lake Champlain's Missisquoi Bay is a large, shallow bay that straddles the Vermont-Quebec border. Public concern over water quality in Missisquoi Bay is high, as the bay suffers from recurrent blue-green algae blooms that are both unsightly and potentially toxic. Although the State of Vermont and its federal and local partners have invested millions of dollars over the past ten years to improve water quality in Missisquoi Bay, these efforts have yet to yield measurable improvements.



Areas of active erosion, such as those visible in the orthophoto at left, were accurately predicted by our model to constitute Critical Source Areas (identified in orange and red on the map at right) Stone's work identified these CSAs at the sub-field scale throughout the Missisquoi Basin.

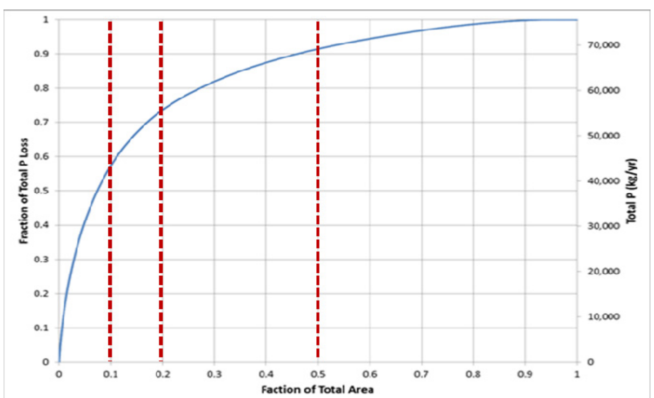
The Missisquoi Bay watershed is dominated by forests (67%) and agricultural lands (27%); urban and other built-up uses comprise less than 5% of the land cover. While there is general agreement among regulatory agencies and conservation organizations that agricultural operations are the dominant source of sediment and nutrient pollution in the Missisquoi Bay watershed, tools were needed to help program managers target their efforts and prioritize management practices for implementation in the 1,200 square mile watershed. Further, from the program managers' perspective, results would ideally be developed and presented at a field or sub-field scale, so that technical and financial assistance could be efficiently directed to individual landowners.

The Soil and Water Assessment Tool (SWAT), a model developed to quantify the impact of land management practices in large, complex watersheds, has proven to be effective for assessing water resources and non-point source pollution for a wide range of scales and environmental conditions, and is particularly well-suited to agricultural landscapes. For the Missisquoi Bay watershed, SWAT model simulations that used 30 years of historical climate data and representative crop rotations were applied to the study area. A unique aspect of the Missisquoi Bay SWAT model was that it incorporated parcel boundary data, and was therefore able to display results in a manner that was truly meaningful to individual landowners. As anticipated, the model predicted that just 10% of the land area in the basin is contributing nearly 60% of the phosphorus load. Maps of these critical source areas have now been prepared and distributed to program managers and are being used by state and federal agencies to inform existing technical and financial assistance programs. Interactive versions of the maps are also available to the public at lcbp.stone-env.com.

This study, and the promise it holds for targeting assistance, resulted in a commitment of new state and federal resources for the implementation of conservation measures. In the summer of 2012, the US Department of Agriculture, Lake Champlain Basin Program, and Vermont's Agency of Agriculture announced nearly $1 million in new funding to support the implementation of conservation measures on priority parcels in the study area. Further, conservation partners working in the Missisquoi watershed seized the opportunity to couple the study results with the new funding, using the maps to drive more than $2 million in sign-ups for conservation programs.

In addition to the watershed-specific, field-level data generated by the SWAT model, several key observations from this effort should have broad application:

- Although it can be tempting to use all available data, it is important to avoid introducing bias into the model by relying on incomplete datasets. For example, farmers who have invested heavily in conservation practices are understandably interested in having these investments reflected in the model. The challenge, however, is that complete, spatially-referenced datasets of all implemented conservation practices were simply not available. Incorporating such data into the model on a case-by-case basis is neither practical nor particularly useful for improving model results.



In the Missisquoi Basin, 10% of the watershed area contributes about 55% of the total phosphorus pollution.

This gully was found in a CSA identified in the model.

- There is enormous value to long-term simulation. Wet weather events drive annual pollutant loads from agricultural lands and are subject to significant year-to-year variability. Coupled with ongoing crop rotations, it is virtually guaranteed that no two years will look the same. The value of a long-term simulation is that it can smooth variability and identify particular land units that will contribute the greatest pollution load over multiple years. Using a long climate record ensures that the modeling results reflect a broad range of weather conditions that have been historically experienced within the watershed.

- From an environmental quality and an economic perspective, using a targeted implementation strategy for technical and financial assistance programs offers clear benefits. For each best management practice tested, targeting management efforts to the areas identified as having the highest pollutant loading rates in the baseline scenario improved the efficacy of the management efforts by two to three times.

- Higher resolution data on the location of surface water features has a substantial influence on identifying the most significant CSAs. Land use, soils, and slope tend to be the critical drivers in identifying CSAs. Introducing higher resolution mapping of surface waters created important distinctions within otherwise uniform ranking classes.

- Although a simpler, GIS-based analysis showed some promise for identifying CSAs, results were only moderately well-correlated with the intensive SWAT analysis and application of the specific GIS approach cannot be fully recommended at this time as a substitute.

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