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Effect of a Recently Completed Habitat Rehabilitation and Enhancement Project on Fish Abundances in La Grange Pool of the Illinois River using Long Term Resource Monitoring Program Data

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Cover photo: Aerial photograph of Lake Chautauqua and Illinois River.
Photo taken by William Starrett, October 27, 1970

Effect of a Recently Completed Habitat Rehabilitation and Enhancement Project on Fish Abundances in La Grange Pool of the Illinois River using Long Term Resource Monitoring Program Data

by

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Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Upper Midwest Environmental Sciences Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report was prepared under Strategy 3.3.2, *Test and Assess the Effectiveness of Prototype Management*, as specified in Goal 3, *Develop Alternatives to Better Manage the Upper Mississippi River System* of the Operating Plan (U.S. Fish and Wildlife Service 1993). This report was developed with full funding provided by the LTRMP.

Effect of a Recently Completed Habitat Rehabilitation and Enhancement Project on Fish Abundances in La Grange Pool of the Illinois River using Long Term Resource Monitoring Program Data

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Abstract: The Long Term Resource Monitoring Program (LTRMP) fish component monitors fish communities to test for changes in abundances and species composition in six regional trend areas of the Upper Mississippi River System. Using these data, we evaluated the ability of the LTRMP to detect changes in the fish community as a consequence of a habitat-enhancement project in La Grange Pool of the Illinois River. In 1996, initial phases of the Chautauqua National Wildlife Refuge Habitat Rehabilitation and Enhancement Project (HREP) south cell construction were completed with the goal of improving fish habitat in the pool. That year, an estimated 46 million fish representing 34 species were produced and discharged from the south cell of Lake Chautauqua. Whereas this response may indicate that the south cell serves as a spawning and nursery area for many fish species, no studies have tested for recruitment to the river fish community. We used geographic information system coverage at three spatial scales in the main-channel and side-channel strata to illustrate potential fish-community responses. At these spatial scales (local 1 river mile [RM], regional ~10 RMs, and pool wide 80 RMs), we assessed fish catch-per-unit-effort (CPUE) data collected from mini-fyke net and day electrofishing among pre- (1993–1995) and post-HREP (1996–2005) periods of the Chautauqua National Wildlife Refuge HREP. Analysis of Similarity results demonstrated no significant differences among periods in fish CPUE ($P > 0.05$). Our results may indicate that (1) the LTRMP sampling design lacked sufficient statistical power to detect effects of the HREP, (2) the LTRMP sampling design lacked the spatial and temporal resolution to detect effects, (3) the Lake Chautauqua HREP has not been established long enough to detect long-term trends in fish production, or (4) the HREP had no effect on fish recruitment to the Illinois River. Nevertheless, our results clearly show that backwaters are major fish producing areas in La Grange Pool and future HREPs to enhance backwater fish habitat may be critical to the long-term sustainability of the Illinois River fish community. As a result of our findings, we suggest that an intensive study at defined temporal and spatial scales may be required to detect changes in the fish community in La Grange Pool as a consequence of HREPs.

Key words: fish communities, Habitat Rehabilitation and Enhancement Project, Illinois River, Lake Chautauqua, Long Term Resource Monitoring Program

Introduction

In 1986, the Water Resources Development Act authorized the implementation of a Long Term Resource Monitoring Program (LTRMP) and Habitat Rehabilitation and Enhancement Projects (HREPs) for the Upper Mississippi River System (UMRS) as elements of the U.S. Army Corps of Engineers Environmental Management Program. Although the LTRMP (monitoring of biological and water resources) and HREPs (restoration and protection of critical fish and wildlife habitat) were developed separately, opportunities exist to use LTRMP data to assess the effectiveness of HREPs in achieving habitat restoration and conservation goals.

Since 1990, the LTRMP and two HREPs have been implemented in La Grange Pool of the Illinois River. The LTRMP fish component has conducted 5,637 collections capturing about 1.25 million fish (89 species) since 1993, representing one of the most comprehensive data sets on the Illinois River. The primary objectives of the LTRMP are to detect long-term trends in the key regional trend areas and to test for correlations among trends and environmental variables to gain insight into possible cause-and-effect relations.

In 1992, the Chautauqua National Wildlife Refuge (U.S. Fish and Wildlife Service) was chosen for a HREP. Prior to HREP construction, Lake Chautauqua was separated from the main stem of the Illinois River by a levee and, before 1992, was shallow and turbid with resuspension of sediments dominating the limnology of the ecosystem (Irons et al. 1997). The major features of the project were to repair a cross dike, which effectively divided the lake into two separate cells (north and south), and add a stop-log water-control structure on the south cell. The management plan for the north cell was to maintain stable water levels in an effort to promote the establishment of submersed aquatic vegetation and to provide aquatic habitat for fish, migratory waterfowl, and shorebirds. The south cell was to be managed for moist-soil conditions to enhance habitat and food plants for migratory waterfowl. In 1996, initial phases of the south cell construction were completed with the stop-log water-control structure, spillways, and levee repair. While constructing the south cell, it was recognized that this area could serve multiple functions by providing spawning and nursery habitats to fish in the spring and early summer season and moist-soil seed production in fall for migrating waterfowl. Fish access from the Illinois River to Lake Chautauqua is provided by flood events that top the levee and water-control structure. Therefore, the south cell of Lake Chautauqua may be considered a semi-natural backwater lake that mimics the hydrologic regime of the Illinois River during some years and seasons.

The goal of our research was to use LTRMP fish-component data to test for changes in the La Grange Pool fish community (i.e., relative abundance) as a result of the Lake Chautauqua HREP. More specifically, we used LTRMP data to test for fish-community responses to the HREP at three spatial scales across pre- and post-periods of project implementation. In addition, we present fish-escapement and community-composition data from the Lake Chautauqua HREP to test for the presence or absence of fish production in the post-period.

Methods

La Grange Pool Study Area

La Grange Pool, with its extensive mosaic of aquatic habitats, is among the most diverse reaches of the UMRS. La Grange Pool spans approximately 80 miles of the Illinois River and is positioned between the Peoria Lock and Dam (River Mile [RM] 157.0) near Peoria, Illinois, and the La Grange Lock and Dam (RM 80.0) south of Beardstown, Illinois. La Grange Pool can be divided into three macrohabitats: main channel (2,441 ha), side channel (163 ha), and backwaters (11,762 ha).

Lake Chautauqua Study Area

Lake Chautauqua has been an integral component of the Illinois River National System since its purchase by the U.S. Fish and Wildlife Service in 1936. Prior to Lake Chautauqua's acquisition, the area was comprised of a mosaic of floodplain forest and wetted habitats ranging from deep-water side channels to shallow pools and exposed soil areas (Starrett and Fritz 1965). However, by the early 1900s, major efforts had taken place to use this area for row-crop agriculture. In 1916, the Chautauqua drainage and levee district was created to facilitate agricultural practices. Several attempts were made to farm the drained land; however, in the mid-1920s, the land was abandoned because of high rate of crop failures from recurrent flooding. Following the purchase of the Lake Chautauqua area, the levees were maintained to allow minimum water-level management, but the lake generally was connected to the Illinois River (Irons et. al. 1997). Lake Chautauqua is between RMs 124 and 129.5 on La Grange Pool near Havana, Illinois (Figure 1).

In the late 1960s, the 1,450 ha lake was divided into two basins (a 480 ha north cell and a 970 ha south cell) by a 1.6 km-long cross dike. The cross dike failed in 1970, and ensuing attempts to repair it were unsuccessful. In 1992, Lake Chautauqua was selected for a HREP in the Environmental Management Program for the UMRS. Project construction began in 1992 and was to be completed in four stages. During each construction stage, significant flooding delayed project completion.

A major feature of the project was the repair of the cross dike, which effectively divided the lake into north and south cells again. In addition, a spillway and a stop-log water-control structure were constructed to facilitate more thorough dewatering of the south cell for moist-soil plant production. The primary purpose of the water-control structure was to incrementally control lake water levels. The control structure also is used to gravity drain the lower lake, which is why the sill is lower than the bottom of the lake. During an impending levee overtop, stop logs can be removed to expedite filling of the lower lake. Refuge personnel can remove stop logs with up to 3 ft of over-topping water.

Before HREP construction, Lake Chautauqua was characterized as shallow and turbid, with high rates of sediment resuspension (Irons et al. 1997). However, Havera (Irons et al. 1997) noted that the lake was an important resting area for migrating waterfowl in the Illinois River Valley portion of the Mississippi River Flyway and probably the most important waterfowl refuge in the Illinois River Flyway. Management actions for the south cell included manipulation of water

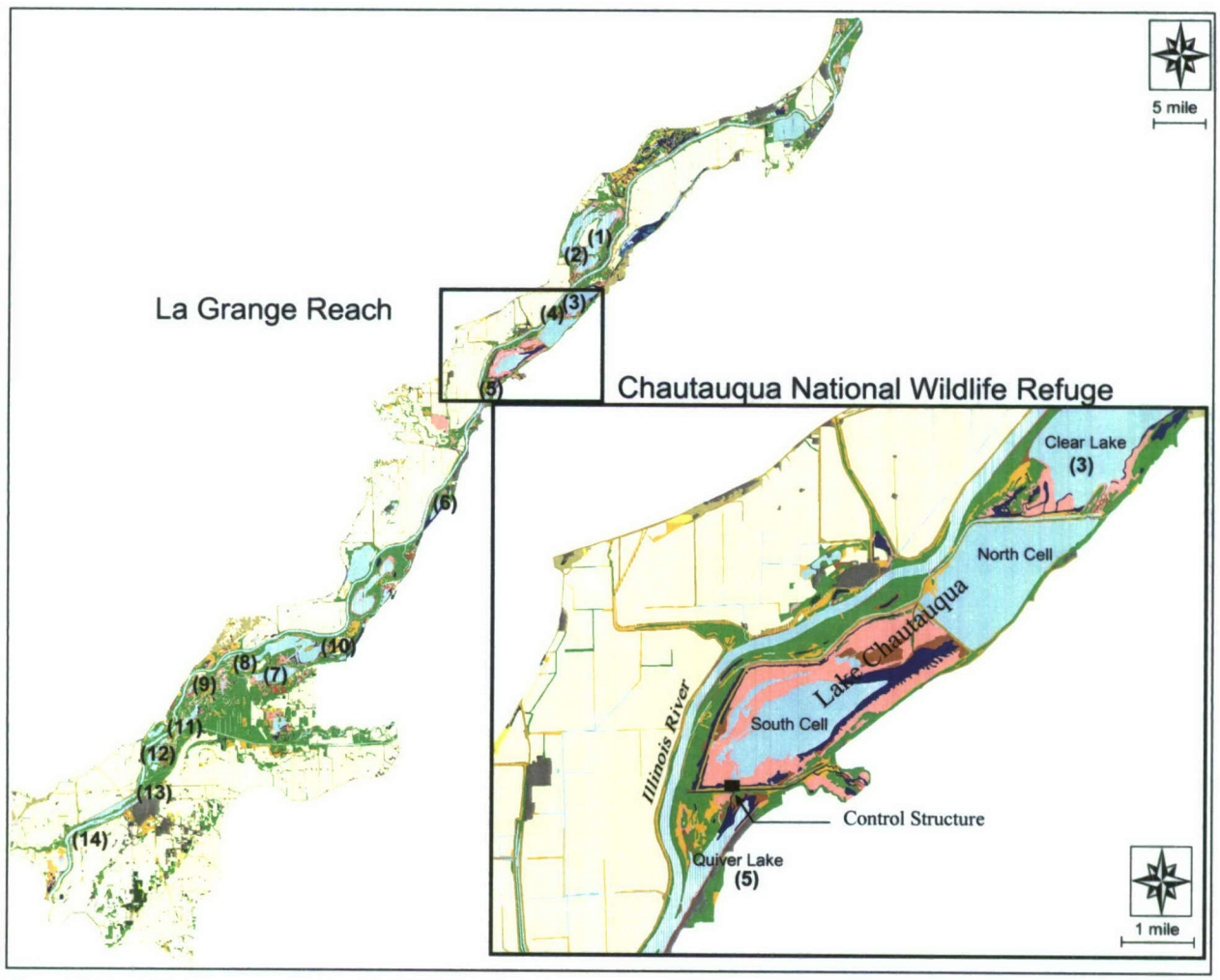

Figure 1. Map of the Chautauqua National Wildlife Refuge illustrating the south cell water-control structure (inset). Map of La Grange Pool with selected backwaters enumerated (1-14). (1=Big Lake; 2=Duck Island; 3=Clear Lake; 4=Meyers Ditch; 5=Quiver Lake; 6=Matanzas Lake; 7=Crane Lake; 8=Chain Lake; 9=Bach Slough; 10=Snicarte Slough; 11=Treadway Lake; 12=Wood Slough; 13=Muscooten Bay; 14=Lilly Lake.)

levels to mimic a natural flood cycle similar to that described by the flood-pulse concept (Junk et al. 1989). Coincidentally, normal spring flooding that generally occurs in the months of March through late June provided fish access to the south cell for feeding, spawning, and nursing. After spawning, seasonally managed July through September drawdowns via the stop-log structure could allow young-of-year, juvenile, and adult fish to escape from the cell into the main stem of the Illinois River and allow moist-soil plants to germinate on the newly exposed sediments. Precise management records of timing and rates of drawdown are not available as a consequence of lack of recording and high refuge-manager turnover.

Long Term Resource Monitoring Program Fish Sampling

Since 1989, the LTRMP has sampled fish in La Grange Pool. In the initial years of the LTRMP, a fixed-site sampling design was used throughout the pool. Therefore, inferences were site-specific and lack of randomization in the site-selection process allowed potential sampling bias into monitoring (Ickes and Burkhardt 2002). As a consequence, the LTRMP adopted a probabilistic design for annual site selection recognized as stratified random sampling to remove potential site-selection bias. This change, coupled with refined standardized protocols and sampling methods, significantly improved the scientific merit of the program (Gutreuter 1993). A complete outline of the LTRMP fish-sampling protocols can be found in Gutreuter et al. (1995). For our analyses, we used day electrofishing and mini-fyke net catch-per-unit-effort (CPUE) from 1993 to 2005. Lubinski et al. (2001) noted that day electrofishing CPUE has the statistical power to detect changes for the greatest number of species relative to all the collection methods used in the LTRMP. Because the focus of our analysis was to use LTRMP data to test for the effects of HREPs, we also used mini-fyke net CPUE because it is the most effective gear for collecting young-of-year fish that may be recruiting to the main stem of the Illinois River. Also, to reduce bias associated with the influences of additional backwater fish production, we specifically analyzed main- and side-channel catches.

The LTRMP fish sites sampled from 1993 to 2005 were classified to the nearest Illinois RM using ArcView 3.3 (Environmental Systems Research Institute 2002). Our classifications ranged from RM 80 at the La Grange Lock and Dam (the downstream end of the sample pool) to RM 158 at the Peoria Lock and Dam (the upstream end of the sample pool). We then separated fish-collection sites into three distinct spatial areas for analysis (local 1 RM, regional ~10 RMs, and pool wide ~77 RMs). These spatial scales were selected because 1-RM increments were the minimum sampling distance required to provide adequate sample sizes for statistical analyses.

We tested for temporal variation in fish responses to the Lake Chautauqua HREP at three spatial scales using abundance data from existing randomized LTRMP La Grange Pool day electrofishing and mini-fyke net catches. We conducted analyses at local (77 individual river mile classifications from HREP location), regional (eight, 10-RM circumference classifications of HREP location), and pool (~77 total river miles) spatial scales. Data were pooled from the pre- (1993–1995) and post-HREP (1996–2005) periods for the three spatial scales in an effort to gain adequate sample size for analyses, as an insufficient collection occurrence was evident with decreasing spatial resolution. We evaluated temporal variation at the pool scale and differences were tested over all years to determine potential fish-community changes at pre- and post-construction periods of the Lake Chautauqua HREP. We used the Lake Chautauqua HREP fish-escapement data collected as part of the project monitoring to corroborate potential findings at both spatial and temporal scales. LTRMP collections ere normally conducted in three standardized riods (with the exception of 2005; where early mmer was omitted and only late summer and fall periods were sampled due to budget constraints).

LTRMP fish sampling is conducted in three general habitats (strata): main-channel borders, side channels, and contiguous backwaters. In an effort to alleviate potential discrepancies from backwater contributions, we only used side-channel and main-channel-border collections. Other backwaters probably exhibit some level of fish production within themselves, similar to Lake Chautauqua, making contributions to the fish population from

outside areas difficult to evaluate because of differences in connectivity with the Illinois River.

Local, Regional, and Pool Scale Habitat Rehabilitation and Enhancement Project Effects

We tested for differences in total catches at local and regional intervals using a one-way Analysis of Variance (ANOVA). We made post hoc comparisons among local and regional intervals using a Tukey's multiple-comparison procedure to identify potential specific significant differences at given intervals. We used linear regression to test for pool-scale changes in mean catches by gear type (dependent variable) over time (independent variable) with the null hypothesis of no change in mean catches across years ($\alpha = 0.05$). We examined temporal fish-community differences of total catches using Analysis of Similarity (ANOSIM) to test for community-structure changes at pre- versus post-HREP intervals. Further validation of ANOSIM results were made via non-parametric multidimensional scaling (NMDS) plots. We used a Before-After Control-Impact (BACI; Stewart-Oaten et al. 1986) design to test for changes in fish catches following the construction of the Lake Chautauqua HREP. We defined the control portion of La Grange Pool as RM 81 through 112 and RM 134 through 157. The impacted site was defined as RM 113 through 133; the Lake Chautauqua HREP water-control structure is at RM 124. The impacted area was defined post hoc as ±10 RMs because this spatial resolution was determined to be the largest interval able to detect effects of the HREP. We conducted a series of two-sample paired *t*-tests assuming unequal variances between all river miles with a sample size greater than or equal to three before and after HREP construction in both the control and impacted portions of La Grange Pool. A minimum sample size of three is required to calculate a valid mean and variance for statistical tests. We assumed unequal variances among groups due to large deviations present in catches associated with the gears used. Day-electrofishing catches and mini-fyke net catches were both assessed independently in the BACI design. Adequate data were available to compare a total of 11 RMs for day-electrofishing runs before and after HREP construction ($n = 7$ control sites; $n = 4$ impacted sites). Ten sites were compared for mini-fyke net catches ($n = 6$ control sites; $n = 4$ impacted sites). We also tested for differences in day-electrofishing and mini-fyke net catches within the control and impacted regions among pre- and post-HREP periods using a one-way ANOVA. In all parametric statistical tests, we used the null hypothesis of no difference in catches by gear among periods or regions at the $\alpha = 0.05$ level. In addition to the main- and side-channel fish data, we also analyzed backwater data from day-electrofishing and mini-fyke nets to demonstrate the flexibility of the LTRMP fish data and to search for differences among the HREP and local backwaters. This comparison was made to determine the level of fish production from adjacent backwaters. No statistical tests were conducted because pre-escapement data from the Lake Chautauqua HREP were not available.

Habitat Rehabilitation and Enhancement Project Fish Escapement Sampling

In 1996, initial phases of the HREP construction were complete and post-HREP fish monitoring was conducted intermittently to evaluate the success of the project. We made fish collections from the south cell in three post-project years (1996, 1997, and 2000). Due to the unpredictable nature of the Illinois River, each study year was distinctly unique in its hydrology and management; therefore, sampling episodes were not conducted during a set time frame. For example, timing of our samples were constrained due to the management goals of the south cell in that distinctive moist-soil plant communities will grow at various times of the summer drawdown period. As mentioned previously, management records of drawdown timing and rates were not available during our sample years. To evaluate fish production occurring in the south cell, we initiated a fish-escapement monitoring program during dewatering (Irons et al. 1997). Although sample periods varied among the monitoring years, our specific objective was to estimate the number of actively swimming and drifting young-of-year fish released into the Illinois River from the south cell of Lake Chautauqua. The water-control structure at the south cell consists of four gates approximately 1.5 m wide. We collected escaping fish with small

mesh-hoop nets (standard LTRMP hoop net [1.2 m diameter] lined with 3-mm "Ace"-type nylon netting) and an ichthyoplankton net (500-µm mesh). We fished nets in the effluent of the structure for 1 to 15 min; sample time was based on the amount of fish collected during the initial net sets. All fish caught were counted, measured, and identified to family and species, if feasible. We used General Oceanics flow meters to determine the amount of water sampled by each net. We calculated estimates of the total numbers of fish escaping from the south cell separately for hoop and ichthyoplankton nets during each escapement period. The number of samples varied in each of the years that escapement data were collected. Sample sizes for escapement collections were not standardized among years because we were simply testing for presence or absence of fish production from Lake Chautauqua.

Results

Local Scale (1 RM) Habitat Rehabilitation and Enhancement Project Effects

Post-HREP day electrofishing mean catches per run were higher in 64% of the individual river miles where data were available for each sample period (Figure 2). The largest variation in catch was RM 123, which had pre-HREP mean catches of 157 fish and post-HREP mean catches of 6,892 fish per run. River mile 123 is 1 RM downstream of the Lake Chautauqua control structure.

Post-HREP mini-fyke net mean catches per net were higher in 86% of the individual river miles where data were available for each sample period (Figure 3). The largest variation in catch was RM 135, which had a pre-HREP mean catch of 19 fish and post-HREP mean catch of 7,106 fish per net. River mile 135 is 13 RMs upstream of the Lake Chautauqua control structure.

Using the BACI design, significantly higher catches were observed in day-electrofishing runs and mini-fyke net sets in the HREP impacted area following construction. No statistically significant differences in catches for both gears were observed in control portions of La Grange Pool among periods ($P > 0.05$). On average, catches for day-electrofishing runs in control portions of the pool were 142 and 150 fish per run before and after HREP construction, respectively (Figure 4). Catches in mini-fyke nets averaged 85 and 418 fish per set among periods; however, catches did not vary significantly among individual control river miles (Figure 5). In the impacted

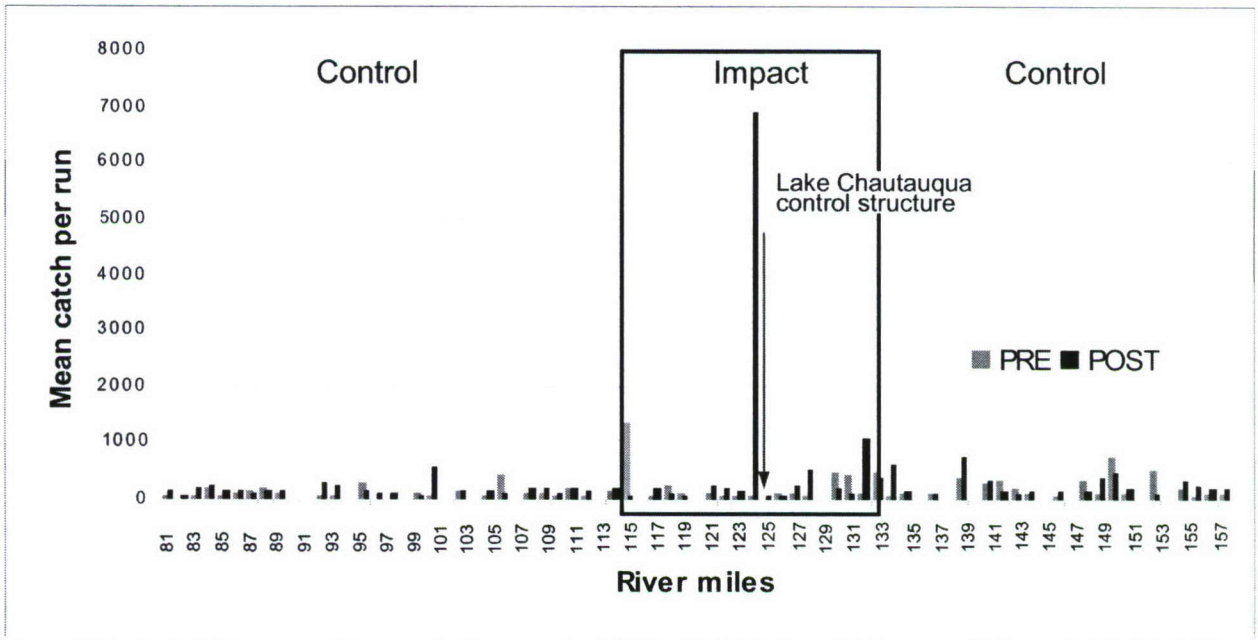

Figure 2. Day electrofishing mean catch per run for the pre- and post-Habitat Rehabilitation and Enhancement Project periods by Illinois River mile (pre-HREP mean catch = -55.564+1.878* river mile, $n = 59$; df = 1,57; $f = 2.328$; $P = 0.133$; $r^2 = 0.022$, post-HREP mean catch = -17.305+2.856*river mile, $n = 59$; df = 1,57; $f = 0.305$; $P = 0.583$; $r^2 = 0$).

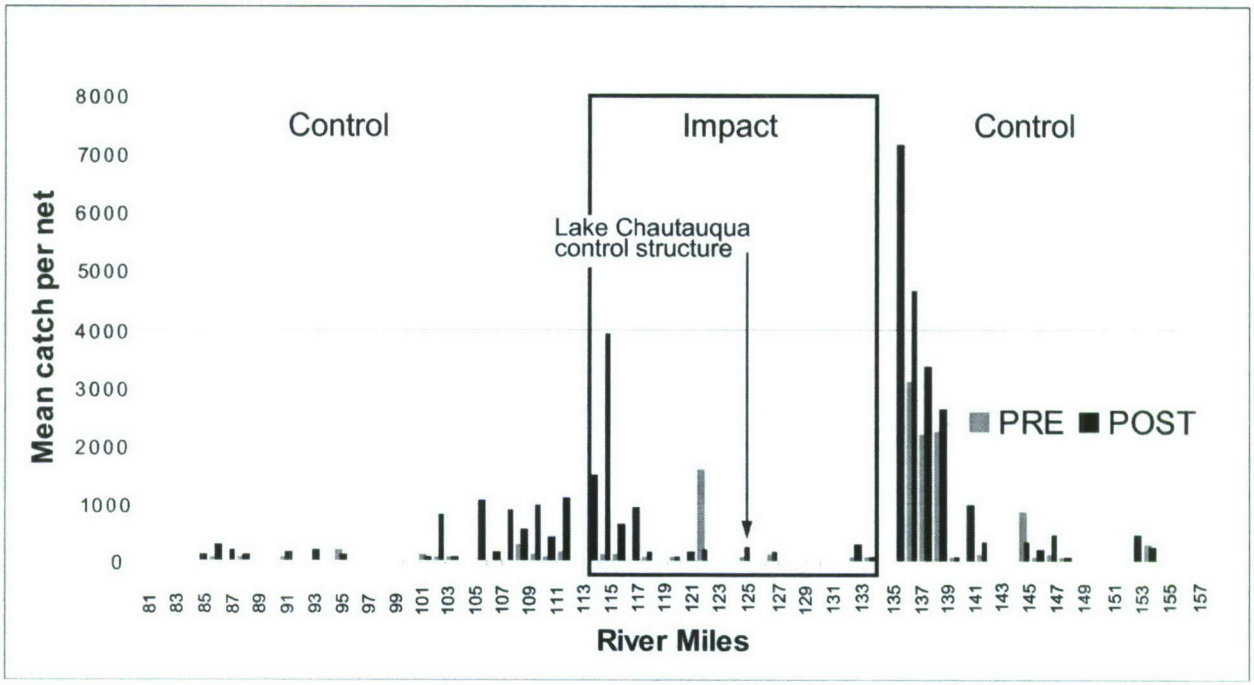

Figure 3. Mini-fyke net mean catch per net for the pre- and post-Habitat Rehabilitation and Enhancement Project periods by Illinois River mile (pre-HREP mean catch = -886.631+9.77* river mile, $n = 43$; df = 1,41; $f = 3.596$; $P = 0.065$; $r^2 = 0.058$, post-HREP mean catch = -1020.833 + 15.513*river mile, $n = 41$; df = 1,94; $f = 1.94$; $P = 0.17$; $r^2 = 0.022$).

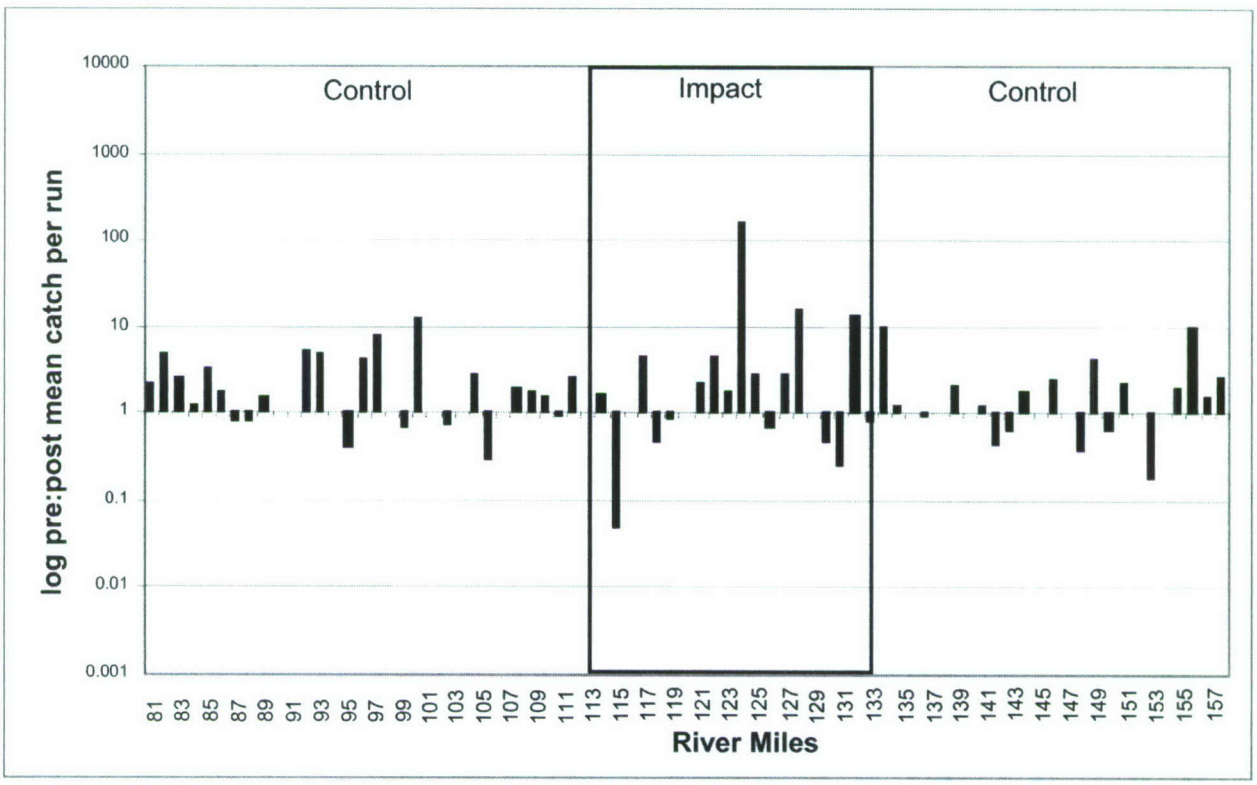

Figure 4. Ratio of pre- to post-Habitat Rehabilitation and Enhancement Project day electrofishing mean catch per run by Illinois River mile and the control and impacted river miles used in the Before-After Control-Impact design.

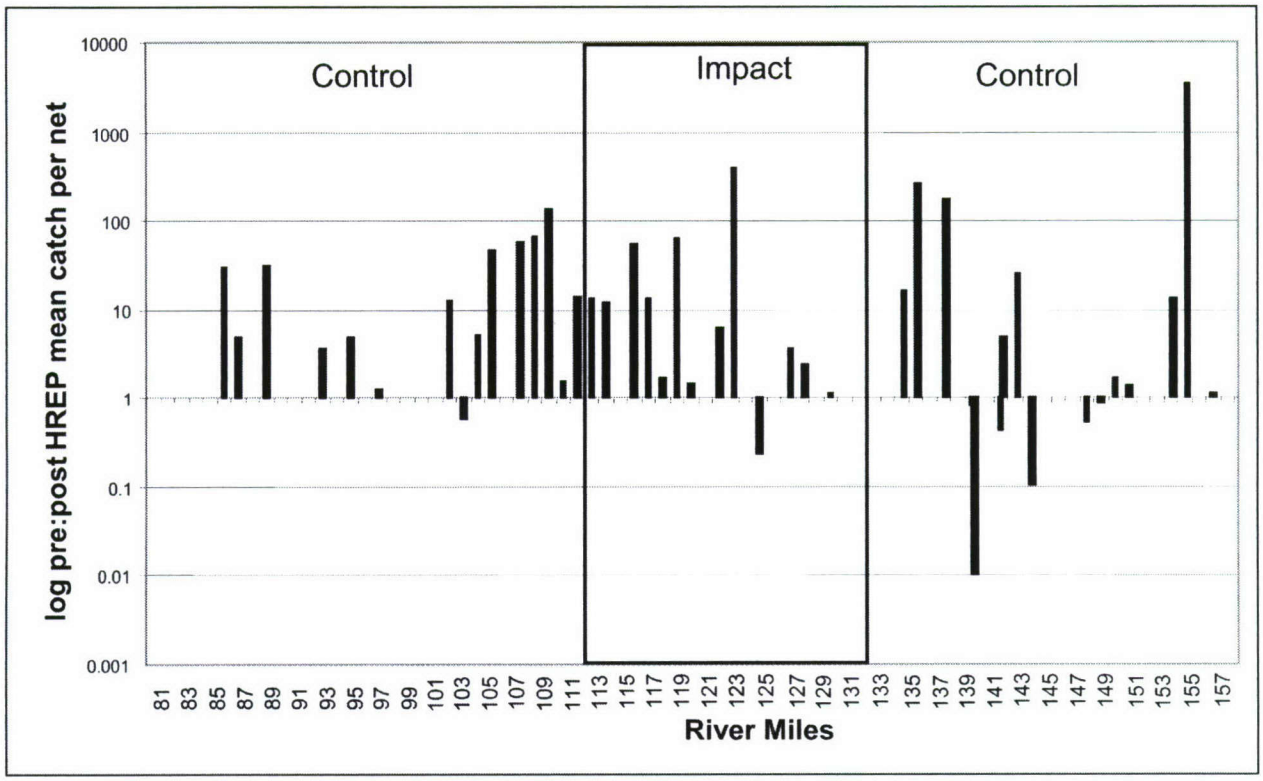

Figure 5. Ratio of pre- to post-Habitat Rehabilitation and Enhancement Project mini-fyke net mean catch per net by Illinois River mile and the control and impacted river miles used in the Before-After Control-Impact design.

region, mean catch rates in day-electrofishing runs increased from 173 to 215 per run among periods. Statistically significant differences in electrofishing catches were observed for RM 113 (117 fish pre-HREP, 190 fish post-HREP; $n = 135$; df = 129; $t = 2.3$; $P = 0.02$), RM 121 (40 fish pre-HREP, 179 fish post-HREP; $n = 43$; df = 39; $t = 2.33$; $P = 0.02$), and RM 122 (67 fish pre-HREP, 122 fish post-HREP; $n = 30$; df = 26; $t = 2.05$; $P = 0.05$). Average mini-fyke net catches increased from 48 to 1,960 fish per set before and after HREP construction in the impacted site. Statistically significant differences in mini-fyke net catches were observed for RM 121 (26 fish pre-HREP, 166 fish post-HREP; $n = 30$; df = 27; $t = 3.12$; $P = 0.004$) and RM 126 (32 fish pre-HREP, 115 fish post-HREP; $n = 7$; df = 5; $t = 3.59$; $P = 0.02$). Most increases in catches in the impacted site were observed downstream of the HREP; however, 1 upstream RM showed a significant increase in catch.

Regional Scale (~10 RM) Habitat Rehabilitation and Enhancement Project Effects

With the high variability of sample sizes in the local-scale analysis, we combined data from approximately 10 individual river miles creating eight regional areas. Results from day electrofishing at this scale revealed six regional areas where mean catches were higher in the post-HREP period (Figure 6). Regional area (RM 119 to 128) demonstrated the most variation in catch between periods. Mean electrofishing catches ranged from 57.2 fish per run during the pre-HREP period to 524.1 in the post-HREP period. Mini-fyke net mean catches showed similar increases in the post-HREP period (Figure 7). Regional area (RM 119 to 128), which showed the most variation in day electrofishing, also revealed increases in the mini-fyke mean catches.

Day electrofishing mean catches from selected backwaters in the pre- and post-HREP periods were highly variable among the two periods with over half of the backwater lakes demonstrating decreases in catches between periods (Figure 8).

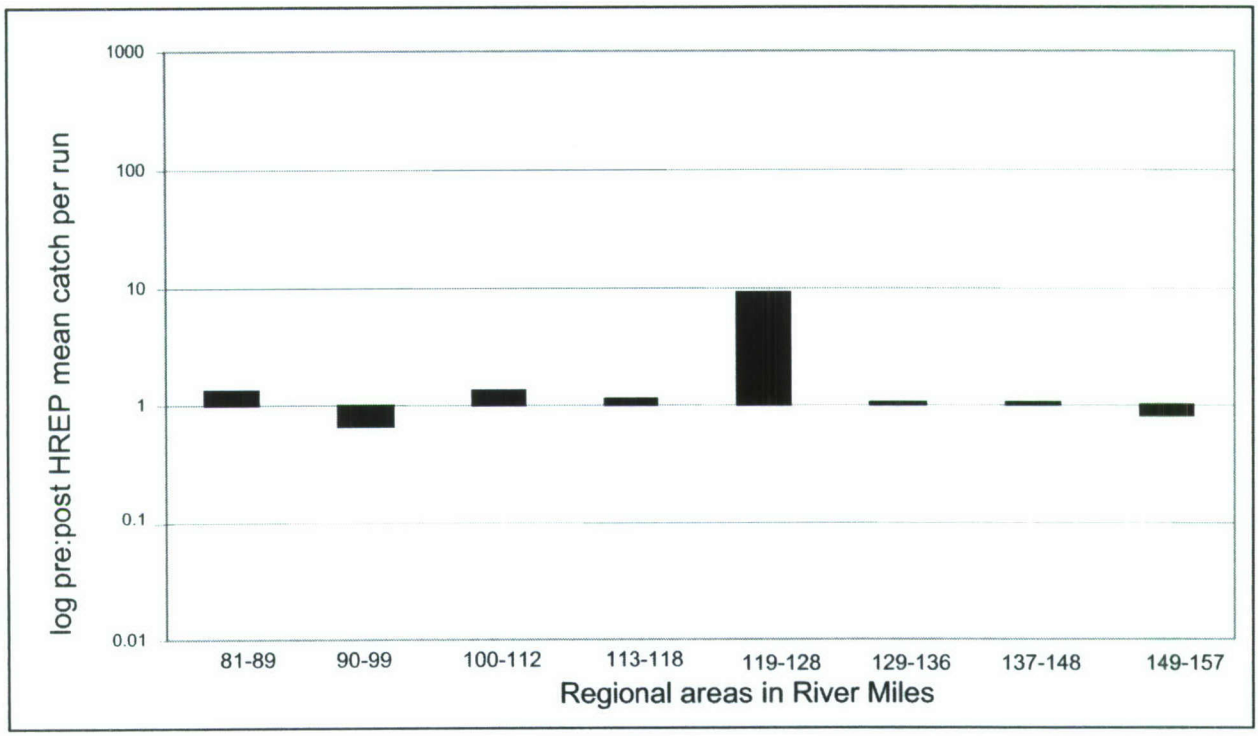

Figure 6. Ratio of pre- to post-Habitat Rehabilitation and Enhancement Project day electrofishing mean catch per run by the La Grange Pool regional area (~10 River Miles). Lake Chautauqua is at River Mile 124.

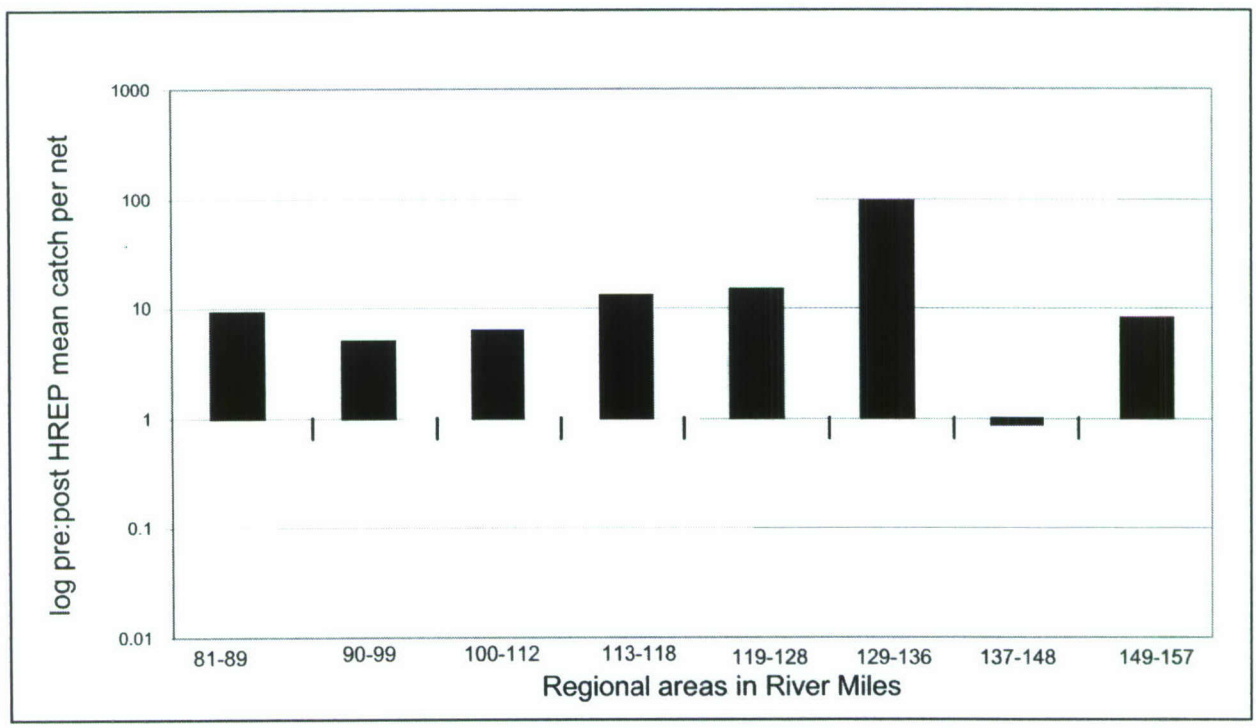

Figure 7. Ratio of pre- to post-Habitat Rehabilitation and Enhancement Project mini-fyke net mean catch per net by the La Grange Pool regional area (~10 River Miles). Lake Chautauqua is at River Mile 124.

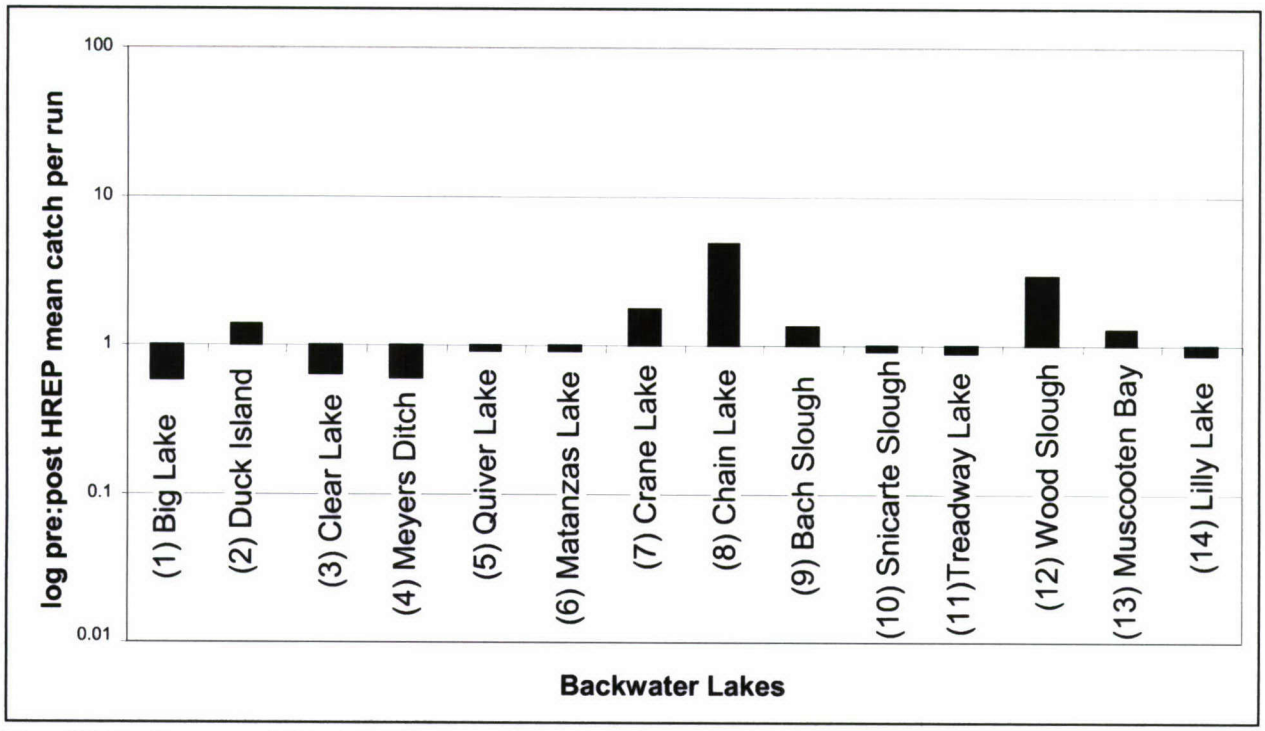

Figure 8. Ratio of pre- to post-Habitat Rehabilitation and Enhancement Project day electrofishing mean catch per run in backwaters of La Grange Pool. Numbers in parentheses correspond with Figure 1 map.

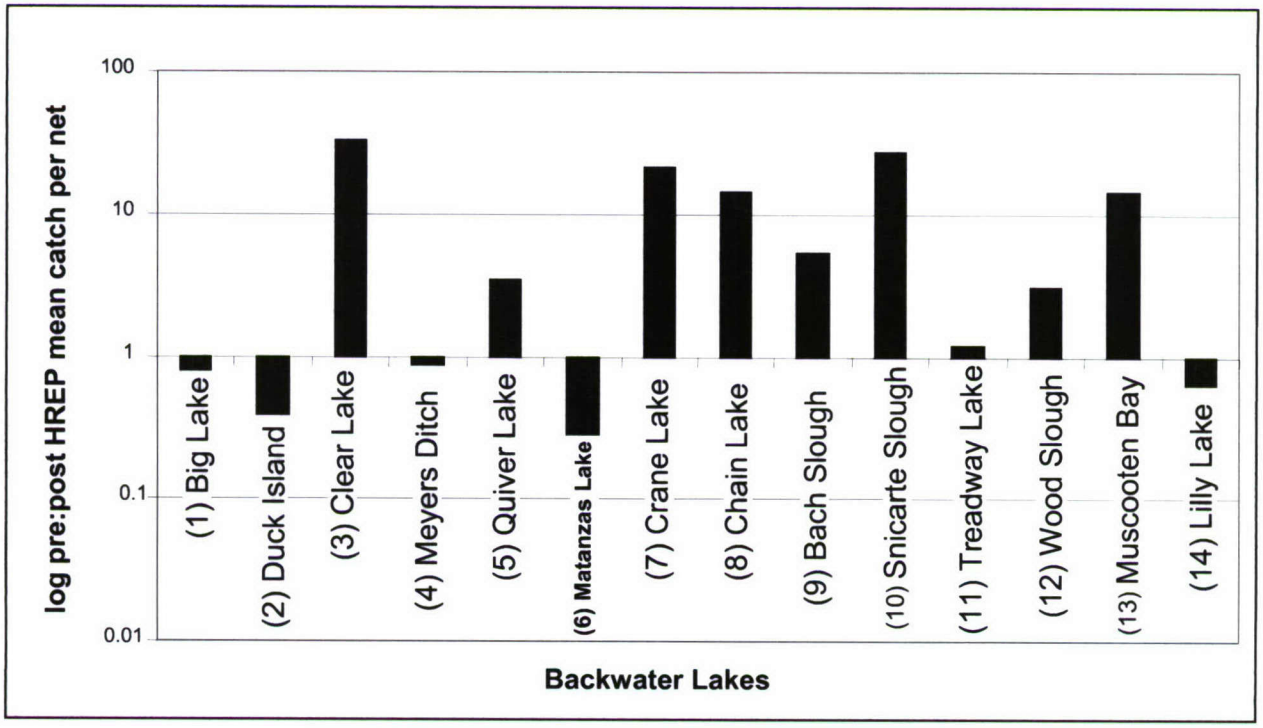

Figure 9. Ratio of pre- to post-Habitat Rehabilitation and Enhancement Project mini-fyke net mean catch per net in backwaters of La Grange Pool. Numbers in parentheses correspond with Figure 1 map.

Quiver Lake, a neighboring backwater to the HREP, revealed a decrease in mean catch for day electrofishing for the post-HREP period in contrast to the highest catches observed in Lake Chautauqua. Mini-fyke net catches illustrated the reverse relation with 57% of the lakes mean catches increasing in the post-HREP period (Figure 9). Quiver Lake mini-fyke net mean catches exhibited increases in the post-HREP period.

Pool Scale Habitat Rehabilitation and Enhancement Project Effects

Day electrofishing and mini-fyke net mean catches did not vary significantly among years and pool wide (Figure 10). The years 1997 and 2002 showed the highest catches for each of the gears. Overall, NMDS plots provided a visual representation for the pre- and post-HREP periods, revealing no distinct separation for day electrofishing (Figure 11) and mini-fyke net (Figure 12) LTRMP abundance data. Stress values were high indicating a less than desirable model.

Habitat Rehabilitation and Enhancement Project Fish Escapement

Previous studies have estimated the abundance of young-of-year, juvenile, and adult fish escaping from the south pool of the Lake Chautauqua HREP into the Illinois River (Irons et al. 1997; Stoekel et al. 1999*a*,*b*; Lemke and Pegg 2001). These studies took place post-HREP completion; baseline escapement data were not collected prior to HREP construction. Years in which fish escapement sampling was conducted and calculated were 1996, 1997, and 2000. Escapement estimates were variable among years sampled ranging from 46 million fish in 1996 to 180 million fish in 2000 (Figure 13). Numerically dominant fish families caught during sampling were the Clupeidae and Cyprinidae, typically comprising about 90% of the total catch (Figure 14). A total of 35 species were caught from Lake Chautauqua during the years sampled.

Discussion

Fish data collected by the LTRMP have been critical for detecting variation in annual abundances and community structure in La Grange Pool. In addition, HREP monitoring has demonstrated the ability to estimate the relative abundances and release of fish into the Illinois River. While our analyses did not detect the Lake Chautauqua HREPs influence on the Illinois River fish community at the pool-wide scale, our results did detect some differences at the local scale of individual river miles within the impacted area. Still, abnormally high sampling events, such as those observed at RM 123 using day electrofishing (mean two of five samples = 16,969 fish) and at RM 135 using mini-fyke netting (mean one of five samples = 34,242 fish), may indicate that the spatial and temporal sampling frequencies of the LTRMP may be insufficient to detect the effects of individual HREPs.

Previous studies have noted that LTRMP fish sampling can detect differences in fish community structure and composition among habitat strata, but it may not be sufficient to reveal local contributions such as those from individual HREPs (Chick et al. 2005). Although an increase in fish relative abundance from the Lake Chautauqua HREP could not be accounted for at the pool scale, our results indicated that (1) the Lake Chautauqua HREP produced millions of fish for the Illinois River following construction and (2) connected backwaters may be local hotspots for fish production in the Illinois River. Therefore, connected backwaters may be critical to sustaining fish populations in the river. Because mini-fyke net catches (proxy for young-of-year production) were consistently high in many backwater areas of La Grange Pool, our results may indicate that any efforts to improve backwater habitats, through HREPs or other methods, may bolster fish production to the main stem of the Illinois River. Our study indicates some possible explanations as to why the effect of the HREP could not be observed at the pool scale using LTRMP data.

La Grange Pool is the longest (80 RMs) and most habitat diverse regional trend area the LTRMP monitors on the UMRS; therefore, the number of sites sampled may be insufficient to observe effects. For example, only one to three samples

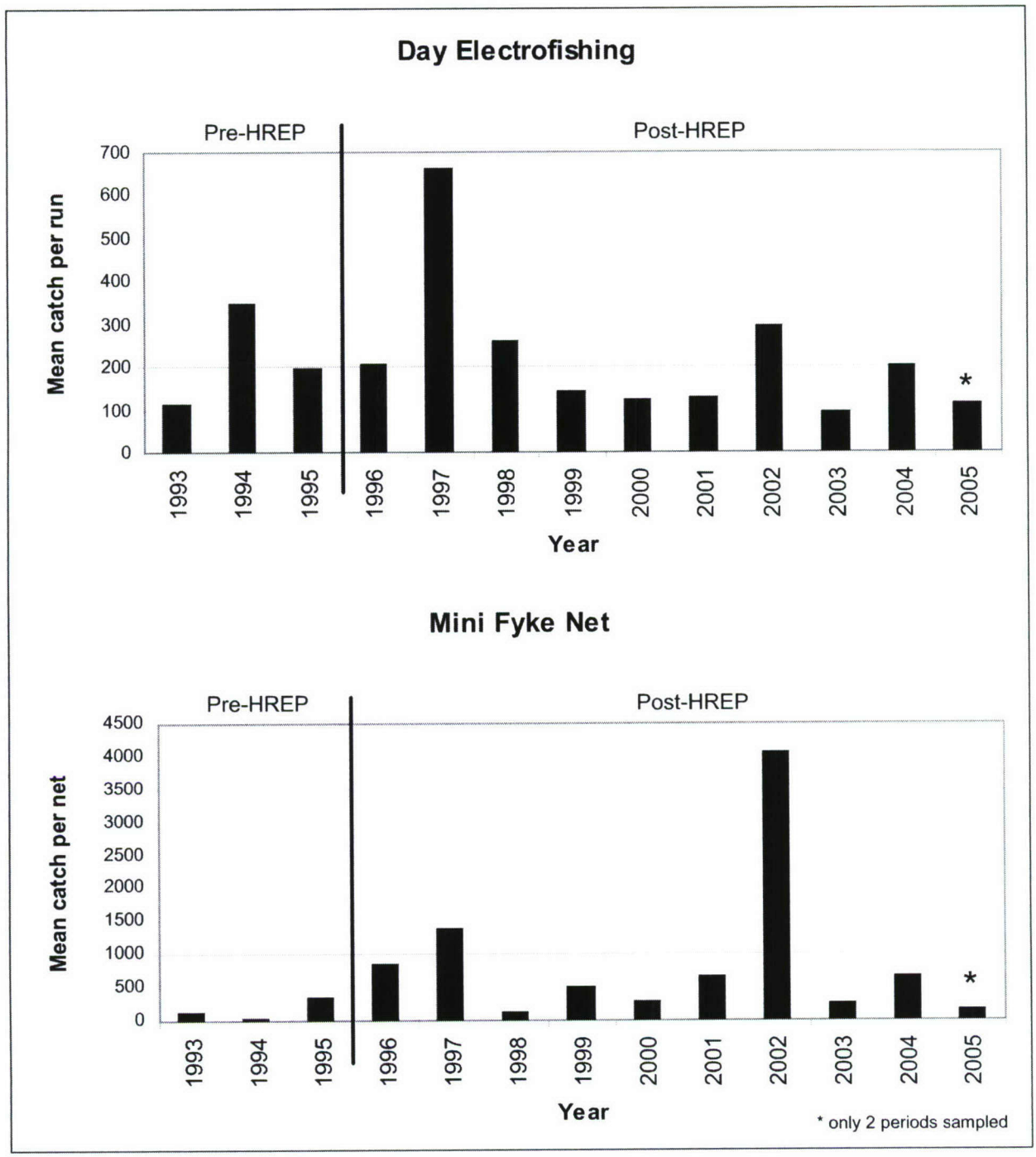

Figure 10. Day electrofishing and mini-fyke net mean catches in La Grange Pool from 1993 to 2005. *Only the late summer and fall were sampled due to budget constraints (day electrofishing mean catch = 23,090.011 - 11.441*River Mile, $n = 13$; df = 1,11; $f = 1.02$; $P = 0.334$; $r^2 = 0.002$ and mini-fyke net mean catch = 121,569.964 - 61.178*River Mile, $n = 13$; df = 1,11; $f = 0.578$; $P = 0.463$; $r^2 = 0$). (HREP, Habitat Rehabilitation and Enhancement Project)

were taken annually per river mile. Insufficient sample sizes may have limited our statistical power to detect effects of the HREP.

Potential additional reasons for our lack of detection of the HREP influence may be attributed to the dilution effects of alternative backwaters. La Grange Pool has several backwater areas

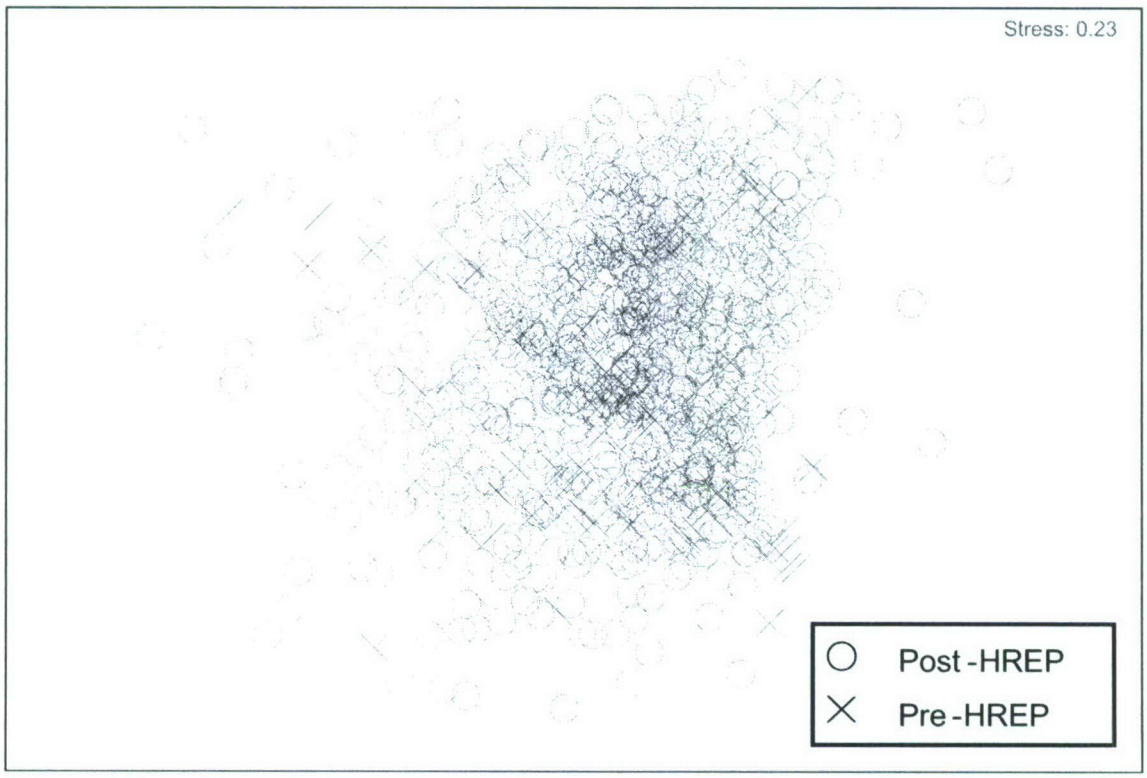

Figure 11. Non-metric multidimensional-scaling ordination of abundance data from day electrofishing (data were square-root transformed and ecological similarity was measured using the Bray-Curtis Similarity metric [Bray and Curtis 1957]). Each point represents fish-species abundances for a given year during the pre- or post-Habitat Rehabilitation and Enhancement Project period.

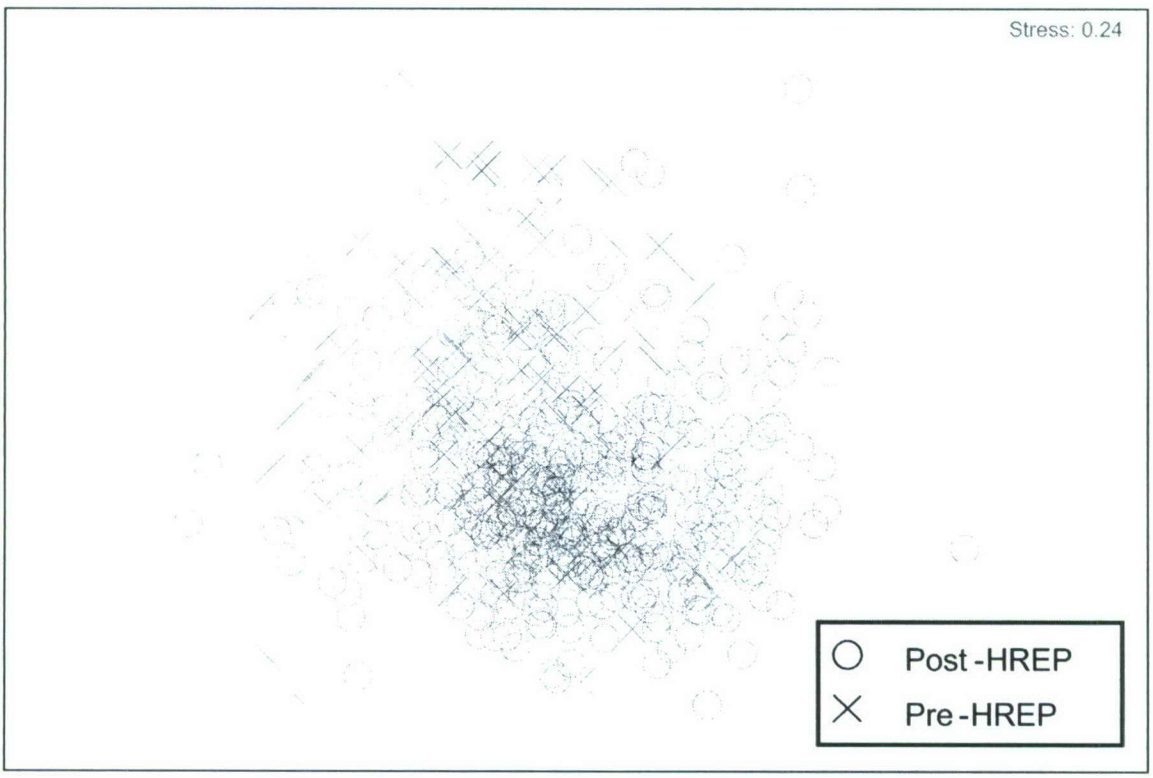

Figure 12. Non-metric multidimensional-scaling ordination of abundance data from mini-fyke nets (data were square-root transformed and ecological similarity was measured using the Bray-Curtis Similarity metric [Bray and Curtis 1957]). Each point represents fish-species abundances for a given year during the pre- or post-Habitat Rehabilitation and Enhancement Project period.

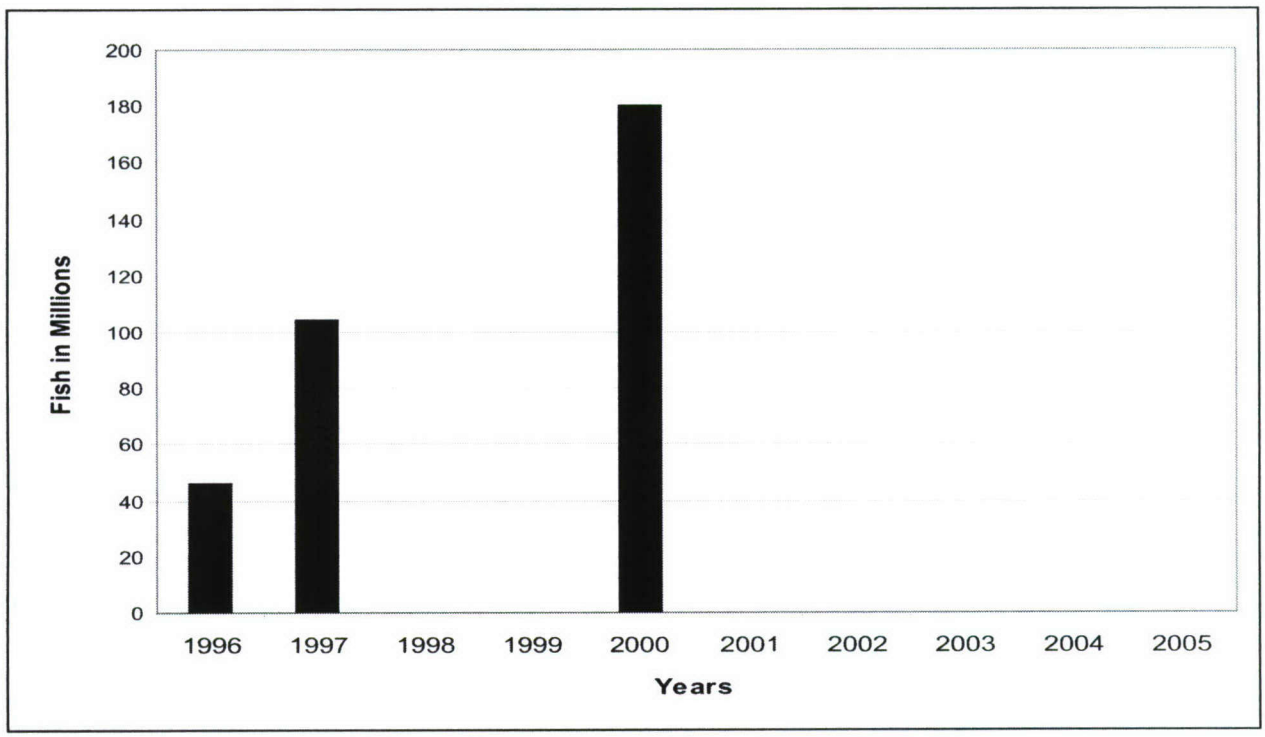

Figure 13. Estimates (fish in millions) from Lake Chautauqua escapement sampling.

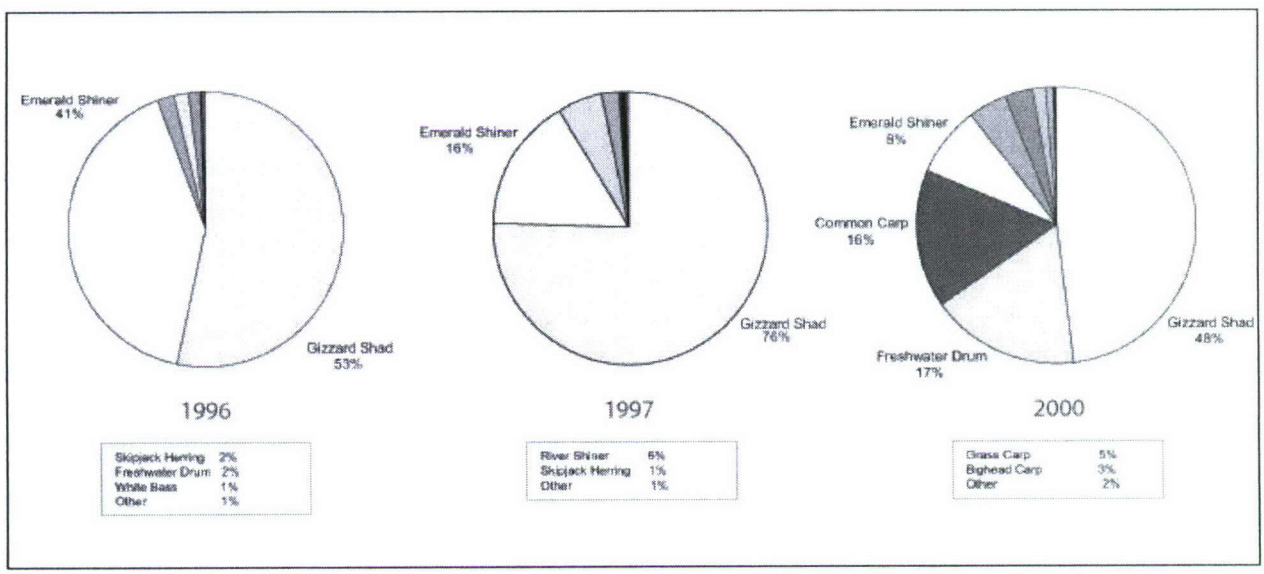

Figure 14. Percent fish-species composition caught during Lake Chautauqua escapement sampling in 1996, 1997, and 2000. Less-abundant species and the percentage of total catch listed below respective charts.

throughout its entirety. Although all are highly degraded, they are functional and capable of producing millions of fish that recruit to the river. For example, the 20 RM area adjacent to Lake Chautauqua encompasses five connected backwaters that may be diluting the effect of the HREP. Influences of these backwaters and local-habitat complexity may have constrained our ability to determine if the Lake Chautauqua HREP catches contributed above the range of normal variability observed in the LTRMP sampling.

Although the HREP has been in place for 10 years, we may have lacked a data set that is

temporally sufficient to yield determinations of the HREP influence. With the absence of pre-HREP escapement data, we cannot determine the effect of the HREP on the Illinois River. In general, all system manipulations or rehabilitation efforts should be preceded by baseline sampling of pre-HREP ecosystem conditions.

A parsimonious explanation for our findings may be that Lake Chautauqua is not contributing any surplus fish production to the Illinois River fish community compared to other regional backwaters. Perhaps, the fish being evacuated from the HREP are subjected to high exploitation and mortality rates immediately after their escape to the river. Despite main-stem river conditions influencing overall recruitment, Lake Chautauqua does produce millions of fish annually, and HREP efforts to improve backwater fish habitat appear to increase fish-production capacities.

Management Implications

Our results indicate that the Lake Chautauqua HREP has improved the fish-producing habitat of La Grange Pool. Prior to the project, the lake was shallow, turbid, and lacked any moist-soil production. After HREP construction, Lake Chautauqua's south cell is now allowed to mimic the hydrologic regime of the Illinois River, which permits a spring flood and a summer drawdown period. The HREP is producing fish and moist-soil plants, which indicates it is providing a dual purpose for the Illinois River ecosystem. A major challenge in assessing the efficacy and effects of these restoration techniques is centered on determining how biotic communities respond to the physical changes (Pegg et. al. 2005). Therefore, it is critical to establish a scientifically rigorous and explicit monitoring design to ensure future HREP contributions can be measured not only within the project area, but also beyond the project boundaries and pool wide.

Acknowledgments

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13. ABSTRACT The Long Term Resource Monitoring Program (LTRMP) fish component monitors fish communities to test for changes in abundances and species composition in six regional trend areas of the Upper Mississippi River System. Using these data, we evaluated the ability of the LTRMP to detect changes in the fish community as a consequence of a habitat-enhancement project in La Grange Pool of the Illinois River. In 1996, initial phases of the Chautauqua National Wildlife Refuge Habitat Rehabilitation and Enhancement Project (HREP) south cell construction were completed with the goal of improving fish habitat in the pool. That year, an estimated 46 million fish representing 34 species were produced and discharged from the south cell of Lake Chautauqua. Whereas this response may indicate that the south cell serves as a spawning and nursery area for many fish species, no studies have tested for recruitment to the river fish community. We used geographic information system coverage at three spatial scales in the main-channel and side-channel strata to illustrate potential fish-community responses. At these spatial scales (local 1 river mile [RM], regional ~10 RMs, and pool wide 80 RMs), we assessed fish catch-per-unit-effort (CPUE) data collected from mini-fyke net and day electrofishing among pre- (1993–1995) and post-HREP (1996–2005) periods of the Chautauqua National Wildlife Refuge HREP. Analysis of Similarity results demonstrated no significant differences among periods in fish CPUE ($P > 0.05$). Our results may indicate that (1) the LTRMP sampling design lacked sufficient statistical power to detect effects of the HREP, (2) the LTRMP sampling design lacked the spatial and temporal resolution to detect effects, (3) the Lake Chautauqua HREP has not been established long enough to detect long-term trends in fish production, or (4) the HREP had no effect on fish recruitment to the Illinois River. Nevertheless, our results clearly show that backwaters are major fish producing areas in La Grange Pool and future HREPs to enhance backwater fish habitat may be critical to the long-term sustainability of the Illinois River fish community. As a result of our findings, we suggest that an intensive study at defined temporal and spatial scales may be required to detect changes in the fish community in La Grange Pool as a consequence of HREPs.		
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2008-T001 Effect of a Recently Completed Habitat Rehabilitation and Enhancement Project on Fish Abundances in La Grange Pool of the Illinois River using Long Term Resource Monitoring Program Data

The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.

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