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Fish Community Assessment and Sport Fish Potential in the LaMoine River Basin in West-Central Illinois

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ABSTRACT

In July 1988, fish were collected in the LaMoine River Basin in west-central Illinois by the Illinois Department of Conservation (IDOC) Streams Program, in an effort to assess stream quality and sport fish potential. Additional sampling was conducted in September on the East Fork where seven sites, including four sites previously sampled in July, were evaluated as part of an intensive effort to examine differences seen in the July samples. Within this watershed, species richness at each station ranged from nine to 23 for a basin wide total of 46, with one additional category of hybrid sunfish. Stream quality, as characterized by the Alternate Index of Biotic Intregity (AIBI) ranged from 27.3 (limited aquatic resource) to 52.4 (unique aquatic resource). Community similarity relationships indicated samples collected from the East Fork drainage were generally more similar to each other than to samples collected from the mainstem or within other drainages. Evenness values (Brillouin Index) were variable (0.483 to 0.861), with low values usually indicative of one or two dominant species at a site.

Angling opportunites for sport fish within this watershed were most consistent for common carp (*Cyprinus carpio*). Of the smallmouth bass (*Micropterus dolomieu*) collected, most were less than stock length (180 mm). In eight samples, from eight to 57 smallmouth bass less than stock length were collected, with the highest abundances in the lower reaches of the East Fork (DGL-02, DGL-03) and on the mainstem (DG-07). Channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*) and white crappie (*Pomoxis annularis*) were also collected, but in low numbers (< 10 per sample).

During a drought, the high biotic integrity at DG-02, DGL-02, and DGL-03, suggests these sites may serve as refugia for fish. Additional studies are needed to more closely evaluate the consistency of use of these areas by fish under various water regimes.

INTRODUCTION

Burgeoning urbanization, pollution, and intensive agriculture are but a few of the problems impacting Illinois streams. Of these problems, siltation associated with agriculture has been noted as a major impact on aquatic life, not only within Illinois (Smith 1971; Larimore and Smith 1963), but across the United States (see Berkman and Rabeni 1987 for overview).

Within this agricultural setting, in Illinois, lies an extensive network of rivers and streams with a total length of over 41,600 km (26,000 miles) (Illinois Streams Information System-ISIS Unpublished data). Since 1981, in an effort to maintain current information on stream fishes, the Illinois Department of Conservation (IDOC) Streams Program has intensively sampled small to intermediate sized streams on a watershed scale. These fish data, combined with physico-chemical data collected from these stream sites by the Illinois Environmental Protection Agency (IEPA), provide an overview of the aquatic resource within each watershed. These data not only supplement ongoing sampling at a limited number of small-stream statewide monitoring stations, but contribute updated information on previously sampled streams, and those streams for which little or no information was available.

In 1988, as part of this effort, fish, water, and habitat were sampled in stream segments within the LaMoine River watershed in west-central Illinois. With the exception of one biennial monitoring station on the lower LaMoine River near Ripley, only intermittent sampling by the IDOC has been conducted within this watershed since the last survey by Dunn (1976).

Previous investigations in this drainage have found basin-wide fish species richness ranging from 31 (Rock 1966) to 78 (Smith 1971). Smith, however included several other Illinois River drainages (McKee, Sugar, Crooked and Bay Creeks) which were not sampled during this study and may partly account for the high species richness he reported. In another survey, Dunn (1976) found 39 species. Smith (1971) indicated streams in this basin underwent frequent desiccation and were impacted by pollution, contributing to low species richness.

Thus, we initiated this study to assess sport fish potential of streams in this watershed by examining the composition and size structure of this group of fish. We also characterized stream quality, using primarily the fish-based Index of Biotic Integrity (Karr 1981; 1986), as adapted for use in Illinois by Hite and Bertrand (1989). Additional physico-chemical attributes of these sites were also used in this evaluation.

METHODS AND MATERIALS

Site Description

From its headwaters near La Harpe, in west-central Illinois, the LaMoine River flows in a southeasterly direction for approximately 161 km (100 miles), draining 3482 km^2

(1360 $miles^2$) (Barker et al. 1970), before emptying into the Illinois River north of Beardstown (Fig. 1). The largest tributary, the East Fork of the LaMoine, joins the mainstem west of Colchester (Fig. 1). Geologically, this river system is situated within the Galesburg Plain of the Till Plains Section (Willman et al. 1975 in Zeuhls et al. 1987). Here, soils vary in permeablity and are mostly developed from loess though alluvial deposits are found along the river valleys (Barker et al. 1970).

The largest population centers within the watershed are Macomb (20,628), Rushville (3,348), Bushnell (3,811), Carthage (2,978), and Mt. Sterling (2,186). Land use involves primarily agriculture such as row crops (corn, soybeans) and livestock (cattle, hogs). In portions of the watershed poor land use practices combined with the topography can lead to severe sheet and gulley erosion (Barker et al. 1970). Additional inputs to streams within the watershed occur from several point sources including wastewater treatment facilities (Joseph 1989). Of the streams sampled for this study, Macomb discharges into Killjordan Creek (DGJA), the town of Industry into Grindstone Creek (DGIA) and Bushnell into Drowning Fork (DGLC). Several streams, including Little Missouri Creek, have historically received runoff from surface coal mining operations.

In 1988, west-central Illinois was under the effects of a severe drought. During July, the USGS gaging station at Ripley, recorded a mean flow of 19.6 cubic feet per second (cfs) compared to the average July flow of 752 cfs over the 65 year period of record (ISWS 1988a). Though average rainfall occurred in western Illinois in August, the precipitation deficit for the growing season was approximately 23 cm (9 inches) (ISWS 1988b) and stream flow remained low. September's average flow for the LaMoine River, recorded at Ripley (5.1 cfs), was the lowest average for any month, over the period of record at that station (ISWS 1988c).

Site Selection

Sampling sites were selected based on several factors. Initial priority was given to sites of previous sampling efforts by IDOC or IEPA (e.g. fish, water quality, macroinvertebrates). We also considered accessibility to the site (especially with reference to boat electrofishing sites), and sport fish potential (primarily based upon depth and instream habitat). Proximity to other sites including both longitudinal spacing on larger streams and general distribution throughout the watershed, relationship to point source inputs (urban areas and tributaries), and representative macrohabitat characteristics (e.g., riparian zone, substrate, instream structure) were also considered.

Sites were denoted using IEPA stream drainage and station codes. In this watershed "DG" is the stream code for the LaMoine River while additional letters correspond to the position of tributaries on the LaMoine River. For example, Missouri Creek is the fourth tributary upstream from the confluence of the LaMoine River with the Illinois River and is therefore assigned a code of DGD. Prior to this study, IEPA sites were present on several streams. Station numbers were assigned as sites were established and therefore may not be in longitudinal sequence on a stream.

Fish Collection

Initial fish collections were made from 25 to 28 July 1988. Due to the severe drought (ISWS 1988a; 1988b), samples could be obtained from only 18 of the original 43 sites which had been selected. From these samples, distinct differences in species richness were evident between stations on the East Fork. To more closely assess these differences, seven stations (four previously sampled in July and three newly established sites) were sampled on 20 and 21 September, 1988.

Where water depth generally exceeded 0.61 m (2 ft) sampling was conducted using a boat-mounted electrofishing unit powered by a 230 volt A.C., 180 cycle, 3000 watt generator. This sampling was supplemented with a minnow seine when feasible. All other sampling was conducted using an electric seine powered by a 1600 W single phase generator, similar to that described by Bayley et al. (1989). This gear was hauled through the stream followed by four netters who collected stunned fish. Duration of sampling varied, but was frequently dictated by availability of water. During each electrofishing run, attempts were made to collect all stunned fish, except at station DG-02 where the extremely abundant common carp were netted for only half of the 30 minute total sampling period.

Length and weight of larger fish were recorded in the field while most smaller fish, primarily minnows, were preserved in formalin. Fish length was measured to the nearest mm or fish were placed in total length groups, with the exception of preserved fish which were placed in 10-mm size groups. For species with high relative abundance such as the red shiner (*Cyprinella lutrensis*), lengths or length groups of a subsample of the preserved fish were recorded with the remaining fish of that species enumerated and weighed collectively. For some smaller sport fish, individual lengths and a group weight were recorded. Due to the wide range of weights of fish collected, fish were weighed on scales of varying precision, but most field weights were on pan balances with approximately 5 gram precision. Fish were identified using Smith (1979) and Pflieger (1975) as references.

Habitat and Water Quality Data

Habitat and water quality data were collected by the IEPA (Joseph 1989) using techniques described in the IEPA field methods manual (IEPA 1987). Water samples were collected in early June, late July and September at all sites except for DGL-06, DGL-07, and DGL-08. Results of the water samples were incorporated into a water quality index (WQI) for each site (Joseph 1989).

Habitat data were collected at all electric seine sites sampled in summer, but could only be obtained at three boat sites due to difficulty in sampling deeper habitats. Limited availability of personnel precluded collection of habitat data at the seven sites sampled in September.

Data analysis

Due to differences in sampling effort between stations, numbers of fish (electrofishing samples) were standardized to number/hour and these values were used in all analyses except the AIBI (Alternate Index of Biotic Integrity). For the AIBI, actual number of fish were used since sampling effort is taken into account in this procedure.

The Index of Biotic Integrity (IBI) (Karr 1981, Karr et al. 1986), based upon the fish community, has received widespread use as a means of assessing stream quality (Miller et al. 1988, Fausch et al. 1990). For this study a modified or Alternate Index of Biotic Integrity (AIBI), was calculated for each sample (Hite and Bertrand 1989). The AIBI has been adapted from the Index of Biotic Integrity and is similarly comprised of 12 metrics. In comparison to the IBI, the AIBI uses the mean of the other 11 metrics for the disease metric when information on occurrence of disease is not used. As with the IBI, AIBI values range from 12 (extremely degraded) to 60 (high quality). For stations in which two or more methods were used to collect fish, a mean of the abundance metric was calculated. Stream order (Strahler 1957), as required for calculation of the IBI, was determined from 7.5 minute topographic quadrangle maps by IEPA personnel.

Using Eckblad (1989), number/hour values were compared using Horn's Index of community similarity (Horn 1966). From this evaluation a dendrogram was developed using values of (1-Horn's Index) which were incorporated into a cluster analysis with an unweighted multiple pair group of arithmetic averages (UMPGA) (Sneath and Sokal 1973). These comparisons were made for samples collected with the same electrofishing method to avoid bias due to differences in sampling efficiency of the electric seine and boat-mounted electrofishing unit.

Diversity and evenness values were determined from electrofishing data for each sample, using Brillouin's Index as suggested by Kaesler and Herricks (1976). Brillouin's Index is the diversity of a subsample and not an estimate of the diversity of the parent population and cautious interpretation of statistical analyses has been recommended (Kaesler and Herricks 1976). Evenness, defined as observed diversity divided by the maximum possible diversity at the observed species richness, ranges from 0 to 1. This analysis assesses how closely the observed species abundances are to an evenly distributed sample having a similar number of species and total number of individuals (Brower and Zar 1977). Low evenness would indicate an excessive relative abundance of a few species within a sample while, conversely, a high evenness would suggest a less disparate distribution.

Sport fish potential was evaluated by categorizing fish in length groups proposed by Gabelhouse (1984). In addition to three of these groups, stock (S), quality (Q), and preferred (P), we also noted fish "less than stock", referred to as (L). Though of limited immediate usefulness to anglers, fish in this smallest group (L) may be indicators of reproductive success or future angling opportunities. No fish of memorable or trophy size were collected.

For both smallmouth bass and common carp, length and weight data were $\log_{10}$-transformed and the slope of lines between stations were compared with an analysis of covariance (ANCOVA) (Zar 1984) (alpha = 0.05) using SYSTAT (Wilkinson 1988). For consistency, samples with stock fish, $N \geq 5$ were used in this analysis. For other sport fish, sample sizes were less than 5 and therefore not used in this anaylsis. As discussed by Murphy et al. (1991), weight-length regression lines were compared prior to determination of relative weight values. Due to the generally small sample sizes we were however, unable to compare these relationships by size category as recommended by Murphy et al. (1991).

For common carp body condition was estimated by relative weight (*Wr*) (Wege and Anderson 1978) using a standard weight formula (Stephen 1978). Only fish of stock length or greater were used to avoid bias associated with weight-length relationships of smaller fish. Mean relative weight (*Wr*) values for each station were compared using an analysis of variance ANOVA and a Tukey multiple comparison test (alpha = 0.05) (Wilkinson 1988) to assess differences between stations.

Relationships of habitat and water quality parameters (Joseph 1989) to both target species and fish community parameters were examined by developing a correlation matrix (Pearsons correlation coefficient) using SYSTAT (Wilkinson 1988). Due to the small sample size (3) of habitat data at boat sites, only electric seine sites sampled in summer were used for habitat analysis. Water quality associations were grouped by electrofishing method (e.g. electric seine or boat) and comparisons were made using fish data collected in July.

Comparisons with basin-wide fish species richness were based upon data from IDOC (Rock 1966, Dunn 1976, IDOC Unpubl. data), Illinois Natural History Survey records (Cummings 1989) and Smith (1979).

RESULTS

Fish data

A total of 46 fish species and one category of hybrid sunfish were collected from 25 stations. Within this watershed, the most abundant species, based upon percent composition using number/hour were red shiner (27.6%), bluntnose minnow (*Pimephales notatus*) (14.5%) and green sunfish (*Lepomis cyanellus*) (7.1 %) (Table 1). The most common sport fish was common carp (1.3%), followed by smallmouth bass (1.1 %). All other sport fish species accounted for less than 1.0% of the catch. No threatened or endangered species were collected.

Boat electrofishing stations, located on the LaMoine River and at deeper sites along the East Fork (Fig. 1), yielded from 222 to 864 fish/hour (Table 2). Sites sampled with the electric seine produced catch rates from 456 to 10,000 fish/hour with most samples exceeding 1000 fish/hour (Table 3).

Using the Biological Streams Characterization (BSC) resource description and corresponding AIBI values (Hite and Bertrand 1989) we found a wide range in stream quality in the LaMoine River watershed (Table 4). A basin wide low AIBI of 26 with an associated BSC characterization of "limited" was obtained at DGL-07 of the East Fork (near Macomb), while AIBI values of 51.3 "unique" were obtained on the same stream at stations DGL-02 and DGL-03, downstream (west) of Colchester. The highest AIBI value of 52.4 was obtained at DG-02 on the LaMoine River (Table 4).

Community similarity values, with the exception of DG-07, showed boat electrofishing samples from within the same stream (LaMoine River or East Fork) were more similar to each other than samples between streams (Fig. 2). Samples collected with the electric seine showed even stronger associations to each other (Fig. 2). Not suprisingly, a high level of similarity was documented "within station" at two sites (DGL-02 and DGL-03) which were resampled in the fall. With one exception (DGLD-01), stations sampled in the fall were more similar to the same station sampled in the summer, than to other stations.

Evenness values ranged from 0.470 (DGLC-01) to 0.861 (DGJ-04), but most values were less than 0.800 (Table 4). Evenness is most useful in detecting the degree of species homogeneity within a sample (Zar 1984). At DGLC-01, blackstripe topminnows (*Fundulus notatus*) and red shiners were prevalent, accounting for a combined total of 88% of the sample. At DGL-05 (evenness 0.483), red shiners accounted for 62% of the fish collected.

Common carp appeared to provide the greatest potential opportunity for anglers (Table 5). Smallmouth bass, in comparison to other sportfish, had the largest number of fish (194 fish in 8 samples) in the "L" category. At stations DGL-02 and DGL-03 on the East Fork, comparatively large numbers of smallmouth bass (36-114 fish/hour) of the "L" group were collected in both July and September samples. On the mainstem, DG-07 had the highest number of smallmouth bass (30) in this category. Largemouth bass, channel catfish and bluegill of stock and quality sizes were present, but of limited availability. White crappie of preferred size (> 250 mm) were collected at four stations, but were also few in number usually (≤ 5 per hour).

For smallmouth bass, $\log_{10}$weight-$\log_{10}$length regression equations for the three stations (N ≥ 5), with length ≥ 180 mm were significantly different. Slope of $\log_{10}$weight-$\log_{10}$length regression equations for nine samples of common carp (N ≥ 5) with length ≥ 280 mm were not significantly different.

Mean relative weight for common carp at each station ranged from 74.6 to 92.8 with significant differences between two groups (DGL-04, DGL-08, DG-07, DG-01, DG-06) and (DG-09, DGLD-01) (Fig. 4). Mean relative weight of fish from DG-02 and DGL-07 were not significantly different between either of these groups. For smallmouth bass, mean relative weight values at the three stations could not be compared due to the significant differences in growth rates between stations and insufficient sample sizes for categorizing fish by length.

<u>Fish, Habitat and Water Quality Associations</u>

As noted earlier, results of the three water samples collected by the IEPA were incorporated in the water quality index (WQI). For this index, values range from 0 to 100, with higher values indicating poorer water quality (Joseph 1989). Within the correlation matrix we also used individual components of the WQI (e.g. temperature, pH, D.O.) to determine if any of these parameters were associated with fish community composition.

Among the water quality variables examined, at electric seine sites, the WQI (total score) and phosphate components of the WQI were most consistently associated with fish metrics (Table 6). Since high values of the WQI indicate poorer water quality, a negative correlation indicates a decline in the fish attributes with poorer water quality. The ammonia component of the WQI was only significantly associated with common carp (carp/hour) (Table 6). Molecular (unionized) ammonia has been suggested as a factor limiting fish community diversity in selected Illinois streams (Lewis et al. 1981). In comparison, at boat sites, though some significant relationships were found, no consistent associations were evident between water quality and fish parameters (Table 6).

Fish association with habitat variables were most common with various measures of smallmouth bass (Table 6). Smallmouth bass/hour was positively associated with mean channel width and water width, while smallmouth bass weight/hour was positively associated with percent boulders, water width, and negatively associated with mean water velocity. Total number/hour (all fish) was also negatively correlated (significantly) with mean water velocity possibly reflecting lower sampling efficiency in faster waters.

Comparisons to Historical Data

Discontinuous sampling has been used to evaluate long-term changes in species composition (Larimore and Smith 1963; Buth 1974). These temporal differences may indicate emmigration, invasion by new species and alterations to habitat or water quality. For the LaMoine River watershed though, comparisons with historical data were confounded by differences in sampling methodology, sampling effort and possibly sampling conditions. As a consequence of these potential influences, we are unable to fully assess the relationship of the present fish resource to historical records.

Though we collected more species in 1988 than in previous IDOC basin-wide investigations (Table 7), records from IDOC (including the monitoring station at Ripley and miscellaneous collections), the Illinois Natural History Survey (Cummings 1989) and Smith (1979) show seven formerly recorded species were not collected during the 1988 investigation (Table 8). Additionally, the stocked hybrid striped bass (*Morone chrysops x Morone saxatilis*), which was not previously listed, had likely escaped from a lake within the watershed and was not reproducing. The records for sauger (*Stizostedion canadense*) and white bass (*Morone chrysops*) show these species were taken in the downstream reach of the LaMoine River, southeast of Ripley, in an area which is likely to be inhabited by species moving upstream from the Illinois River. Species collected before 1908 (Smith 1979), and "rediscovered" in 1988 include the golden shiner (*Notemigenous crysoleucas*) and highfin carpsucker (*Carpiodes velifer*). One species, previously unrecorded in the watershed, the silver redhorse (*Moxostoma anisurum*), was collected at seven stations.

DISCUSSION

Stream quality in the LaMoine River watershed in 1988, as determined through assessment of the fish community, was quite variable. This was apparent in the wide range of species richness, diversity, evenness, and AIBI values between stations. Notably impacting streams in west-central Illinois during this study was a severe drought (ISWS 1988a; 1988c). By late July, many tributaries of the LaMoine River were pooled or completely dry. From our observations in September (and perhaps earlier), the East Fork was reduced to a series of large pools. Though frequent drying of streams in this watershed has been noted (Smith 1971), Illinois State Water Survey reports (ISWS 1988a; 1988c), indicate a record level of drought during 1988. Typically, it might be anticipated that drought related degradation of important water quality parameters (e.g. diel dissolved oxygen levels, temperature) and other physical aspects (low flow, pooled reaches) would lead to a reduction in species richness due to the loss of species intolerant of such conditions. Though such affects may have occurred, we suspect the latter conditions may have improved sampling efficiency at some stations by limiting escapement and thus contributed to our catch rates. For evaluating streams with the IBI, Karr et al. (1986) noted the importance of sampling effort and sampling pool/riffle sequences or sites 11 to 15 times stream width. In this study, sampling effort was sometimes limited by the pooled condition of the sites, though as noted above, such conditions do not appear atypical for this watershed.

The drought could also have initially increased dispersement of fish. Post-drought movement of fish into rewetted areas has been documented (Larimore et al. 1959, Peterson 1991) and we suggest that fish may also have emigrated from these drying areas to escape effects of the drought. Smallmouth bass have been found to migrate downstream in autumn, in response to decreasing water temperatures (Langhurst and Schoenike 1990) and it would seem likely that such movement could also occur with increasing temperature. Preferential temperature selection has been noted as a means of controlling physiological processes and could therefore influence distribution patterns of fish (Hlohowskyj and Wissing 1987). Thus, concentration of fish in areas with suitable water quality and habitat would be expected. In this study, these areas may be indicated by the high AIBI values at DG-02, DGL-02 and DGL-03 and the consistency of fish community (July and September) at DGL-02 and DGL-03. Pools maintained at these sites showed only minor to minimum water quality problems (Joseph 1989). Thus, these sites may play an important role by providing fish for post-drought recolonization. When areas of recruitment are available, reestablishment of the fish community can be rapid following a drought (Griswold et al. 1982; Hynes 1970; Larimore et al. 1959).

Water quality, based upon the WQI, was significantly correlated with fish species richness, smallmouth bass/hour and the AIBI at electric seine sites with lower values of each parameter associated with poorer water quality (higher WQI values). During drought, smaller streams are most likely to reflect water quality problems associated with limited flow.

On the East Fork, a longitudinal relationship in the WQI was apparent, with better water quality (lower WQI values) in the lower reaches of this stream. It is unknown if this moderate upstream decline in water quality was a consequence of low flow due to the drought, adjacent landuse or inputs from upstream sources. The consistent above average AIBI values at the downstream stations, even during the fall sampling, were further evidence of the higher quality of these stations. On the mainstem some site-specific differences in quality were observed, with the highest AIBI at DG-02 and the lowest value at the uppermost site DG-09. Longitudinal trends in both AIBI and WQI were however, not observed as on the East Fork.

Comparison of fish and habitat data sets suggests a positive relationship between fish diversity and habitat complexity. While we made no attempt to directly quantify habitat diversity, a shift from the basin-wide prevalent silt and sand substrates to coarser substrates, i.e. gravel and cobble, implied a change in habitat. Fish diversity basin-wide was positively correlated ($P \leq 0.05$) with both percent coarse gravel and percent small cobble (Table 6), supporting Gorman and Karr's (1978) contention that fish species diversity in streams is positively associated with habitat complexity, of which substrate type is a major component.

On the East Fork, coarse gravel and cobble comprised nearly half of the bed material at DGL-03; these materials were not present at the other stations. Predictably, the fish community at DGL-03 appeared more diverse than elsewhere on this stream. Conversely, despite a similar species richness, the fish community at the relatively silt-laden DGL-02 was dominated by two tolerant species (Smith 1979), the red shiner and bluntnose minnow. In the absence of a habitat diversity index, the proportion of coarse gravel and cobble appeared to be a predictor of fish species diversity at wadeable sites in the LaMoine River basin.

At the four East Fork stations sampled in July and revisited in September, only small temporal changes in AIBI estimates were observed. This is supported by the community similarity analyses which showed, with the exception of DGLD-01, summer and fall samples from the same station to be more similar to each other than to other samples (Fig. 3). We are uncertain of the causes of the low similarity between summer and fall samples at DGLD-01, though difficulties in equably sampling a scour hole downstream of a bridge may have been a factor. On the East Fork consistency may have been enhanced by the pooled condition of this stream which is likely to have reduced longitudinal movement of fish. Further research is needed to determine if this indication of seasonal constancy is maintained under various water regimes.

Assessment of fish body condition (*Wr*) was limited to common carp due to overall small sample sizes or significantly different weight-length regressions between sites, for other species. Carp are typically non-specific in their feeding habits (Edwards and Twomey 1982) and tolerant of harsh habitat conditions (Smith 1979). In this study, the sample parameter (carp/hour) was significantly positively associated with both detritus and claypan. While claypan was only found at four sites (Joseph 1989), detritus occurred at all sites except DGL-03 and has been noted as a constituent of the diet of common carp (see Edwards and Twomey 1982 for a review of carp ecology). Despite the occurrence of some significant differences in *Wr* values between stations (Fig. 4), non-significant ranges were present for seven of the nine stations. We were unable to determine the specific role of habitat in this relationship, since many of the sites where common carp were collected were boat sites, for which habitat information could not be obtained. Additionally, caution in the use of *Wr* in evaluating ecosystems has been suggested (Murphy et al. 1990). Therefore, before addressing site-specific relationships further work is needed to determine the consistency of these associations.

No clear assessment can be made regarding long-term changes in species composition in the watershed and implications for changes in water quality or habitat. Though one new species (silver redhorse) and two other species not collected since 1908 were found in 1988, several other species which had been recorded from this basin were not collected (Table 8). In comparison to previous IDOC collections (Table 7), sampling effort in 1988 may account, in part, for the increase in species richness especially on the mainstem and the East Fork. The drought of 1988 may also have improved sampling efficiency by concentrating fish in a smaller area following the dessication of tributaries. Many tributaries which were sampled in 1966 and 1976 could not be sampled in 1988 due to drought conditions (Table 7).

Despite limited year-round use by fish, seasonally desiccated tributaries may function as spawning and/or nurseries for sport fish when sufficient flow is available. From our reconnaissance in spring, we found some streams (Camp Creek, Little Missouri Creek and Williams Creek) with substrates consisting of bedrock, gravel, cobble or boulders, which are considered valuable to sport fish such as smallmouth bass (Todd and Rabeni 1989; Edwards et al. 1983; Smith 1979) and channel catfish (McMahon and Terrell 1982). Even with limited direct use by sport fish, these streams may provide them with forage. Though some studies have found little movement of smallmouth bass in streams (Todd and Rabeni 1989), seasonal migration of this species of distances up to 109 km has been reported from the northern range of this species, in Wisconsin (Langhurst and Schoenike 1990). While little is known about seasonal movements of smallmouth bass in Illinois, the Wisconsin study demonstrates the potential value of the LaMoine River tributaries to the smallmouth bass fishery of the Illinois River.

Future studies within this watershed should focus on use of specific areas by fish during drought and consistency of use under various water regimes. If defined stream reaches are used by fish as refugia, it is essential these areas be protected from degradation. Information regarding these associations, along with angler usage is needed for fish management and stream protection within the LaMoine River basin.

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Figure 1. Map of the LaMoine River Basin showing stations sampled in 1988.

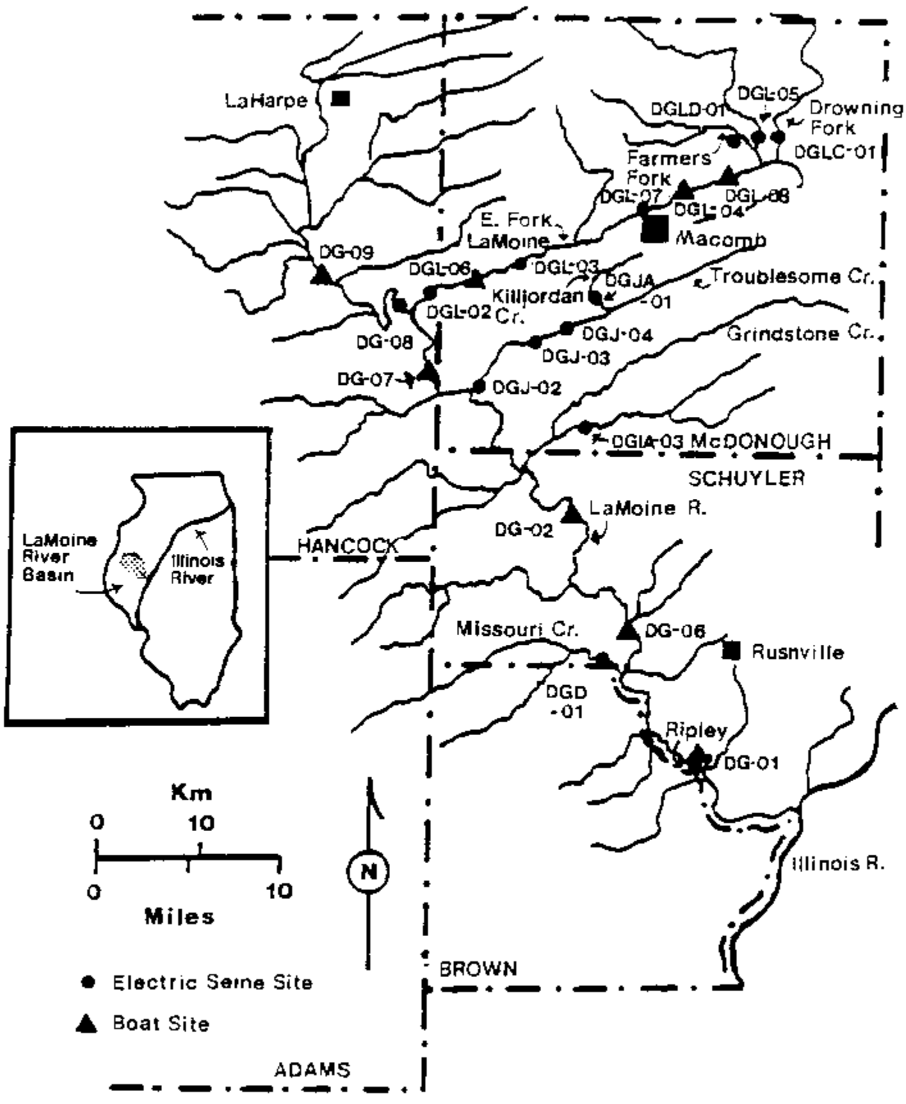

Figure 2. Coefficient of similarity for boat electrofishing stations using Horn's Index, based upon number/hour for all taxa.

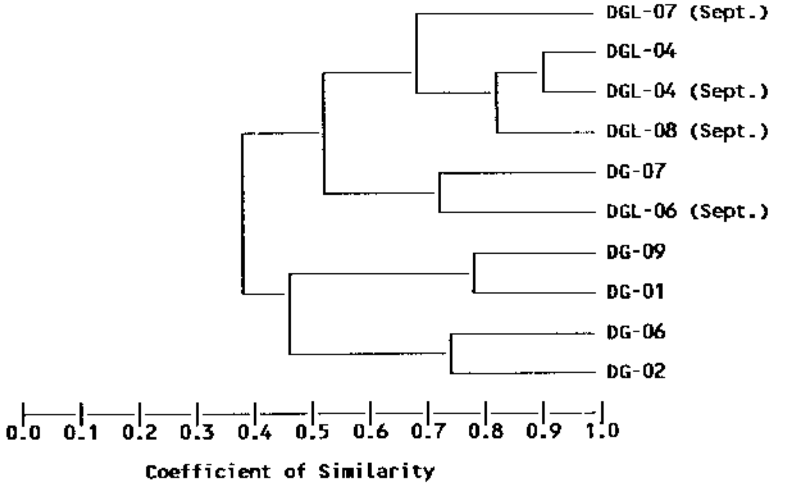

Figure 3. Coefficient of similarity for electric seine stations using Horn's Index based upon number/hour and all taxa.

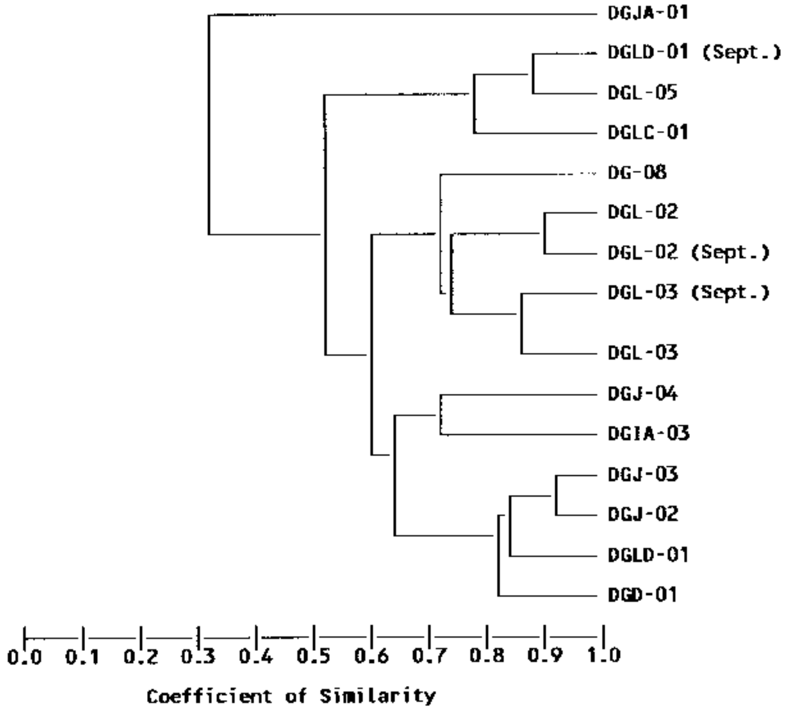

Figure 4. Mean relative weight (*Wr*) of each sample for common carp. Nonsignificance is indicated by horizontal bars. (Equation: $Log_{10}Ws = -4.418 + 2.859 * Log_{10}Length$). Sample size for each station is indicated within each bar.

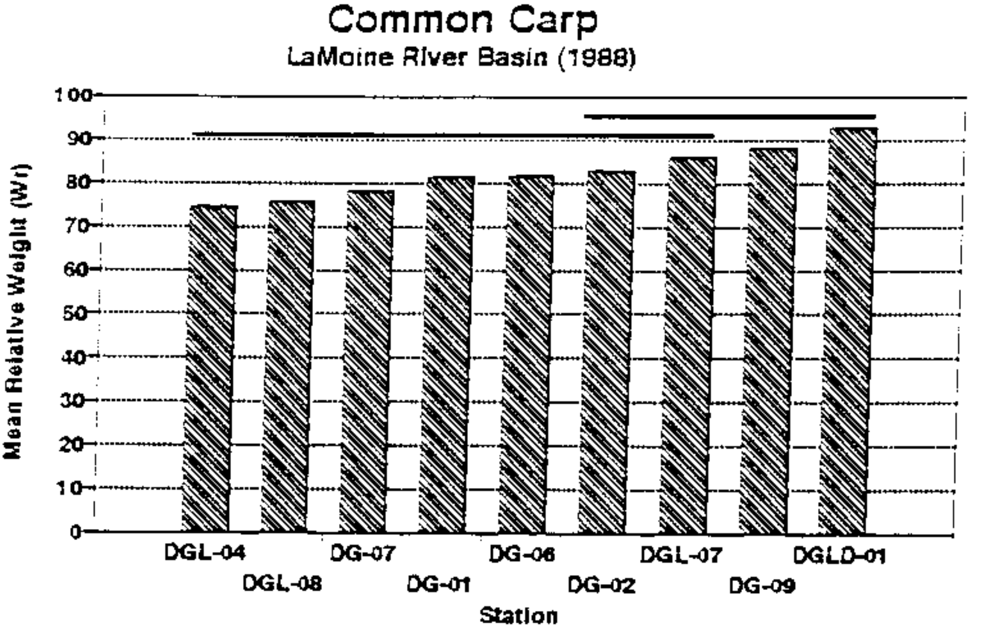

Table 1. Percent composition of each species for all stations based upon total relative abundance (number/hour) for all fish. Total number/hour are summed for each species across all stations and divided by the total number/hour for all species and sites.

Species	Percent Composition
1 Red shiner (*Cyprinella lutrensis*)	27.570
2 Bluntnose minnow (*Pimephales notatus*)	14.530
3 Green sunfish (*Lepomis cyanellus*)	7.059
4 Sand shiner (*Notropis ludibundus*)	5.853
5 Creek chub (*Semotilus atromaculatus*)	5.771
6 Common stoneroller (*Campostoma anomalum*)	5.465
7 Johnny darter (*Etheostoma nigrum*)	5.024
8 Redfin shiner (*Lythrurus umbratilis*)	4.692
9 Blackstripe topminnow (*Fundulus notatus*)	3.840
10 Bigmouth shiner (*Notropis dorsalis*)	3.143
11 Suckermouth minnow (*Phenacobius mirabilis*)	2.918
12 Gizzard shad (*Dorosoma cepedianum*)	1.869
13 Shorthead redhorse (*Moxostoma macrolepidotum*)	1.742
14 Common carp (*Cyprinus carpio*)	1.326
15 White sucker (*Catostomus commersoni*)	1.131
16 Smallmouth bass (*Micropterus dolomeiu*)	1.089
17 Emerald shiner (*Notropis atherinoides*)	0.874
18 Quillback (*Carpiodes cyprinus*)	0.847
19 Northern hogsucker (*Hypentelium nigricans*)	0.724
20 Yellow bullhead (*Ameiurus natalis*)	0.698
21 Golden redhorse (*Moxostoma erythrurum*)	0.648
22 Orangethroat darter (*Etheostoma spectabile*)	0.569
23 Hornyhead chub (*Nocomis biguttatus*)	0.545
24 Slenderhead darter (*Percina phoxocephala*)	0.376
25 River carpsucker (*Carpiodes carpio*)	0.257
26 Blackside darter (*Percina maculata*)	0.196
27 Channel catfish (*Ictalurus punctatus*)	0.181
28 Highfin carpsucker (*Carpiodes velifer*)	0.178
29 Silver redhorse (*Moxostoma anisurum*)	0.150
30 Freshwater drum (*Aplodinotus grunniens*)	0.133
31 Fathead minnow (*Pimephales promelas*)	0.111
32 Fantail darter (*Etheostoma flabellare*)	0.101
33 Stonecat (*Noturus flavus*)	0.090
34 White crappie (*Pomoxis annularis*)	0.076
35 Largemouth bass (*Micropterus salmoides*)	0.068
36 Bluegill (*Lepomis macrochirus*)	0.065
37 Black buffalo (*Ictiobus niger*)	0.060
38 Flathead catfish (*Pylodictus olivaris*)	0.053
39 Smallmouth buffalo (*Ictiobus bubalus*)	0.020
40 Bigmouth buffalo (*Ictiobus cyprinellus*)	0.015
41 Black bullhead (*Ameiurus melas*)	0.007
42 Golden shiner (*Notemigonus crysoleucas*)	0.005
43 Black crappie (*Pomoxis nigromaculatus*)	0.004
44 Longnose gar (*Lepisosteus osseus*)	0.004
45 Shortnose gar (*Lepisosteus platosomus*)	0.004
46 Freckled madtom (*Noturus nocturnus*)	0.004
Hybrid sunfish (*Lepomis species*)	0.038

Table 2. Relative abundance (number/hour) of fish from boat electrofishing (EF/AC) and total number of fish from seine hauls (SH).

												September							
STATION CODE-->>	DG-01		DG-02[1]		DG-06		DG-07		DG-09	DGL-04		DGL-04		DGL-06		DGL-07		DGL-08	
METHOD--->>	EF/AC	SH	EF/AC	SH	EF/AC	SH	EF/AC	SH	EF/AC	EF/AC	SH	EF/AC	SH	EF/AC	SH	EF/AC	SH	EF/AC	SH
SAMPLING TIME (MINUTES)--->>	29		30		15		30		20	22.5		19		35		30		30	
1 Longnose gar	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Shortnose gar	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
3 Gizzard shad	128.1	0	6	1	8	0	38	0	549	0	0	0	0	15.3	0	2	0	0	0
4 Common carp	46.2	0	124	2	112	0	40	0	63	16.2	0	9.6	0	1.7	0	14	0	64	0
5 Creek chub	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Suckermouth minnow	2.1	0	0	0	0	1	0	0	0	0	0	0	0	1.7	0	0	0	0	0
7 Emerald shiner	10.5	12	22	163	316	113	2	1	0	0	0	0	0	0	0	0	0	0	0
8 Bigmouth shiner	0	0	0	7	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Red shiner	23.1	81	20	611	204	326	28	128	18	29.7	83	60.8	17	59.5	75	2	0	6	1524
10 Sand shiner	0	0	0	8	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Redfin shiner	8.4	0	0	4	0	0	4	0	0	16.2	69	28.8	55	11.9	0	78	6	2	0
12 Bluntnose minnow	12.6	20	10	51	0	3	10	4	3	2.7	4	19.2	6	56.1	1	20	2	0	0
13 Fathead minnow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14 Common stoneroller	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
15 Smallmouth buffalo	2.1	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Bigmouth buffalo	2.1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
17 Black buffalo	2.1	0	6	0	8	0	2	0	6	0	0	0	0	0	0	0	0	0	0
18 River carpsucker	0	0	22	0	24	0	10	1	18	0	0	12.8	0	3.4	0	0	0	2	0
19 Quillback	4.2	0	6	7	32	4	10	0	27	8.1	0	3.2	0	6.8	0	0	0	10	0
20 Highfin carpsucker	2.1	0	2	0	0	0	6	0	51	5.4	0	3.2	0	0	0	0	0	2	0
21 Silver redhorse	0	0	2	0	0	0	0	1	0	0	0	0	0	8.5	0	0	0	0	0
22 Golden redhorse	2.1	0	4	0	0	0	6	0	0	0	0	0	0	74.8	0	0	0	0	0
23 Shorthead redhorse	10.5	0	12	1	12	0	40	0	9	13.5	0	3.2	0	151.3	0	0	0	0	0
24 Northern hogsucker	0	0	0	0	0	0	0	0	0	0	1	0	0	3.4	0	0	0	0	0

Table 2. (continued)

25 White sucker	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0
26 Channel catfish	0	0	10	1	4	1	12	0	6	0	0	0	0	0	0	0	0	2	0
27 Flathead catfish	4.2	0	2	0	0	0	0	0	0	5.4	0	3.2	0	0	0	0	0	2	0
28 Freckled madtom	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29 Blackstripe topminnow	0	1	0	0	0	0	0	0	0	0	0	0	0	1.7	0	2	3	0	0
30 Smallmouth bass	0	0	0	0	0	0	34	5	0	0	0	0	0	13.6	0	0	0	0	0
31 Largemouth bass	2.1	0	0	0	0	0	0	0	3	0	1	3.2	0	6.8	0	2	1	0	0
32 Green sunfish	27.3	0	12	0	24	0	42	0	90	137.7	11	342.4	4	79.9	0	100	44	194	20
33 Bluegill	2.1	0	2	1	8	0	0	0	6	0	0	0	0	0	0	0	0	8	0
34 White crappie	0	0	2	0	0	0	0	1	12	2.7	0	0	0	0	0	0	0	8	3
35 Black crappie	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
36 Blackside darter	0	0	0	1	0	0	0	1	0	0	0	0	0	1.7	0	0	0	0	0
37 Slenderhead darter	6.3	13	0	13	0	0	6	9	0	2.7	0	3.2	0	0	0	0	0	0	0
38 Johnny darter	0	0	0	1	0	2	0	1	3	0	23	3.2	1	5.1	0	0	0	0	0
39 Orangethroat darter	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40 Freshwater drum	35.7	0	6	0	8	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Hybrid sunfish	0	0	0	0	0	0	2	0	0	13.5	0	0	0	0	0	0	0	0	0
TOTAL NUMBER/HOUR	333.9	128	278	879	760	575	304	154	864	253.8	192	496	83	503.2	76	222	56	300	1548
NUMBER OF SPECIES[2] (BY METHOD)	20	6	20	17	12	11	21	12	15	12	7	13	5	18	2	9	5	11	4
TOTAL NUMBER OF SPECIES[2]	22		28		19		27			15		13		18		9		12	

1 - Common Carp netted for 15 minutes, Actual number multiplied by 4. 2 - Includes Hybrid sunfish

Table 3. Relative abundance (number/hour) of fish collected with the electric seine (ES/AC).

													September		
STATION CODE-->>	DG-08	DGD-01	DGIA-03	DGJ-02	DGJ-03	DGJ-04	DGJA-01	DGL-02	DGL-03	DGL-05	DGLC-01	DGLD-01	DGL-02	DGL-03	DGLD-01
METHOD--->>	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC	ES/AC
SAMPLING TIME (MINUTES)--->>	22	18.5	25	24	29	30	16.5	32	25	36	22	25	30	30	30
1 Gizzard shad	0	3.2	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Common carp	0	9.6	0	0	0	0	0	0	0	13.6	0	14.4	0	0	4.0
3 Golden shiner	0	0	2.4	0	0	0	0	0	0	0	0	0	0	0	0
4 Creek chub	0	51.2	300.0	200.0	56.7	96	1404.0	22.8	57.6	6.8	13.5	45.6	18.0	22.0	20.0
5 Hornyhead chub	0	0	60.0	0	0	0	0	26.6	64.8	5.1	18.9	7.2	8.0	26.0	2.0
6 Suckermouth minnow	0	12.8	74.4	55.0	14.7	72	18.0	292.6	336.0	13.6	5.4	0	162.0	110.0	0
7 Bigmouth shiner	0	0	67.2	0	0	0	1144.8	19.0	0	3.4	5.4	2.4	14.0	4.0	0
8 Red shiner	243.0	518.4	868.8	597.5	319.2	78	61.2	2783.5	343.2	622.2	936.9	175.2	2290.0	330.0	436.0
9 Sand shiner	0	0	314.4	215.0	96.6	22	583.2	376.2	98.4	23.8	102.6	4.8	246.0	264.0	0
10 Redfin shiner	5.4	70.4	1550.4	12.5	23.1	18	0	0	4.8	6.8	0	4.8	8.0	22.0	6.0
11 Bluntnose minnow	110.7	76.8	2824.8	20.0	60.9	6	104.4	307.8	328.8	1.7	37.8	7.2	1024.0	762.0	20.0
12 Fathead minnow	0	0	0	0	2.1	0	0	0	0	1.7	10.8	12	0	0	18.0
13 Common stoneroller	0	22.4	1483.2	17.5	21.0	50	36.0	57.0	208.8	0	13.5	0	54.0	228.0	0
14 River carpsucker	5.4	0	0	0	0	0	0	3.8	0	0	0	0	0	2.0	0
15 Quillback	18.9	22.4	100.8	0	0	0	3.6	19.0	19.2	18.7	0	0	14.0	16.0	0
16 Silver redhorse	2.7	0	0	0	0	0	0	0	19.2	0	0	0	4.0	24.0	0
17 Golden redhorse	27.0	3.2	33.6	0	4.2	0	0	0	19.2	0	0	0	20.0	66.0	0
18 Shorthead redhorse	56.7	35.2	4.8	10.0	0	0	0	112.1	62.4	0	0	0	90.0	76.0	0
19 Northern hogsucker	5.4	0	0	0	0	0	0	51.3	86.4	0	0	0	56.0	88.0	0
20 White sucker	0	44.8	100.8	67.5	90.3	12	90.0	0	0	0	0	38.4	0	0	8.0

Table 3. (continued)

21 Black bullhead	0	3.2	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Yellow bullhead	0	3.2	120.0	22.5	8.4	2	21.6	0	9.6	22.1	45.9	16.8	0	0	8.0
23 Channel catfish	24.3	0	0	5.0	0	0	0	5.7	0	1.7	0	0	0	2.0	0
24 Flathead catfish	2.7	0	0	0	0	0	0	0	0	0	0	0	0	2.0	0
25 Stonecat	0	0	0	0	0	0	0	7.6	16.8	0	0	0	0	12.0	0
26 Freckled madtom	0	0	0	0	0	0	0	1.9	0	0	0	0	0	0	0
27 Blackstripe topminnow	0	0	26.4	0	0	0	0	0	0	161.5	1128.6	9.6	0	0	210.0
28 Smallmouth bass	32.4	0	33.6	0	0	0	0	60.8	86.4	0	0	0	38.0	138.0	0
29 Largemouth bass	5.4	0	4.8	0	0	0	0	0	0	0	0	0	0	0	0
30 Green sunfish	45.9	153.6	782.4	120.0	142.8	34	3.6	20.9	19.2	96.9	2.7	79.2	4.0	36.0	240.0
31 White crappie	0	0	0	0	0	0	0	0	2.4	3.4	0	0	0	0	0
32 Blackside darter	0	9.6	57.6	0	0	0	0	3.8	0	0	0	0	2.0	4.0	0
33 Slenderhead darter	0	0	0	0	0	0	0	51.3	33.6	0	0	0	16.0	32.0	0
34 Fantail darter	0	0	40.8	0	0	0	0	0	0	0	0	0	0	0	0
35 Johnny darter	2.7	3.2	1068.0	32.5	12.6	8	126.0	456.0	175.2	3.4	21.6	0	66.0	28.0	0
36 Orangethroat darter	0	0	158.4	0	0	58	0	0	12.0	0	0	0	0	0	0
TOTAL NUMBER/HOUR	588.6	1043.2	10077.6	1375	852.6	456	3596.4	4679.7	2004	1006.4	2343.6	417.6	4134	2294	972
NUMBER OF SPECIES	15	17	23	13	13	12	12	20	21	17	13	13	19	23	11

Table 4. Alternate Index of Biotic Integrity (AIBI), Water Quality Index (WQI), diversity and evenness values for stations sampled in the LaMoine River Basin in 1988.

Stream	Station Code	AIBI[a]	WQI[b c]	Brillouin Diversity	Evenness
July					
LaMoine River	DG-01	43.6	25.5	2.06	0.695
	DG-02	52.4	31.6	2.32	0.779
	DG-06	44.7	33.2	1.60	0.651
	DG-07	46.9	26.3	2.44	0.817
	DG-08	44.0	13	1.87	0.703
	DG-09	36.0	73.7	1.38	0.513
Missouri Creek	DGD-01	42.5	34.2	1.78	0.634
Grindstone Creek	DGIA-03	44.7	37	2.21	0.706
Troublesome Creek	DGJ-02	38.2	67.8	1.78	0.692
	DGJ-03	38.2	74.1	1.91	0.749
	DGJ-04	33.8	71.2	2.08	0.861
Killjordan Creek	DGJA-01	44.7	67.1	1.52	0.611
East Fork LaMoine River	DGL-02	51.3	20.4	1.54	0.514
	DGL-03	51.3	30.7	2.44	0.798
	DGL-04	40.4	39.9	1.62	0.677
	DGL-05	38.2	41.5	1.35	0.483
Drowning Fork	DGLC-01	38.2	94.7	1.20	0.470
Farmers Fork	DGLD-01	38.2	44	1.81	0.726
September					
East Fork LaMoine River (downstream to upstream)	DGL-02	46.9	--	1.41	0.481
	DGL-06	42.5	--	2.08	0.714
	DGL-03	49.1	--	2.22	0.708
	DGL-07	27.3	--	1.27	0.579
	DGL-04	38.2	--	1.18	0.471
	DGL-08	37.1	--	1.11	0.471
Farmers Fork	DGLD-01	38.2	--	1.39	0.584

a-Aquatic Resource Description (IBI value): Unique (51-60), Highly valued (41-50), Moderate (31-40), Limited (21-30), Restricted ($\leq$ 20). From Hite and Bertrand (1989).
b-From Joseph (1989)
c-Scale of 0 - 100 (0 = No problems, 100 = Severe problems)

Table 5. Length categorization of sport fish species from electrofishing samples collecte from the LaMoine River Basin (1988). Values are number/hour. Stock, quality and preferred values represent minimum length (mm) for each category. (After Gablehouse 1984).

	L	S	Q	P		L	S	Q	P
Smallmouth Bass	< 180	180	280	350	Bluegill	< 80	80	150	200
Largemouth Bass	< 200	200	300	380	Channel Catfish	< 280	280	410	610
Common Carp	< 280	280	410	530	White Crappie	< 130	130	200	250

	Smallmouth Bass				Largemouth Bass				Common Carp			
Station	L	S	Q	P	L	S	Q	P	L	S	Q	P
DG-01	-	-	-	-	2.1	-	-	-	2.1	14.7	29.4	-
DG-02	-	-	-	-	-	-	-	-	-	76	44	4
DG-06	-	-	-	-	-	-	-	-	-	56	52	4
DG-07	30	-	2	2	-	-	-	-	-	22	18	-
DG-08	18.9	13.5	-	-	2.7	2.7	-	-	-	-	-	-
DG-09	-	-	-	-	-	-	3	-	15	9	39	-
DGIA-03	21.6	7.2	4.8	-	2.4	2.4	-	-	-	-	-	-
DGJ-02	-	-	-	-	-	-	-	-	-	-	-	-
DGL-02	58.9	1.9	-	-	-	-	-	-	-	-	-	-
DGL-02 (Sept.)	36	2	-	-	-	-	-	-	-	-	-	-
DGL-03	88.8	-	-	-	-	-	-	-	-	-	-	-
DGL-03 (Sept.)	114	24	-	-	-	-	-	-	-	-	-	-
DGL-04	-	-	-	-	-	-	-	-	-	13.5	2.7	-
DGL-04 (Sept.)	-	-	-	-	3.2	-	-	-	-	-	9.6	-
DGL-05	-	-	-	-	-	-	-	-	13.6	-	-	-
DGL-06	13.6	-	-	-	-	8.5	-	-	-	-	-	1.7
DGL-07	-	-	-	-	2	-	-	-	-	2	10	2
DGL-08	-	-	-	-	-	-	-	-	10	44	8	2
DGLD-01	-	-	-	-	-	-	-	-	-	7.2	7.2	-
DGLD-01 (Sept.)	-	-	-	-	-	-	-	-	-	-	4	-

	Bluegill				Channel Catfish				White Crappie			
DG-01	-	2.1	-	-	-	-	-	-	-	-	-	-
DG-02	-	2	-	-	2	4	4	-	-	-	-	2
DG-06	-	4	4	-	4	-	-	-	-	-	-	-
DG-07	-	-	-	-	6	6	-	-	-	-	-	-
DG-08	-	-	-	-	13.5	10.8	-	-	-	-	-	-
DG-09	-	3	3	-	-	6	-	-	9	-	3	-
DGIA-03	-	-	-	-	-	-	-	-	-	-	-	-
DGJ-02	-	-	-	-	2.5	2.5	-	-	-	-	-	-
DGL-02	-	-	-	-	5.7	-	-	-	-	-	-	-
DGL-02 (Sept.)	-	-	-	-	-	-	-	-	-	-	-	-
DGL-03	-	-	-	-	-	-	-	-	-	-	-	-
DGL-03 (Sept.)	-	-	-	-	2	-	-	-	-	-	-	-
DGL-04	-	-	-	-	-	-	-	-	-	-	-	2.7
DGL-04 (Sept.)	-	-	-	-	-	-	-	-	-	-	-	-
DGL-05	-	-	-	-	1.7	-	-	-	-	-	-	3.4
DGL-06	-	-	-	-	-	-	-	-	-	-	-	-
DGL-07	-	-	-	-	-	-	-	-	-	-	-	-
DGL-08	-	8	-	-	-	2	-	-	2	-	-	6
DGLD-01	-	-	-	-	-	-	-	-	-	-	-	-
DGLD-01 (Sept.)	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. Summary of correlation analyses of fish, water quality, and habitat parameters. Values are Pearson's r for ($P \leq 0.05$). Water quality and habitat data from Joseph (1989).

WATER QUALITY

ELECTRIC SEINE SITES N = 12	AIBI	Diversity	Evenness	No. of Species	No./ Hour	SMB/ Hour	SMBWT /Hour	Totalwt /Hour	Carp /Hour
Stream Order	--	--	--	--	--	0.620	--	--	--
Water Temperature (°C)	--	--	--	--	--	--	--	--	--
D.O. (mg/l)	--	--	--	--	--	--	--	--	--
Conductivity (umhos/cm)	--	--	--	--	--	--	--	--	--
pH (units)	--	--	--	--	--	--	--	--	--
Alkalinity (mg/l)	--	--	--	--	--	--	--	--	--
Unionized Ammonia (mg/l)	--	--	--	--	--	--	--	--	--
BOD (mg/l)	--	--	--	--	--	--	--	--	--
COD (mg/l)	--	--	--	--	--	--	--	--	--
Turbidity (NTU)	--	--	--	--	--	--	--	--	--
WQI	-0.617	--	--	-0.661	--	-0.626	--	0.596	--
TSS (WQI)[b]	--	--	--	--	--	--	--	--	--
METALS (WQI)[b]	--	--	--	--	--	--	--	--	--
AMMONIA (WQI)[b]	--	--	--	--	--	--	--	--	0.658
PHOSPHATES (WQI)[b]	-0.576	--	--	-0.747	--	-0.604	--	-0.668	--
pH (WQI)[b]	--	--	--	--	--	--	--	--	--
D.O. (WQI)[b]	--	--	--	--	--	--	--	--	--
WATER TEMPERATURE (WQI)[b]	--	--	-0.589	--	--	--	--	--	--
CONDUCTIVITY (WQI)[b]	--	--	--	--	--	--	--	--	--
BOAT ELECTROFISHING SITES N = 6									
Stream Order	--	--	--	--	--	--	--	--	--
Water Temperature (°C)	--	--	--	--	--	--	--	0.853	--
D.O. (mg/l)	0.933	--	--	--	--	--	--	--	--
Conductivity (umhos/cm)	--	--	--	--	--	--	--	--	--
pH (units)	0.828	--	--	--	--	--	--	--	--
Alkalinity (mg/l)	--	--	--	--	--	--	--	--	--
Unionized Ammonia (mg/l)	--	--	--	--	--	--	--	0.857	--

Table 6. (continued)

BOD (mg/l)	--	--	--	--	--	--	--	--	--
COD (mg/l)	--	--	--	--	--	--	--	0.817	--
Turbidity (NTU)	--	--	--	--	--	--	--	--	--
WQI	--	--	-0.859	--	--	--	--	--	--
TSS (WQI)[b]	--	--	--	--	--	1.000	1.000	--	--
METALS (WQI)[b]	--	--	--	--	--	--	--	--	--
AMMONIA (WQI)[b]	--	--	--	--	--	--	--	--	--
PHOSPHATES (WQI)[b]	--	--	--	--	--	--	--	--	--
pH (WQI)[b]	--	--	--	--	--	--	--	--	--
D.O. (WQI)[b]	--	--	-0.819	--	--	--	--	--	--
WATER TEMPERATURE (WQI)[b]	--	--	--	--	--	--	--	0.868	--
CONDUCTIVITY (WQI)[b]	--	--	--	--	--	--	--	--	--
HABITAT ELECTRIC SEINE SITES N = 12									
%Silt	--	--	--	--	--	--	--	--	--
%Sand	--	--	--	--	--	--	--	--	--
%Fine Gravel	--	--	--	--	--	--	--	--	--
%Medium Gravel	--	--	--	--	--	--	--	--	--
%Coarse Gravel	--	0.677	0.709	--	--	--	--	--	--
%Small Cobble	--	0.779	0.706	--	--	0.579	--	--	--
%Large Cobble	--	--	--	--	--	--	--	--	--
%Boulder	--	--	--	--	--	--	0.838	0.677	--
%Clay	--	--	--	--	--	--	--	--	0.686
%Detritus	--	--	--	--	--	--	--	--	0.735
%Vegetation	--	--	--	--	--	--	--	--	--
%Submerged Logs	--	--	--	--	--	--	--	--	--
Discharge (cfs)	--	--	--	--	--	--	--	--	--
Mean Channel Width	--	--	--	--	--	0.604	--	--	--
Mean Water Width	--	0.693	--	--	--	0.661	0.586	--	--
Mean Velocity (@ Q)	--	--	--	--	-0.589	--	--	--	--
Mean Velocity (Reach)	--	--	--	-0.591	--	--	--	--	--
Mean Depth	--	--	--	--	--	--	--	--	--
%Pool	--	--	--	--	--	--	--	0.713	--
%Riffle	--	--	--	--	--	--	--	--	--
%Instream Cover	--	--	--	--	--	--	--	--	--

b - These represent individual components of the total WQI.

Table 7. Comparison of species richness from 1988 sampling with previous Illinois Department of Conservation basin-wide investigations of Rock (1966) and Dunn (1976).

	Number of Stations[a]			Number of Species[b]		
Stream	1966	1976	1988	1966	1976	1988
LaMoine River	3	3	6	25	25	39
E. Fork LaMoine River	1	1	10[a]	25	14	36
Grindstone Creek	-	1	1	--	10	23
Troublesome Creek	1	1	3	12	7	16
Killjordan Creek	-	-	1	--	--	12
Missouri Creek	1	-	1	14	--	17
Drowning Fork	-	-	1	--	--	13
Farmers Fork	-	-	2[a]	--	--	13
Rock Creek[c]	1	1	-	14	10	--
Pilot Grove Creek[c]	1	1	-	12	14	--
Long Creek[c]	1	1	-	14	10	--
LaHarpe Creek[c]	1	1	-	13	7	--
Bronson Creek[c]	1	1	-	15	8	--
Williams Creek[c]	1	1	-	19	12	--
Camp Creek[c]	2	1	-	24	10	--
Total	14	11	25	39	32	47

a - Includes stations resampled in the fall, 1988.
b - Includes hybrid categories.
c - Not sampled in 1988.

Table 8. Fish species not collected in 1988, but previously recorded by IDOC, the INHS[a] or Smith (1979)[b].

Common shiner	(*Luxilus cornutus*)
Southern Redbelly dace	(*Phoxinus erythrogaster*)
Silvery minnow	(*Hybognathus nuchalis*)
White bass	(*Morone chrysops*)
Hybrid stripe bass	(*Morone chrysops* x *Morone saxatallis*)
Pumpkinseed sunfish	(*Lepomis gibbosus*)
Sauger	(*Stizostedion canadense*)
Logperch	(*Percina caprodes*)

a - From (Cummings, 1989).
b - Historical occurrence as determined from distributional maps in Smith (1979). Species collected prior to 1908, but not collected since that time are not included.