Global Environmental Issue:

Restoration of Polluted Waterways

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I had been living in Buffalo, New York for nearly two years before I discovered that a river flows through the southern portion of the City, carrying the City's name. In an environmental forum sponsored by the local chapter of the Adirondack Mountain Club, one presentation introduced the Buffalo River and its environmental problems. Now, nearly eight years later, the Buffalo River is an integral component in my classroom discussions, and provides numerous opportunities for students to participate in research projects. The river also serves as an excellent example of a local environmental issue with international implications.

Background

The polluted condition of the Buffalo River can be traced to the industrialization of Buffalo. Until fairly recently, numerous industries (including chemical, steel, and oil refining) lined the shores of the river (Figure 1) and routinely discharged metals and organic compounds into it. Today, most of the industry either has shut down or decreased production, and all operating facilities are subject to stricter environmental controls. The legacy of the past has led to the destruction of habitat, poor water quality, and the deposition of contaminated bottom sediments, and has resulted in the Buffalo River being included in the list of Canadian-United States Area of Concerns (AOC). There are 43 AOCs within the Great Lakes basin (Figure 2) and through the 1987 amendments to the Great Lakes Water Quality Agreement, the US and Canadian governments have made strong commitments that should ultimately lead to the restoration of the AOCs. For each AOC, a remedial action plan (RAP) is developed. The RAP process is a systematic and comprehensive ecosystem approach to restoring environmental integrity in the AOCs. In the US, the Environmental Protection Agency is the lead agency, coordinating and assisting the eight Great Lakes States in drafting RAPs. In 1989, the EPA implemented the Assessment and Remediation of Contaminated Sediments (ARCS) Program, designed to develop guidelines for evaluating remediation options which are broadly applicable to all AOCs. The Buffalo River was designated one of the five ARCS study locations which resulted in several demonstration projects.

The International Joint Commission (IJC) is a binational organization responsible for assessing and reporting progress of the US and Canadian governments in restoring the beneficial uses of the AOCs. The IJC sets goals, establishes guidelines, and reviews RAPs. To ensure shared decision making in the RAP process, the IJC recommended the integration of citizens groups into the structure. By the time I learned about the Buffalo River, the RAP committee already was formed. Because the monthly RAP meetings were open to the general public, it was easy for me to become involved. I joined the technical subcommittee which was responsible for the review and compilation of available data. The Buffalo River RAP (NYSDEC, 1989) was submitted to the IJC for review in 1989. Several months later, the Buffalo River Remedial Advisory Committee was appointed to advise and assist the New York State Department of Environmental Conservation in the implementation of the RAP. For the past five years, I have been a co-chair of this advisory committee. In Buffalo, public outreach continues to be coordinated largely through the Friends of the Buffalo River, a not-for-profit organization comprised of concerned citizens. I serve on the board of directors of this organization.

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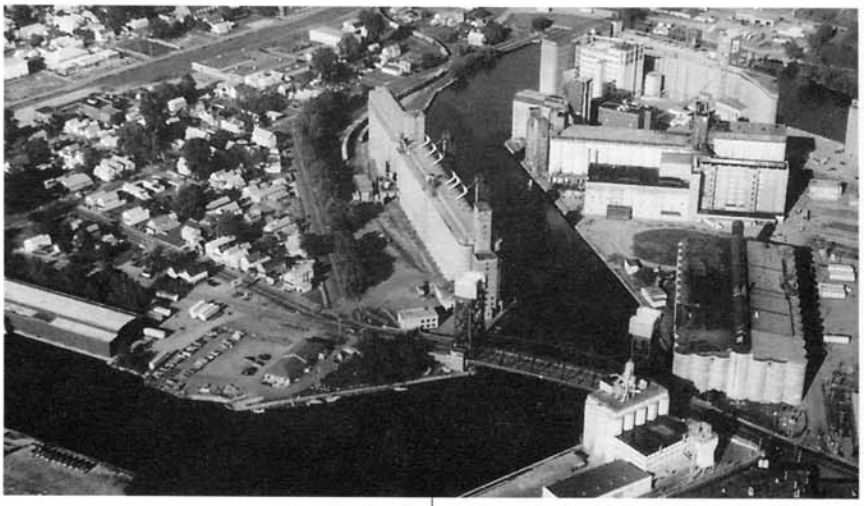
Undergraduate Opportunities

Research efforts in the Buffalo River have centered on water and sediment quality, sediment transport dynamics, pollutant transport modeling, and assessment of habitat. Funding sources have included the United States Environmental Protection Agency (EPA), The Petroleum Research Fund (PRF), National Science Foundation, and United States Army Corps of Engineers (USACE). Buffalo State College maintains a waterfront field station with 2 Boston Whalers, providing faculty and students easy access to the Buffalo River.

Undergraduate students have taken part in a variety of field studies and research projects. A major effort funded by the EPA involved the development of a mini-mass balance model for the Buffalo River. Water column samples, collected under low and high flow conditions, were analyzed for conventionals (i.e., dissolved oxygen, dissolved organic carbon, particulate concentration, etc.) and selected organic compounds. Undergraduate students were hired to assist in this sampling. Although students did not complete a research project of their own, they were exposed to EPA sampling protocols and learned to use a variety of field sampling equipment. Undergraduates also took part in an intensive monitoring effort as part of an EPA-USACE funded environmental dredging demonstration project. The students collected water column samples that were analyzed for particulate concentration; they also took part in pre- and post-dredging side-scan sonar profiling and helped evaluate changes in bottom morphology immediately following (several days) and one month following dredging activities. One of the students produced a videotape showing the different dredging techniques used during the demonstration project. This video was shown at an international symposium on environmental dredging, held in Buffalo, New York in 1992. A third large-scale effort involved undergraduate field assistants in a multidisciplinary study that included: evaluation of siltation rates, biological surveys of the river, and shoreline and river bottom mapping. Undergraduate earth science and geography majors were involved in this field intensive effort. Many of the students taking part in these studies completed an individual research project.

Figure 1. Aerial view of a portion of the Buffalo River, Buffalo New York



Because a senior thesis is not required at Buffalo State College, students receive elective credit for research by enrolling in independent studies (usually 3 credit hours for I or 2 semesters). Several research projects involving undergraduates are described below.

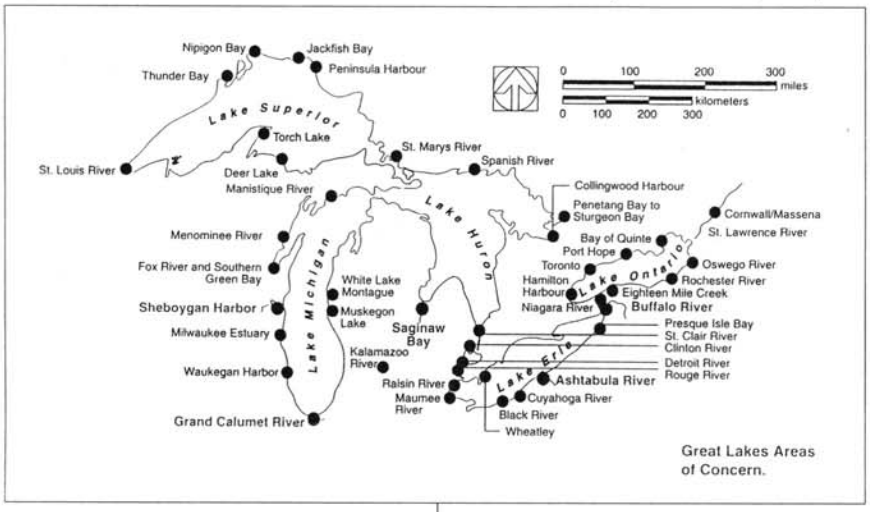
River Bottom Morphology

For the past five years, I have been working with Dr. Patricia Manley (Middlebury College) to document changes in river bottom morphology. Our approach has involved the use of side-scan sonar (Figure 3), with one or more surveys conducted each year. This multi-year effort has resulted in 2 senior theses (Middlebury College), 2 individual research projects (Buffalo State College), and several presentations (Manley et al., 1992; Ruhl, 1993; and Sweet and Singer, 1994). Students have identified areas of sediment erosion and deposition (by noting the appearance of sediment tailings and exposed bedrock), and have documented slumping following removal of sediment by maintenance dredging. A particularly interesting feature discovered through side-scan sonar mapping is the sedimentary furrow. Furrows are longitudinal bedforms that have been identified in a number of diverse sedimentary environments including the deep sea, estuaries, and large lakes. Their origin has been attributed to secondary circulation in the bottom boundary layer. The furrows in the Buffalo River persist from year-to-year along a 1000 m section of the river. Biannual to annual surveys within this furrow field reveal changes in the convergence and divergence of individual furrows, as well as the addition of new furrows and disappearance of others. Because furrow formation involves both erosion and deposition, the migration of furrows within this stretch of the Buffalo River has been linked to the resuspension of contaminated sediment. Research projects undertaken by students include characterization of furrow morphology and annual changes in appearance and number. With funding from PRF, a current meter has been placed within the furrow field in an effort to understand the role of bidirectional flow in furrow formation.

Levels and Sources of Indicator Bacteria

Dr. Kim Irvine (Department of Geography) and Dr. Gary Pettibone (Department of Biology) have involved undergraduate students in a multi-year effort examining levels and sources of indicator bacteria (fecal coliform, E. coli, fecal streptococci). Three students assisted with the sampling for bacteria, suspended sediment, dissolved oxygen, pH, and conductivity. These students also did the suspended sediment concentration and bed sediment size distribution analyses. Another student plotted farm

Figure 2. Location of the Great Lakes Areas of Concern (from USEPA, 1994)



centroids having a field edge within 1000 feet of a waterway on the GRASS GIS system at the Soil Conservation Service (SCS) office. The centroid locations were tied together with the SCS farm tract database, and this provided locations and information on possible sediment and bacteria sources. One undergraduate was an author in an abstract on this research (Pettibone et al., 1994).

Estimation of Siltation Rates

Dr. Kim Irvine also has involved undergraduates in an EPA funded project examining siltation rates and suspended sediment dynamics within the Buffalo River AOC and watershed. Two undergraduates (Figure 4) assisted with the sampling and analysis of suspended sediment concentrations for sites on the major tributaries to the Buffalo River. Another student worked at the USACE, Buffalo District to develop a 3-dimensional bathymetry analysis methodology on the InterGraph GIS. This methodology was used to evaluate siltation rates using bathymetric data collected in a section of the river after navigational dredging one year, and prior to dredging the following year. Two of the undergraduates were authors in a publication resulting from this research (Monahan et al., 1994).

Figure 3. Lana Fuller collecting side-scan sonar data on the Buffalo River

Conclusions

Faculty and undergraduate students involved in the restoration of the Buffalo River face the exciting challenge of the dual role of scientist and concerned citizen. Geologists are becoming increasingly involved in the decision-making process, and, based upon student feedback, undergraduates are very interested in taking part in projects with practical applications. For faculty considering becoming involved in local environmental issues, a first step may include phone calls to state and county environmental agencies and local chapters of environmental organizations. These sources likely will be able to provide information on environmental issues of concern and also if public meetings are scheduled. Public meetings are ideal for networking and learning more about the issues. Once you learn more about a particular area, it becomes much easier to identify potential projects for undergraduates. ▼

References

(underline denotes undergraduate)

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Figure 4. Kelly Monahan analyzing water column samples from the Buffalo River