Missisquoi Bay Basin Project:
Identifying Critical Source Areas of Pollution

Workshop on Defining Critical Source Areas and Management Needs
Thursday, January 22, 2009
10:00 AM – 4:00 PM
Missisquoi National Wildlife Refuge, Swanton, VT

Workshop Summary

I. Welcome and Introductions

II. Overview of the Missisquoi Bay Basin Project

Bill Howland, manager of the Lake Champlain Basin Program (LCBP), provided an overview of the Missisquoi Bay Basin Project. The Program received funding from the International Joint Commission (IJC) to identify critical source areas (CSAs) of nonpoint source phosphorus pollution in the Missisquoi Bay Basin of Lake Champlain. One of the major tasks of this project is to conduct a series of workshops and meetings to guide the project and development of a request for proposals. As part of that series, this workshop, facilitated by Mike Winslow of the Lake Champlain Committee, aims to define CSAs and determine how information generated by CSA identification can be useful to people in the region.

III. What is the definition of a critical source area?

A series of presentations provided definitions of CSAs and was followed by a facilitated discussion about a useful definition for this project. The following questions were asked of the presenters:

1. What is a good two sentence definition of a critical source area?
2. How do you recommend we distinguish between a critical source and a critical source area?
3. What are the 2-3 most important driving characteristics of a critical source area?
4. What should the final product of this project to identify a critical source areas be? (Please think about the spatial scale).
5. What are some limitations to your definition or concept of a critical source area?

Mary Watzin, University of Vermont

A critical source area is defined by the intersection of a phosphorus source and a transport pathway. Soil P concentrations could locate sources, but land management practices and geophysical attributes provide the pathway for P transport. However, there are non-agricultural sources of P that we must also consider. In this case, considering critical sources is unnecessary because knowing what critical sources are is irrelevant without knowing where they are so we can eliminate them. The major limitation in modeling is gathering appropriate data (both geophysical and chemical) for calibration. We are a lacking data on farm practices and urban infrastructure.

The general driving characteristics of a CSA are high erosion, high P concentration, and human management practices. We need to target areas where management is either inappropriate or non-existent. Ultimately, the CSA identification should locate places where landscape features and management practices lead to high P loss. Modeling challenges may require coarse analysis on the level of sub-watersheds, which will give context within the Basin and could be supplemented with on-the-ground assessment.

Don Meals, independent contractor
A critical source area is defined by the intersection of a phosphorus source and a transport pathway, at the same place and time. CSAs vary with management and hydrology and their identification helps locate Best Management Practices (BMPs), which either change the source of P or interrupt its transport. The major limitation in identifying CSAs is the lack of data on P sources, including P index, soil test P/P_{sat}, management data, and mass balance. Another limitation is the ability to accurately locate runoff contributing areas, which require variable source area hydrology, topographic analysis, field studies/ LiDAR.

Driving characteristics can be split into sources (based on factors such as fertilizer application, soil P concentrations, or land management) and transport mechanisms (e.g. runoff, drainage, impervious surfaces, or hydrological activity). CSA identification should focus on long-term issues, rather than infrequent phenomena like a 25-year storm shortly after manure application. Analysis should begin with determining runoff contributing areas. The end product should be a map that overlays locations of high P with the probability that an area will experience runoff; data should be detailed enough to locate fields.

Aubert Michaud, Institut de Recherche et Développement Agroenvironnement
The definition of a CSA includes the pollution source, its transport mechanism, and its impact on the ecosystem. CSAs differ from critical sources in their inclusion of a spatial aspect and are limited to nonpoint sources; pollution is also variable in space and time and can only be prevented (rather than treated). A CSA analysis should consider multiple spatial scales, mass-balance of point and non-point sources, landscape features, land use, validation from monitoring, and user-driven diagnoses of needed BMPs. This analysis will be limited by the seasonality of P transport, variation in bioavailability of P, ground- and surface-water interactions, and the external and internal loadings.

Driving characteristics of a CSA are landscape (relative position within an area, water table levels, connectivity and density of hydrologic network, soil properties) or land use (management practices, nutrient inputs) related. A tool for identifying CSAs could be either strategic or tactical. A strategic approach would consider the entire basin at a low resolution, be quantitative and validated by models, be informed by hydrological modeling, and would assess BMP efficiency. A tactical approach would consider micro-watersheds at a high resolution, be relative in nature, be informed by remote sensing rather than hydrologic modeling, and support site-specific implementation of BMPs.

Reed Sims, Natural Resources Conservation Service
From a scientific standpoint, a CSA is "a region in which a convergence of environmental stressors causes ecological disruption and the detrimental release of nutrients or toxic substances to a vulnerable hydrological network." Or, more simply, it's "a place where we've messed things up so much, you can't first, swim, or breathe anymore" – the results are what matter to humans and other species. The process of locating CSAs will require breaking the complex picture down into measurable things: legacy P in soil or streambeds, proximity of and protection between certain land uses to the hydrologic network, management practices that alter access to the network, and climate conditions. While we can determine possible CSAs based on P presence and mechanism, we are only predicting their likelihood. Limitations to the analysis will be inadequate data, incorrect

conclusions derived from the inadequate data, government reluctance to point fingers, and how the results apply to conservation efforts.

Driving characteristics of a CSA are human activity in the area, connectedness or proximity to surface water, and topography. Maps showing field and parking lot scale CSAs should be generated in order to help prioritize BMPs that will require farm-by-farm assistance. It should also publicize where CSAs are and provide evidence of their existence (empirical, photographic, or geospatial).

Facilitated Discussion:
Mike Winslow emphasized that there is general agreement that a CSA occurs at the intersection of a source and a transport mechanism, but that management practices also factor into CSAs since they can support or impede transport. The final product of the workshop must be considered during the discussion – we have already identified critical subwatersheds and now need more detailed spatial data. The following topics were discussed:

How should CSA analysis be approached?
It might be most efficient to start with hydrological assessments in the Basin so that we can target areas for which to gather detailed management information (rather than beginning by locating all tiling, for example). A high resolution Digital Elevation Model (DEM) within a meter of vertical error would be necessary to do this effectively. Running this assessment under different water flow scenarios could be a good place to start.

Modeling could also begin with a small watershed to determine landscape characteristics that combine to create CSAs and could then extend to find these characteristics elsewhere in the Basin. Or, we could look at current data to identify critical watersheds to focus on first. In addition to considering the spatial scale of analysis, temporal variations need to be captured when identifying CSAs; a model can function under different weather scenarios or incorporate crop rotation schedules, but this level of detail should not impede its progress.

The model will need to be validated; however, we are not trying to validate what we already know, we are trying to model unknown areas and future problems. Properly documenting animal densities, land use, and physiographic information would create a useful and usable model.

Ultimately, studies should focus on P attenuation: low concentration point sources which are directly discharged may have a higher impact than higher concentration loads that are decreased as they travel across the landscape. The actual P contribution to the Bay from a CSA needs to be considered.

What data should be included?
The locations of direct transport pathways from farmsteads to streams is available but would be enhanced by information on livestock in order to identify CSAs (VAAFM or NRCS may have this data). Information about farm mass balance is necessary to identify farms with manure excess, which would be CSAs – some fields are greater contributors than others so we need to look beyond transport mechanisms. Soil test data should also be included but is collected differently in Vermont and Quebec; fortunately, we know how to compare this data.

In-stream processes, such as hydrological modification, should be included in the analysis, if possible. We could consider geomorphic assessment data to identify unstable reaches as CSAs, but we also need to address associated land practices. Alternatively, we could identify land-based CSAs and then consider ones adjacent to or upstream of unstable reaches as more critical to address. Although the stream network can act as a CSA in addition to a transport mechanism, in-stream P storage will be difficult to reduce in the short-term, so this analysis might best focus on land-based CSAs.

The analysis might need to consider different forms of P (sediment and soluble), though this can be difficult with models. We will need to choose forms that comply with existing monitoring data and are inexpensive to measure. We must also consider impervious surfaces in addition to agricultural lands because they impact transport (more than they add to the load).

Monitoring is a minor source of data in the Basin compared to remote sensing but should inform the determination of CSAs and be used to assess remediation techniques.

What are the challenges of this analysis?
Using detailed data with general data can affect the accuracy of CSA locations (e.g. LiDAR without field-specific land practices). Detailed land-use information combined with runoff contributing areas would show likely sources of P, but this information is difficult to obtain. However, we do know where farmsteads are and census data of animal densities could show an area's potential as a CSA.

What should analysis results be?
The result could be a gridded index which gives a relative coefficient of P for pixels in the Basin and could be used to target BMPs. The model might be easier for people on the ground to use if it exists for a smaller area than the whole basin, and the frequency with which it is run should be considered.

Generated maps (paper or electronic) should be available to land managers and the public, though we need to be wary of finger-pointing. Should this data be used to limit development or agriculture in identified CSAs? Although this analysis will identify CSAs of pollution, land managers should keep current and potential P sinks in mind in order to reduce the total P load to the Bay. We must also remember that this effort will only identify areas of concern, and that land managers will need to offer incentives in order to obtain land-owner participation in mitigation efforts. How to do this tactical piece is separate from the modeling effort, and will help to narrow a CSA down into more specific and targetable point sources.

Ultimately, we must measure long-term progress in the Bay; we can use monitoring to determine if the correct CSAs have been identified and properly mitigated. It may take a while to see significant improvements. We should determine a time-period (three years was proposed) after which we expect to see ecosystem recovery, due to BMP implementation, and reassess our progress. This assessment might be easiest at the subwatershed level, so it might make sense to begin by targeting investments in a specific watershed.

Since this initiative is funded by the IJC and must focus on the Missisquoi Bay Basin, we are not concerned with the transferability of modeling efforts to other areas.

IV. What type of information would be most useful for people working in the Basin to reduce phosphorus pollution?

A series of presentations by field staff, managers, policy makers, and farm and citizen advocates addressed the types of information they currently use to prioritize their work or could benefit from in the future. These were followed by a facilitated discussion about useful outputs from a CSA analysis. The following questions were asked of the presenters, whose responses are summarized below:

1. What type of information do you currently use to set your priorities for the phosphorus reduction work that you do?
2. What type of information do you wish you had to better target your work?
3. What format and scale of information on identifying critical source areas would be most useful?

Julie Moore, Vermont Agency of Natural Resources
The agency prioritizes BMP projects based on how they will help obtain the lake TMDL goals, landowner willingness, and partnering opportunities (with regional planning commissions and watershed groups, e.g.). Often projects become concentrated because growing local awareness leads to more interest. "Everyone needs to do everything everywhere" … there are no bad projects.

It would be helpful to be able to compare P loads between rivers, urban areas, and agricultural areas. A framework for targeting work beyond just anecdotal evidence would help decision-making. It would also be useful to locate and determine the effects of hydrological modifications.

We need to set interim targets that are challenging and can lead to the final goal of TMDL achievement. The model should assist field staff and must recognize the current mix of regulatory and voluntary programs.

Ben Gabos, Vermont Agency of Agriculture Food and Markets
In order to target areas, Ben uses anecdotal evidence (observations or complaints), aerial imagery, monitoring data, communications between agencies, VT DEC River Management assessments, and the wetland restoration plan. He also assesses landowner interest. Often, responding to one problem can lead to finding more issues, but it also prevents locating others.

It would be helpful to have LiDAR data to locate features such as ephemeral gullies because obtaining accurate soil P data within the Basin is unlikely – landscape features will be problematic regardless of P loads.

Information needs to be given on a field scale and shared so that efforts are not duplicated. Additionally, communication is important because landowners may not be aware of runoff issues because they lease their fields to farmers. Also, choosing priority watersheds would be helpful for field work. Ultimately Ben hopes to use better geographic analysis and CSA identifications to target field work.

Roger Rainville, Farmer's Watershed Alliance
First, farmers must volunteer to have their water quality assessed. The Farmer's Watershed Alliance surveys the farmstead in a few hours using an adapted the EPA's Water Quality Assessment Plan. They focus actions on simple and obvious problems. They must also consider future farm expansion and how those change farm needs as well as the long-term business implications of implementing a BMP. Solutions are prioritized on a first-come, first-served basis.

The alliance would benefit from more outreach to increase farmer awareness of their programs, as well as more funds to help implement projects in this tightening economy. The Alliance also has limited scientific resources but a strong volunteer base.

Brian Jerose, Waste Not Resource Solutions and the Missisquoi River Basin Association
Brian uses visual observations, site visits (farmstead walks or geomorphic assessments), water quality monitoring results, conversations with landowners, and information generated by partner groups or agencies to locate areas of high flow to target for phosphorus reduction initiatives.

It would be helpful to have flow accumulation maps (like have been recently created by the NRCS) to limit field assessments to areas of high runoff potential. Field-level hydrological information (e.g. slope, floodplains, tile drain locations, annual and perennial streams or ditches) and soil physical properties (e.g. porosity and moisture retention of soils, soil type, background levels of nutrients) would also be helpful. Brian noted that areas with tile drainage can be problematic if the soil is saturated or crusted over and that variable soil conditions are the most important during the spring when the ground is bare.

Field-scale maps would be useful to share with farmers, towns, and land managers in order to inform precision agriculture and conservation and should be provided as both geographic files and finalized maps. Information generated from this analysis should be able to help adjust behaviors (economic impact is useful to know), identify the most appropriate lands to be cropped, assist in customizing incentives, and determine places to improve tile drainage networks. This analysis may be limited by money, and so it may have to focus on targeting sub-watersheds so that other groups or agencies can continue their work effectively. In terms of resources and time, is modeling or field studies more effective?

Deb Perry, Northwest Regional Planning Commission
For the Planning Commission water quality is a priority in the context of other community concerns (flooding, recreation value, scenic value, farm vitality, etc.). The planning commission considers the functionality of reaches of waterways based on information from other sources in order to facilitate mitigation projects. They focus on areas when landowners and waterways both benefit or determine suitable landowner compensation, if necessary.

When the commission prioritizes projects, it considers: likelihood of success, restoration to geomorphic equilibrium, location of project within the watershed, landowner willingness, cost effectiveness, visibility and educational value of project, and its ability to leverage other agency funding.

The commission would benefit most if the CSA locations were supplemented with recommended BMPs. It is currently difficult to compare and prioritize projects or do cost-benefit analyses. The regional planning commissions work with communities involved in planning and zoning in order to protect nutrient sinks and avoid development on potential CSAs, so knowing where these areas could be would be useful preventative information. Data generated should be provided as both geographic files and pdf maps. Models also need to be sustainable in the long-term so they can continue to generate results and have input data updated.

Facilitated Discussion:

The state and NRCS will still prioritize their work based on landowner volunteers, so in some ways ranking CSAs may not be that helpful. Perhaps known CSAs could receive greater incentives than other areas. Locating CSAs could help farmers change their practices in target areas, if outreach were done. It might help farmers within CSAs to know that they are not managing their land differently than their neighbors, but rather that the land is more sensitive due to its physical features. The Farmer's Watershed Alliance believes they could get farmer participation without regulations or penalties because their program is confidential and voluntary; however, they don't have the resources to recruit farms, thus knowing the locations of CSAs would make approaching farmers more feasible.

CSA identification will determine long-term issues which are currently only found because of short-term phenomena. In addition to managing for these short-term issues, we should be able to target long-term efforts based on CSA analysis.

While the goal of this project is to inform management and policy and not to decide how CSAs should be targeted by agencies, the group discussed how targeting could occur. Although it may be true that there are no bad projects, there may be ineffective ones. It is necessary to target efforts so that limited money can be spent on the most critical areas. The results of the CSA analysis will need to be considered from a programmatic standpoint, so that issues can be addressed with voluntary state programs. One option may be to set a priority watershed or area for BMPs so that it is obvious to farmers why they are involved in the program; however, we cannot exclude problematic farms in other watersheds. .

The group noted that pollution factors affecting blue green algae growth in the Bay are still unknown – because nitrogen might be the limiting nutrient for its growth, this should be included in the analysis. Phosphorus is more commonly associated with soil whereas nitrogen is with organic matter, thus the sources and transport pathways differ. While this grant requires that we focus on phosphorus it does not preclude us from looking at nitrogen. Additionally, this modeling effort will require that we develop data and methods which may be helpful for considering other nutrient transport.

Given the discussion of data needed and generated by this analysis, the confidentiality of this data was discussed. The NRCS, for example, requires a signed release form in order to share any information that can be traced back to an individual, but summary data can be released. In Quebec, a minimum of four farms are aggregated before farm-scale nutrient data can be shared and soil test data is linked to postal codes (nutrient management plans remain confidential). Unfortunately, very general aggregates may obscure farm-specific management practices and make that aspect of CSA identification very challenging.

It was proposed that we tie soil test data to coordinates but not specific landowners for this analysis or that perhaps we could eliminate landowner liability so that they would be willing to share information. It was suggested that the Farmer's Watershed Alliance could get information from every farm but would landowners of other types would also be willing to divulge their information? The LCBP cannot provide confidential information to the IJC, thus any information used for or generated by the analysis will become public domain. Although it cannot be shared in detail, data from nutrient management plans shows the range and variation between fields and can give a basic idea of P amounts. Perhaps the problem is partly an issue of language – informing farmers that they are in an "environmentally sensitive area" that requires special management rather than that they are a "critical source of pollution" might avoid an accusatory tone. Also, it is likely that enough places will be identified so that people will not feel singled out.

Surrogate or general data may not allow modeling to be sufficient. It was suggested making landowners partners will help them share their information. Providing incentives for sharing information and committing to help landowners if their land is identified as a CSA may also help. In general, landowners will need incentives (either internal or external) before they factor CSAs into their decisions.

The regional planning commission worked with a model in St. Albans that was created based on stakeholder meetings where people expressed their concerns and connected with each other over the local issues. The model recommended BMPs, some of which were implemented and used as demonstration projects for further implementation. A few years later, the commission wishes that they had a way of updating cost/benefit calculations and other changing variables. The "Don't P on Your Lawn" project is also a good example of successful outreach and education.

The idea that we might not actually have a soil P problem as much as we have an erosion problem was also raised. Nutrient management plans could focus on soil P while the model could locate CSAs based on physical features. If that's the case, then would a map showing areas of concern be sufficient? Flow accumulation data (especially from LiDAR) and tile drainage networks will help target restoration to original hydrology. But, because soil tests are more variable in the short-term, they will help to narrow down current CSAs.

It is also necessary to be mindful of areas of than agriculture, e.g. urban areas, suburban developments, and back roads. The model must also be an accessible and repeatable tool and geographic data should be shared. It was also suggested that the model is only a strategic tool that should help us focus tactical actions in the future.

V. Workshop Summary, Next Steps, and Adjourn

Bill Howland thanked everyone for attending and providing input. It was a productive meeting and the LCBP and project workgroup will meet to discuss the general messages from the workshop and the next steps, in light of these ideas. The next workshop will focus on the application of different models to similar problems as well as research currently being done in the Basin. Throughout this process, the LCBP will refine the requirements of an RFP to carry out the CSA analysis. Additionally, LCBP will draft a QAPP for monitoring stations and host another workshop focusing on available and necessary data. The LCBP will send invitations and encourages everyone's participation.

Workshop Attendees

Name	Organization
Bill Bartlett	
Erik Beck	Environmental Protection Agency
Laura DiPietro	Vermont Agency of Agriculture Food & Markets
Fred Dunlap	NYS Department of Environmental Conservation
Greg Fanslow	University of Vermont, Rubenstein School
Evan Fitzgerald	Fitzgerald Environmental
Sally Flis	Bourdeau Brothers
Ben Gabos	Vermont Agency of Agriculture Food & Markets
Bob Hammerl	Vermont Agency of Natural Resources
Brian Jerose	Waste Not Resource Solutions
Matt Kittredge	Vermont Agency of Agriculture Food & Markets
Mike Kline	Vermont Department of Environmental Conservation
Suzanne Levine	University of Vermont
Paul Madden	Friends of Missisquoi Bay
Don Meals	private consultant
Aubert Michaud	Institut de Recherche et Développement Agroenvironnement
Megan Moir	Vermont Agency of Natural Resources
Julie Moore	Vermont Agency of Natural Resources
Leslie Morrissey	University of Vermont
Eric Perkins	Environmental Protection Agency
Debra Perry	Northwest Regional Planning Commission
Staci Pomeroy	Vermont Department of Environmental Conservation
Kip Potter	Natural Resource Conservation Service
Roger Rainville	Farmer's Watershed Alliance
Mike Rapacz	Conservation Law Foundation
Gary Sabourin	Vermont Department of Forests, Parks, & Recreation
Nate Sands	Vermont Agency of Agriculture Food & Markets
Cynthia Scott	Missisquoi River Basin Association
Reed Sims	Natural Resource Conservation Service
Eric Smeltzer	Vermont Agency of Natural Resources
Chris Smith	US Fish & Wildlife Service
Mary Watzin	University of Vermont
Michael Winchell	Stone Environmental, Inc.
Mike Winslow	Lake Champlain Committee

Lake Champlain Basin Program Staff:
Nicole Grohoski, Colleen Hickey, Bill Howland, Kris Joppe-Mercure, Meg Modley, Michaela Stickney