The Effectiveness of Artificial Riffles as an Aquatic Habitat Restoration Technique

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Introduction:

In the late 19th and early 20th centuries large expanses of land in the Midwest were drained for agriculture. Rivers and streams were dredged, causing the loss of woody debris and gravel deposits. Fine and course cobble that create natural riffles were replaced by fine sediment. These vast physical changes over the past century have been a major factor in the loss of habitat heterogeneity in Illinois streams. This has had negative effects on diversity, abundance and biomass in both fish and invertebrates. These changes have directly affected those species that rely on course substrate and high velocity and can only be reversed by the re-creation of the depleted habitat. To mediate the loss of riffle habitat and associated loss of aquatic diversity due to increased sediment and channelization in the Midwest, the Illinois Department of Agriculture installed thirty artificial riffles on eight different perturbated streams between 2000 and 2003. The purpose of this project was to determine whether artificial riffles and naturally occurring riffles support similar fish assemblages and assess the economic feasibility of artificial riffles.

Materials and Methods:

Three study sites in east central Illinois were chosen due to their stream order and accessibility. These sites include Sugar Creek in McLean County, Hurricane Creek in Coles County, and Ashmore Creek in Clark County. Sugar Creek is a third order stream having two artificial riffles installed in the year 2000. Hurricane Creek is a second order stream that had five artificial riffles installed in 2003 and Ashmore Creek is a first order with three artificial riffles installed in 2000.

Fish communities on two artificial riffles and one adjacent downstream natural riffle were sampled using standard stream sampling techniques (electro shocking). Two spring fish samples were taken on each creek between March and June 2005, and another two samples from Sugar and Ashmore Creeks between September and November 2005.

Three benthic macroinvertebrate samples were collected from June 2005-September 2005 on Sugar and Ashmore Creeks using a $1m^2$ kicknet. For each sampling date, one upstream and one downstream sample were taken per riffle. Two ½ m area sites were scraped and kicked until all organisms were thought to be dislodged into $1m^2$, 500 μ mesh kicknet. All biological samples and substrate were preserved in 95% ethanol and brought back to the laboratory for identification. Sub sampling procedures defined by the EPA and further modified by Caton 1991 were employed to identify organisms to the family level where possible.

Results:

Over 6000 individual fish were collected and identified from artificial and natural riffles during spring and fall of 2005. Species richness did not differ between natural and artificial riffles within streams but significantly differed between Sugar and Hurricane and Sugar and Ashmore Creeks ($P<.001$). Artificial riffles in Sugar Creek supported the greatest number of fish species of all three creeks. Although diversity did not significantly differ between artificial and natural riffles within streams, artificial riffles in Sugar and Hurricane Creeks were characterized by higher diversity than natural riffles. Diversity differed between Ashmore and Sugar and Ashmore and Hurricane Creeks ($P<.05$) with Sugar Creek having the greatest diversity. IBI scores categorized all sites as fair to moderate quality but scores did not differ between artificial and natural riffles within streams. Scores significantly differed between Sugar and Hurricane and Sugar and Ashmore Creeks ($P<.05$) with Sugar Creek characterized by the greatest scores.

A Bray Curtis Similarity matrix identified that 1st, 2nd, and 3rd order streams were distinctly grouped ($P<.001$) and fish assemblages were significantly different among creeks. Within streams, no difference was observed in the fish communities between natural and artificial riffles in all three creeks.

Approximately 9000 macroinvertebrates were picked and identified from the samples taken from Sugar and Ashmore Creeks. A Bray Curtis Similarity matrix of invertebrate assemblages identified no difference between creeks or between natural and artificial riffles within streams. Natural and artificial riffles seem to function similarly with respect to their invertebrate communities.

Discussion:

Overall, the results of this study indicate that artificial riffles mimic natural riffles in species richness, diversity and IBI scores of fish assemblages within creeks. Bray Curtis Similarity Matrices also indicate that fish and invertebrate communities on natural and artificial riffles within streams are quite similar, reiterating the idea that artificial riffles are restoring stream communities to a more natural state. Our data suggest this type of restoration effort proves economically feasible with respect to fish and invertebrate communities and will hopefully aid in future management decisions.

Measurable Outcomes:

Professional Presentations:

- 2006 Association of Southeastern Biologists 67th Annual Meeting, Gatlinburg, TN (paper). Artificial Riffles as a Remediation Technique in Three Illinois Streams

- 2006 Illinois American Fisheries Society State Meeting, Rend Lake, IL (paper). A Comparison of Fish Assemblages Between Natural and Artificial Riffles in East Central Illinois Streams

- 2005 American Fisheries Society National Meeting, Anchorage, AK (poster). The Effectiveness of Artificial Riffles as an Aquatic Habitat Restoration Technique

- 2005 Midwest Fish and Wildlife Conference, Grand Rapids, MI (poster). Artificial Riffles as a Remediation Technique in Three Illinois Streams

Honors:

-	2006	Eastern Illinois University Graduate Student Investigator Award
-	2006	Associate member of Sigma Xi Scientific Research Society
-	2005- 2006	Biological Sciences Graduate Student Association Vice President
-	2005	Sigma Xi Grant in Aid of Research
-	2004-2006	Phi Sigma Biological Sciences Honor Society

Project Pictures:

Setting up block nets above artificial riffle on Sugar Creek (3rd Order).

Picking fish from the downstream block net on Sugar Creek.

Sampling fish communities on Hurricane Creek (2nd order) using an electric seine.

Setting up a block net above artificial riffle on Hurricane Creek.

Artificial Riffle on Hurricane Creek.

Artificial riffle on Ashmore Creek (1st order).