Previous projects:

Hydrological characterization of Woodlawn Beach State Park: Implications for E. coli

Woodlawn Beach State Park protects a 12 acre wetland that is listed on the park's master plan for preservation and enhancement. The project focuses on defining the hydrological flowpaths implicated in the transport and fate of E. coli and other contaminants within the Woodlawn Beach State Park. This status of the project is reaching its final stages, with a focus on data analysis and publications. We are currently working on the development of a combined hydrologic and biologic model that will be used to define the hydrologic dynamics required to maintain a healthy wetland ecosystem and one that is able to effectively abate E. coli concentrations and transport. (2009-2011)

Wetland remapping project

In collaboration with the New York State Department of Environmental Conservation (NYSDEC), this project is reaching phase two of the wetland remapping of the distribution and boundaries within the Oswego/Oneida watershed. This year has seen the revision of a large sector of Oneida and Oswego maps and is being followed up by field ground truthing. (2008-2011)

Impacts of climate change on subarctic lakes

As part of a collaborative effort with Umeå University, Sweden, an ongoing project is looking at carbon and energy redistribution within watersheds affected by permafrost degradation and ultimately the impact on and fate in aquatic ecosystems. This is an ongoing three year collaborative project. (2008-2011)

Point Peterbrooke and Cattaraugus Creek Watershed Dynamics

The Great Lakes Center has made a substantial commitment to the study of the impact of the contributing watersheds on the Great Lakes. We have continued the development of our model watershed in Point Peter Brook watershed in Cattaraugus County, where we have installed weirs with water level gauges and automated samplers along the trunk stream and several tributaries, piezometers, rain gauges, and a meteorological station. The initial goal for this project was to identify Variable Source Area (VSA) controls on the exports of nitrogen (N) and dissolved organic carbon (DOC) during storm events. We have expanded our watershed monitoring program, with funding from the USACE, USEPA, and NYS DEC as part of an effort to identify critical sources of sediment and nutrients to the Cattaraugus Creek, a major contributing watershed to Lake Erie. Part of the goal of the Cattaraugus Creek project is to assess how land use and climate change will affect sediment and nutrient loading, via model predictions. The model can then be used 1) as input to a lake-wide model and 2) for managers and stakeholders to make informed decisions about nutrient management such as developing remediation plans to reduce future excessive loading. The model is currently in finalization stages. The monitoring of the Point Peterbrooke watershed is continuing and this summer will incorporate additional measurement parameters to include the contribution of carbon loads. (2008-2009)

Algal blooms in coastal wetlands of the Great Lakes

This project aims to identify physical and biological parameters that cause the initiation of algal blooms within coastal wetlands. Wetlands are often considered traps for excess nutrients and contaminants.

However, should the threshold of accumulation be exceeded, these ecosystems may contribute to the formation of blooms, which can be hydrologically transported into the Great Lakes during periods of high flow. This study aims to understand the complex dynamics of algal bloom formation and contribution within coastal wetlands through a combination of field observations and laboratory bioassays. (2008-2009)

<u>Characterizing the sediments in the Buffalo River.</u>

The lower Buffalo River is one of the 47 Areas of Concern in the Great Lakes. The US Army Corps of Engineers is very interested in identifying the amount and chemical character of sediment that enters the Buffalo River and its source areas so that it can control sediment sources and thus reduce costs associated with dredging. We have embarked on a series of projects in partnership with several agencies to provide this information. The first series of projects were aimed at characterizing the spatio-temporal pattern of sediment pollution in the watershed and generating sediment budgets for the Buffalo River watershed and its sub-basins. Critical landscapes and stream reaches contributing sediment to the river have been identified, and hydrologic and sediment data measured in the watersheds been used to calibrate the models. Scenario analyses were then performed on the calibrated models to answer important questions regarding the effectiveness of sediment control practices in the watershed.

The second series of projects involved the composition of the sediments themselves. Sediment cores from the Buffalo River were serially sectioned and analyzed for a variety of organic and inorganic contaminants. From these analyses, a history of contamination at a particular site can be interpreted. The trace metal chemistry of suspended sediments recovered from the major sub-catchments of the river with an *in situ* centrifuge on loan from the Canadian Centre for Inland Waters was also determined. While the water chemistry in the tributaries is well-known, there was no data on the chemistry of the sediments entering the river. The effectiveness of planned habitat restoration in the river can be estimated from this work.

<u>Tracking the storm-water plume from the Buffalo River.</u>

The Buffalo River is a receiving water for contaminants from a variety of chemical, metallurgical, and petroleum industries that line its shores Possible pollutant sources to the Buffalo River include industrial discharges, leaching from inactive hazardous waste sites, and upstream point and nonpoint sources Combined sewer overflows (CSO’s) are also a source of contaminant loading and they undoubtedly impact the linkage between sediment and contaminant transport. There are a total of 39 combined sewer overflows to the Buffalo River AOC that produce discharge high in bacteria and organochlorine compounds, such as polychlorinated biphenyls and polyaromatic hydrocarbons during heavy storm events.

The contaminated bed sediments in the Buffalo River are also likely vectors for contaminant loading to the river. Sediments are an ideal sink for contaminants, and they can be a direct source of contaminants if resuspended, and they can also be a diffusive source of contaminants into the overlying water column. Therefore, it is critical to determine the path sediments take during transport and deposition, as well as their ultimate fate in the system.

The goal of our research was to determine the impact of storms on the water quality of the Buffalo River, Niagara River and Black Rock Canal. We used Seabird CTD oceanographic profilers and EVS-Pro three-dimensional visualization software to collect data and create visual models of parameter responses to storm events and baseflow conditions.

We found that storm events over the Buffalo River watershed produce runoff from the watershed and from CSOs that degrade the water quality in the Buffalo River and the Black Rock Canal. The effects in the Niagara River, however, are minimal. EVS models suggest that suspended sediment settles out quickly and other contaminants are greatly diluted by ambient waters in the Outer Harbor or the Niagara River. Storm events had a more noticeable impact on the Canal than the Buffalo River.

Urban impacts on water quality in Scajaquada Creek.

Scajaquada Creek has been identified as one the most polluted tributaries contributing to the Niagara River AOC. Natural resource agencies responsible for the health of the watershed are very keen to identify contaminant sources so that appropriate management measures could be implemented to control these new sources of pollution. We propose to identify these new sediment source areas and quantify their contributions using a combination of monitoring and modeling approaches. Monitoring will be performed using continuously recording hydrolabs and grab sampling for suspended sediment. The GIS based SWAT model will be implemented for the watershed to develop sediment budgets for subbasins and creek reaches. The model will then be calibrated and verified using monitored data. The GIS based model can then be used as a tool by the resource agencies to identify critical source areas of sediment and target appropriate management strategies for these areas.

Dynamics of flow.

The Niagara River is the principal outlet for Lake Erie and the Upper Great Lakes Drainage Basin. Its discharge of 200,000 cfs is about the same as the base flow discharge of the Mississippi River at New Orleans. Previous work in the Niagara River by GLC researchers showed that there is a pronounced lateral temperature gradient across the river despite the fact that the water column in the river is thoroughly mixed vertically. The work suggests that the interplay of (1) flow constriction, both laterally and vertically, (2) stratification of the water column in the lake, and especially (3) Coriolus forces, may somehow force lateral flow partitioning. This phenomenon has not previously been described, much less explained. The GLC has undertaken a research program that will provide the preliminary data to choose between the most likely explanations. These two are:

1. The distribution may be the result of “flow stripping” and Coriolus force. Water in Lake Erie is normally stratified in the summer with warmer waters near the surface overlying cooler, denser waters. As this stratified water mass approaches the head of the Niagara River, it encounters the progressively shoaling lake bottom so that the cooler water at depth is prevented from flow into the channel, but the warmer water is allowed to pass. At this point, Coriolus forces could force warmer, buoyant waters to the U.S. shore. A compensatory flow of cooler water toward the surface along the Canadian shore would take place so that the whole mass then becomes laterally partitioned. Preliminary calculations of the Burger number suggests that this scenario is possible.

2. The distribution may be the result of lateral segregation of temperatures in Lake Erie itself due to upwelling. Winds that blow across Lake Erie from the north during a storm pile up warmer waters along the southern shore, producing a superelevation that results in coastal downwelling. A compensatory upwelling of colder bottom waters occurs offshore, again producing a water mass that would enter the Niagara River as a laterally partitioned field.

A third hypothesis, that the segregation is simply due to warm water flowing from the Buffalo River, has already been rejected based on our previous research because (1) we have tracked the flow from the river into the Black Rock Canal, not the Niagara River; and (2) the warm water flow from the Buffalo River is volumetrically insignificant when compared to that of the Niagara.

Four cruises will be made in the summers of 2005 and 2006 to collect data that will help determine the nature of the hydraulic fractionation in the river. Data in Niagara River near its head, and to a distance of 20 km into Lake Erie will be collected. The data will consist of results from (1) CTD profiling which will give us detailed 3-dimensional models of the temperature, turbidity, conductivity, dissolved oxygen, and pH distributions, and (2) current meter observations which will give us vector information on the velocity field.

Plume of the Buffalo River.

Like most large cities around the Great Lakes, the waste water and the storm water drainage systems of Buffalo are combined into a single system. Under normal conditions, this poses no problems because the treatment plant is capable of handling the volume of water entering the system. During intense storms, however, the treatment plants are incapable of handling all the water, and overflows of untreated water enter the Buffalo River. The GLC was commissioned by the Buffalo Sewer Authority to monitor the overflows as they entered the river and then flowed out into the lake and down the Niagara River. We used CTD dataloggers deployed from both the R/V Pisces and the R/V Aquarius during the project to develop 3-dimensional models of the plumes. We were most interested in determining the effect of the plumes on the temperature, turbidity, and dissolved oxygen of the receiving waters.

The Buffalo River is a receiving water for contaminants from a variety of chemical, metallurgical, and petroleum industries that line its shores. Contaminant loadings may also come from its upper watershed and from the 39 combined sewer overflows to the Buffalo River, especially during storm events. The goal of our research was to determine the impact of storms on the water quality of the Buffalo River, Niagara River and Black Rock Canal. We used Seabird CTD oceanographic profilers and EVS-Pro three-dimensional visualization software to collect data and create visual models of parameter responses to storm events and baseflow conditions.

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