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Aquatic Insects as Bioindicators of Land Use Change in the Grand Traverse Bay Area of Michigan

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In 1996, the US-Canadian International Joint Commission identified five key stresses impacting the Great Lakes Basin Ecosystem: nutrient inputs (e.g., phosphorous and nitrogen), persistent toxic substances, physical alterations (e.g., sedimentation, infiltration, runoff, water levels), human activities and values (as manifested in land-use change, populations growth, urbanization, etc.), and exotic species. Michigan's Grand Traverse Bay Watershed (GTBW) is currently undergoing all of these problems as a result of rapid population growth and regional land-use change. In 1992, a Relative Risk Analysis Project identified the absence of land-use planning as Michigan's most urgent environmental priority. This project report stated that land-use planning was seldom carried out due to the lack of adequate water quality indicators of land use practices.

Researchers at Michigan State University (David Hyndman, David Long, Bryan Pijanowski) and the US Geological Survey (Sheridan K. Haack) initiated work in 1997 on biogeochemical indicators of land use change in the GTBW. The objectives of this project are to (1) develop linkages between stream biogeochemistry and land use/management for inclusion in a Land Transformation Model; (2) develop linkages between land use and groundwater dynamics to provide a mechanism to examine the transport of chemicals associated with particular land use activities: (3) conduct high and low resolution sampling with an expanded list of chemicals/bioindicators to verify water quality indicators of specific land uses; (4) develop state-of-the-art 2-dimensional and 3-dimensional computer visualizations of data and model outputs; (5) conduct a viewshed analysis of the GTBW to approximate the influence of views and vantage points on regional development; (6) develop and calibrate the new land use change model using neural network techniques; and (7) conduct stake holder workshops and technology transfer activities of that knowledge and data generated by this project can be used by local government and regional resource mangers.

We (Robert Haack and Toby Petrice) became involved in the above study in 1998, adding an aquatic macroinvertebrates component to the study. Aquatic macroinvertebrates are useful bioindicators of water quality because most are relatively immobile and dwell on the stream-bottom. Macroinvertebrates vary greatly in their tolerance to pollution with some groups being very sensitive (e.g., Plecoptera, Ephemeroptera, Trichoptera, Megaloptera: Corydalidae, and gilled snails), others being moderately sensitive (e.g., Diptera: Tipulidae, Odonata, and amphipods), and others being tolerant to pollution (e.g., Diptera: many Simulidae and Chironomidae, leeches and lunged snails). Several stream quality indices have been developed based on the relative abundance of macroinvertebrates from these three sensitivity groups present in stream samples collected according to standardized procedures.

In the fall of 1998, we sampled 31 sites in the Boardman River and Mitchell Creek watersheds, which are part of the larger GTBW. The sites were distributed in areas with different amounts of forest cover and land use. Percent forest cover and urban and agricultural land use at each site was quantified. At each site, three Hester-Dendy multiple plate samplers were set out in the stream bottom and anchored with a brick. The samplers were collected after six weeks and all insects were identified to the order and family level. We determined stream quality using three macroinvertebrate indices: 1) the Percent EPT (Ephemeroptera, Plecoptera, and Trichoptera); 2) the Ratio of EPT to Chironomidae; and 3) the Total Stream Quality Index (used by the Michigan Department of Environmental Quality). At each site, water quality analyses were performed by the other cooperating scientists and included parameters such as water pH, turbidity, dissolved oxygen content, temperature, specific conductance, and concentrations of selected ions. Water samples were collected and plated to determine coliform bacterial counts.

The three different macroinvertebrate indices all gave similar results. Overall, water quality, as measured by the aquatic macroinvertebrate indices, was positively related to increases in percent forest cover, and negatively related to increases in percent urban and agricultural land use, specific conductance, concentrations of Ca and NO_3 ions, and total coliform count.

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A Michigan Monarch Recovered in Mexico

Adapted from *Monarch News: A Newsletter from the Monarch Butterfly Project*, Volume 1, Issue 1, 2000.

The Monarch Butterfly Project is a cooperative project between the Hiawatha National Forest of the US Forest Service and Wildlife Unlimited of Delta County, Michigan. In 1999, 58 volunteers contributed over 450 hours to monitor monarch reproduction and migration and to improve habitat for monarch butterflies near Penninsula Point, Delta County, in Michigan's upper peninsula.

The highlight of the 1999 Monarch Butterfly Project was the recovery of the monarch bearing tag number 105247. It was recovered by Dr. Lincoln Brower at El Rosario, a monarch butterfly reserve near Angangueo, Mexico, on 23 March 1999. El Rosario is over 2000 miles from Peninsula Point. This male monarch was tagged at Peninsula Point on 4 September 1998 by Ruth Gifford, a resident of Delta County. Dr. Brower, called the " Dean of Monarch Studies" by National Geographic, has been of great assistance to the Monarch Butterfly Project and his recovery of monarch #105247 makes this recovery all the more special.

More remarkable perhaps is the fact that only 88 monarchs were tagged at Penninsula Point in 1998. The chances of any of these being recovered were very slim. Monarch Watch at the University of Kansas and the Monarch Program in California are now paying rewards in Mexico for tagged monarchs. This has increased the recovery rate of tagged monarchs from less than 0.01 percent to about 1 percent.