Final Report
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The Influence of Extreme Hydrologic Events on Benthic Macroinvertebrate Assemblage Structure

STUDY OBJECTIVES:

1.) Determine the baseflow macroinvertebrate community downstream from the impoundment

2.) Determine the effect of an extreme hydrologic event on the macroinvertebrate community structure downstream from the impoundment

3.) Determine recolonization rates of macroinvertebrates after the high flow disturbance

Introduction:

One of the most adverse disturbances exerted on aquatic systems is river impoundment. The expansion of human populations and activities has resulted in extensive damming, regulation and diversion of the world's rivers. Ecologically, dams alter a river's important processes by changing the flow of water, nutrients, sediment, biota and energy. When a dam is built, alterations to the flow of water and sediment may lead to changes in habitat including increased bank erosion, scouring of the river bottom and manipulation of habitat structure, causing the ecology of the river to be significantly and detrimentally altered. One of the most significant influences exerted by dams on downstream biota is a reduction in seasonal flow variability and alterations in timing and/or magnitude of extreme flow events.

Freshwater macroinvertebrates have often been used as biomonitors due to their variability in sensitivity of groups to stress exerted on the aquatic environment. Invertebrates vary greatly in their taxonomic-specific abilities to cope with environmental stress, therefore they are useful as biomonitors of aquatic integrity.

The washing out of macroinvertebrates and the subsequent recolonization below river impoundments after an extreme flow event has not received much attention to date. This study investigates the effect of flow variability due to dam activity on the benthic macroinvertebrate assemblage within the downstream reach of the Sangamon River. Specifically, the study addressed the following objectives: 1.) Determine the base flow macroinvertebrate assemblage present downstream from the impoundment, 2.) Determine the effect of an extreme hydrologic event on the macroinvertebrate assemblage structure downstream from the impoundment.

Materials and Methods:

This study was conducted in the downstream reach of the Sangamon River in Decatur, Illinois starting at the dam on Lake Decatur. The dam was constructed to create a reservoir for municipal consumption, industrial utilization, sewage disposal and recreation. As a result of the impoundment, variable flow rates are common in the downstream reach of the Sangamon River. Four sample sites were identified and a100 meter reach of stream was marked at each of the selected sites. The benthic macroinvertebrate assemblages were described as determination of the extent of hydrologic flow disturbance on the assemblages in relation to distance from the high flow event release from the dam on Lake Decatur. Sampling was done in the spring and summer of 2006. Sampling dates were determined based on estimates of daily discharge (ft^3/sec) of the Sangamon River. Samples were collected at base flow conditions before and after major hydrologic events. For this study a major hydrologic event was determined to be a discharge class of >2000 ft^3/sec.

The sampling method used was the EPA 20 Jab Method. Samples were taken in approximate proportion to each habitat type's surface area of the total benthic habitat within the desired reach. Three replicates of 20 jab kick samples were taken at each site on each sampling date. Samples were stored in one-gallon plastic containers and preserved in 95% ethanol containing rose bengal. Collected samples were processed in the lab according to the Illinois EPA Bureau of Water macroinvertebrate processing procedures. Samples were processed according to the Illinois EPA Bureau of Water macroinvertebrate processing procedures. Sub-sampling was done using guidelines provided by Canton (1991). Elutriation was done using a 500 micrometer USA Standard Testing Sieve. A sample was considered complete when approximately 300 (+10%) macroinvertebrate individuals were obtained, or the entire sample was sorted. Upon completion of sub-sampling, organisms were identified to the lowest taxonomic level using proper keys (Merrit and Cummins 1984, Thorp and Covich 1991) and abundances were determined and recorded on laboratory data sheets.

Results:

Overall, 6,724 macroinvertebrates representing 30 taxonomic groups were collected and identified throughout the sampling period from spring and summer 2006. The dominant taxonomic groups present were: Chironimidae (83%), Oligochaeta (10%) and Hydropsychidae (4%). All other taxonomic groups encompassed the remaining 3% of the organisms collected.

To evaluate changes in macroinvertebrate assemblage structure, relative abundance for taxonomic groups present were used to determine relatedness of assemblages by sample date and site using multidimensional scaling (MDS) based on Bray-Curtis similarity matrices (BC). Data were standardized by sample total and square root transformed to moderate the effects of extreme abundances. Similarity of macroinvertebrate assemblages between sample site and date was portrayed in scatter plots using the first two ordination axes. Multivariate analysis of similarity (ANOSIM) was run to determine any significant differences in assemblage data by site and sample date. All multivariate analyses were preformed using Primer 6.1.6 and significance levels were set at $p < 0.05$.

ANOSIM results for all samples dates by site indicate that there is an overall significant difference in macroinvertebrate assemblage composition by site ($p=0.01$). Specifically, the two sites that are the most different from one another are site A (closest downstream site to the dam) and site D (furthest downstream site from the dam) ($p=0.001$). The two sites that were not significantly different from one another are site B and C (two middle stream reaches) ($p=0.408$). This is important to note, as it disregards the influence of sanitary district discharge as a confounding variable due to the fact that sanitary discharge is released between sites B and C. MDS ordinations show similar results with distinct groupings of macroinvertebrate assemblage data for all sample dates by site. Site A shows a tightly packed grouping loading on the opposite side of a tightly packed grouping of site D. Sites B and C, however, overlap and are not distinct from one another, thus visually demonstrating their similarity in macroinvertebrate assemblage composition.

ANOSIM results for all sites by sample date indicate that there an overall significant difference in macroinvertebrate assemblage composition by sample date ($p=0.01$). This significant difference can be attributed to both natural and anthropogenically induced changes within the aquatic ecosystem. A seasonal trend associated with the macroinvertebrate assemblage data was observed as a natural disturbance. Anthropogenic disturbance influence was an extreme hydrologic flow event from a large release of water through the impoundment. These events disrupted the natural seasonal trend and reset the system to a similar macroinvertebrate assemblage composition from an earlier date.

Discussion:

Overall, the results of this study indicate that extreme hydrologic events negatively impact macroinvertebrate assemblages within the Sangamon River. Significant differences in assemblages by site indicate that the further downstream a site is from the source of a high flow event, the more different the assemblage composition is from a site that is immediately downstream from the discharge. Therefore, it may be said that sites closer to the high flow impact are differently affected by the event compared with a site that is further downstream (in this case 7 km downstream from the dam). Additionally, data suggest that extreme hydrologic flow events disrupt naturally occurring seasonal trends. The intermittent interruption of riverine natural processes due to dam presence could detrimentally alter aquatic ecosystems on various ecological levels. More studies conducted at other trophic levels may yield similar results.

Measurable Outcomes:

Professional Presentations:

- 2007 Association of Southeastern Biologists 68th Annual Meeting, Columbia, SC. (paper). *"How extreme flow events affect benthic macroinvertebrate assemblages in the Sangamon River, Decatur, Illinois."*

- 2007 Illinois American Fisheries Society State Meeting, Lake Shelbyville, IL (paper). *"The Response of Benthic Macroinvertebrate Assemblage Structure to an Extreme Hydrological Event."*

- 2006 Midwest Fish and Wildlife Conference, Omaha, NE (poster). *"The Influence of Extreme Hydrologic Flow on the Benthic Macroinvertebrate Community Structure in the Sangamon River, Decatur, IL."*

Honors:

Spring 2007	Eastern Illinois University- College of Science Graduate Student Investigator Award
Spring 2007	Eastern Illinois University – Williams Travel Grant
Spring 2007	Student Travel Grant - Illinois Chapter of the American Fisheries Society
Spring 2007	Associate member of Sigma Xi Scientific Research Society
2006- 2007	Biological Sciences Graduate Student Association Activities Committee Member
Fall 2006	Eastern Illinois University- Graduate School Research/Creative Activity Research Grant
Spring 2006	Illinois Department of Natural Resources- Illinois Wildlife Preservation Fund Grant
2006-present	Phi Sigma Biological Sciences Honor Society member
2005-2007	Eastern Illinois University- Graduate Research Assistantship
Fall 2005	Eastern Illinois University- Graduate School Research/Creative Activity Research Grant

As a result of my education and research experience at Eastern Illinois University, I was offered and have accepted a job with the National Park Service. I am the aquatic ecologist for the Heartland Inventory and Monitoring Network at Ozark National Scenic Riverways in Van Buren, MO. I am specifically responsible for the collection, processing and identification of invertebrates within OZAR rivers and streams. I am very fortunate to have received helpful advising and funding for my Master's thesis which have allowed me to be where I am today.

Budget to be sent by Business Office.

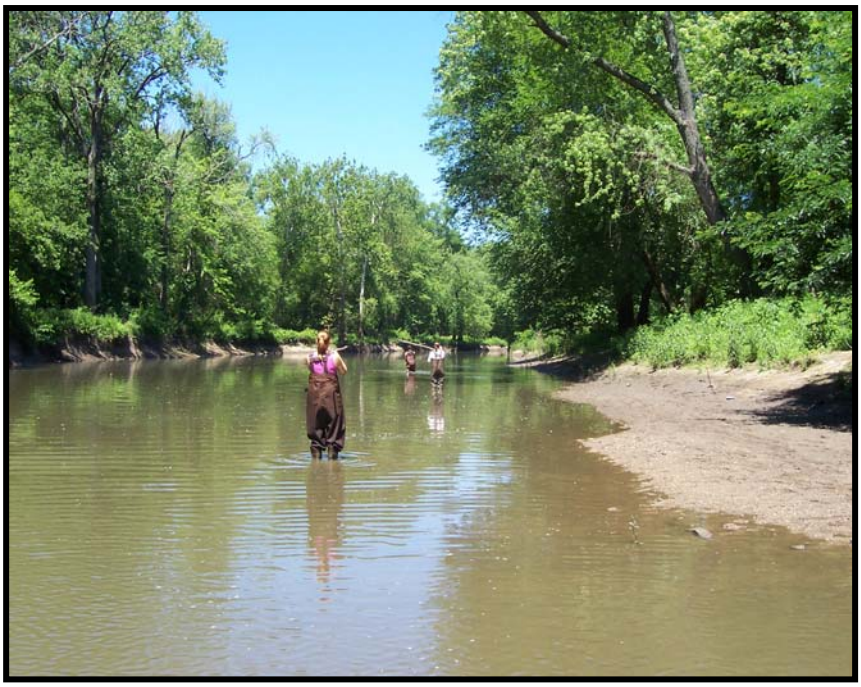
Project Pictures:

Dam on Lake Decatur holding water back from the Sangamon River, resulting in low flow conditions.

Dam releasing water from Lake Decatur to the Sangamon River, resulting in high flow conditions.

Low flow conditions below the dam.

High flow conditions below the dam.



EPA 20-Jab Method used to collect benthic macroinvertebrates.

Processing samples in the lab.

Identifying macroinvertebrates in the lab.