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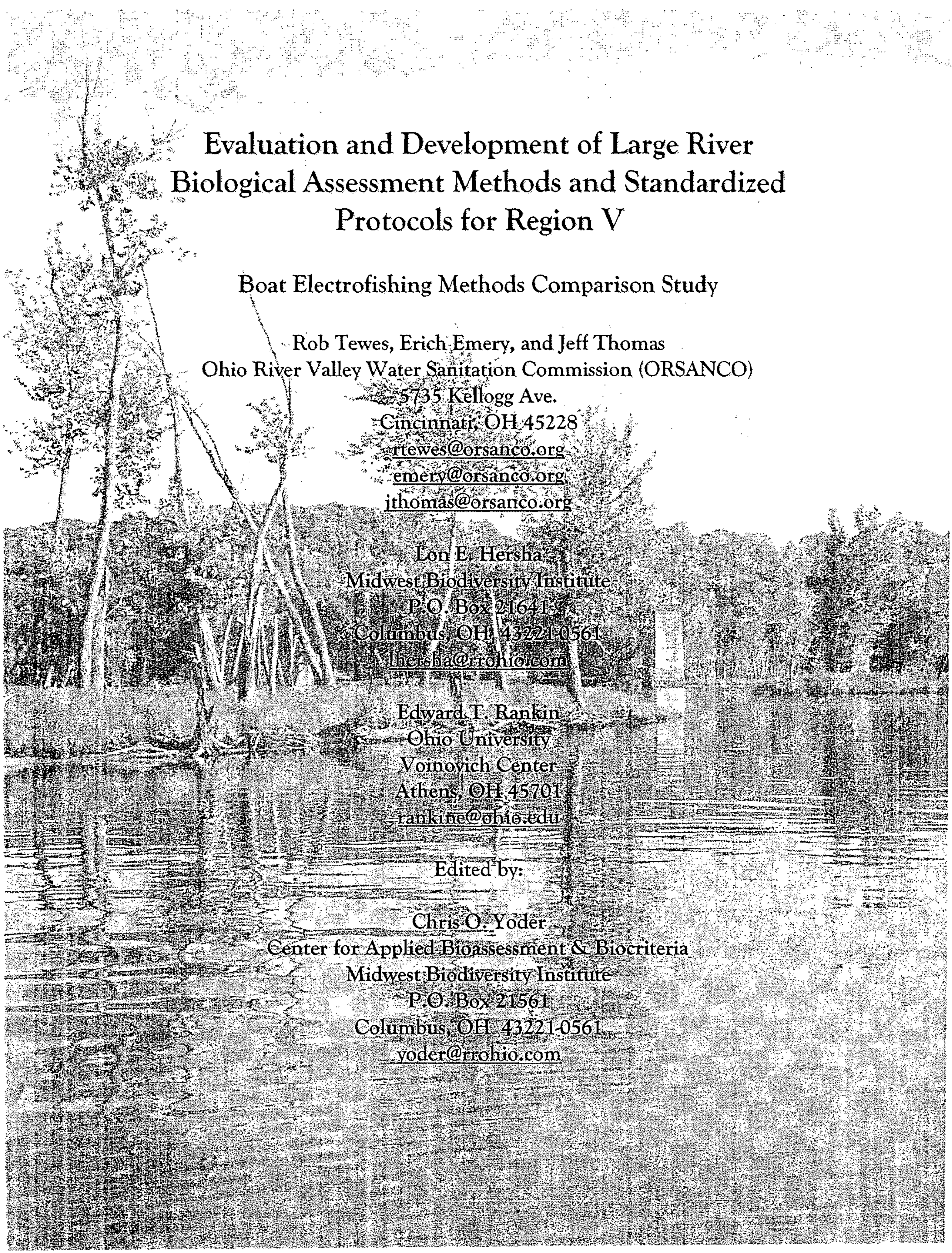

Evaluation and Development of Large River Biological Assessment Methods and Standardized Protocols for Region V

Boat Electrofishing Methods Comparison Study

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ACKNOWLEDGEMENTS

This study was made possible by the cooperation of the organizations and individuals who agreed to participate by providing sampling effort, data, logistical support, and report review. This includes the following organizations and personnel: Minnesota PCA (Dan Helwig, Scott Niemela, Mike Feist), Minnesota DNR (Nick Proulx), Wisconsin DNR (John Lyons), Illinois DNR (Steve Pescitelli), Indiana DEM (Stacey Sobat), Elkhart Department of Public Works (Len Kring, Joe Foy), Metropolitan Water Reclamation District of Greater Chicago (Jennifer Wasik, Sam Denison), Michigan DNR/IFR (Dana Infante), and American Electric Power (Alan Gaulke). This study would not have been possible without the direct participation and cooperation of these organizations and individuals. Ed Hammer, U.S. EPA, Region V provided technical assistance and project oversight. Funding for this study was provided by U.S. EPA, Region V under Section 104(b)(3) of the Clean Water Act via grant CP-96510501.

II. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

During a summer-fall seasonal index period in 2004 and 2005 a controlled comparison of boat electrofishing methods used by the Midwest Biodiversity Institute and ORSANCO was accomplished within 8 discrete study areas with the participation of 6 state agencies, 2 municipal governments, and one private industry. This study is necessarily experimental and provides information that contributes to the comparatively new and emerging science and practice of bioassessment comparability. This project is allied with simultaneous studies being conducted in Region V that are researching spatial monitoring designs, fish and other biological assemblage indicator development, and the application of tiered aquatic life uses (TALUs) in large, non-wadeable rivers. Taken together, these studies are largely focused on 11 principal mainstem rivers that are tributary to the upper Mississippi and Ohio Rivers within Region V.

Every attempt was made to conduct sampling/comparisons on as many of an original set of 11 principal mainstem rivers as was possible. We were able to conduct methods comparisons on 3 of these rivers while conducting sampling for an allied project designed to test probabilistic sampling designs. Additionally, sampling that was initiated on two of the original target rivers was precluded by extended periods of unacceptably high river flows. We were able to augment the database for this study by including data collected as part of allied studies conducted by MBI on other non-wadeable rivers in 2005. This included three river systems sampled by MBI that added 5 additional entity comparisons. This study is necessarily experimental as there were virtually no precedents for the design or conduct of direct comparisons of fish sampling methodologies when it was initiated in 2004. Since that time U.S. EPA has initiated research and demonstration projects for the conduct of bioassessment comparability projects, but none of these deal with electrofishing comparisons.

The goal of this study is to produce samples collected by MBI/ORSANCO and each participating entity at the *same* sampling sites within the *same* summer-fall index period. This necessitated establishing standards for the temporal separation of individual sampling events, which was set at a minimum of two weeks. We also determined the level of variability that could be expected between two different samples collected at the same sampling site on *different dates*. This was accomplished by analyzing the variability of data from multiple passes at the same sites from the Ohio EPA statewide database, which consists of 2-3 boat electrofishing passes per site within the same seasonal index period. MBI/ORSANCO employed the same methods as those developed and used by Ohio EPA for daytime electrofishing, thus it was used to determine the expected variability between sampling passes. Thresholds were then established for what constituted similar, weakly similar, and dissimilar results for baseline catch parameters and two assemblage indices. Data from different years at the same site were included for two entities in order to have an adequate number of comparisons.

It was necessary to designate the MBI/ORSANCO methods as the "arbiter" of the comparisons since it was impractical to have each participating entity sample at all of the comparison sites. The comparisons were made to determine the comparability of baseline sample parameters such as species richness, relative numbers, and relative biomass. As such these are the baseline "ingredients" of a fish assemblage assessment regardless of the techniques used to analyze that data. We are focused here on determining if differences exist, characterizing their magnitude, and attempting to determine what might be the sources of variation in the results of a respective methodology and its execution beyond that expected. We analyzed the Ohio EPA boat electrofishing database to determine the expected variability between sampling passes conducted at the same site on different dates within the same summer-fall seasonal index period and the same site sampled in different years. Some variation in baseline sample parameters (species richness, numbers, biomass) is to be expected even with the same crew and equipment. Thus making comparisons between two different entities on different dates had to factor this into the comparison of results.

The comparisons were made using species richness, relative density (numbers/km), and biomass (kg/km) when the latter was available. We also used two transformations of the relative abundance data in the comparison analyses, the Modified Index of Well-Being (MIwb) and the Bray-Curtis coefficient of similarity. The comparisons were made on a sampling site basis as an average and as a distribution of data for all sites combined. Each comparison was designated as being similar, weakly similar, or dissimilar. The criteria for similar results was the 75th percentile of the analysis of the Ohio EPA multiple pass data used to establish the expected variation in results between different dates within the same seasonal index period or different years for species richness, density, biomass, and the MIwb. The 25th percentile was used for the Bray-Curtis results as a statistically consistent threshold for that index. Weakly similar results were between the 75th and 95th percentiles (25th and 5th for Bray-Curtis), and dissimilar results were outside of the 95th percentile (5th percentile for Bray-Curtis). Using these criteria reflects an increasing deviation of results between each comparison to the point where the results are either comparable or not for bioassessment purposes.

Results and Conclusions

It is clear from the information compiled here that there are a variety of differences between the boat electrofishing protocols used by the different entities involved in this study. Some of these are easily distinguished and include sampling distance, sampling direction (upstream vs. downstream), site location (single bank, both banks, mid-channel), equipment specifications (pulsator specifications, settings, dip net mesh size), number of netters (1 vs. 2 primary netters, assist netters), and time electrofished. Other differences were not as apparent, but can be inferred from other information and include the "thoroughness" of sampling, i.e., how thoroughly were all available habitats (e.g., woody debris, riffles, gravel shoals, deep runs, pools, all cover types, etc.) sampled. This may be one of the most important, yet difficult to document variables that contributed to some of the observed differences in the results.

The results indeed showed a wide range of comparability from similar to dissimilar results for individual sites and to a lesser extent for the overall average and range of results for all sites combined with respect to each entity comparison. Raw catch differences ranged from similar to dissimilar for species richness, density, biomass, and the MIwb. The

Bray-Curtis coefficient showed mostly dissimilar results which may be an artifact of this tool and the current thresholds for what constitutes "similar" results. This will require further examination beyond the scope of this study. Nevertheless, it was the only parameter that we felt was amenable to making comparisons among and between all entities.

The results were deemed "comparable" with MBI in terms of average and site-specific results for 3 of the 8 participating entities. For the remaining 5 entities, MBI produced higher species richness and relative abundance, some by one order of magnitude margins or greater. MBI electrofishing times exceeded most of the other entity times when that data was available and seemed to be one of the factors associated with dissimilar results in some, but not all of the comparisons.

We can make some preliminary conclusions at this time pending further analyses of the results (see recommendations below), but it would appear that the factors involved in the weakly similar and dissimilar results are electrofishing time (as a reflection of the "thoroughness" of sampling), sampling procedures (e.g., sampling upstream vs. downstream, daytime vs. nighttime, habitats sampled), equipment specifications and settings (wattage, pulse settings, % of duty cycle), electrode configuration (anode array, use of the boat hull as the cathode, etc.), site conditions (i.e., temporal water quality and flow variations), and the general "intensity" of the sampling protocol and its execution. The latter is not possible to conclusively confirm as we did not observe the operations of all of the participating entities, but it may be inferred from electrofishing time results and the descriptions and inherent nature of the cooperating entity sampling protocols. If these conclusions hold pending more detailed investigation, gaining better comparability may be a matter of standardizing the execution of the sampling protocols as opposed to making wholesale changes in equipment. Standardizing results between different entities for attaining consistent bioassessment outcomes would more likely be achieved by adherence to a standardized sampling protocol. This would also be enhanced by conducting on-site training as a mechanism for assuring consistency in the execution of the protocol. This will be an important consideration for the upcoming U.S. EPA national large rivers survey in 2008-9.

Cooperator Feedback

We afforded an opportunity for each participating entity to offer feedback and make suggestions based on an earlier draft of this report. Concern was expressed by some cooperators about the potential impact that this study might have on the status of their current protocol and bioassessment program by extension. The bioassessment indices used by each entity are to varying degrees *method and protocol dependent*, hence the impact of a substantial change in methods is of concern. In at least one study area the potentially confounding influence of temporal water quality conditions was raised as an undesirable factor that might have compromised the comparability of the results. We agree that minimizing external and potentially uncontrollable influences is a necessity in conducting comparability studies. Ideally the comparisons would have been better controlled by limiting the number f sampling locations, but that was impractical to accomplish for this initial study.

Perhaps the most significant concern was about the effect of the observed differences on the resulting assessment of overall assemblage condition - do the observed differences in raw catch statistics translate to a significant difference in the assignment of condition for bioassessment purposes? We did not conduct sufficient analyses to answer this question due to the limitations of the data analyses and the priority that was placed on collecting the baseline comparison data. This is quite likely a non-linear phenomenon that addresses not only the accuracy of a "pass/fail" presumption (at least one commenter indicated the differences did indeed affect their assessment outcome), but also includes the capacity to accurately measure along a continuous gradient of biological quality, i.e., the U.S. EPA Biological Condition Gradient (U.S. EPA 2005; Davies and Jackson 2005). It has been shown that the capacity to accurately measure across this gradient is a product of the overall rigor of the bioassessment protocol that includes the aggregate effect of methods, natural classification, reference condition, taxonomy, and other detail in the data (Barbour and Yoder 2006). Two different protocols may well yield the same ability to function within a general pass/fail dichotomy, yet be dissimilar in their capability to accurately depict multiple categories of condition such as excellent, very good, good, fair, poor, and very poor conditions and the margins between each. This capability is a consistent prerequisite for supporting the development and application of tiered aquatic life uses and a bioassessment framework that measures incremental change along a biological condition gradient. Without first testing each resulting dataset across a gradient of environmental quality, it will be difficult to determine how much the basic sampling protocol and resulting dataset actually play in this issue. This could be examined at the assessment outcome level of analysis that is recommended to follow this study.

Recommendations

In order to answer the important question about condition assessment comparability, we recommend that further analyses be conducted, in particular calculating Index of Biotic Integrity (IBI) values using the most applicable *calibrated and verified IBI.* This would fulfill a key missing analysis by basing comparability on the *resulting assessment of condition*, rather than singularly focusing on baseline catch statistics. While this study focused on making comparisons over a standardized sampling effort based on the same unit of distance, comparisons of the net effect of each entity's protocol would also be of value since this is a reality of the current state of electrofishing methods in Region V.

We also recommend that the results from each study area be discussed in greater detail with each cooperator in an effort to more closely ascertain what factors the differences are most attributable and what the impact of any implied changes in an existing protocol might have. This will require detailed interactions with each entity that would be enhanced by making observations of their sampling procedures in the field. We believe this is one way of ensuring that the data collected by different entities is comparable for bioassessment purposes across Region V. It would also have the benefit of being useful in the development of applicability of QAPPs, training curricula, and methods for ensuring comparable results and the resulting bioassessments that are produced.

1. INTRODUCTION

1.1. Problem Definition and Background

Conducting biological assessments in large, non-wadeable rivers is widely regarded as being more difficult and resource intensive than for smaller, wadeable streams, hence the historical emphasis on this latter waterbody type by most states and EPA guidance for aquatic bioassessments. The intent of this and its allied projects is to develop and evaluate a process by which systematic and standardized methods for the biological assessment of large, non-wadeable rivers can be made available to the states and EPA. This was and is an important and requisite first step to attaining the goal of having fully developed and calibrated biological assessment tools and biological criteria, which in turn supports specific water quality management programs within the states and Region V. Of particular interest here is the assessment of the effectiveness of NPDES permits on an individual and collective basis by using the health of the biota as a keystone measure of response. This will also have value to the national assessment of large rivers that is planned for 2008 and 2009 by U.S. EPA.

This project consisted of an assessment of fish assemblage electrofishing methods used by selected Region V states, municipalities, research groups, private organizations, ORSANCO, and U.S. EPA. The primary goal of this project was to evaluate a methodology for determining the comparability of the different methods and protocols and if the first order data produced by each is similar. This is a critical first step towards the development and production of biological criteria and scientifically and statistically valid assessments of the large river resources in the basins of the Ohio and Upper Mississippi rivers within Region V. This project was designed to deliver a standardized methodology that can be used by the EPA, the states, and other organizations in assessing and managing their large river resources.

A systematic approach to assessing large, non-wadeable riverine resources is presently an unmet need throughout much of the region (Yoder 2004). The knowledge gained by this project is particularly useful in determining the ability of existing fish assemblage assessment protocols to address water quality and aquatic resource management concerns including status and trends, water quality standards (WQS), use attainability analyses (UAAs), watershed planning, and NPDES permits. Collaborating organizations included the states of Illinois, Indiana, Minnesota, Michigan, Wisconsin, and Ohio, all of which contain large rivers that are tributaries to the Ohio and/or upper Mississippi Rivers. Collaboration with U.S. EPA-ORD also took place as appropriate via a separate, but allied project initiated by ORSANCO in 2004. Collaboration with the states and EPA occurred with monitoring and studies already planned by each and as facilitated by the Region V State Bioassessment Working Group. It should also be noted that this was intended to serve as a possible first step towards the eventual determination of a standardized biological assessment methodology and biological criteria, each of which are necessary to produce a valid assessment of the large river resources of the region. We expect that the products of this grant will be useful to the states for conducting long-term assessments of their riverine resources.

Large rivers are an important ecological resource and constitute a significant water quality management challenge in the U.S. and elsewhere. They are the focus of numerous environmental and natural resource management issues, which can be attributed in part to their highly visible economic and natural resource values. In particular, numerous major and significant NPDES permitted discharges occur in the large rivers of Region V. Despite their importance and visibility, biological assessment methodologies are not as well developed nor as widely employed in Region V as they are in smaller, wadeable streams, and hence are only recently receiving emphasis by EPA and the states (Yoder 2004). This is not to imply that the states are not interested or that some have not sampled large rivers, when in fact most have some type of effort ongoing. However, sufficiently robust, refined, and systematic large river fish assemblage assessment approaches and coverages that can support biocriteria and TALUs have been developed and implemented by only two Region V states and ORSANCO on a statewide or regional basis (Yoder and Smith 1999; Lyons et al. 2001; Emery et al. 2003; Yoder et al. 2005). These were developed entirely within the jurisdiction of each entity and are based on methods and equipment that may or may not be transferable across the region. Ohio EPA developed standardized methods and adopted numeric biocriteria based on calibrated multimetric indices (i.e., fish IBI) and adopted numeric and TALU-based biocriteria in their WQS. Routine assessments of large river fish assemblages have been conducted for more than 25 years (Ohio EPA 1987; Yoder and Smith 1999; Yoder et al. 2005) and are accompanied by similarly developed macroinvertebrate assessments. ORSANCO developed a fish assemblage method and calibrated index for the Ohio River (ORFIn; Emery et al. 2003) for routine application within their monitoring program and eventual adoption of biocriteria. Wisconsin DNR developed a fish assemblage method and index (Lyons et al. 2001) that supports a consistent statewide assessment of their large rivers. All three efforts are conceptually similar, but exhibit differences in equipment and methods. Indiana DEM has developed a working IBI for the Wabash River (Simon and Stahl 1998). The remaining Region V states (Illinois, Michigan, and Minnesota) also sample large rivers, but not as extensively, nor have they developed calibrated indices or numeric biocriteria. More importantly, each state employs different equipment and methods, some of which are markedly different from the other states and ORSANCO.

If the goal of having comparable assessments for the large rivers of Region V is to be reasonably achieved, methodological issues need to be assessed. While there are conceptual similarities in the different approaches presently employed by each state (e.g., all use boat-mounted electrofishing, all use it to generate assemblage level data in support of bioassessment), there are important differences in the configuration and application of the equipment, differences in the manufacture and design of the equipment, differences in site sampling protocols, and differences in the execution of the sampling. The cumulative result of these differences leaves important questions about the comparability of the data and the resulting biological assessments unanswered. Besides the in-common issues of the adequacy and comprehensiveness of individual approaches, the comparability of the assessments produced by different protocols also needs to be established. For example, the methods used by ORSANCO and the Region V states are generally similar, yet exhibit explicit differences that *potentially could* produce different assessments of fish assemblage condition. Night electrofishing is one such variation in these methods that may affect assessment results in the lower sections of the large river tributaries to the Ohio and Upper Mississippi Rivers. Sanders (1991) discovered the advantages of night electrofishing in the Ohio River while initially using a daytime methodology, an approach that ORSANCO eventually adopted (Emery et al. 2003). It is therefore possible that the application of this method may have merit over daytime electrofishing in the lower sections of the large river tributaries to the Ohio and Upper Mississippi Rivers. Another variation is with sampling distance covered at a site. Ohio EPA and ORSANCO sample fixed distances of 0.5 km, which was developed based on extensive methods testing first accomplished by Gammon (1976), which they independently retested (Yoder and Smith 1999; Emery et al. 2003). Wisconsin uses a fixed distance of 1 mile, which is based on initial methods testing as well (Lyons et al. 2001). This protocol is followed by Minnesota DNR and Michigan DNR and IFR. EPA's EMAP program and some states employ a river width formula for determining the dimensions of a sampling site. Some states sample both banks and the mid-channel whereas others sample the "best habitat" available. Some states sample river sites in both an upstream and downstream direction. Differences also exist in electrofishing gear specifications, boat platforms, and electrode configurations. Finally, the execution of the methodology at a site may also comprise a major factor in any observed variations between protocols. This factor includes how deliberately and intensively a site is sampled. All of these were examined and tested as much as was practicable in order to determine if methodological differences alone could produce differences in the baseline data upon which assignments of quality and condition (status) are ultimately based, thus making comparability across the region more challenging.

It should also be noted here that assemblage level data is also used to characterize and quantify reference condition, which plays a critical role in how the various assessment tools are developed and calibrated in the process of establishing numeric biological criteria. Evaluating the comparability of individual organization practices is very important in determining the utility of bioassessments as a major program support tool. Large rivers also present challenges in terms of shared and multiple jurisdictions. Therefore, a regionally consistent approach to biological assessment and reference condition would constitute a major advancement in the management of large rivers.

1.2. Geographic Area of Coverage

The geographic area of coverage of this study primarily included the large, non-wadeable rivers that are tributary to the Upper Mississippi River (above the confluence with the Ohio River) and the Ohio River that occur within Region V states (Figure 1). One Great Lakes tributary and two entities were also included in the study in recognition of this drainage within Region V. For the purposes of this project, large rivers are defined as the primary tributaries of the Ohio and upper Mississippi Rivers and the Great Lakes, and subsequent tributaries that drain land areas >500-1000 square miles. Non-wadeable rivers that require boat electrofishing to secure an adequate assemblage assessment can include drainage areas <500 square miles, but none were included in this study. An interest of this and our allied river studies is to address the transition between great and large rivers. The Ohio and Mississippi are considered to be great rivers for the purposes of

EMAP GRE; however, the ecological definition of great rivers also includes portions of the largest Ohio and upper Mississippi tributaries such as the lower Wabash, Illinois, and Wisconsin Rivers (Simon and Emery 1995). The reality of the ecological definition has functional implications for both sampling methods and the development of biological assessment tools such as multimetric indices (e.g., IBI), and eventually biocriteria.

1.3. Objectives, Approach, and Methodology

Several Region V states and ORSANCO have developed and used standardized methods for sampling and assessing large and great river fish and macroinvertebrate assemblages on a statewide or regional basis. Ohio EPA has methods for both assemblages and has adopted numeric biocriteria based on multimetric indices; routine assessments have been conducted for more than 25 years (Ohio EPA 1987; Yoder and Smith 1999). ORSANCO developed a fish assemblage method and index (ORFin; Emery et al. 2003) and uses it formally to report on conditions in the Ohio River mainstem. Wisconsin developed a fish assemblage method and index (Lyons et al. 2001) and is interested

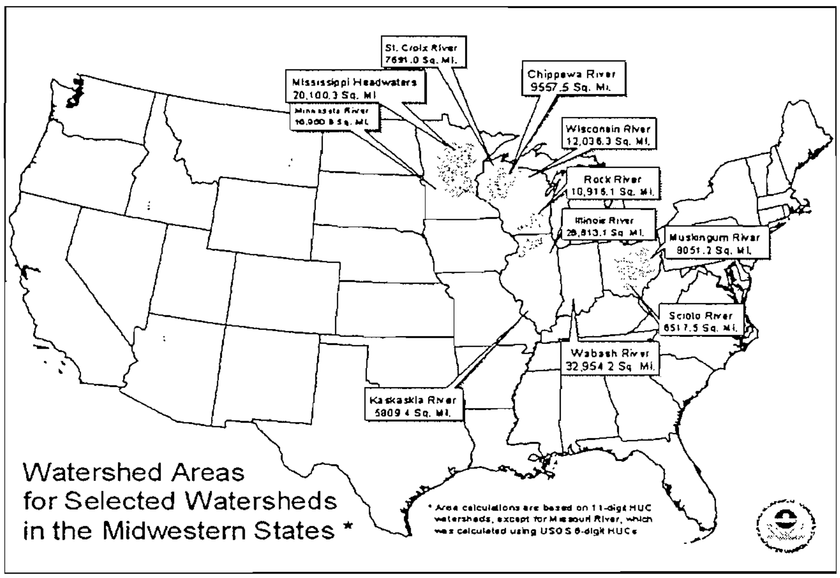


Figure 1. Large river basins and candidate rivers for testing and comparing biological assessment methods in Region V.

in developing a macroinvertebrate assemblage method. Indiana DEM has developed a working IBI for the Wabash River and samples other non-wadeable rivers. Michigan DEQ (not a participant in this study) has sponsored recent research on a large river macroinvertebrate method. Selected other state agencies, municipalities, and private organizations also sample fish assemblages in large rivers. Hence, a basis for developing a comparability study was already in place.

The principal objective of this project was to collect and analyze boat electrofishing data for the purpose of making comparisons of the methods currently employed by each participant and MBI/ORSANCO. Comparison test sites were established and sampled by MBI/ORSANCO (hereinafter referred to as MBI) and the participating entity during two distinct periods within a summer-fall seasonal index period in 2004 and 2005. These sites were established in various rivers in accordance with the detailed work plan and as opportunities arose via allied projects and where other sampling was already planned by the participating entities. What approximates "split samples" were obtained by sampling each site using the ORSANCO nighttime method (Emery et al. 2003) and/or MBI daytime method (Ohio EPA 1989; Yoder and Smith 1999) as the basis for comparison with the participating entities. The decision about which of these two methods to use was based on a site-specific judgment by the MBI crew leader, but was largely determined by where mainstem rivers functionally transitioned from a large river to a wider and deeper great river. At sites located at this transition both night and day methods were employed. Data from two previous years was included for two cooperators in order to enhance the data analyses.

In each comparison, sites were subdivided as needed to accomplish the protocols of each participating organization. This yielded a side-by-side comparison of equivalent effort based on cumulative sampling distance, which provided the weighted comparisons needed to evaluate the basic data attributes and characteristics produced by each of the methodologies. A minimum two-week period was used to separate sampling by MBI and the participating entity for data collected in the same year. Of critical interest was determining the minimum sampling effort needed to produce a reliable assessment of biological quality and condition, which is an important prerequisite to producing assessments at the regional and river reach scales. We spent a minimum of two weeks sampling in each of the comparison study areas, based on detailed sampling plans developed as part of the Quality Assurance Program Plan (QAPP). There were three principal areas of testing and comparison:

1) Equipment and design specifications – differences in electrofishing units (power, output, duty cycle, efficiency), electrode configurations, boat size, etc.

2) Protocols – differences in site configuration (best shoreline, both shorelines, runs/riffles or pools, fixed distance vs. variable distance), CPUE basis (time or distance), day vs. night, river flow or turbidity restrictions, net mesh size, number of netters, single or multiple passes, taxonomic procedures, data recording and custody, etc.

3) Execution – "thoroughness" of the sampling, intensity of sampling within a site, attention to detail, crew leader and crew member qualifications, skill and knowledge, quality of workmanship, QA/QC adherence and documentation, etc.

This allowed us to evaluate potential differences yielded by key methodological and technological issues and then determine if existing state methods are both adequate and comparable, or if a different or modified set of methods should be adopted uniformly across the region. Given the more advanced and broader application of fish assemblage methods in the large rivers of Region V, we focused the study on this assemblage group.

2.0. MATERIALS AND METHODS

2.1. STUDY AREA/SITE DESCRIPTIONS

2.1.1. St. Croix River

The St. Croix River is a sixth order tributary to the upper Mississippi River that originates at St. Croix Lake near Solon Springs, Wisconsin. The St. Croix River lies within the Superior Upland and Central Lowland physiographic provinces. It is approximately 170 mi (276 km) long with a mean discharge of 131 m^3/s. Approximately 80% (129 miles) of the St. Croix River forms part of the boundary between Wisconsin and Minnesota. The upper 20% of the river is entirely within Wisconsin. The watershed covers approximately 20,098 km^2 (7,760 mi2) and extends from near Mille Lacs Lake in Minnesota on the west to near Cable, Wisconsin, on the east. Approximately 46% of the watershed is located in Minnesota. Originating in Upper St. Croix Lake near Solon Springs, Wisconsin, at an elevation of 337 m(1,105 ft); it flows southwest to its confluence with the Mississippi River at Prescott, Wisconsin (elevation 206 m, 675 ft) (Young and Hindall 1973). The Namekagon River is a 5th order stream that drains northwestern Wisconsin and joins the St. Croix above Danbury, Wisconsin. The St. Croix River is a National Wild and Scenic Riverway and is considered one of the best recreational rivers in the Midwest. The river exhibits moderate sinuosity and winds through primarily forested regions of Wisconsin and Minnesota in a series of rapids and pools. The riverbed is primarily tillage with coarse substrates throughout (DeLong 2005).

Comparisons were made on the St. Croix River between three agencies at a total of ten sites between river miles 28 and 92 during the 2004 sampling season (index period) (Figure 2). The participating entities included the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Natural Resources (MNDNR). Throughout the index period, all three agencies executed their respective sampling protocols once (single pass) at each site.

2.1.2. Wabash River

The Lower Wabash River is a seventh order tributary to the Ohio River and incorporates the drainage basin between Honey Creek in Vigo County and the mouth of the Wabash River at the Ohio River in Posey County. The river is approximately 475 mi (765 km) long with a mean discharge of 1001 m^3/s. The basin has an area of 1,339 mi^2 (Hoggatt 1975) and includes most of Sullivan and Posey Counties, plus parts of Vigo, Greene, Knox, Gibson, and Vanderburgh Counties in southwestern Indiana. The major cities and towns in the basin are Vincennes, Sullivan, and Princeton. The Lower Wabash River valley is a broad, flat glacial drainage channel that includes winding channels, a wide flood plain, and adjacent terrace levels. The valley floor ranges from 3 to 10 mi in width. Local relief on the valley floor is typically less than 50 ft except for isolated hills (Fidlar 1948). Undulating, rolling plains with a thin cover of till, loess, and silt characterize the area east of the Wabash terraces. Local relief is greater in the uplands of southern Posey

County beyond the maximum extent of glaciation. Broad, flat lake plains that form present day bottomlands east of the terraces were created during Wisconsinan time when tributary valleys became ponded by the rapid aggradation of the valley floor (Fidlar, 1948, p. 102). In the surrounding uplands, bedrock terraces were eroded on resistant limestone and shale.

Comparisons were made on the Wabash River with one entity at a total of seven sites between river miles 23 and 257 during the 2004 sampling season (Figure 3). The Indiana Department of Environmental Management (IDEM) executed their sampling protocols once (single pass) at each site.

2.1.3. Wisconsin River

The Wisconsin River is an eighth order tributary of the Mississippi River, approximately 430 mi (692 km) long, in the state of Wisconsin and drains an area of 31,080 km^2. It originates in the forests of the Lake District of northern Wisconsin, in Lac Vieux Desert near the border of the upper peninsula of Michigan. It flows southward across the glacial plain of central Wisconsin, passing Wausau and Stevens Point. In southern Wisconsin it encounters the terminal moraine formed during the last ice age, where it forms the Dells of the Wisconsin River. North of Madison, it turns to the west, flowing across the hills of southwest Wisconsin and joins the Mississippi approximately 10 mi (16 km) south of Prairie du Chien. It is navigable up to the town of Portage, 200 mi (320 km) from its mouth, where it is separated from the Fox River by only 2 mi (3.2 km), furnishing an important early route between Lake Michigan and the Mississippi for Native Americans and early French explorers. The Wisconsin is impounded in 26 places for hydroelectric power. The lower Wisconsin River is a shallow, sandy river of braided channels among numerous vegetated islands. Turbulent currents create and obliterate sandbars and bank holes with unpredictable frequency. Near Muscoda (RK 71.5), the average discharge is 247 m^3/s (Holmstrom et al. 1996). As the Wisconsin River passes under a railroad bridge at RK 2.6, it becomes nearly indistinguishable from the side channels and backwaters in Navigation Pool 10 of the upper Mississippi River.

Methodological comparisons were made on the Wisconsin River at a total of nine sites between river miles 4 and 90 sampled by the Wisconsin Department of Natural Resources (WDNR) during the 2005 sampling season (Figure 4) once (single pass) at each site.

2.1.4. Kankakee River

The Kankakee River basin, located in northwestern Indiana, is the sixth largest (2,989 mi2) of the 12 water-management basins in the State. The basin includes most of Newton, Jasper and Starke Counties and one-half to two-thirds of Lake, Porter, LaPorte, St. Joseph, Marshall and Benton Counties. Most of the towns in the basin are farming communities; the largest cities are LaPorte, Plymouth, Knox, and Rensselaer. It encompasses approximately 3,000 square miles of river basin which includes at least thirteen northwestern Indiana Counties. The topography of the watershed is flat to moderately rolling, expressing the effects of extensive glaciation. Sand and gravel river bottom and scoured bedrock are indicators of glacial activity.

Land use in the river basin is predominantly agricultural, with over 75% of the land used for cropland, pastureland, or forest land. Extensive corn, soybean, wheat, and hay fields surround the Kankakee River. The Kankakee River drains 5,165 mi2 in northeastern Illinois and northwestern Indiana (State of Indiana and others, 1976, p. III-1). Within Indiana, the Kankakee River basin has an area of 2,989 mi2 (Hoggatt, 1975). The Kankakee River begins in northwestern St. Joseph County and flows southwest for about 80 mi before reaching Illinois. Before development of the area, the Kankakee River was a large, meandering river surrounded by marshes. Now the river in Indiana is ditched, has a gradient of about 1 ft/mi, and has been shortened to about one-third of its natural stream length (State of Indiana and others, 1976, p. III-24). The Kankakee River in Illinois remains a naturally meandering stream. Principal tributaries are the Iroquois River, Singleton Ditch, and the Yellow River with the Iroquois being the largest. The Kankakee River in Illinois drains 2169 square miles and travels a distance of 62 miles from the state line generally west to merge with the Des Plaines River and form the Illinois River. Almost the entire Kankakee River basin in Illinois falls within the Kankakee Plain physiogeographic subdivision. Most of the riverbed in Illinois is on or near bedrock.

Comparisons were made on the Kankakee River with the Indiana Department of Environmental Management at a total of six sites between river miles 67 and 111 during the 2004 sampling season (index period) once (single pass) at each site (Figure 5). Comparisons were also made on the Kankakee River with the Illinois Department of Natural Resources (IDNR) at a total of 13 sites between the Illinois/Indiana state line and the Des Plaines River during the 2005 sampling season (index period) (Figure 6) once (single pass) at each site.

2.1.5. St. Joseph River (Lake Michigan tributary)

Although it is known locally as "the St. Joe River", it is associated with Lake Michigan here because of the close proximity (less than 5 miles) of its headwaters to the headwaters of the Saint Joseph River of the Maumee River watershed. The St. Joseph River of Lake Michigan rises near Baw Beese Lake in Hillsdale County in southern Michigan. While its course is generally westward to Lake Michigan, it is not direct.

From its headwaters, the St. Joseph flows northwest to southeastern Calhoun County, passing the city of Hillsdale. It then turns directly southwest passing near the Kalamazoo-Portage metropolitan area, eventually arriving at Three Rivers, so named for the confluence in this vicinity of the Portage River from the north, and the Prairie River from the southwest. Continuing southwest, it crosses the Indiana border and heads west through the metropolitan areas of Elkhart - Goshen and South Bend, (named for the river's abrupt turn north). Once back in Michigan the St. Joseph meanders roughly northwest through the town of Niles, past the town of Berrien Springs and on to the metropolitan area of St. Joe - Benton Harbor where it empties into Lake Michigan. Approximately one mile from the mouth of the St. Joseph, it receives the Paw Paw River from the north.

The St. Joseph River watershed drains 4685 square miles in 15 counties, 8 in Michigan and 7 in Indiana. Over 70 percent of the riparian habitat is agricultural / urban and the rest (25-30 percent) is forested. Historically it furnished two important portages that allowed for continuous river travel in the regional watersheds. The first, as has been alluded to, was in the headwaters where portage could be made to the St. Joe of the Maumee River which empties into Lake Erie. The second was in South Bend where a short portage was all that was necessary to put in on the Kankakee River which flows into the Illinois River, a tributary of the Mississippi River. In modern times, the damming of the St. Joe restricts river traffic to the pools they form. From source to mouth there are 18 dams on the mainstem, 14 in Michigan and 4 in Indiana.

Comparisons were made on the St. Joseph River during the 2005 sampling season with the Michigan Institute for Fisheries Research (MIFR) (using methods described in Lyons 2001) and the City of Elkhart Office of Public Works (EPW) (using standardized IDEM protocols). MIFR and MBI executed their respective sampling protocols once (single pass) at four sites, each 1 mile in length in Michigan (Figure 7). EPW sampled 15 sites of 500m each in Indiana (Figure 8).

2.1.6. Chicago Area Water System (CAWS)

The Chicago Area Water System (CAWS) comprises both natural and man-made waterways, and it could be argued that the natural waterways are, in fact, only so in origin. They lie within the Central Lowlands physiographic province which is divided into two physiogeographic sections: the Great Lake Section and the Till Plains Section (Fenneman 1938). Leighton and others (1948) divided the Illinois part of these sections into two subsections each. In the Illinois, the Great Lake Section was divided into the Chicago Lake Plain and the Wheaton Morainal Plain. Most of the sampled waterways lie within the Chicago Lake Plain subsection. Only the Sanitary - Ship Canal below its confluence with the Des Plaines River and the Cal - Sag Channel below Worth, Illinois flow into the Wheaton Morainal Plain. The Chicago Lake Plain consists of poorly drained lake clay and silt and lake sand and gravel. Clayey till of the Wedron Formation also is present and is deposited as moraines. The Wheaton Morainal Plain is predominately clayey till, sandy loamy till, and sand and gravel. Limestone and dolomite bedrock underlies both of these subsections. A large portion of the Sanitary - Ship Canal and the lower Cal - Sag Channel were carved from this bedrock.

The topography of the land in the study area is relatively flat. It generally does not vary more than 50 feet. This precipitates serious waste management problems for urban areas. In 1822 Canal legislation was passed and the Illinois and Michigan Canal was opened for river traffic in 1848. Up to the 1860's the city of Chicago had dumped its waste into the Chicago River and ultimately into Lake Michigan, but in 1865 obtained permission to pump sewage from the Chicago River into the Illinois & Michigan Canal. By 1881 the canal had become a health hazard. In 1889 the Chicago Sanitary District was formed to build the Chicago Sanitary and Ship canal, the main channel of which was completed in 1900. The Sanitary and Ship Canal extended from the Des Plaines River to the Chicago River's south branch, causing a reversal of flow in the Chicago River, and diverting lake water into the Mississippi River system. Later, an additional North Shore Channel was constructed from the north branch of the Chicago River to Lake Michigan. Prior to 1900, the City of Chicago discharged sewage directly into Lake Michigan, the Chicago River, and Calumet River. In 1922, the Sanitary District completed the Calumet-Sag Channel extending the Sanitary and Ship Canal, and reversing the flow of the Calumet and Little Calumet Rivers resulting in another diversion of lake water into Illinois. Today sewage treatment plants treat most of the sewage before it reaches the waterways, but combined sewer overflows remain a problem during flood events. The recently proposed Tunnel and Reservoir Plan (TARP) is designed to ease that problem.

Comparisons were made the Aquatic Ecology Section of the Research and Development Department of the Metropolitan Water Reclamation District of Greater Chicago (MWRGC) on the North Shore Channel, the North Branch of the Chicago River, the mouth of the Chicago River, the Sanitary Ship Canal, The Cal - Sag Channel and the Calumet River at a total of 8 sites during the 2005 sampling season (index period) (Figure 9) once (single pass) at each site.

2.1.7. Scioto River

The Scioto River is a sixth order tributary to the Ohio River, approximately 225 mi (364 km) in length and drains an area of 16,882 km^2. Mean discharge is 189 m^3/s. It is contained entirely within Ohio, originating in the glacial till plains of the Central Lowland physiographic province of Ohio in Auglaize County flows to its confluence with the Ohio River at Portsmouth in Scioto County. It flows southeast across west-central Ohio, becoming entrenched in the sloping landscape. From Chillicothe downstream the river runs through the heavily forested Appalachian Plateaus physiographic province. Major tributaries to the Scioto River include Big and Little Darby creeks; large portions of which are designated as National Wild and Scenic River. The Scioto River is shallow and generally sandy with some larger glacial till. The Scioto has not been heavily impounded with the exception of two places in Franklin and Delaware counties respectively, creating reservoirs for flood relief. Impacts from impoundments on the mainstem are low. However middle portions near the confluence with the Olentangy River exhibit impacts from increasing agriculture and urbanization (White et al. 2005).

Comparisons were made on the Scioto River between June and October during the 2005 sampling season at a total of six 500m sites with EA Engineering, Science and Technology (on behalf of AEP (American Electric Power)) using methods similar to those established by OEPA and employed by MBI. EA executed their protocol twice (two passes) at each of six sites during June and August. MBI conducted two sampling runs at the exact same geographic locations (Figure 10) during July and October.

2.2. SITE MAPS

2.2.1. St. Croix River (2004)

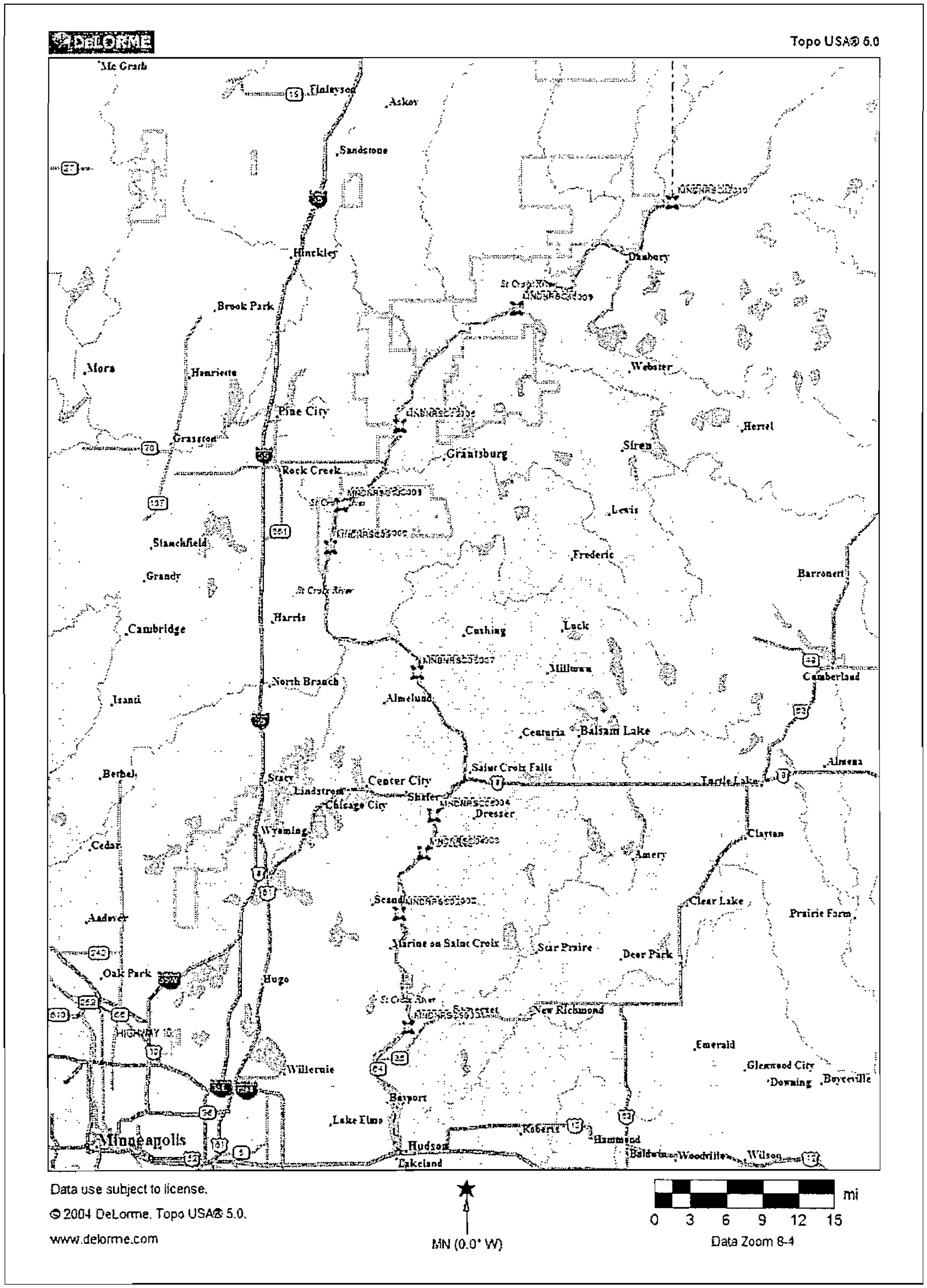


Fig. 2. St. Croix River sites; MBI (X), MNDNR ( ), MPCA ( ); 2004.

2.2.2. Wabash River (2004)

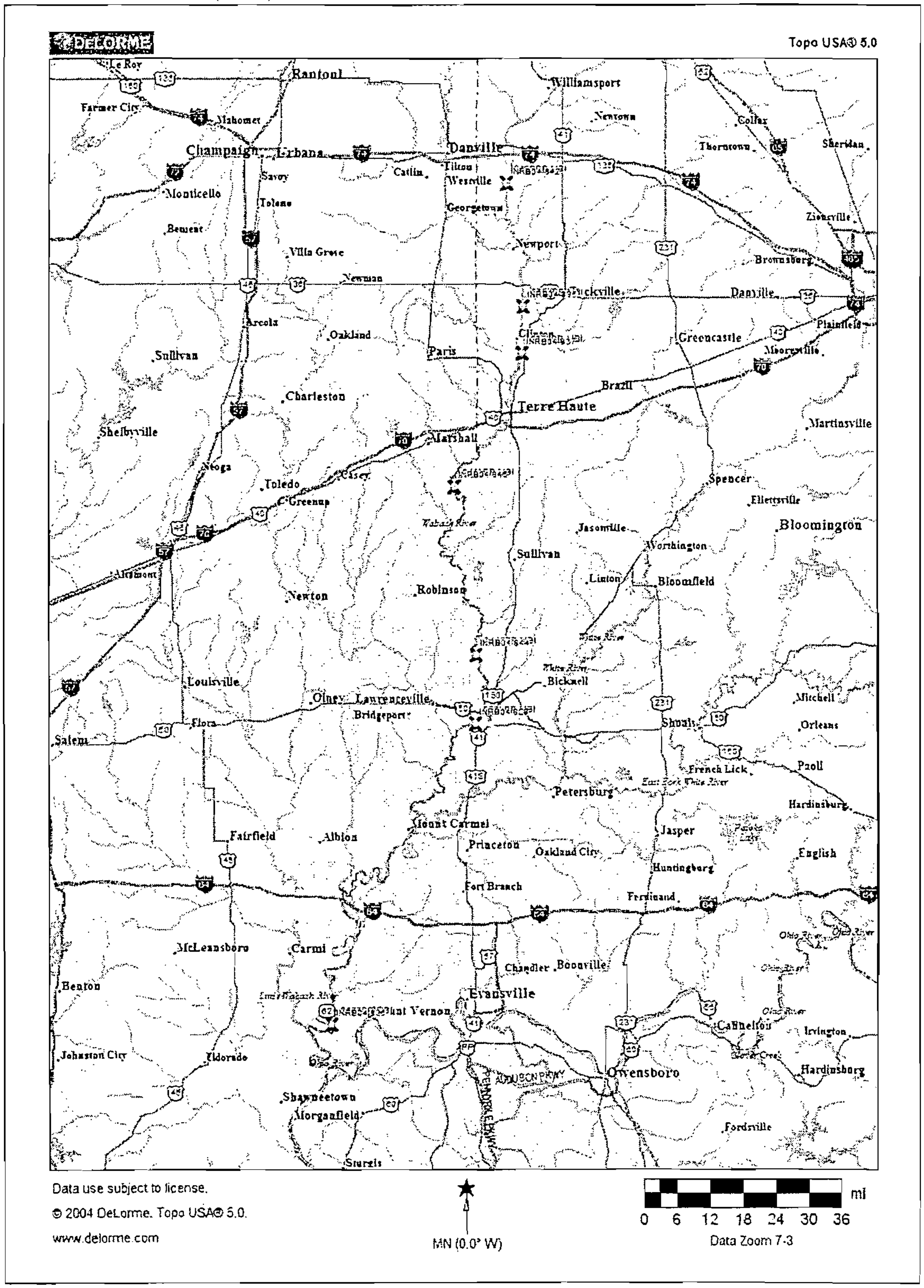


Fig. 3. Wabash River sites; MBI (X), IDEM ( ); 2004.

2.2.3. Wisconsin River (2005)

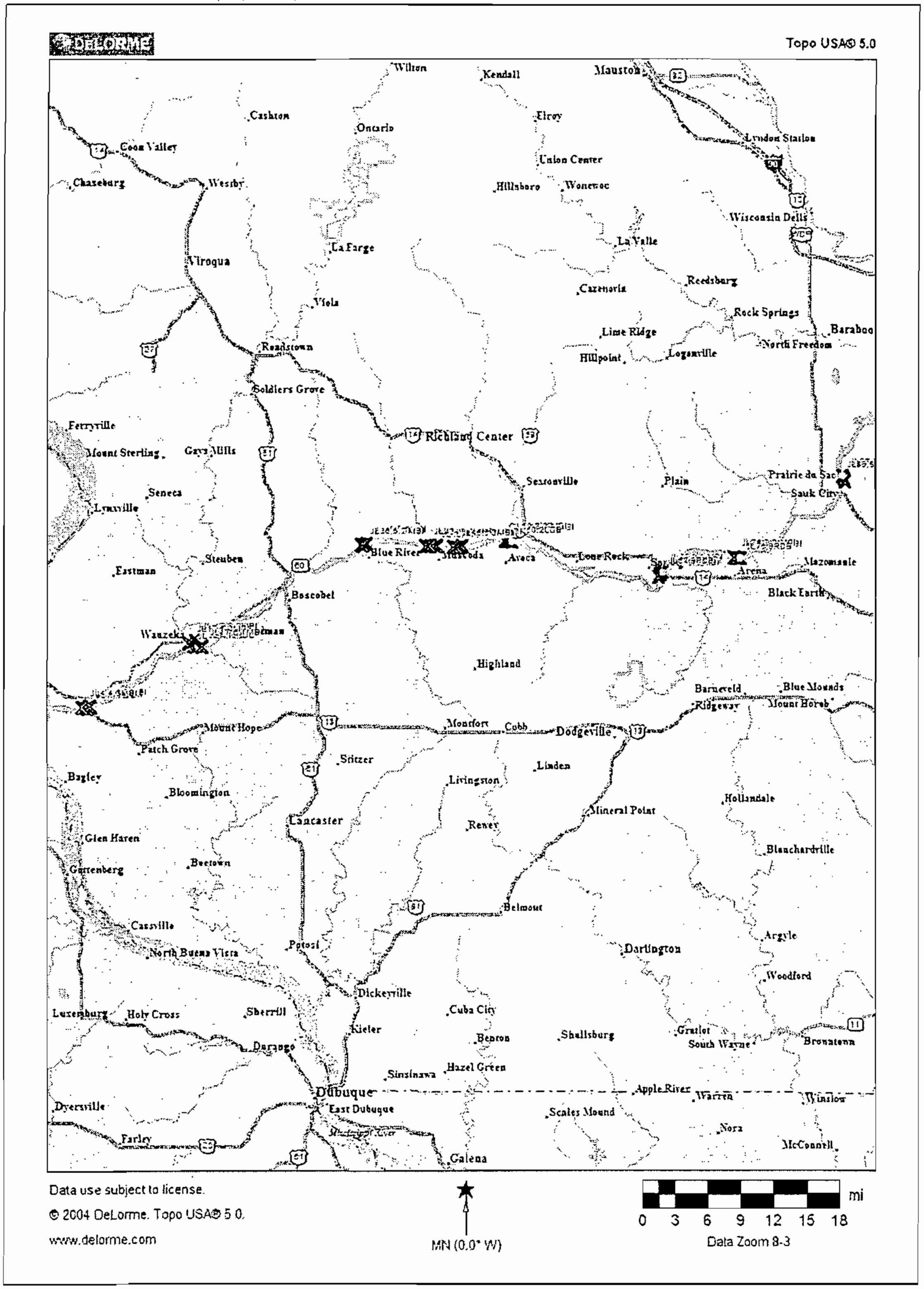


Fig. 4. Wisconsin River sites; MBI (X), WDNR ( ); 2005.

2.2.4. Kankakee River (2004)

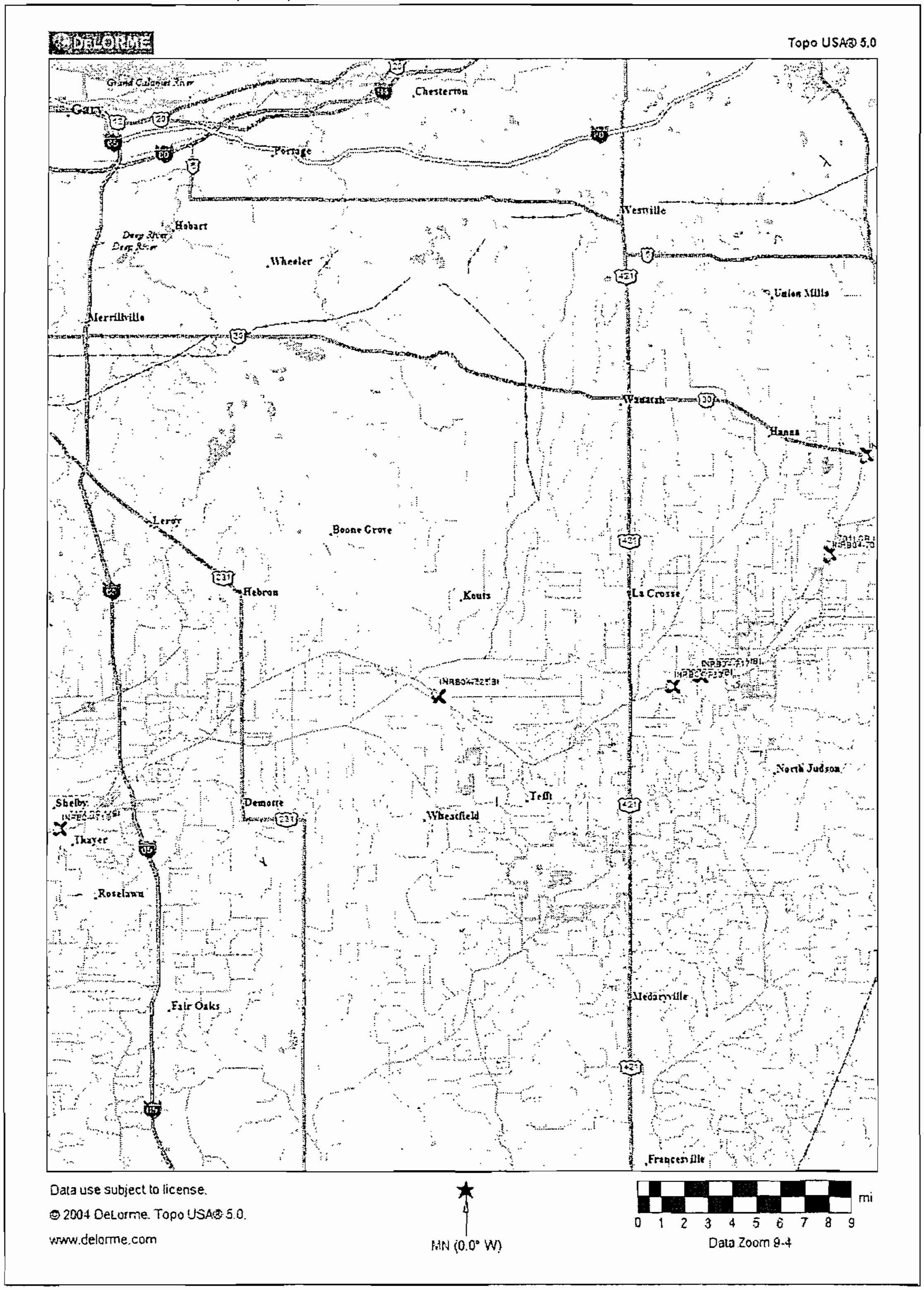


Fig. 5. Kankakee River sites; MBI (X), IDEM ( ); 2004.

2.2.5. Kankakee River (2005)

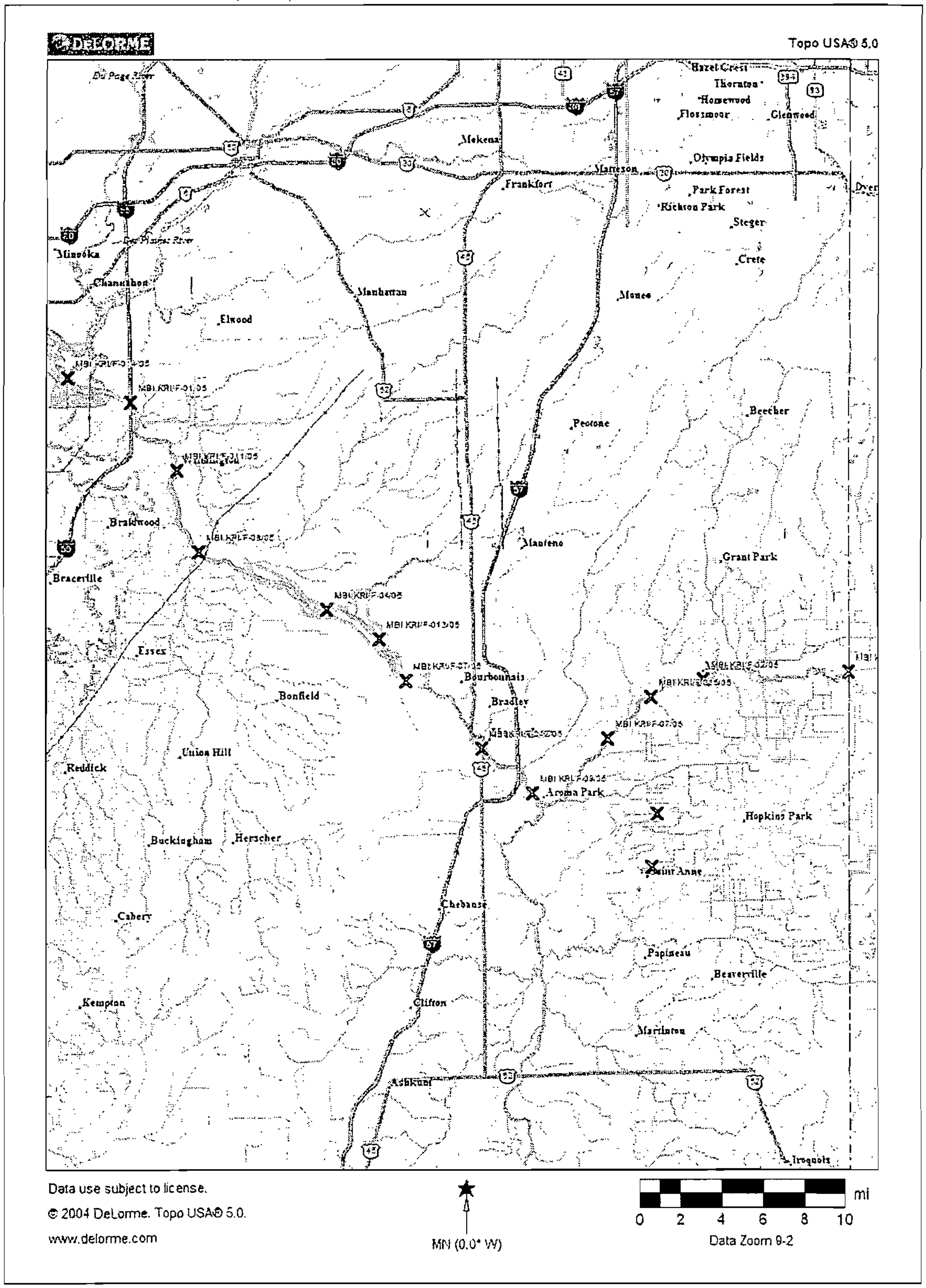


Fig. 6. Kankakee River sites; MBI, IDNR (X); 2005.

2.2.6. St. Joseph River (2005)

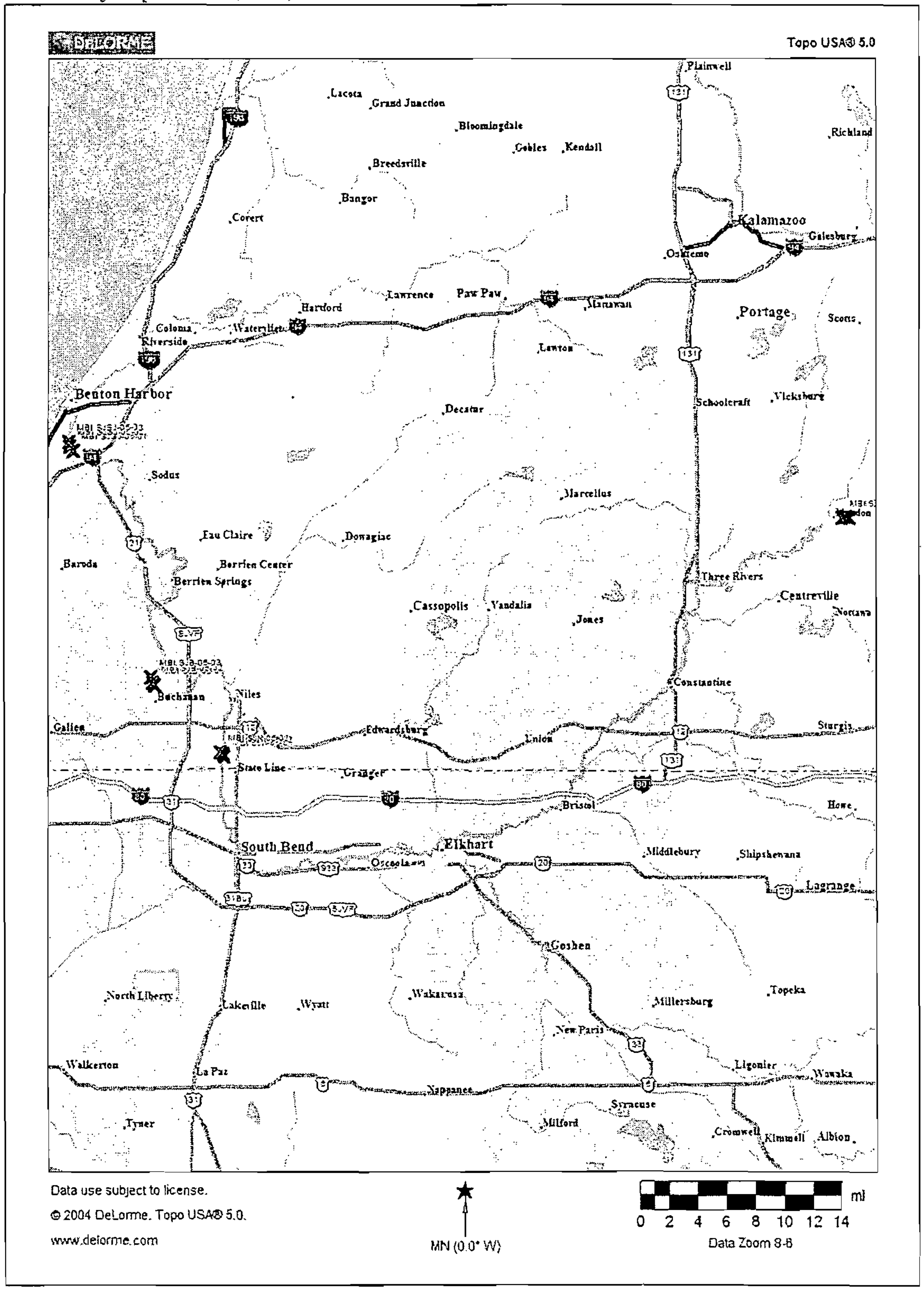


Fig. 7. St. Joseph River 1 mile sites; MBI, MIFR (X); 2005.

2.2.7. St. Joseph River 500m Sites (2005)

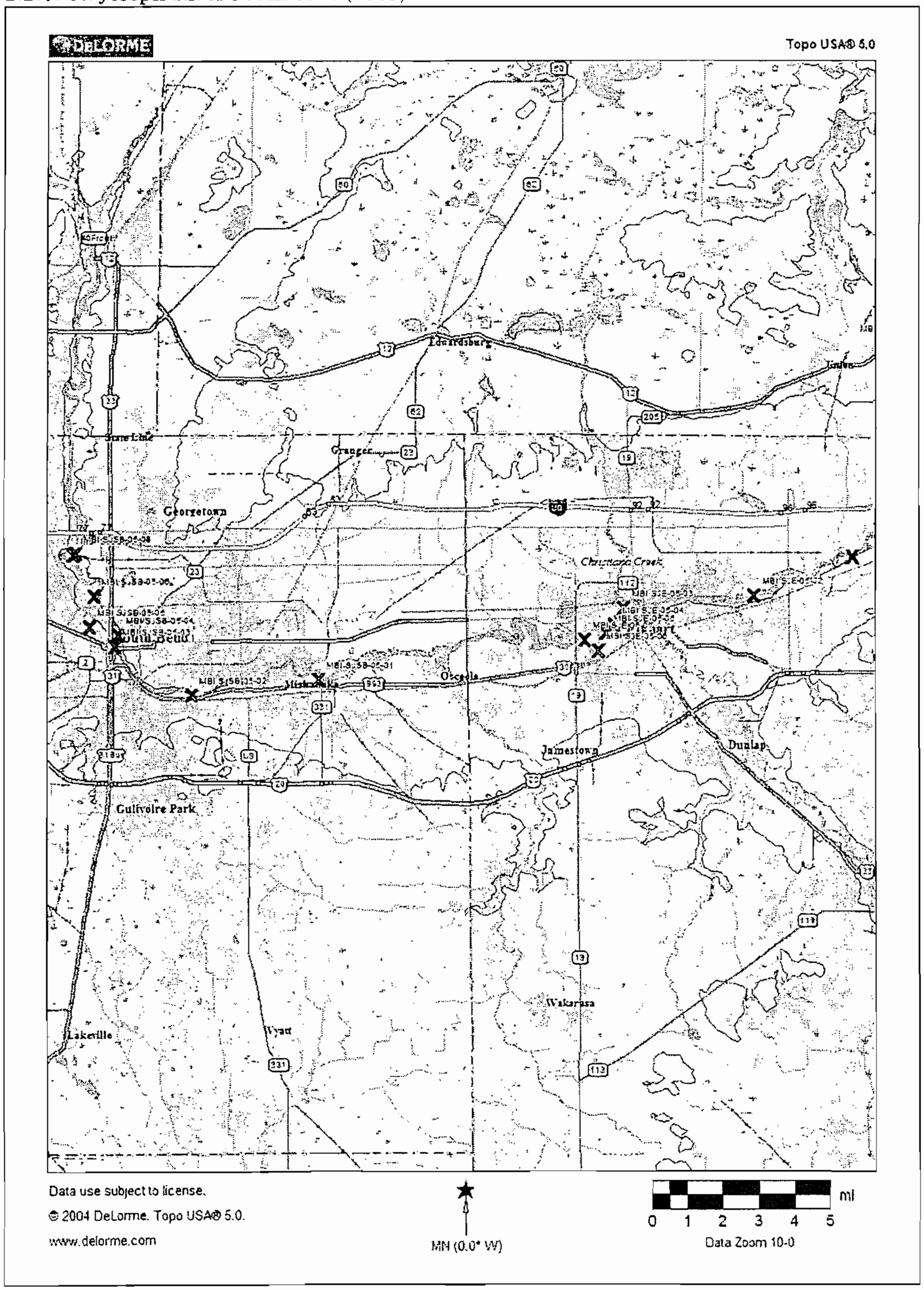


Fig. 8. St. Joseph River 500m sites; MBI, EPW (X); 2005.

2.2.8. Chicago Area Water System (2005)

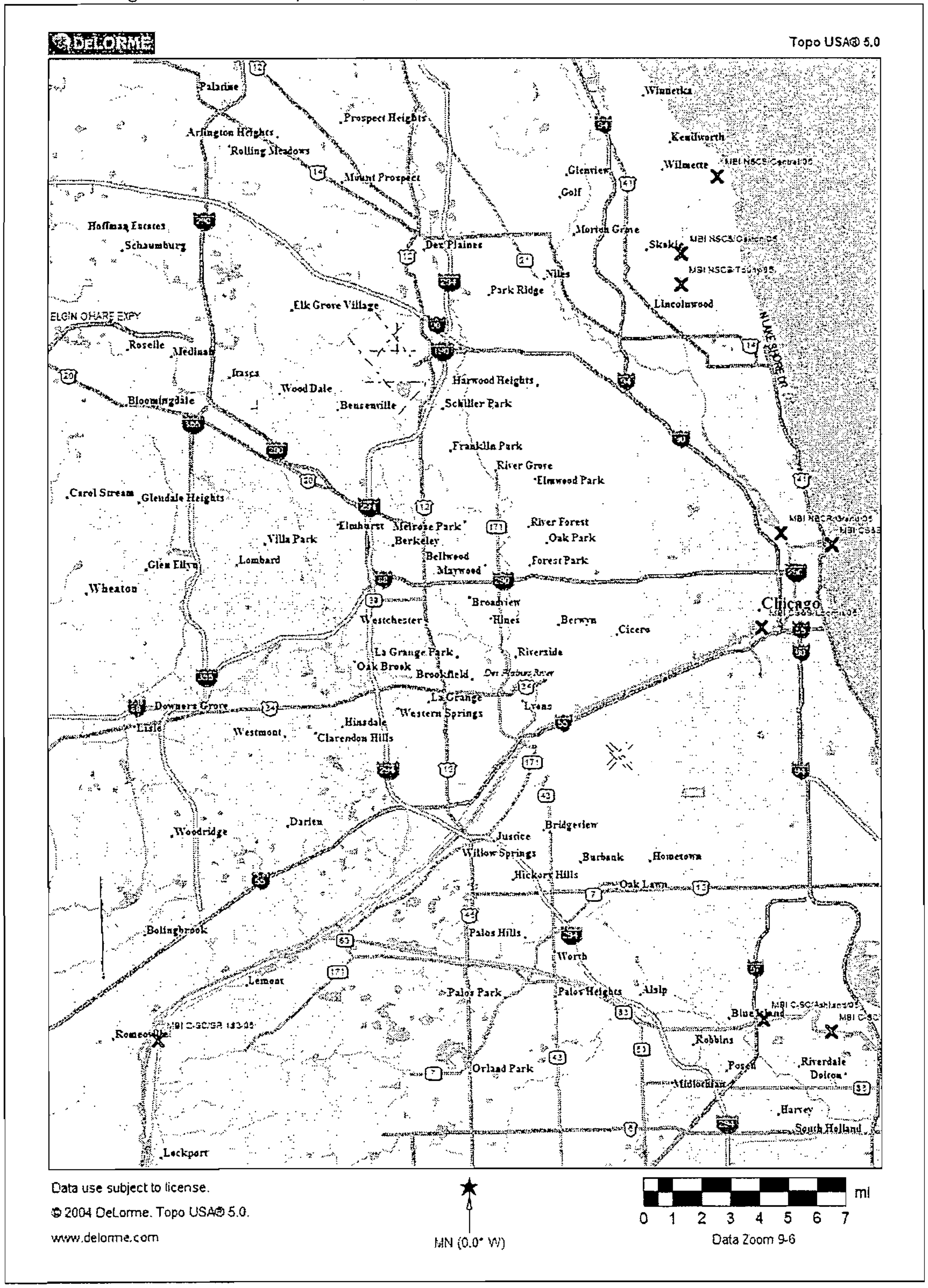


Fig. 9. Chicago Area Water System sites; MBI, MWRGCA (X); 2005.

2.2.9. Scioto River (2005)

Fig. 10. Scioto River sites; MBI, EA (X); 2005.

2.3. SAMPLING EQUIPMENT/ PROTOCOLS

2.3.1. Midwest Biodiversity Institute (MBI) and ORSANCO

Sampling Procedure

The standard MBI and ORSANCO large river (non-wadeable) sampling protocols include boat electrofishing and habitat evaluation at each site. The methods and approaches described by Ohio EPA (1989) and Yoder and Smith (1999) for the collection of daytime samples and Emery et al. (2003) for the collection of nighttime samples were used to generate the baseline data that served as a comparison to the individual cooperating entity methods. As such, the MBI and ORSANCO methods are the default arbiter of comparability.

A boat-rigged, pulsed D.C. electrofishing apparatus was the single gear employed in this study. This consisted of a 16' (daytime) or 19.5' (nighttime) aluminum boat specifically constructed and modified for electrofishing. Electric current was converted, controlled, and regulated by Smith-Root 5.0 GPP alternator-pulsator that produced up to 1000 volts DC at 10-20 amperes depending on relative conductivity and power output. The latter was adjusted to the maximum range that could be produced given the relative conductivity of the water. The pulse configuration consisted of a fast rise, slow decay wave that can be adjusted to 30, 60, or 120 Hz (pulses per second). Generally, electrofishing was conducted at 120 Hz, but other settings were used depending on which selection was producing the optimum combination of voltage and amperage output and most effectively stunning fish. This was determined on a trial and error basis at the beginning of each boat electrofishing zone and the settings generally held for similar reaches of the same river. On the 16' daytime boat, the electrode array consisted of four 8' long cathodes (negative polarity; 1" diameter flexible stainless steel conduit) which were suspended from the bow and 5 anodes (positive polarity; 3/8" by 4" in length woven stainless steel cable) suspended from a retractable aluminum boom that extended 2.75 meters in front of the bow. These could be added, detached, and replaced as conditions changed. The width of the array was 0.9 meters. Anodes and cathodes were replaced when they were lost, damaged, or became worn. For the 18' nighttime boat, the boat hull, in combination with 32, 3/8" woven steel cable strands bolted to angle iron welded to the bow, served as cathodes. The anodes consisted of a pair of Smith-Root retractable fiberglass standard GPP booms each fitted with removable Smith-Root LPA-6 low profile 3/8" woven steel cable dropper arrays. Illumination for nighttime sampling was provided by 12 volt DC lights supplemented by auxiliary headlamps worn by the sampling crew (which consists of a driver and 2 netters) and hand held lamps of at least 1,000,000 candle power.

The sampling procedure was to slowly and methodically maneuver the electrofishing boat in a *down-current* direction along the shoreline of the bank with the "best habitat" following the original design of Gammon (1973, 1976). This generally included sampling along the outside bends of meandering rivers and/or the bank with deeper water and the most diversity of cover types. It also included sampling deep run habitats which are what might be regarded as mid-channel habitats. Sampling was performed by maneuvering the boat in and around submerged cover to advantageously position the netter to pick up stunned and immobilized fish. At times this required frequent turning, circling back upstream, backing in and out of cover, shifting between forward and reverse, changing speed, etc. depending on current velocity and cover density and variability. The driver's task was to maneuver the electrofishing boat in a manner that advantageously positioned the netter(s) to pick up stunned and immobilized fish. The driver also monitored and adjusted the 5.0 GPP pulsator to provide the maximum, yet safe operational mode in terms of voltage range, pulse setting, and amperage. In areas with extensive woody debris and submergent aquatic macrophytes, it was necessary to maneuver the boat in and out of these "pockets" of habitat and wait for fish to appear within the netter's field of view. In moderately swift to fast current the procedure was to electrofish with or slightly ahead of the current through fast water sections and then return upstream to more thoroughly sample eddies and side edges of the faster water. It was often necessary to pass over these swift water areas 2-3 times to ensure adequate sampling.

Electrofishing efficiency was enhanced by keeping the boat and electric field moving with or at a slightly faster rate than the prevailing current velocity. This allowed the field to remain vertically extended as opposed to being collapsed against the bottom of the boat by the resistance of the current. In addition, fish are generally oriented into the current and must turn sideways or swim into the approaching electric field to escape. As such they present an increased voltage gradient making the fish more susceptible to the electric current. Sampling these areas in an upstream direction was avoided as this collapses the electrical field upwards against the boat, which significantly diminishes the effective volume of the field. Based on visual observations and our experience, fish can avoid capture more easily when sampling against the current. Although sampling effort is measured by distance, the time fished was an important indicator of adequate effort. Time fished could legitimately vary over the same distance as dictated by cover and current conditions and the number of fish encountered. In most cases, there was a minimum time spent sampling each zone regardless of the difficulty or size of the catch. In our experience this was generally in the range of 2000-2500 seconds of electrofishing time (time during which current is actively applied to water) for 500 meters, but could range upwards to 3000-3500 seconds or more where there was extensive instream cover and slack flows. Time was recorded in seconds on the 5.0 GPP control unit and recorded on each electrofishing data sheet.

Safety features included easily accessible toggle switches on the pulsator unit and next to the driver and a foot pedal switch operated by the primary netter. Netters wore jacket style personal floatation devices and rubber gloves. Sampling was conducted between June 16 and October 30. This represented the seasonal index period developed for the Ohio River for assessing the overall fish assemblage in keeping with the goals and objectives of the study. However, earlier cutoff dates were adhered to when established by individual states.

Netters were required to wear polarized sunglasses during daylight to facilitate seeing stunned fish in the water during each daytime boat electrofishing run (not required for nighttime runs). Smith-Root heavy duty dip nets with 2.5m long fiberglass handles and 7.62mm Atlas mesh knotless netting were used to capture stunned fish as they were attracted to the anode array and/or stunned. A concerted effort was made to capture every fish sighted by both the netters and driver. Since the ability of the netters to see stunned and immobilized fish was partly dependent on water clarity, sampling was conducted only during periods of "normal" water clarity and flows. Periods of abnormally high turbidity and flows were avoided due to their negative influence on sampling efficiency. If high flow conditions prevailed, sampling was postponed until flows and water clarity returned to seasonal, low flow norms.

Field Sample Processing Procedures

Captured fish were immediately placed in an on-board live well for processing. Water was replaced regularly in warm weather to maintain adequate dissolved oxygen levels in the water, reduce waste by-products, and minimize mortality. Aeration was provided to further minimize stress and mortality. Fish that were not retained for vouchers for laboratory identification were released back into the water after they were identified to species, examined for external anomalies, weighed, and measured for total length. Every effort was made to minimize holding and handling times. Invasive alien species were kept and appropriately disposed of out of the water as required by state collecting permits. The majority of captured fish were identified to species in the field; however, small specimens (mostly Cyprinidae) were preserved for later laboratory identification to ensure both accurate identifications and enumeration.

Any uncertainty about the field identification of individual fish also required their preservation for later laboratory identification, except for unusually large specimens that were photographed. Fish were preserved for future identification in buffered 10% formalin and labeled by date, river, collector(s) and geographic identifier (e.g., river mile, site number). Identification was required to the species level at a minimum and to the sub-specific level in certain instances if necessary. We followed the scientific naming nomenclature in Nelson et al. (2006). A number of regional ichthyology keys were used and included Page and Burr (1991), Trautman (1981), Lee et al. (1980), Etnier and Starnes (1993), and Tomelleri and Eberle (1990). Questions were pursued with the recognized taxonomical expert in each state.

The sample from each site was processed by counting individuals and recording weights and total lengths by species. Total lengths of each specimen were recorded to the nearest 3 cm size class, with 0.1 cm to 3 cm representing size class 1, and so on. Fish weighing less than 1000 grams were weighed to the nearest gram on a spring dial scale (1000 x 2g) with those weighing more than 1000 grams weighed to the nearest 25 grams on a 12 kg spring dial scale (12 kg x 50 g). Scales were properly zeroed prior to each individual sampling run. Individuals of the same species within the same size class were weighed together. If too many individuals of a given species were encountered to make individual weighing and measuring practical, mass weights were taken via a systematic subsampling process. Larval fish were excluded in the data, as these are not only difficult to identify, but offer questionable information to an assemblage assessment (Angermier and Karr 1986).

The incidence of external anomalies was recorded following procedures outlined by Ohio EPA (1989) and refinements made by Sanders et al. (1999). All external abnormalities were recorded and included any type of deformity, lesions, tumor, parasite, or other body part anomaly. The frequency of DELT anomalies (deformities, eroded fins and body parts, lesions, and tumors) is an essential indicator of stress caused by chronic agents, intermittent stresses, and chemically contaminated sediments. The percent DELT anomalies is a metric in most of the large river fish assemblage assessments that have been developed across the U.S. Crew members were trained to recognize anomalies prior to each field season.

Habitat Evaluation

Prior to conducting electrofishing at each site, the field crew completed ORSANCO's Habitat Data Collection Protocol (2003) as outlined in Appendix 2. This procedure is a physical evaluation of the benthic macrohabitat features and immediate riparian characteristics within the designated sampling area. This is a thorough yet rapid evaluation technique employed by agencies for the purpose of developing expectation of site specific performance. Habitat characteristics were recorded after the completion of sampling at each site using a qualitative, observation based method (Rankin 1989, 1995) under seasonal low flow conditions. Attributes of the Qualitative Habitat Evaluation Index (QHEI) include substrate diversity and composition, degree of embeddedness, cover types and amounts, flow velocity, channel morphology, riparian condition and composition, and pool and run-riffle depths. The original QHEI (QHEI; Ohio EPA 1989; Rankin 1989) was modified for application to non-wadeable rivers (Appendix 2) and was completed by the crew leader at the completion of each electrofishing event. The QHEI is a physical habitat index designed to provide an empirical, qualified evaluation of the lotic macrohabitat characteristics that are important to fish assemblages. The QHEI was developed within several constraints associated with the practicalities of conducting a large-scale monitoring program, i.e., the need for a rapid assessment tool that yields meaningful information and which takes advantage of the knowledge and insights of experienced field biologists who are conducting biological assessments. This index has been used widely outside of Ohio and similar habitat evaluation techniques are in widespread existence throughout the U.S. It incorporates the types and quality substrate, the types and amounts of instream cover, several characteristics of channel morphology, riparian zone extent and quality, bank stability and condition, and pool-run-riffle quality and characteristics. Slope or gradient is also factored into the QHEI score. We followed the specific guidance and scoring procedures outlined in Ohio EPA (1989) and Rankin (1989). A QHEI habitat assessment form was completed by the crew leader for each zone over the standard 500 meters of sampling distance (see Appendix 2).

Local gradient was determined from USGS 7.5' topographic maps and water clarity was measured with a secchi disk. Water quality included basic field parameters such as temperature, dissolved oxygen, and conductivity. These were determined at each sampling location with portable meters and at fewer locations using continuous monitoring devices. The habitat evaluation methods provide an ancillary benefit to the sampling crew by revealing various features within the sampling reach that must be included, but may not be considered upon initial visual inspection. These data help facilitate a thorough execution of the electrofishing protocol.

Field Data Recording

Field data and observations were recorded on water resistant data sheets. Fish assemblage data including species, size class, numbers and weights by species and size class, external anomalies, chemical/physical data, site name and numeration, sampling crew membership, time of day, time sampled, distance sampled, and electrofishing unit settings and electrode configurations will be recorded on the fish sampling data sheet (Appendix 2). Data sheets are retained by ORSANCO and MBI. Voucher specimens collected by ORSANCO crews were deposited at ORSANCO for a period of one year then moved to the Center for Ohio River Research and Education at the Thomas More College Ohio River Biological Field Station for storage/ archiving. Samples collected by MBI were permanently deposited at the Ohio State University Museum of Biodiversity. As such they provide a permanent record. The vouchers served to validate new species distribution records and for verification of questionable field identifications. Each set of vouchers were labeled with the same location data recorded on the field sheet and they are also denoted on the field sheet. All data were entered into an electronic data format maintained and supported by ORSANCO. At this time we are using a Microsoft Access database, which is translatable to spreadsheet formats such as Microsoft Excel.

2.3.2. Minnesota DNR

Sampling Procedure

The Minnesota Department of Natural Resources (MNDNR) large river (non-wadeable) sampling protocol includes both electrofishing and habitat evaluation at each site. A modification of the method and approach described by Lyons et al. (2001) for the collection of fish by boat electrofishing was used at each site to generate the data that would be incorporated into the state's monitoring initiative. The principal modifications include a smaller dip net mesh size and two netters.

Fish were collected using a boat-mounted, VVP-15 Coeffelt pulsed-DC electrofishing unit. A 17-foot long aluminum boat with 6, 5/16-inch stainless steel cables serving as the cathode was the primary electrofishing platform. The anode was a single 4m boom with a "Wisconsin ring", from which 16 cylindrical, 17mm diameter stainless steel droppers were suspended (Lyons et al. 2001). About 125mm of each dropper was in contact with the water. This cathode array is not commercially available. Electricity was provided by a gasoline-powered AC generator rated at 5,000W. The sampling crew maintained 300 volts at 5-7amps, 30% duty cycle, and 60% frequency through the control box. Electrofishing time was recorded in seconds on the control box and recorded on the data sheets.

During sampling, two crewmembers used 1/8" mesh dip nets and attempted to capture all of the stunned fish. Captured fish were identified to species, counted, and weighed in the aggregate by species. Most specimens were released after processing.
At each sampling site 1,600m (1 mile) of channel border habitat was sampled on one bank with the first 500m processed separately for the purpose of this study. MNDNR chose 1,600m as a standard length based on methods described by Lyons et al. (2001). Sampling occurred in daylight and was done in a downstream direction as close to the channel

border shoreline as possible. Fish collections were made between mid-May and late September. Sampling did not occur if the river stage was more than 1 m above normal, but it did take place at below-normal flows. Turbidity was not a sampling criterion.

Habitat Evaluation

At each site MNDNR crews completed an appropriately modified version of the Qualitative Habitat Evaluation Index (QHEI; Ohio EPA 1989; Rankin 1989). Habitat evaluation is conducted after electrofishing is completed at each site in order to provide the crew a perspective of the fish habitat within the zone. MNDNR utilizes the same modified version of this index as MPCA. A QHEI assessment form was completed by the sampling crew for each zone (see example in Appendix 2).

2.3.3. Minnesota PCA

Sampling Procedure

The Minnesota Pollution Control Agency (MPCA) large river (non-wadeable stream) sampling protocol includes boat electrofishing and habitat evaluation/ reconnaissance at each site. The methods and approaches described by the MPCA for the collection of fish by boat electrofishing were used at each site to generate basic data necessary for biological assessment (Appendix 2).

The MPCA's Biological Monitoring Program utilizes four electrofishing gear types. Care is taken to select the gear type that will most effectively sample the fish assemblage within a selected reach. For the purposes of this study, and as dictated by the study area within which methods comparisons were made, a boat-mounted electrofishing apparatus was the only sampling gear employed. Fish were collected using a 17' aluminum johnboat fitted with a Smith-Root 5.0 GPP electrofishing unit. The boat hull served as the cathode, and the anode array consisted of two umbrella-type droppers. Electrofishing time was recorded in seconds on the 5.0 GPP control box and recorded on the data sheets.

Three electrofishing runs are made at each site in a downstream direction, one each along the right bank, left bank, and mid-channel. Personnel consist of one person to drive the boat, monitor the control box, and ensure the safety of the two fish collectors on the bow. Netters capture fish with 1/8 inch mesh long-handled dipnets. The location and length of the sampling reach is determined during site reconnaissance (see SOP- "*Reconnaissance Procedures for Initial Visit to Stream Monitoring Sites*" (Appendix 2)). For the purposes of this study each of the three electrofishing runs was 500m in length. The complete protocol SOP, gear list, and processing procedure are outlined in detail in the MPCA *Fish Community Sampling Protocol* (Appendix 2).

Sampling is conducted during daylight hours within the summer index period of mid-June through mid-September. The sampling crew conducts detailed reconnaissance at each site prior to sampling to describe stream status and determine sampleability. Sampling occurred when streams were at or near base-flow. All habitat types available to fish within the reach in the approximate proportion that they occurred were sampled. An effort was made to collect all fish observed. Fish < 25 mm in total length were not counted as part of the catch. All fish that were alive after processing were immediately returned to the stream, unless they were needed as voucher specimens. Substantial efforts to minimize handling mortality were taken, including using a live well, and quickly sorting fish into numerous wet containers. Fish survey results were recorded on the Fish Survey Record data sheet (Appendix 2).

Habitat Evaluation

Physical habitat assessment was conducted after electrofishing each site. At each site the field crew completed an appropriately modified version of the Qualitative Habitat Evaluation Index (QHEI; Ohio EPA 1989; Rankin 1989). All MPCA SOPs can be found in Appendix 2.

2.3.4. Indiana DEM

Sampling Procedure

The Indiana Department of Environmental Management (IDEM) large river (non-wadeable stream) sampling protocol includes both electrofishing and habitat evaluation at each site. The methods and approaches employed by the IDEM Office of Water Quality/ Biological Studies Section were established and refined in 1996 to collect a representative fish community sample for IBI analysis with probabilistic sampling and stressor identification projects (Appendix 2).

The IDEM Office of Water Quality/ Biological Studies Section utilizes three electrofishing gear types. In similar fashion to other agencies physical reconnaissance is necessary to determine which gear will most effectively sample the fish community. For the purposes of this study, and as dictated by the study area within which methods comparisons were made, a boat-mounted electrofishing apparatus was the only sampling gear employed. Fish were collected using 16' Lowe Olympic Jon boat powered by a 25 h.p. outboard motor and outfitted with a 5000 X Honda generator producing 5000W, a Coeffelt VVP-2E box producing pulsed DC at 340 volts and 3-6 amps. In this configuration the boat hull serves as the cathode while the anode consists of a boom-mounted electrosphere. Electrofishing time was recorded in seconds on the control box and recorded on the data sheets.

Two electrofishing runs are made at each site in an upstream direction, one on each bank. Sampling distance on each bank is calculated as15 times the stream width up to a maximum of 500m. All zones sampled by IDEM for this study were 500m in length. Personnel consist of one person to drive the boat, monitor the control box, and ensure the safety of the two fish collectors. The driver maneuvers the boat in a slow upstream direction, frequently circling around to allow netters to capture fish that surface behind the boat. Netters capture fish with 1/8 inch mesh long-handled dipnets. All habitat types available to fish within the reach in the approximate proportion that they occurred were sampled. An effort was made to collect all stunned fish.

Sampling was conducted during daylight hours within the summer index period of mid-June through mid-September. Captured fish were identified to species, counted, and weighed in species batches (fish <20 mm in length were not included). After processing, all live fish were immediately returned to the stream, unless required as voucher specimens.

Considerable efforts were taken to minimize handling mortality, such as maintaining and replenishing a live well, and quickly sorting fish into numerous wet containers. Detailed reconnaissance was conducted at each site prior to sampling events to determine location and length of sampling reach. This was also necessary in order to describe stream status and sampleability. Sampling occurred when streams were at or near base flow. High flow and turbid conditions were important sampling criteria as incidence of these conditions prevented sampling efforts.

Habitat Evaluation

A general site evaluation is made while sampling each location using an appropriate modification of the QHEI, with all findings reported in a Qualitative Habitat Evaluation Index (QHEI) field sheet. Habitat evaluation is conducted after electrofishing is completed at each site in order to provide the crew a perspective of the fish habitat within the zone. Physical measurements of maximum depth, percentage of substrates, or exact widths of riparian vegetation are not taken. Instead these values are estimated based on knowledge of the river system, geology of the surrounding area, and conditions during sampling both banks. (Indiana Department of Environmental Management (IDEM). How to complete the Qualitative Habitat Evaluation Index (QHEI) modified from (OHIO EPA 1989). Indiana Department of Environmental Management, Office of Water Quality, Assessment Branch, Biological Studies Section, Indianapolis, Indiana. IDEM/OWQ/ Assessment Branch/BSS-SOP, June 2002, revision number 2). All IDEM SOPs are detailed in Appendix 2.

2.3.5. Wisconsin DNR

Sampling Procedure

The WDNR large river (non-wadeable) sampling protocol is based on boat mounted electrofishing. The methods and approaches described by Lyons et al. (2001) for the collection of fish by boat electrofishing were used at each site to generate the data that would be incorporated into the state's monitoring initiative.

Fish were collected with a boat-mounted, custom made, pulsed-DC electrofishing unit manufactured by the University of Wisconsin Engineering Department. WDNR used a 5m aluminum johnboat powered by a 15hp or 25hp outboard motor, with the boat hull serving as the cathode for the electrofishing unit. The anode was comprised a single 4m boom with a "Wisconsin ring", from which 16 cylindrical, 17mm diameter stainless steel droppers were suspended. In normal operation, about 125mm of each dropper was in contact with the water. Electricity was provided by a gasoline-powered AC generator that was rated at 3500W. WDNR prefers to maintain 3000W of output through a control box that converted AC to DC. The DC current was pulsed at 60Hz with a 25% duty cycle (Lyons et al. 2001). Electrofishing time was recorded on the data sheets.

At each sampling site, WDNR crews sampled 1620m (1 mile) of contiguous shoreline in a single run. Electrofishing was confined to main-channel-border habitats. Sampling distance was not divided into segments. Personnel included one person to drive the boat, monitor the electrofishing control box and ensure the safety of a single netter. The netter used a 17mm mesh (stretch) dip net and attempted to capture all fish observed.

All sampling occurred during the day and was performed in a downstream direction as close to the shoreline as possible. All fish that were alive after processing were immediately returned to the water, unless retained as voucher specimens. Efforts to minimize handling mortality included using a live well and sorting fish quickly. All fish collections were made within the seasonal index period of mid-May through late September. Sampling did not occur if the river stage was more than 1m above normal stage, but did occur at below normal flow and stage. Turbid conditions were not considered in their sampling criteria. WDNR did not conduct a standardized habitat evaluation at their electrofishing zones.

2.3.6. Illinois DNR

Sampling Procedure

The IDNR non-wadeable stream sampling protocol is based on boat electrofishing. Guidelines for IDNR stream sampling help standardize the collection of stream-fish information, allowing for valid comparisons among sites by minimizing variability in sampling technique. Such comparisons are necessary for effective management and stewardship of stream resources throughout the state. The IDNR Stream Sampling Guidelines address the three main objectives of fish sampling. These objectives are: 1) Fish community composition, 2) Sport fishery characterization and 3) Special (targeted) fish studies (Appendix 2).

For the purposes of this comparison, fish were collected using a 16'-18' johnboat and fitted with a three- phase AC electrofishing unit. Electricity was provided by a gasoline-powered AC generator and delivered to the water at 240VAC via boom-mounted electrodes. AC output was regulated by a control box coupled to the generator. It should be noted that IDNR also employs pulsed DC with a Smith-Root type system. This system was not, however used on the Kankakee River in 2005.

At each site IDNR crews conducted a 0.25 to 1.0 mile long sampling reach that includes all available habitats including open water and mid-channel areas in addition to shoreline habitats. Zone length was predicated on 15 to 30 minute timed sampling runs rather than a fixed distance. Boat electrofishing runs were conducted in a general downstream direction, but circling back upstream and into various habitats as needed. Personnel included one person to drive the boat, monitor the electrofishing control box and ensure the safety of one netter. The netter used a long-handled, 1/4" mesh dipnet to capture all fish observed within the field. Frequent circling and backing of the watercraft was necessary to retrieve all stunned fish. Electrofishing time was accurately recorded and was the principal basis for determining CPUE. The length of stream sampled (combined length along both banks and mid-channel) was estimated (to within 10ft with tape measure or rangefinder) or was measured on USGS topographic 7.5 minute quadrangle.

Sampling was conducted during daylight hours within the summer index period of early July through mid-September. After processing, all live fish were immediately returned to the stream, unless required as voucher specimens. Considerable efforts were taken to minimize handling mortality. In most cases, an oxygen supply was required to prevent undo stress, and the use of a 0.5% solution (0.04 lbs per gallon) of non-iodized salt was also used. Detailed reconnaissance was conducted at each site prior to sampling events to obtain permission from landowners where applicable and to determine location and length of sampling reach. All sampling was conducted under low flow conditions. Turbidity was a sampling criterion.

2.3.7. Michigan Institute for Fisheries Research (Michigan DNR)

Sampling Procedure

The Michigan DNR large river (non-wadeable stream) sampling protocol is based on electrofishing. The methods and approaches described by Lyons et al. (2001) for the collection of fish by boat electrofishing (as used by WDNR) were used at each site to generate the data that would be incorporated into the state's monitoring initiative. Equipment, personnel and sampling guidelines are outlined in the WDNR subsection of Appendix 2.

2.3.8. City of Elkhart Department of Public Works (EPW)

Sampling Procedure

The City of Elkhart EPW non-wadeable sampling protocol is based primarily on boat electrofishing. The methods and approaches employed are intended to collect a representative fish community sample for stressor identification purposes (Appendix 2).

Fish were collected with boat-mounted DC electrofishing. The hull of the boat served as the cathode while the anode consisted of two removable booms, each fitted with an array of steel droppers. Electricity was provided by a 5000W gasoline-powered AC generator. DC output was determined by a control box coupled to the AC generator.

At each site EPW crews conducted a single 500m electrofishing run on opposite banks. Sampling is conducted in an upstream direction close to the shoreline and in and around cover, then drifting downstream further from the shore over vegetated areas and ledges. Each site is sampled two times with a minimum of 5 weeks between passes and within a late-May/early June to mid/late August seasonal index period. Personnel included one person to drive the boat, monitor the electrofishing control box and ensure the safety of two netters. The netters used long-handled mesh (stretch) dip net and attempted to capture all fish observed within the electrical field.

Sampling was conducted during daylight hours within the summer index period of mid-June through mid-September. After processing, all live fish were immediately returned to the water, unless required as voucher specimens. As with all other agencies involved, considerable efforts were taken to minimize handling mortality.

Habitat Evaluation

The EPW uses the QHEI to assess habitat at each site. The QHEI data form is completed after each electrofishing run.

2.3.9. Metropolitan Water Reclamation District of the Greater Chicago Area (MWRD)

Sampling Procedure

The MWRD large river (non-wadeable stream) sampling protocol is based on electrofishing and habitat evaluation at each site. The methods and approaches employed by the MWRD were used at each site to generate data that would be incorporated into specific monitoring initiatives and biological assessments (Appendix 2).

Fish were collected with a boat-mounted, pulsed DC electrofishing unit. The hull of the boat served as the cathode while the anode consisted of two removable booms, each fitted with an array of steel droppers. Electricity was provided by a gasoline-powered AC generator. DC output was determined by a control box coupled to the AC generator. 120V DC was pulsed at 12-14 amps, depending on conductivity at a 20-40% duty cycle. Electrofishing time was recorded in seconds.

At each sampling site, MWRD crews conducted 400m sampling runs of contiguous shoreline along both banks and in an upstream direction. This is not invariable as some sites are sampled along one shoreline as local conditions dictate. Personnel included one person to drive the boat, monitor the electrofishing control box and ensure the safety of two netters. Netters used fiberglass handled, 1/8" mesh dipnets to collect all fish observed within the electrical field.

Sampling was conducted during daylight hours within the summer index period of mid-June through mid-September. After processing, all live fish were immediately returned to the stream, unless required as voucher specimens. Considerable efforts were taken to minimize handling mortality, such as maintaining and replenishing a live well, and quickly sorting fish into numerous wet containers. Detailed reconnaissance was conducted at each site prior to sampling events to determine location and length of sampling reach. This was also necessary in order to describe stream status and sampleability. Sampling occurred when conditions were favorable (i.e. no obstructions, channel walls etc.) Flow rate and stage were also sampling criteria.

Habitat Evaluation

Physical habitat measurements were conducted following electrofishing at each site using the QHEI. Latitude/longitude, date, arrival time, water temperature, water conductivity, water depth, air temperature, wind speed, wind direction, and sky condition information were gathered and recorded. Ponar grab samples, sediment sampling locations, constituents, color and odor data were recorded.

2.3.10. American Electric Power (AEP)

Sampling Procedure

The AEP large river sampling protocol is based primarily on electrofishing at each site. The methods employed are generally based on the protocols established by Ohio EPA and are generally analogous to methods employed by MBI with respect to gear, protocol and execution (Appendix 2).

Fish were collected with a boat-mounted, pulsed DC electrofishing unit manufactured by Coeffelt. The watercraft used was an 18' johnboat manufactured by War Eagle. The hull of the boat served as the cathode. The anode configuration was a modified Wisconsin ring. Electricity was provided by a gasoline-powered AC generator. DC output was determined by a control box coupled to the AC generator. 120V DC was pulsed at 40 pulses per second at a 100% pulse width as determined by the control box. Electrofishing time was not recorded.

At each sampling site, AEP crews conducted a single 500m sampling run of contiguous shoreline in a downstream direction. Personnel included one person to drive the boat, monitor the electrofishing control box and ensure the safety of two netters. Netters used fiberglass handled, 3/16" mesh dipnets to collect all fish observed within the electrical field.

Sampling was conducted during daylight hours on the Scioto River within the summer index period of mid-June through mid-September. AEP conducts electrofishing studies at night as well when conditions require this technique. After processing, all live fish were immediately returned to the stream, unless required as voucher specimens. Considerable efforts were taken to minimize handling mortality.

Habitat Evaluation

Physical habitat measurements were conducted prior to electrofishing at each site. Water temperature, dissolved oxygen, specific conductance, and water clarity (i.e., Secchi disk depth) were measured at all electrofishing locations. Temperature was measured at two areas within each electrofishing zone: upper and lower ends (nearshore at mid-depth and off shore at approximately 2-m depth) using electronic meters. At those electrofishing locations that were immediately downstream of the thermal discharges, temperature was measured at the point where the highest stable reading is obtained. No formalized habitat protocol (QHEI) was observed.

2.3.11. Principal Differences between Entities (Electrofishing Method Summary)

Within the eight electrofishing sampling protocols involved in this study, there exist differences with respect to equipment and methodology. Although it would be difficult to associate differences (between performances of individual protocols) with a single variable such as an individual piece of equipment, sampling reach design, effort, etc. differences in some of these variables may be of value in explaining differences in the results. It is important to note that different sampling distances are employed by each entity for the purpose of generating data in accordance with their own assessment protocols. The gear and protocol specifications of each are summarized in Table 1. Comparisons made here are based upon a common sampling distance in order to standardize the comparisons and determine the similarity of baseline catch results between methods.

As methods employed by the cooperating entities are directly compared to those employed by MBI it was necessary to establish the "normal" or expected variability within the protocol executed by MBI. This was accomplished by an analysis of data collected previously by Ohio EPA (Section 2.4.2.3). In each method described, the boat hull served as the cathode unless otherwise noted (Table1). MBI used cathode droppers in conjunction with the boat hull to increase cathode surface area and depth of field. All entities used gasoline powered generators to produce AC current that was converted to pulsed DC. Illinois DNR used 3 phase AC current without conversion.

The Indiana DEM (IDEM) large river sampling protocol was unique in that they sampled a distance of 500m on both banks in an *upstream* direction. All of their sampling was conducted during the daytime. IDEM utilized a Coeffelt electrofishing unit at 340VDC and 3-6 amps and a boom-mounted electrosphere. The gear and method were used in the Kankakee and Wabash River study areas.

The Minnesota DNR protocol was based on a single bank, 1620 m (1 mile) site that was sampled in a downstream direction. This followed the protocol of Lyons et al. (2001) with the exception of a smaller dip net mesh size (1/8"). Sampling was conducted during the daytime from mid-May through late September. MNDNR utilized a Coeffelt electrofishing unit generating 300VDC at 5-7 amps. Current was delivered to the water via a boom-mounted Wisconsin electrode ring configuration. The boat hull served as the cathode and was augmented by the addition of 6 stainless steel cable droppers. The gear and method were used in the St. Croix River study area.

Minnesota PCA sampled 500m on each bank and one 500 m mid-channel run in a downstream direction for a total of three 500 m zones per site. All sampling was conducted during the daytime between mid-June and mid-September. MPCA used a Smith-Root 5.0 GPP electrofisher producing 500-1000VDC at a maximum of 20 amps. Current was delivered to the water via 2 boom-mounted umbrella-type droppers. The gear and method were used in the St. Croix River study area.

The WDNR electrofishing strategy involved sampling 1620m (1-mile) on a designated bank in a downstream direction (Lyons et al. 2001). All sampling was conducted during the daytime from mid-May through late September. WDNR crews utilized a Wisconsin DNR pulsed DC electrofishing unit producing 250-335VDC at 9-12 amps that was powered by a 3000W alternator. Power output was standardized at a single setting (25% duty cycle). Current was delivered to the water via a boom-mounted Wisconsin Ring. The gear and method were used in the Wisconsin River study area by WDNR. The Michigan Institute for Fisheries Research (MIFR) used the same equipment and protocol as WDNR. This was applied in the St. Joseph River (Michigan) study area.

The Illinois DNR utilized a three-phase AC electrofishing apparatus. The crew consisted of two persons and sampling occurred in a downstream direction including all available habitats sampled for a period of one hour. Sampling was not confined to a single bank and included mid channel habitats. The gear and method were used in the Kankakee River study area in Illinois.

The City of Elkhart EPW (EPW) gear was the same as that used by MBI. The EPW approach calls for a 500m zone length along channel border habitat. The principal difference between the method employed by MBI and EPW is that EPW sampled each site in an upstream direction, then drifting downstream through the site. The gear and method were used in the St. Joseph River study area in Indiana.

Table 1. Electrofishing method/ gear comparison table.

Gear Category	IDEM	MNDNR	MPCA	WDNR/MIFR	MBI/ORSANCO
PLATFORM:	17' aluminum johnboat	17' alum. johnboat	17' aluminum johnboat	5m alum. johnboat	16' aluminum johnboat (day); 19.5' aluminum johnboat (night)
POWER SOURCE:	5000W generator, Coeffelt VVP-2E electrofisher	5000W generator, Coeffelt VVP-15 electrofisher	Smith-Root 5.0 GPP electrofisher	WDNR pulsed-DC electrofishing unit	Smith-Root 5.0 GPP electrofisher
CURRENT TYPE:	pulsed DC	pulsed DC	pulsed DC	pulsed DC	pulsed DC
WATTAGE (AC POWER SOURCE):	5000W	5000W	5000W	3500W	5000W
VOLTS (DC OUTPUT):	340V	300V	0-500V (low); 0-1000V (high)	250-335V	0-500V (low); 0-1000V (high)
AMPERAGE (OUTPUT):	3-6 A	5-7 A	0-25 A	9-12 A	0-20 A
ANODE TYPE/ LOCATION:	electrosphere/ boom	Wisconsin Ring/ boom	umbrella-type droppers/ 2 booms	Wisconsin Ring/ single boom	5, 3/8" woven steel cable strands/ square boom (day); Smith-Root LPA-6 low profile 3/8" woven steel cable dropper arrays/ 2 booms
CATHODE TYPE:	boat hull	boat hull; 6 - 5/16-inch stainless steel cables	boat hull	boat hull	boat hull; 4 - 8' long 1" diameter flexible steel conduits (day); boat hull; 32, 3/8" woven steel cables (night)
NUMBER OF NETTERS/ MESH SIZE:	2 netters; 1/8 inch mesh long-handled dipnets	2 netters; 1/8 inch mesh long-handled dipnets	2 netters; 1/8 inch mesh long-handled dipnets	1 netter (seated); 3/8 inch mesh size	1 primary netter, 1 secondary; 7.62mm mesh long-handled dipnets
DISTANCE SAMPLED (meters)/ BANK(S):	15 times stream width up to a maximum of 500m (both banks)	1600m channel border habitat; one bank	500m each; right bank, left bank, and mid-channel (1500 m total)	1620m channel border habitat; one bank	500m channel border habitat; "best" bank
SAMPLING DIRECTION:	upstream	downstream	downstream	downstream	downstream
STREAM SIZE:	large/great rivers	large/great rivers	large/great rivers	large/great rivers	large/great rivers
SAMPLING INDEX PERIOD:	September to mid-October	mid-May to late September	mid-June to mid-September	mid-May to late September	mid-June to mid-October (day); mid-June to late-October (night)
DAY/NIGHT:	day	day	day	day	day/ night
HABITAT EVAL	QHEI; post-sampling	QHEI (modified); post sampling	QHEI (modified); post sampling	N/A	QHEI (modified); post sampling, ORSANCO Habitat; pre-sampling

Table 1 (cont'd). Electrofishing method/ gear comparison table.

Gear Category	IDNR	EPW	MWRDGC	AEP
PLATFORM:	14' aluminum johnboat	17' aluminum johnboat	17' aluminum johnboat	18' aluminum johnboat
POWER SOURCE:	5000W generator,3-phase AC converter	Smith-Root or Coeffelt type pulsed DC electrofisher	Smith-Root 17-C (custom) control box; Smith-Root 5.0 GPP electrofisher	5000W generator, Coeffelt VVP-15 electrofisher
CURRENT TYPE:	3 phase AC	pulsed DC	pulsed DC	pulsed DC
WATTAGE (AC POWER SOURCE):	5000W	5000W	5000W	5000W
VOLTS (DC OUTPUT):	240V AC	300VDC	120VDC	120VDC
AMPERAGE (OUTPUT):	n/a	n/a	12-14 A	12-14 A
ANODE TYPE/ LOCATION:	steel droppers/ electrodes/ boom	umbrella-type droppers/ 2 booms	umbrella-type droppers/ 2 booms	Wisconsin Ring/ single boom
CATHODE TYPE:	n/a	boat hull	boat hull	boat hull
NUMBER OF NETTERS/ MESH SIZE:	1 netter; <.25" inch mesh long-handled dipnet	2 netters; 1/8 inch mesh long-handled dipnets	2 netters; 1/8 inch mesh long-handled dipnets	2 netters; 7.62mm mesh long-handled dipnets
DISTANCE SAMPLED (M)/ BANK(S):	Variable distance, all habitats; 60 minute runs	500m channel border habitat; one bank	800m; opposite banks (400 m along each)	500m channel border habitat; one bank
SAMPLING DIRECTION:	downstream	upstream, then downstream	upstream	downstream
STREAM SIZE:	large rivers	large rivers	large/great rivers	large/great rivers
SAMPLING PERIOD:	mid-June to mid-October	mid-June to mid-September	mid-June to mid-September	mid-June to mid-September
DAY/NIGHT:	day	day	day	day
HABITAT EVAL	N/A	QHEI; post sampling	QHEI (modified); post sampling	N/A

The MWRD method is a two-bank approach where a 400m of shoreline habitat is sampled on opposite banks in an upstream direction. All sampling was conducted during the daytime from mid-May through late September. Current was delivered to the water via boom mounted anode arrays. The gear and method were used in the Chicago Area Waterway System (CAWS) study area.

The American Electric Power (AEP) protocols and equipment were similar to those employed by MBI. The AEP approach involved a 500m zone along the same channel border habitats on the same shoreline. A pulsed DC electrofishing unit was used to transmit current through a boom dropper array. Sampling was conducted between June and October. The gear and method were used in the Scioto River study area in Ohio.

2.4. ANALYTICAL METHODS

2.4.1. Data Compilation

All electrofishing data collected by MBI underwent a QA/QC process during which voucher specimens were identified to species and all records were checked for errors and cross-checked against established distributional information and state threatened and endangered species lists. Keys used in identification included Page and Burr (1991), Trautman (1981), Etnier and Starnes (1993), and Tomelleri and Eberle (1990). Questions were pursued with experts in each state as needed. Habitat data underwent QA/QC and were entered into Access database and archived at ORSANCO. QHEI data were entered and archived at MBI using the Ohio ECOS data management system. Participating entity data was compiled and formatted using Excel. These data were then entered into an Access database such that they could be queried and analyzed in Excel and other analytical routines.

2.4.2. Data Analysis

The principal analytical tools used in this project are those associated with conventional data and statistical analysis. These were performed on personal computers using relational databases such as Access, Excel, FoxPro and various statistical and graphical packages. Maps were generated using DeLorme Topo USA 5.0. For each data set from each river and each individual site, several calculations were performed to ascertain performance of each method executed by the individual entity. Initially these included compilation/analysis of raw catch data including the number of individual fish collected (per site; per collector) from which was derived the total number of species. Electrofishing time (in seconds) was also included as a measure of sampling effort when that was recorded.

Four transformations or parameters of the data were used to determine comparability between samples. These included the Modified Index of Well-Being (MIwb; Gammon 1976, Ohio EPA 1987), the Bray-Curtis coefficient of similarity, species richness, and relative density expressed as the number of individuals per km. The MIwb could be calculated only when biomass data was available; species richness, numbers/km, and the Bray-Curtis coefficient were generated for all entity comparisons.

2.4.2.1. Modified Index of Well Being (MIwb)

The Modified Index of well-being (MIwb; Gammon 1976, Ohio EPA, 1987) was calculated for each sample that included biomass data. A modification of the Iwb originally developed by Gammon (1976), the MIwb incorporates numbers of individuals, biomass and the Shannon Diversity index (H) based on numbers and weight. Thirteen highly tolerant species are eliminated from the numbers and biomass components, but retained in the Shannon indices. This modification of the original Iwb has the effect of precluding the inappropriate inflation of scores at moderately degraded sites with high numbers of tolerant species. The MIwb is a relatively simple measure of assemblage health based on diversity and abundance data. The MIwb can be used in multiple geographic locations as it does not require site-specific or regional calibration. It is a relative measure of the diversity, evenness, and relative abundance of a sample, thus it is a logical choice to compare data resulting from the various electrofishing methods tested by this study. The MIwb and Shannon's H formulae follow:

$$\boxed{MIwb = 0.5\ln N + 0.5\ln B + H(\text{no.}) + H(\text{wt.})}$$

Where:
N = relative (number/kilometer) numbers of all species excluding those designated as highly tolerant (Appendix 3)

B = relative weight (kilogram/km)of all species - excluding those designated as highly tolerant

$H(\text{no.})$ = Shannon Diversity index based on numbers ($\log_e$ transformation)

$H(\text{wt.})$ = Shannon Diversity index based on weight ($\log_e$ transformation)

Shannon Diversity index:

$$\boxed{H' = -\sum_{i=1}^{S} \frac{n_i}{N} \ln \frac{n_i}{N}}$$

Where:
n_i = relative number or weight of the ith species

N = total number or weight of the sample

The MIwb as it is applied to electrofishing data is based on a standardized distance of 1.0 km. This makes it possible to compare MIwb scores derived from data collected at sites of differing sample distances by normalizing the relative numbers of all species - excluding those designated as highly tolerant (N) and relative weight of all species - excluding those designated as highly tolerant (B) to a distance of 1.0 km. The standardized values for N and B are then incorporated into the MIwb equation.

2.4.2.2. Bray-Curtis Coefficient of Similarity

Multiple measures of community similarity were considered to determine the extent of similarity between samples collected by each entity. These included the Bray-Curtis coefficient (BC), Jaccard's index, and Sorenson's index. Jaccard's Index, the simplest of these comparisons, considers the presence/absence of species. It is calculated by dividing the number of species found in both of two samples (*j*) by the number found in only one sample or the other (*r*) and then multiplying by 100. This gives a percentage of faunal similarity:

$$\boxed{\textit{Jaccard's Index} = \frac{j}{r} x\, 100}$$

Where:
j = # of species in sample 1

r = # of species in sample 2

Sorensen's Quotient of Similarity (Q/S) is a diversity index that computes the percentage similarity between two samples and is given by:

$$\boxed{Q/S = \frac{2j}{(a+b)}\, x\ 100}$$

Where:
a = # of species in sample 1

b = # of species in sample 2

j = # of species common to both samples

The Bray-Curtis coefficient of similarity (*BC*), the most complex of these coefficients, is a commonly used community similarity index and is given by:

$$\boxed{BC_{jk} = 100\left\{1 - \frac{\sum_{i=1}^{p}\left|y_{ij} - y_{ik}\right|}{\sum_{i=1}^{p}\left(y_{ij} + y_{ik}\right)}\right\}}$$

Where;
BCjk = similarity between the *j*th and *k*th sites

Yij = the abundance for the *i*th species in the *j*th site.

As the resulting computational value approaches 1.0 the samples are exhibiting increased degrees of similarity. Although each is a useful tool for comparison, Jaccard's and Sorenson's coefficients do not weight the occurrence of species with respect to their relative abundance in the sample. The Bray-Curtis coefficient incorporates relative abundance, and was set to exclude non-native species. For this reason Bray-Curtis was employed as the primary community similarity analysis tool in these comparisons.

2.4.2.3. Establishing Normal Variation in Assemblage Parameters

This study necessarily required sampling the same sites on two different dates, one by MBI and the other by the participating entity. As such, we can expect different results due simply to the samples being collected on different dates. In terms of evaluating the comparability of the resulting data, we first needed to know what type of variation would be expected by sampling the same site on different dates. We analyzed electrofishing data from the Ohio EPA statewide database as the methods employed by Ohio EPA are the same as those used by MBI. This database consists of 2-3 samples collected at the same sites within the same year and seasonal index period. The analysis was restricted to boat electrofishing sites sampled after 1990 that yielded IBI scores $\geq$48 (exceptional quality) and over a 500 meter sampling distance. Using post-1990 exceptional quality sites as characterized by the IBI minimizes potential variation due to factors other than sampling on different dates (i.e., intermittent pollutional stresses). We then calculated the various assemblage parameters and indices among all possible combinations of individual paired samples. Figure 11 illustrates the variation in Bray-Curtis coefficients between sampling passes collected at the same site within the same year, at the same site between different years, and between different sites. For the purpose of this study, this calculation (as with all others) was performed to include only sites at the same site within the same year, as all data were collected by the participating agencies within the same season (Table 2).

The variation at the same site within the same year represents an expectation for "normal" variation. We used the following criteria to establish three levels of comparability for evaluating the results obtained from each comparison:

Similar:	>25th percentile (Bray-Curtis
Weakly Similar:	between 25th percentile and 5th percentile (Bray-Curtis
Dissimilar:	<5th percentile (Bray-Curtis)

Thus, Bray-Curtis similarity values between two samples at the same site in the same year would need to have a coefficient of 0.7 - 1.0 to reflect a similar sample. Values of <0.7 to 0.6 represent weak similarity, and values <0.6 reflect dissimilar results and suggest that the data are not comparable (Table 2).

We performed similar analyses to establish a similar set of thresholds for species richness (Figure 12), MIwb scores (Figure 13), and relative numbers of individuals per km (Figure 14) as follows:

Similar:	>75th percentile
Weakly Similar:	between 75th percentile and 95th percentile
Dissimilar:	>95th percentile

Species richness was restricted to the number of native species in a sample. Based on the analysis and percentile ranges, a difference of 5 or fewer species represented similar results.

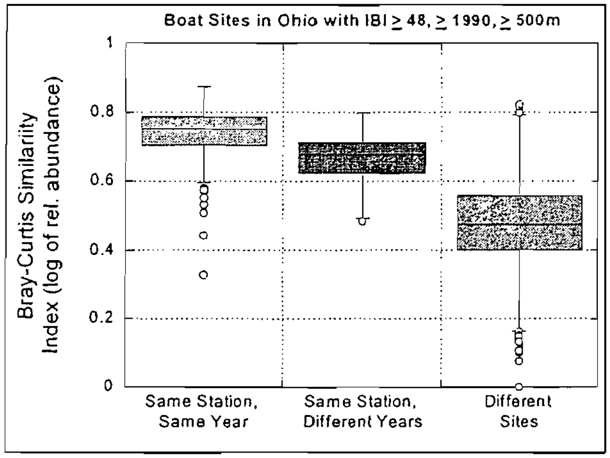


Figure 11. Differences in Bray-Curtis similarity coefficients at the same site and same year, same site in different years, and different sites

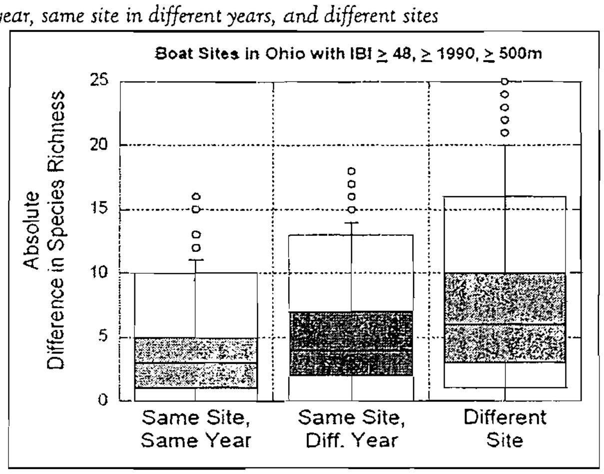


Figure 12. Differences in species richness results at the same site and same year, same site in different years, and between different sites.

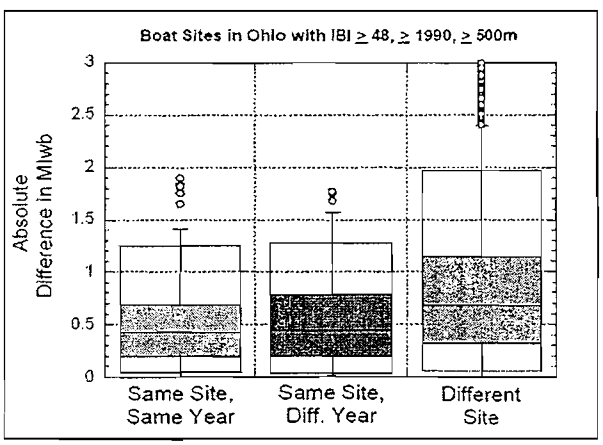


Figure 13. Differences in MIwb results at the same site and same year, same site in different years, and between different sites.

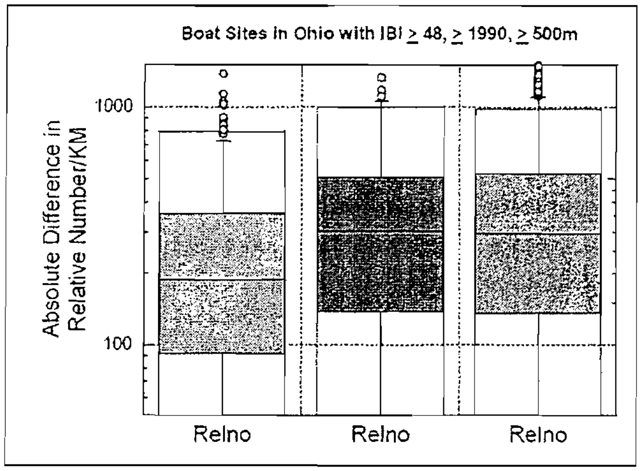


Figure 14. Differences in relative numbers results at the same site and same year, same site in different years, and between different sites.

A difference of 6 - 10 species demonstrated a weakly similar result, and a difference >10 species reflected dissimilar results (Table 2). For the MIwb, a difference of <0.70 units reflects similar results while differences >0.70, <1.25 reflected weakly similar results; >1.25 reflected a dissimilar result (Table 2). For relative numbers a difference of <359 individuals/km demonstrated a similar relationship while differences of >359, <784 reflected weakly similar results and > 784 reflected a dissimilar result (Table 2).

Table 2. Statistical mean, median, and percentile values for Bray-Curtis Similarity, species richness, MIwb scores, and numbers of individuals per km for MBI methods.

Site Type	Variable	# of samples	mean	median	p10	p25	p75	p95
SAME SITE, SAME YEAR	BC Similarity	236	0.738	0.752	0.6	0.7	0.788	0.835
SAME SITE, SAME YEAR	Total Species	219	3.731	3	0.4	1	5	10
SAME SITE, SAME YEAR	MIwb	219	0.501	0.43	0.08	0.2	0.698	1.246
SAME SITE, SAME YEAR	Relative Number/km	219	259.799	188	46	92	359	784.1

3.0. RESULTS

3.1. ST. CROIX RIVER

Between June and September 2004, 10 sites between river miles 28 and 92 were sampled by MBI, MPCA and MNDNR. Raw data generated by each participating entity appears in Appendix 3. Sites were sampled by each entity along a common bank. Each entity began their respective sampling runs as close to the exact geographical position of the site as dictated by coordinates provided by U.S. EPA for the location of probability sites associated with a regional EMAP project. Although each entity employs different sampling distances, the comparisons were made based on a 500 meter subset of electrofishing data provided by each entity. Subsets of data provided by MPCA and MNDNR allowed for comparison of method execution and protocol. Additional comparisons using each entity's complete assessment unit were made for the purpose of demonstrating differences in assessment outputs (catch data, MIwb scores). As such, results for each entity are listed for standardized 500 m distances and, in the case of MNDNR and MPCA, for their 1620m and 1500 m site protocols, respectively.

At three of the ten sites (655RDB, 658RDB and 642LDB), MBI performed nighttime electrofishing using the ORSANCO protocol. At site 642LDB MBI performed both daytime and nighttime sampling on two different dates.

3.1.1. Species Composition / Metrics; #species, #individuals, electrofishing time per 500m site (10)

Data collected by the three entities at 500m sites on the St. Croix River showed some marked differences. Data collected by MPCA exhibited higher numbers of individuals than MNDNR or MBI at five of ten sites. MPCA collected higher numbers of species at six of ten sites. MNDNR collected a higher number of individuals and species at one site, and MBI collected higher numbers of individuals at four of 10 sites and higher numbers of species at three sites (Table 3). MPCA collected the highest average number of individuals across all 500m sites. MBI collected the highest average number of species across all 500m sites and had the highest average electrofishing time (Table 4).

With respect to the full assessment protocols both MNDNR and MPCA collected higher numbers of individuals than did MBI (Table 3). Likewise, the greater sampling distances produced higher numbers of species. As sampling distance increased, numbers of individuals and numbers of species did not necessarily increase at an equal rate. These findings are not surprising as it is generally understood that longer sampling distances will yield more species and greater numbers of individuals.

Day versus night electrofishing results on the part of MBI was not substantially different than the daytime results of MPCA and MNDNR. Results from 642LDB show that MBI nighttime sampling produced higher numbers than those from the same site during the day. Coincidentally, MBI night sampling produced the highest number of individuals per 500m at that site.

Table 3. Site/Collector data, # of individuals; # of species collected and electrofishing time (seconds) at 500m sites; High scores = Red.

Site #	Collector	RM	Zone length(km)	C-Date	Bank	D/N	#Ind	#Species	E-Time
655RDB	MNDNR	28.1	0.5	18-Aug-04	RDB	DAY	171	17	NA
	MNDNR	28.1	1.6	18-Aug-04	RDB	DAY	579	25	4408
	MPCA	28.1	0.5	07-Sep-04	RDB	DAY	481	25	1522
	MPCA	28.1	1.5	07-Sep-04	ALL	DAY	938	32	3920
	MBI	28.1	0.5	23-Jul-04	RDB	NIGHT	303	21	2208
658RDB	MNDNR	38.3	0.5	06-Aug-04	RDB	DAY	382	23	1798
	MNDNR	38.3	1.6	06-Aug-04	RDB	DAY	1230	35	5156
	MPCA	38.3	0.5	08-Sep-04	RDB	DAY	249	24	1546
	MPCA	38.3	1.5	08-Sep-04	ALL	DAY	458	34	4642
	MBI	38.3	0.5	23-Jul-04	RDB	NIGHT	553	29	2102
642LDB	MNDNR	44.4	0.5	11-Aug-04	LDB	DAY	275	21	1749
	MNDNR	44.4	1.6	11-Aug-04	LDB	DAY	481	26	4626
	MPCA	44.4	0.5	14-Sep-04	LDB	DAY	254	23	2064
	MPCA	44.4	1.5	14-Sep-04	ALL	DAY	665	31	5384
	MBI	44.4	0.5	26-Jul-04	LDB	NIGHT	388	21	2653
	MBI	44.4	0.5	04-Sep-04	LDB	DAY	110	18	3000
647LDB	MNDNR	47.9	0.5	10-Aug-04	LDB	DAY	112	12	1411
	MNDNR	47.9	1.6	10-Aug-04	LDB	DAY	614	27	4311
	MPCA	47.9	0.5	16-Sep-04	LDB	DAY	98	11	1809
	MPCA	47.9	1.5	16-Sep-04	ALL	DAY	580	21	5495
	MBI	47.9	0.5	04-Sep-04	LDB	DAY	146	18	1920
660RDB	MNDNR	62.4	0.5	03-Aug-04	RDB	DAY	284	27	2116
	MNDNR	62.4	1.6	03-Aug-04	RDB	DAY	1051	29	5331
	MPCA	62.4	0.5	15-Sep-04	RDB	DAY	143	13	2053
	MPCA	62.4	1.5	15-Sep-04	ALL	DAY	338	26	6363
	MBI	62.4	0.5	11-Aug-04	RDB	DAY	119	23	2745
649LDB	MNDNR	79.2	0.5	22-Jul-04	LDB	DAY	220	21	1642
	MNDNR	79.2	1.6	22-Jul-04	LDB	DAY	420	23	4260
	MPCA	79.2	0.5	15-Sep-04	LDB	DAY	320	22	1736
	MPCA	79.2	1.5	15-Sep-04	ALL	DAY	655	31	5958
	MBI	79.2	0.5	11-Aug-04	LDB	DAY	174	19	2373
638LDB	MNDNR	82.9	0.5	21-Jul-04	LDB	DAY	79	16	NA
	MNDNR	82.9	1.6	21-Jul-04	LDB	DAY	209	25	4714
	MPCA	82.9	0.5	20-Sep-04	LDB	DAY	140	16	1501
	MPCA	82.9	1.5	20-Sep-04	ALL	DAY	655	28	4466
	MBI	82.9	0.5	12-Aug-04	LDB	DAY	201	19	2444
641LDB	MNDNR	91.8	0.5	19-Jul-04	LDB	DAY	85	11	1225
	MNDNR	91.8	1.6	19-Jul-04	LDB	DAY	1208	24	3867
	MPCA	91.8	0.5	16-Sep-04	LDB	DAY	112	18	967
	MPCA	91.8	1.5	16-Sep-04	ALL	DAY	370	25	2772
	MBI	91.8	0.5	12-Aug-04	LDB	DAY	80	14	1961
654RDB	MNDNR	108	0.5	14-Jul-04	RDB	DAY	318	20	1810
	MNDNR	108	1.6	14-Jul-04	RDB	DAY	610	27	4844

Table 3 (cont'd).

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	#Ind	#Species	E-Time
	MPCA	108	0.5	21-Sep-04	RDB	DAY	348	21	1725
	MPCA	108	1.5	21-Sep-04	ALL	DAY	696	28	5059
	MBI	108	0.5	02-Sep-04	RDB	DAY	110	17	2160
667RDB	MNDNR	128	0.5	13-Jul-04	RDB	DAY	222	20	1902
	MNDNR	128	1.6	13-Jul-04	RDB	DAY	358	22	5395
	MPCA	128	0.5	22-Sep-04	RDB	DAY	290	20	1621
	MPCA	128	1.5	22-Sep-04	ALL	DAY	601	26	4880
	MBI	128	0.5	31-Aug-04	RDB	DAY	148	16	2160

Table 4. Average # of individuals; # of species collected and EF time(sec) per 500m at all 10 sites. 500m high scores = Red.

Collector	AVG #IND	AVG. #SPECIES	AVG E-TIME
MBI	212	19.55	2338
MNDNR	214.8	18.8	NA
MPCA	243.5	19.3	1654

3.1.2. MIwb Scores

MIwb scores also differed between entities. Data collected by MPCA yielded higher scores at six of ten 500m (not standardized) sites, while MBI data yielded higher scores at three sites (Table 5). MNDNR data yielded the highest score per 500m at one site. Differences between day and night protocols did not stand out. As mentioned previously, although the participating agencies provided data from their respective complete sampling distance, a standardized 500 m distance was used for this comparison. Standardization of MIwb scores based on a 1.0 km distance had the effect of marginally increasing scores compared to 500 m sites. Scores from MPCA 1.5km zone lengths were lowered slightly and those from MNDNR 1.62km zone lengths were lower yet. Therefore, MIwb scores from 500 m sites were slightly higher and, not surprisingly, did not differ in pattern from non-standardized 500m scores. Although not discussed in detail here, this transformation may be useful when assessing method performance based on each entity's complete assessment unit.

With respect to complete assessment sites, MPCA and MNDNR exhibited higher average scores than those generated by MBI due to the greater sampling distances. When scores corresponding to 500 m zones on the same bank were compared, MBI data yielded marginally higher average MIwb scores across all sites (Figure 15).

Table 5. Site/Collector data, MIwb scores at 500m sites; High scores = Red.

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	MIWB	MIWB(ST)
655RDB	MNDNR	28.1	0.5	18-Aug-04	RDB	DAY	7.76	8.45
	MNDNR	28.1	1.6	18-Aug-04	RDB	DAY	9.20	8.73
	MPCA	28.1	0.5	7-Sep-04	RDB	DAY	9.08	9.78
	MPCA	28.1	1.5	7-Sep-04	ALL	DAY	10.08	9.68
	MBI	28.1	0.5	23-Jul-04	RDB	NIGHT	8.46	9.15

Table 5. (Cont'd) Site/Collector data, MIwb scores at 500m sites; High scores = Red.

Site #	Collector	RM	Zonelength(km)	CDate	Bank	D/N	MIWB	MIWB(ST)
658RDB	MNDNR	38.3	0.5	6-Aug-04	RDB	DAY	7.52	8.22
	MNDNR	38.3	1.6	6-Aug-04	RDB	DAY	10.17	9.70
	MPCA	38.3	0.5	8-Sep-04	RDB	DAY	8.65	9.34
	MPCA	38.3	1.5	8-Sep-04	ALL	DAY	10.00	9.60
	MBI	38.3	0.5	23-Jul-04	RDB	NIGHT	9.66	10.35
642LDB	MNDNR	44.4	0.5	11-Aug-04	LDB	DAY	8.63	9.33
	MNDNR	44.4	1.6	11-Aug-04	LDB	DAY	9.43	8.96
	MPCA	44.4	0.5	14-Sep-04	LDB	DAY	9.19	9.89
	MPCA	44.4	1.5	14-Sep-04	ALL	DAY	10.45	10.05
	MBI	44.4	0.5	26-Jul-04	LDB	NIGHT	9.18	9.88
	MBI	44.4	0.5	4-Sep-04	LDB	DAY	8.78	9.48
647LDB	MNDNR	47.9	0.5	10-Aug-04	LDB	DAY	6.13	6.82
	MNDNR	47.9	1.6	10-Aug-04	LDB	DAY	9.16	8.69
	MNPCA	47.9	0.5	16-Sep-04	LDB	DAY	6.33	7.02
	MNPCA	47.9	1.5	16-Sep-04	ALL	DAY	5.98	8.11
	MBI	47.9	0.5	4-Sep-04	LDB	DAY	8.49	9.18
660RDB	MNDNR	62.4	0.5	3-Aug-04	RDB	DAY	8.86	9.55
	MNDNR	62.4	1.6	3-Aug-04	RDB	DAY	9.42	8.95
	MPCA	62.4	0.5	15-Sep-04	RDB	DAY	7.13	7.83
	MPCA	62.4	1.5	15-Sep-04	ALL	DAY	9.80	9.40
	MBI	62.4	0.5	11-Aug-04	RDB	DAY	8.65	9.35
649LDB	MNDNR	79.2	0.5	22-Jul-04	LDB	DAY	7.85	8.55
	MNDNR	79.2	1.6	22-Jul-04	LDB	DAY	9.11	8.64
	MPCA	79.2	0.5	15-Sep-04	LDB	DAY	8.58	9.27
	MPCA	79.2	1.5	15-Sep-04	ALL	DAY	10.23	9.82
	MBI	79.2	0.5	11-Aug-04	LDB	DAY	7.79	8.48
638LDB	MNDNR	82.9	0.5	21-Jul-04	LDB	DAY	6.80	7.50
	MNDNR	82.9	1.6	21-Jul-04	LDB	DAY	9.09	8.62
	MPCA	82.9	0.5	20-Sep-04	LDB	DAY	7.67	8.36
	MPCA	82.9	1.5	20-Sep-04	ALL	DAY	9.97	9.57
	MBI	82.9	0.5	12-Aug-04	LDB	DAY	7.80	8.50
641LDB	MNDNR	91.8	0.5	19-Jul-04	LDB	DAY	6.15	6.84
	MNDNR	91.8	1.6	19-Jul-04	LDB	DAY	8.00	7.53
	MPCA	91.8	0.5	16-Sep-04	LDB	DAY	7.61	8.30
	MPCA	91.8	1.5	16-Sep-04	ALL	DAY	9.59	9.19
	MBI	91.8	0.5	12-Aug-04	LDB	DAY	7.28	7.98
654RDB	MNDNR	108	0.5	14-Jul-04	RDB	DAY	7.89	8.58
	MNDNR	108	1.6	14-Jul-04	RDB	DAY	9.46	8.99
	MPCA	108	0.5	21-Sep-04	RDB	DAY	9.22	9.91
	MPCA	108	1.5	21-Sep-04	ALL	DAY	10.71	10.30
	MBI	108	0.5	2-Sep-04	RDB	DAY	7.91	8.61
667RDB	MNDNR	128	0.5	13-Jul-04	RDB	DAY	7.72	8.41

Table 5. (cont'd).

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	MIWB	MIWB(ST)
	MNDNR	128	1.6	13-Jul-04	RDB	DAY	8.66	8.19
	MPCA	128	0.5	22-Sep-04	RDB	DAY	8.89	9.58
	MPCA	128	1.5	22-Sep-04	ALL	DAY	9.60	9.20
	MBI	128	0.5	31-Aug-04	RDB	DAY	7.48	8.18

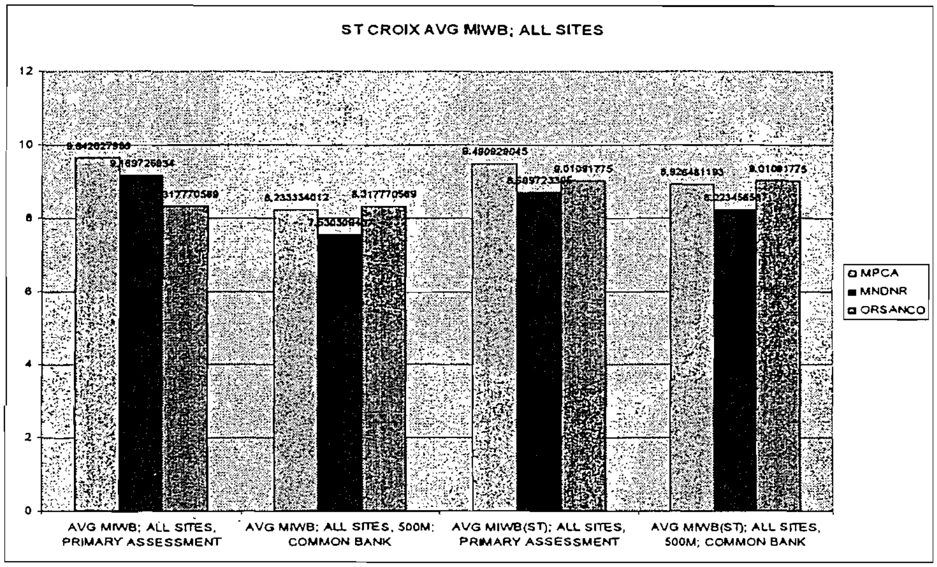


Figure 15. Average MIwb scores by MBI, MPCA, and MNDNR across all 10 sites.

3.1.3. Bray-Curtis/ Community Similarity Analysis

Bray-Curtis community similarity scores differed across sites. Community composition exhibited variation between entities and BC similarity indices showed weak similarity between MNDNR and MPCA at one site (BC value 0.643 at 655RDB) and a similar relationship between MBI and MPCA at one site (BC value 0.705 at 641LDB) (Table 6). All other comparisons yielded dissimilar values and do not support any clear association between methods based on these data.

Table 6. Site/Collector data, Bray-Curtis Coefficients, # species at 500m day sites. Similar = Red.

site id	RM	bank	collector1	collector2	bray	#species; collector 1	# species; collector 2	#shared_sp
655RDB	28.1	RDB	MBI	MNDNR	0.425	21	25	14
	28.1	RDB	MBI	MPCA	0.43	21	24	16
	28.1	RDB	MNDNR	MPCA	0.643	25	24	20
658RDB	38.3	RDB	MBI	MNDNR	0.466	28	32	22
	38.3	RDB	MBI	MPCA	0.477	28	23	13
	38.3	RDB	MNDNR	MPCA	0.248	32	23	20
642LDB	44.4	LDB	MBI	MNDNR	0.585	20	25	16
	44.4	LDB	MBI	MPCA	0.512	20	22	16
	44.4	LDB	MNDNR	MPCA	0.441	25	22	17

Table 6. (Cont'd) Site/Collector data, Bray-Curtis Coefficients, # species at 500m day sites. Similar = Red.

site id	RM	bank	collector1	collector2	bray	#species; collector 1	# species; collector 2	#shared_sp
647LDB	47.9	LDB	MBI	MPCA	0.413	19	13	12
	47.9	LDB	MNDNR	MBI	0.304	25	19	15
660RDB	62.4	RDB	MBI	MPCA	0.349	22	11	7
	62.4	RDB	MNDNR	MBI	0.127	27	22	17
	62.4	RDB	MNDNR	MPCA	0.189	27	11	10
649LDB	79.2	LDB	MBI	MPCA	0.335	18	23	13
	79.2	LDB	MNDNR	MBI	0.342	21	18	13
	79.2	LDB	MNDNR	MPCA	0.376	21	23	18
638LDB	82.9	LDB	MBI	MPCA	0.28	18	14	10
	82.9	LDB	MNDNR	MBI	0.316	22	18	14
	82.9	LDB	MNDNR	MPCA	0.307	22	14	10
641LDB	91.8	LDB	MBI	MPCA	0.705	12	15	8
	91.8	LDB	MNDNR	MBI	0.102	20	12	9
	91.8	LDB	MNDNR	MPCA	0.12	20	15	13
654RDB	107.9	RDB	MBI	MPCA	0.445	15	19	12
	107.9	RDB	MNDNR	MBI	0.212	24	15	15
	107.9	RDB	MNDNR	MPCA	0.457	24	19	15
667RDB	128.2	RDB	MBI	MPCA	0.546	14	18	11
	128.2	RDB	MNDNR	MBI	0.387	19	14	13
	128.2	RDB	MNDNR	MPCA	0.566	19	18	15

Species richness exhibited variation between entities. With the exception of three instances (MNDNR/MPCA at 647LDB, MBI/MPCA and MNDNR/MPCA at 660RDB, all comparisons yielded at least weak similarities. Of the thirty comparisons made between all entities at ten sites, 3 were dissimilar, 7 were weakly similar, and 20 were similar (Table 7). These analyses suggest that methods employed by the three entities involved produced similar results with respect to species richness.

Table 7. Site/Collector data, # species per collector similarity at 500m day sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	#species; collector 1	# species; collector 2	difference	similarity
655RDB	28.1	RDB	MBI	MNDNR	21	25	4	S
	28.1	RDB	MBI	MPCA	21	24	3	S
	28.1	RDB	MNDNR	MPCA	25	24	1	S
658RDB	38.3	RDB	MBI	MNDNR	28	32	4	S
	38.3	RDB	MBI	MPCA	28	23	5	S
	38.3	RDB	MNDNR	MPCA	32	23	9	WS
642LDB	44.4	LDB	MBI	MNDNR	20	25	5	S
	44.4	LDB	MBI	MPCA	20	22	2	S
	44.4	LDB	MNDNR	MPCA	25	22	3	S
647LDB	47.9	LDB	MBI	MPCA	19	13	6	WS
	47.9	LDB	MNDNR	MBI	25	19	6	WS
	47.9	LDB	MNDNR	MPCA	25	13	12	D
660RDB	62.4	RDB	MBI	MPCA	22	11	11	D
	62.4	RDB	MNDNR	MBI	27	22	5	S

Table 7. (cont'd).

site id	RM	bank	collector1	collector2	#species; collector 1	# species; collector 2	difference	similarity
	62.4	RDB	MNDNR	MPCA	27	11	16	D
649LDB	79.2	LDB	MBI	MPCA	18	23	5	S
	79.2	LDB	MNDNR	MBI	21	18	3	S
	79.2	LDB	MNDNR	MPCA	21	23	2	S
638LDB	82.9	LDB	MBI	MPCA	18	14	4	S
	82.9	LDB	MNDNR	MBI	22	18	4	S
	82.9	LDB	MNDNR	MPCA	22	14	8	WS
641LDB	91.8	LDB	MBI	MPCA	12	15	3	S
	91.8	LDB	MNDNR	MBI	20	12	8	WS
	91.8	LDB	MNDNR	MPCA	20	15	5	S
654RDB	107.9	RDB	MBI	MPCA	15	19	4	S
	107.9	RDB	MNDNR	MBI	24	15	9	WS
	107.9	RDB	MNDNR	MPCA	24	19	5	S
667RDB	128.2	RDB	MBI	MPCA	14	18	4	WS
	128.2	RDB	MNDNR	MBI	19	14	5	S
	128.2	RDB	MNDNR	MPCA	19	18	1	S

MIwb score similarity was highly variable between agencies at 500 m sites. MBI results were at least weakly similar to those of MPCA at six of ten sites and likewise to MNDNR at eight of ten sites. MPCA results were at least weakly similar to those of MNDNR at six of ten sites (Table 8). There were three sites where all three agencies were similar to each other with respect to MIwb scores (642LDB, 649LDB, 638LDB). Across all sites, MBI and MNDNR methods performed similarly with respect to MIwb score more so than compared to MPCA.

Table 8. Site/Collector data, # MIwb score per collector similarity at 500m day sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	MIwb score collector 1	MIwb score collector 2	difference	similarity
655RDB	28.1	RDB	MBI	MNDNR	8.46	7.76	0.70	WS
	28.1	RDB	MBI	MPCA	8.46	9.08	0.63	S
	28.1	RDB	MNDNR	MPCA	7.76	9.08	1.33	D
658RDB	38.3	RDB	MBI	MNDNR	9.66	7.52	2.13	D
	38.3	RDB	MBI	MPCA	9.66	8.65	1.01	WS
	38.3	RDB	MNDNR	MPCA	7.52	8.65	1.12	WS
642LDB	44.4	LDB	MBI	MNDNR	8.78	8.63	0.15	S
	44.4	LDB	MBI	MPCA	8.78	9.19	0.41	S
	44.4	LDB	MNDNR	MPCA	8.63	9.19	0.56	S
647LDB	47.9	LDB	MBI	MPCA	8.49	6.33	2.16	D
	47.9	LDB	MNDNR	MBI	6.13	8.49	2.36	D
	47.9	LDB	MNDNR	MPCA	6.13	6.33	0.20	S
660RDB	62.4	RDB	MBI	MPCA	8.65	7.13	1.52	D
	62.4	RDB	MNDNR	MBI	8.86	8.65	0.20	S
	62.4	RDB	MNDNR	MPCA	8.86	7.13	1.72	D

Table 8. (cont'd).

site id	RM	bank	collector1	collector2	MIwb score collector 1	MIwb score collector 2	difference	similarity
649LDB	79.2	LDB	MBI	MPCA	7.79	8.58	0.79	WS
	79.2	LDB	MNDNR	MBI	7.85	7.79	0.07	S
	79.2	LDB	MNDNR	MPCA	7.85	8.58	0.72	WS
638LDB	82.9	LDB	MBI	MPCA	7.80	7.67	0.13	S
	82.9	LDB	MNDNR	MBI	6.80	7.80	1.00	WS
	82.9	LDB	MNDNR	MPCA	6.80	7.67	0.86	WS
641LDB	91.8	LDB	MBI	MPCA	7.28	7.61	0.32	S
	91.8	LDB	MNDNR	MBI	6.15	7.28	1.14	WS
	91.8	LDB	MNDNR	MPCA	6.15	7.61	1.46	D
654RDB	107.9	RDB	MBI	MPCA	7.91	9.22	1.30	D
	107.9	RDB	MNDNR	MBI	7.89	7.91	0.03	S
	107.9	RDB	MNDNR	MPCA	7.89	9.22	1.33	D
667RDB	128.2	RDB	MBI	MPCA	7.48	8.89	1.40	D
	128.2	RDB	MNDNR	MBI	7.72	7.48	0.23	S
	128.2	RDB	MNDNR	MPCA	7.72	8.89	1.17	WS

Numbers of individuals per km comparability exhibited little variation between agencies. All pairings revealed similar relationships, with only 3 instances (MNDNR/MPCA at 655RDB, MBI/MPCA at 658RDB and 654RDB) yielding weak similarities (Table 9). These analyses suggest that methods employed by the three agencies involved produced comparable results with respect to numbers of individuals collected per km.

Table 9. Site/Collector data, # individuals/ km per collector similarity at 500m day sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	# ind/km; collector 1	# ind/km; collector 2	difference	similarity
655RDB	28.1	RDB	MBI	MNDNR	606	342	264	S
	28.1	RDB	MBI	MPCA	606	962	356	S
	28.1	RDB	MNDNR	MPCA	342	962	620	WS
658RDB	38.3	RDB	MBI	MNDNR	1106	764	342	S
	38.3	RDB	MBI	MPCA	1106	498	608	WS
	38.3	RDB	MNDNR	MPCA	764	498	266	S
642LDB	44.4	LDB	MBI	MNDNR	220	550	330	S
	44.4	LDB	MBI	MPCA	220	508	288	S
	44.4	LDB	MNDNR	MPCA	550	508	42	S
647LDB	47.9	LDB	MBI	MPCA	292	196	96	S
	47.9	LDB	MNDNR	MBI	224	292	68	S
	47.9	LDB	MNDNR	MPCA	224	196	28	S
660RDB	62.4	RDB	MBI	MPCA	238	286	48	S
	62.4	RDB	MNDNR	MBI	568	238	330	S
	62.4	RDB	MNDNR	MPCA	568	286	282	S
649LDB	79.2	LDB	MBI	MPCA	348	640	292	S
	79.2	LDB	MNDNR	MBI	440	348	92	S
	79.2	LDB	MNDNR	MPCA	440	640	200	S
638LDB	82.9	LDB	MBI	MPCA	402	280	122	S

Table 9. (cont'd).

site id	RM	bank	collector1	collector2	# ind/km; collector 1	# ind/km; collector 2	difference	similarity
	82.9	LDB	MNDNR	MBI	158	402	244	S
	82.9	LDB	MNDNR	MPCA	158	280	122	S
641LDB	91.8	LDB	MBI	MPCA	160	224	64	S
	91.8	LDB	MNDNR	MBI	170	160	10	S
	91.8	LDB	MNDNR	MPCA	170	224	54	S
654RDB	107.9	RDB	MBI	MPCA	220	696	476	WS
	107.9	RDB	MNDNR	MBI	636	220	416	S
	107.9	RDB	MNDNR	MPCA	636	696	60	S
667RDB	128.2	RDB	MBI	MPCA	296	580	284	S
	128.2	RDB	MNDNR	MBI	444	296	148	S
	128.2	RDB	MNDNR	MPCA	444	580	136	S

3.2. WABASH RIVER

Between September and October 2004, 7 sites between river miles 23 and 257 were sampled by MBI and IDEM. Raw data generated by each entity can be found in Appendix 3. Initial comparisons were made based on a per 1.0 km standardization of effort. MBI subdivided the IDEM zones into two 500 m sites. Sites were sampled by each entity on a both banks. Each entity began their respective sampling runs as close to the exact geographical position of the site as dictated by coordinates provided by IDEM for their seven sampling sites. All MBI electrofishing took place at night using the ORSANCO methodology. All IDEM sampling was conducted during daytime. Additional comparisons using each entity's complete assessment unit were made for the purpose of demonstrating differences in sampling protocol outputs (metric data, MIwb scores).

3.2.1. Species Composition/Metrics; #species, #individuals, electrofishing time per 1.0 km site (7)

Data collected at the seven study sites on the Wabash River (Appendix 3) shows marked differences between MBI and IDEM. Night electrofishing by MBI yielded higher numbers of individuals and higher electrofishing times at all sites and higher numbers of species at five sites (Table 10). MBI collected higher average numbers of individuals and species and higher electrofishing times than those of IDEM (Table 11). With respect to complete sampling sites, MBI produced higher numbers of individuals and species in a 500 m site than did IDEM sampling 1.0 km at 3 sites (836, 828, and 837).

Table 10. Site/Collector data, # of individuals; # of species collected and electrofishing time (seconds) at 1km sites. High scores = Red.

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	#Ind	#Species	E-Time
INRB04-836	IDEM	23.5	1	14-Oct-04	BOTH	DAY	183	19	3600
	MBI	23.5	1	22-Sep-04	BOTH	NIGHT	822	27	5196
	MBI	23.5	0.5	22-Sep-04	LDB	NIGHT	591	23	2654
	MBI	23.5	0.5	22-Sep-04	RDB	NIGHT	231	16	2542
INRB04-828	IDEM	117	1	13-Oct-04	BOTH	DAY	94	12	3600
	MBI	117	1	20-Sep-04	BOTH	NIGHT	490	20	4145

Table 10. (Cont'd).

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	#Ind	#Species	E-Time
	MBI	117	0.5	20-Sep-04	LDB	NIGHT	213	15	2122
	MBI	117	0.5	20-Sep-04	RDB	NIGHT	277	20	2023
INRB04-844	IDEM	134	1	14-Oct-04	BOTH	DAY	166	19	3800
	MBI	134	1	23-Sep-04	BOTH	NIGHT	284	17	4498
	MBI	134	0.5	23-Sep-04	LDB	NIGHT	106	12	1800
	MBI	134	0.5	23-Sep-04	RDB	NIGHT	178	15	2698
INRB04-846	IDEM	183	1	13-Oct-04	BOTH	DAY	188	28	3600
	MBI	183	1	21-Sep-04	BOTH	NIGHT	227	20	4350
	MBI	183	0.5	21-Sep-04	LDB	NIGHT	142	12	1861
	MBI	183	0.5	21-Sep-04	RDB	NIGHT	85	14	2489
INRB04-837	IDEM	220	1	13-Oct-04	BOTH	DAY	124	22	3600
	MBI	220	1	15-Sep-04	BOTH	NIGHT	275	30	3841
	MBI	220	0.5	15-Sep-04	LDB	NIGHT	128	23	1739
	MBI	220	0.5	15-Sep-04	RDB	NIGHT	147	20	2102
INRB04-835	IDEM	229	1	12-Oct-04	BOTH	DAY	189	18	3700
	MBI	229	1	14-Sep-04	BOTH	NIGHT	208	19	3708
	MBI	229	0.5	14-Sep-04	LDB	NIGHT	52	8	1898
	MBI	229	0.5	14-Sep-04	RDB	NIGHT	156	16	1810
INRB04-842	IDEM	257	1	12-Oct-04	BOTH	DAY	140	20	3719
	MBI	257	1	13-Sep-04	BOTH	NIGHT	419	24	3761
	MBI	257	0.5	13-Sep-04	LDB	NIGHT	384	19	1937
	MBI	257	0.5	13-Sep-04	RDB	NIGHT	35	12	1824

Table 11. Average # of individuals; # of species collected and EF time (sec) per 500m at all 7 sites. High scores = Red.

Collector	AVG #IND	AVG. #SPECIES	AVG E-TIME
MBI	389.29	22.43	4214
IDEM	154.86	19.71	3659

3.2.2. MIwb Scores

MIwb scores differed between agencies. Data collected by IDEM yielded higher scores at one site, while nighttime MBI data yielded higher scores at six sites (Table 12). MBI data generated higher average MIwb scores across all sites (Figure 16).

Table 12. Site/ Collector data, MIwb scores at 1km sites. High scores = Red.

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	MIWB	MIWB(ST)
INRB04-836	IDEM	24	1	14-Oct-04	BOTH	DAY	8.66	8.66
	MBI	24	1	22-Sep-04	BOTH	NIGHT	9.96	9.96
	MBI	24	0.5	22-Sep-04	LDB	NIGHT	9.02	9.71
	MBI	24	0.5	22-Sep-04	RDB	NIGHT	8.71	9.40

Table 12. (cont'd).

Site #	Collector	RM	Zonelength(km)	CDate	Bank	D/N	MIWB	MIWB(ST)
INRB04-828	IDEM	117	1	13-Oct-04	BOTH	DAY	7.81	7.81
	MBI	117	1	20-Sep-04	BOTH	NIGHT	9.84	9.84
	MBI	117	0.5	20-Sep-04	LDB	NIGHT	8.84	9.53
	MBI	117	0.5	20-Sep-04	RDB	NIGHT	8.89	9.58
INRB04-844	IDEM	134	1	14-Oct-04	BOTH	DAY	8.84	8.84
	MBI	134	1	23-Sep-04	BOTH	NIGHT	9.25	9.25
	MBI	134	0.5	23-Sep-04	LDB	NIGHT	7.56	8.25
	MBI	134	0.5	23-Sep-04	RDB	NIGHT	8.75	9.44
INRB04-846	IDEM	183	1	13-Oct-04	BOTH	DAY	9.71	9.71
	MBI	183	1	21-Sep-04	BOTH	NIGHT	9.16	9.16
	MBI	183	0.5	21-Sep-04	LDB	NIGHT	8.16	8.86
	MBI	183	0.5	21-Sep-04	RDB	NIGHT	7.65	8.34
INRB04-837	IDEM	220	1	13-Oct-04	BOTH	DAY	8.99	8.99
	MBI	220	1	15-Sep-04	BOTH	NIGHT	10.09	10.09
	MBI	220	0.5	15-Sep-04	LDB	NIGHT	9.08	9.77
	MBI	220	0.5	15-Sep-04	RDB	NIGHT	8.97	9.66
INRB04-835	IDEM	229	1	12-Oct-04	BOTH	DAY	9.05	9.05
	MBI	229	1	14-Sep-04	BOTH	NIGHT	9.46	9.46
	MBI	229	0.5	14-Sep-04	LDB	NIGHT	8.20	8.89
	MBI	229	0.5	14-Sep-04	RDB	NIGHT	6.90	7.60
INRB04-842	IDEM	257	1	12-Oct-04	BOTH	DAY	8.40	8.40
	MBI	257	1	13-Sep-04	BOTH	NIGHT	9.67	9.67
	MBI	257	0.5	13-Sep-04	LDB	NIGHT	8.61	9.31
	MBI	257	0.5	13-Sep-04	RDB	NIGHT	7.56	8.25

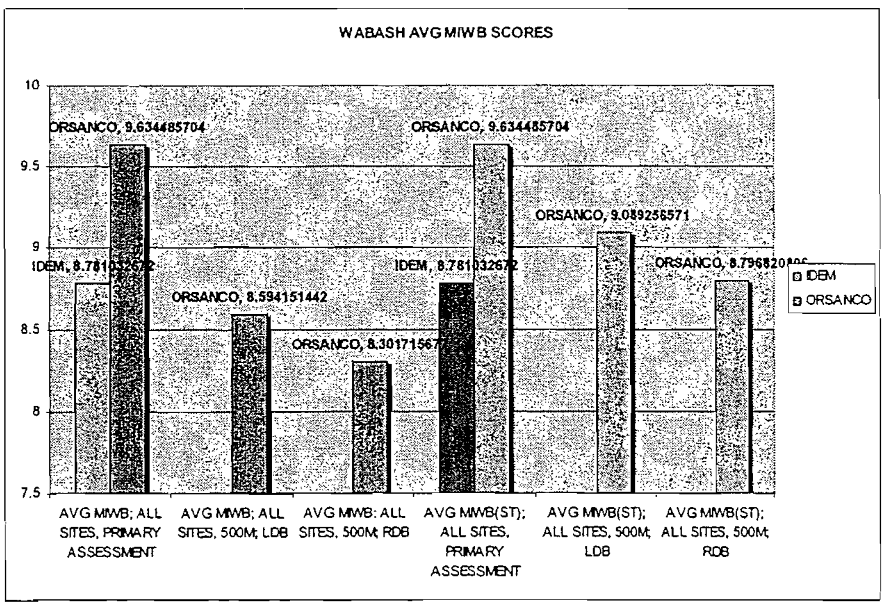


Figure 16. Average MIwb scores by MBI and IDEM across all 7 Wabash River study sites.

3.2.3. Bray-Curtis/ Community Similarity Analysis

Community similarity scores differed across sites. Although community composition exhibited variation between entities, BC similarity indices supported a similar condition at two sites (844 and 835; Table 13). These analyses produced dissimilar results at five sites.

Table 13. Site/ Collector data, Bray-Curtis Coefficients, # species at 1km sites. Similar = Red.

site id	RM	bank	collector1	collector2	bray	#species; collector 1	# species; collector 2	shared_sp
INBR04-836	23.5	BOTH	MBI	IDEM	0.299	26	19	14
INBR04-828	117.4	BOTH	MBI	IDEM	0.316	20	13	10
INBR04-844	133.5	BOTH	MBI	IDEM	0.602	18	20	15
INBR04-846	182.8	BOTH	MBI	IDEM	0.417	21	27	11
INBR04-837	219.5	BOTH	MBI	IDEM	0.378	29	22	18
INBR04-835	228.6	BOTH	MBI	IDEM	0.739	19	19	12
INBR04-842	257.2	BOTH	MBI	IDEM	0.493	24	19	13

Species richness similarity exhibited little variation between entities. All comparisons yielded at weak similarity. Of the results from the seven sites, 4 were weakly similar, and 3 were similar (Table 14). These analyses suggest that methods employed by the two agencies involved produce generally similar results with respect to species richness.

Table 14. Site/ Collector data, , # species per collector similarity at 1km sites. S - similar; WS - weakly similar; D – dissimilar.

site id	RM	bank	collector1	collector2	#species; collector 1	# species; collector 2	difference	similarity
INBR04-836	23.5	BOTH	MBI	IDEM	26	19	7	WS
INBR04-828	117.4	BOTH	MBI	IDEM	20	13	7	WS
INBR04-844	133.5	BOTH	MBI	IDEM	18	20	2	S
INBR04-846	182.8	BOTH	MBI	IDEM	21	27	6	WS
INBR04-837	219.5	BOTH	MBI	IDEM	29	22	7	WS
INBR04-835	228.6	BOTH	MBI	IDEM	19	19	0	S
INBR04-842	257.2	BOTH	MBI	IDEM	24	19	5	S

MIwb score similarity varied between entities. Scores at four sites demonstrated at least a weak similarity (Table 15), but three scores were dissimilar. MBI scores were consistently higher and reflect a significant difference in the results.

Table 15: Site/ Collector data, # MIwb score per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	Miwb score; collector 1	Miwb score; collector 2	difference	similarity
INBR04-836	23.5	BOTH	MBI	IDEM	9.96	8.66	1.30	D
INBR04-828	117.4	BOTH	MBI	IDEM	9.84	7.81	2.03	D
INBR04-844	133.5	BOTH	MBI	IDEM	9.25	8.84	0.41	S
INBR04-846	182.8	BOTH	MBI	IDEM	9.16	9.71	0.55	S
INBR04-837	219.5	BOTH	MBI	IDEM	10.09	8.99	1.11	WS

Table 15. (cont'd).

site id	RM	bank	collector1	collector2	Miwb score; collector 1	Miwb score; collector 2	difference	similarity
INBR04-835	228.6	BOTH	MBI	IDEM	9.46	9.05	0.41	S
INBR04-842	257.2	BOTH	MBI	IDEM	9.67	8.40	1.28	D

Numbers of individuals per km exhibited little variation between entities. All pairings revealed similar relationships, with 2 yielding weak similarity (Table 16). These analyses suggest that methods employed by the two agencies involved produce similar results with respect to numbers of individuals collected per km.

Table 16. Site/ Collector data, # individuals/ km per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	#ind/km; collector 1	# ind/km; collector 2	difference	similarity
INBR04-836	23.5	BOTH	MBI	IDEM	822	183	639	WS
INBR04-828	117.4	BOTH	MBI	IDEM	490	94	396	WS
INBR04-844	133.5	BOTH	MBI	IDEM	284	166	118	S
INBR04-846	182.8	BOTH	MBI	IDEM	227	188	39	S
INBR04-837	219.5	BOTH	MBI	IDEM	275	124	151	S
INBR04-835	228.6	BOTH	MBI	IDEM	208	189	19	S
INBR04-842	257.2	BOTH	MBI	IDEM	419	140	279	S

3.3. WISCONSIN RIVER

Between July and September 2005, 9 sites between river miles 4 and 90 were sampled by MBI and WDNR. Raw data generated by each entity can be found in Appendix 3. Both agencies employ differing sample distances as their primary assessment unit. In lieu of discreet 500 m sites, the comparisons were made based on the 1620m assessment unit employed by WDNR (Lyons et al. 2001). MBI subdivided this site into two adjacent 500 m subsites and a third subsite measuring 620 m. Sites were sampled by both agencies on a common bank. Each entity began their respective sampling runs as close to the exact geographical position of the sampling sites established by WDNR.

3.3.1. Species Composition / Metrics; #species, #individuals, electrofishing time per site (9)

Sampling data collected by each entity on the Wisconsin River showed some marked differences. Data collected by MBI exhibited higher numbers of individuals and species richness at each site (Table 17). MBI also exhibited much higher electrofishing times. As a result MBI produced higher average numbers of individuals and species richness and higher average electrofishing times across all nine sites (Table 18).

Table 17. Site/Collector data, # of individuals; # of species collected and electrofishing time (seconds) at 1mile sites. High scores = Red.

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	#Ind	#Species	E-Time
JL 4.4	WDNR	4.4	1.62	8/25/2005	LDB	DAY	83	23	2220
	MBI	4.4	1.62	9/12/2005	LDB	DAY	1835	36	7287
JL17.6	WDNR	17.6	1.62	8/25/2005	LDB	DAY	249	21	1980
	MBI	17.6	1.62	9/11/2005	LDB	DAY	1449	37	7580
JL36.5	WDNR	36.5	1.62	8/31/2005	RDB	DAY	183	20	1740
	MBI	36.5	1.62	9/10/2005	RDB	DAY	1532	40	7425
JL43.1	WDNR	43.1	1.62	8/26/2005	LDB	DAY	824	23	2400
	MBI	43.1	1.62	9/9/2005	LDB	DAY	1760	45	6620
JL45.5	WDNR	45.5	1.62	8/26/2005	LDB	DAY	196	24	1860
	MBI	45.5	1.62	9/8/2005	LDB	DAY	1175	42	6710
JL50.2	WDNR	50.2	1.62	8/26/2005	RDB	DAY	79	16	1860
	MBI	50.2	1.62	8/4/2005	RDB	DAY	83	23	5593
JL67.9	WDNR	67.9	1.62	8/26/2005	LDB	DAY	98	18	1980
	MBI	67.9	1.62	8/4/2005	LDB	DAY	217	27	5875
JL75.9	WDNR	75.9	1.62	8/24/2005	RDB	DAY	147	23	2040
	MBI	75.9	1.62	8/3/2005	RDB	DAY	152	26	6142
JL89.9	WDNR	89.9	1.62	8/24/2005	RDB	DAY	97	16	2100
	MBI	89.9	1.62	8/3/2005	RDB	DAY	261	27	5937

Table 18. Average # of individuals; # of species collected and EF time (sec) per km at all 9 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG E-TIME
MBI	940	34	6575
WDNR	217	20	2020

3.3.2. Bray-Curtis/ Community Similarity Analysis

BC similarity scores differed across sites. Although community composition did exhibit variation between investigators, BC similarity values were dissimilar based on these data (Table 19). Due to a statistical anomaly BC values were calculated for only eight of nine sites.

Table 19. Site/ Collector data, Bray-Curtis Coefficients, # species at 1 mile sites. Similar = Red.

site id	RM	bank	collector1	collector2	bray	species	species2	shared_sp
JL4.4	4.4	RDB	MBI	WDNR	0.062	33	22	19
JL17.6	17.6	RDB	MBI	WDNR	0.193	35	20	16
JL36.5	36.5	LDB	MBI	WDNR	0.209	36	18	16
JL43.1	43.1	LDB	MBI	WDNR	0.01	2	22	1
JL45.5	45.5	LDB	MBI	WDNR	0.27	39	23	20
JL50.2	50.2	RDB	MBI	WDNR	0.27	20	15	12
JL67.9	67.9	RDB	MBI	WDNR	0.146	26	17	16
JL75.9	75.9	LDB	MBI	WDNR	0.342	26	19	16

Species richness also exhibited some variation between entities. All but three comparisons were dissimilar. Of the eight comparisons made between agencies at eight sites (one omitted due to statistical anomaly), 2 were weakly similar, and 1 was similar

(Table 20). These analyses suggest that methods produced different results with respect to species richness. In all but one comparison, MBI collected higher numbers of species.

Table 20. Site/ Collector data, # species per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	#species; collector 1	#species; collector 2	difference	similarity
JL4.4	4.4	RDB	MBI	WDNR	33	22	11	D
JL17.6	17.6	RDB	MBI	WDNR	35	20	15	D
JL36.5	36.5	LDB	MBI	WDNR	36	18	18	D
JL43.1	43.1	LDB	MBI	WDNR	2	22	20	D
JL45.5	45.5	LDB	MBI	WDNR	39	23	16	D
JL50.2	50.2	RDB	MBI	WDNR	20	15	5	S
JL67.9	67.9	RDB	MBI	WDNR	26	17	9	WS
JL75.9	75.9	LDB	MBI	WDNR	26	19	7	WS

Numbers of individuals per km exhibited little variation between entities. All but two pairings revealed similar results. Of the remainder, three were weakly similar and four were similar (Table 21). Similarity declined in a downstream direction as the difference between the numbers of individuals per km increased. These analyses suggest that methods employed by the two agencies involved produced variable results with respect to numbers of individuals collected per km.

Table 21. Site/ Collector data, # individuals/ km per collector similarity at 1mile sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	#ind/ km; collector 1	#ind/ km; collector 2	difference	similarity
JL4.4	4.4	RDB	MBI	WDNR	1132.72	51.23	1081.49	D
JL17.6	17.6	RDB	MBI	WDNR	894.44	153.7	740.74	WS
JL36.5	36.5	LDB	MBI	WDNR	945.68	112.96	832.72	D
JL43.1	43.1	LDB	MBI	WDNR	1086.42	508.64	577.78	WS
JL45.5	45.5	LDB	MBI	WDNR	725.31	120.99	604.32	WS
JL50.2	50.2	RDB	MBI	WDNR	51.23	48.77	2.46	S
JL67.9	67.9	RDB	MBI	WDNR	133.95	60.49	73.46	S
JL75.9	75.9	LDB	MBI	WDNR	93.83	90.74	3.09	S
JL89.9	89.9	RDB	MBI	WDNR	161.11	59.88	101.23	S

3.4. KANKAKEE RIVER (Indiana DEM 2004)

Between July and September 2004, a total of six sites between river miles 67 and 111 were sampled by MBI and Indiana DEM. Raw data generated by each entity can be found in Appendix 3. The initial comparisons were made based on data generated by sampling a 1.0 km electrofishing zone. MBI retained data based on 500 m subsites. Sites were sampled by each entity on opposite banks. Each entity began their respective sampling runs as close to the exact geographical position of the sites established by IDEM. All sampling was conducted during daylight hours. Additional comparisons using each entity's standard assessment unit were made for the purpose of demonstrating differences in overall outputs (metric data, MIwb scores).

3.4.1. Species Composition / Metrics; #species, #individuals, electrofishing time per site (6)

The raw electrofishing data taken from the six sites on the Kankakee River (Appendix 3) shows marked differences between the two entities. At all six sites, MBI produced higher numbers of individuals and higher electrofishing times (Table 22). MBI collected more species at five sites (Table 22). As a result MBI collected higher average numbers of individuals, species, and higher electrofishing times at all sites (Table 23). With respect to complete assessment units, there exist a few instances where higher numbers of individuals and species were collected per 500 m than per 1.0 km.

Table 22. Site/ Collector data, # of individuals; # of species collected and electrofishing time(sec). High scores = Red.

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	#Ind	#Species	E-Time
INRB04-719	IDEM	67.8	1	9/15/2004	BOTH	DAY	109	21	3705
	MBI	67.8	1	8/5/2004	BOTH	DAY	210	22	4003
	MBI	67.8	0.5	8/5/2004	LDB	DAY	119	18	2002
	MBI	67.8	0.5	8/5/2004	RDB	DAY	91	15	2001
INRB04-725	IDEM	85.3	1	9/14/2004	BOTH	DAY	116	23	3094
	MBI	85.3	1	8/3/2004	BOTH	DAY	199	22	4998
	MBI	85.3	0.5	8/3/2004	LDB	DAY	76	13	1998
	MBI	85.3	0.5	8/3/2004	RDB	DAY	123	19	3000
INRB04-733	IDEM	97	1	9/15/2004	BOTH	DAY	43	11	2521
	MBI	97	1	8/3/2004	BOTH	DAY	90	18	3619
	MBI	97	0.5	8/3/2004	LDB	DAY	57	16	1724
	MBI	97	0.5	8/3/2004	RDB	DAY	33	15	1895
INRB04-717	IDEM	98.3	1	9/14/2004	BOTH	DAY	47	18	2112
	MBI	98.3	1	8/3/2004	BOTH	DAY	95	19	3192
	MBI	98.3	0.5	8/3/2004	LDB	DAY	52	16	1222
	MBI	98.3	0.5	8/3/2004	RDB	DAY	43	11	1970
INRB04-701	IDEM	107	1	9/13/2004	BOTH	DAY	55	14	2147
	MBI	107	1	8/4/2004	BOTH	DAY	274	23	4391
	MBI	107	0.5	8/4/2004	LDB	DAY	50	15	2257
	MBI	107	0.5	8/4/2004	RDB	DAY	224	15	2134
INRB04-706	IDEM	111	1	9/14/2004	BOTH	DAY	39	11	2359
	MBI	111	1	8/4/2004	BOTH	DAY	93	16	4947
	MBI	111	0.5	8/4/2004	LDB	DAY	38	8	2422
	MBI	111	0.5	8/4/2004	RDB	DAY	55	11	2525

Table 23. Average # of individuals; # of species collected and EF time (sec) per 1km at all 6 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG ETIME
MBI	160	20	4191
IDEM	68.17	16.33	2656

3.4.2. MIwb Scores

MIwb scores differed between entities. Data collected by IDEM yielded higher scores at three, while MBI data yielded higher scores at three sites (Table 24). MBI data generated higher average MIwb scores across all sites (Figure 17).

Table 24. Site/ Collector data, MIwb scores at 1km sites. High scores = Red.

Site #	Collector	RM	Zonelength(km)	C-Date	Bank	D/N	MIWB	MIWB(ST)
INRB04-719	IDEM	68	1	9/15/2004	BOTH	DAY	8.15	8.15
	MBI	68	1	8/5/2004	BOTH	DAY	7.20	7.20
	MBI	68	0.5	8/5/2004	LDB	DAY	6.12	6.81
	MBI	68	0.5	8/5/2004	RDB	DAY	6.65	7.34
INRB04-725	IDEM	85	1	9/14/2004	BOTH	DAY	8.10	8.10
	MBI	85	1	8/3/2004	BOTH	DAY	6.69	6.69
	MBI	85	0.5	8/3/2004	LDB	DAY	5.01	5.70
	MBI	85	0.5	8/3/2004	RDB	DAY	6.33	7.02
INRB04-733	IDEM	97	1	9/15/2004	BOTH	DAY	4.60	4.60
	MBI	97	1	8/3/2004	BOTH	DAY	6.63	6.63
	MBI	97	0.5	8/3/2004	LDB	DAY	5.72	6.41
	MBI	97	0.5	8/3/2004	RDB	DAY	5.78	6.48
INRB04-717	IDEM	98	1	9/14/2004	BOTH	DAY	7.20	7.20
	MBI	98	1	8/3/2004	BOTH	DAY	6.49	6.49
	MBI	98	0.5	8/3/2004	LDB	DAY	6.29	6.29
	MBI	98	0.5	8/3/2004	RDB	DAY	4.57	5.26
INRB04-701	IDEM	107	1	9/13/2004	BOTH	DAY	5.24	5.24
	MBI	107	1	8/4/2004	BOTH	DAY	7.36	7.36
	MBI	107	0.5	8/4/2004	LDB	DAY	6.43	7.13
	MBI	107	0.5	8/4/2004	RDB	DAY	4.91	4.91
INRB04-706	IDEM	111	1	9/14/2004	BOTH	DAY	5.21	5.21
	MBI	111	1	8/4/2004	BOTH	DAY	5.89	5.89
	MBI	111	0.5	8/4/2004	LDB	DAY	5.28	5.97
	MBI	111	0.5	8/4/2004	RDB	DAY	4.77	5.46

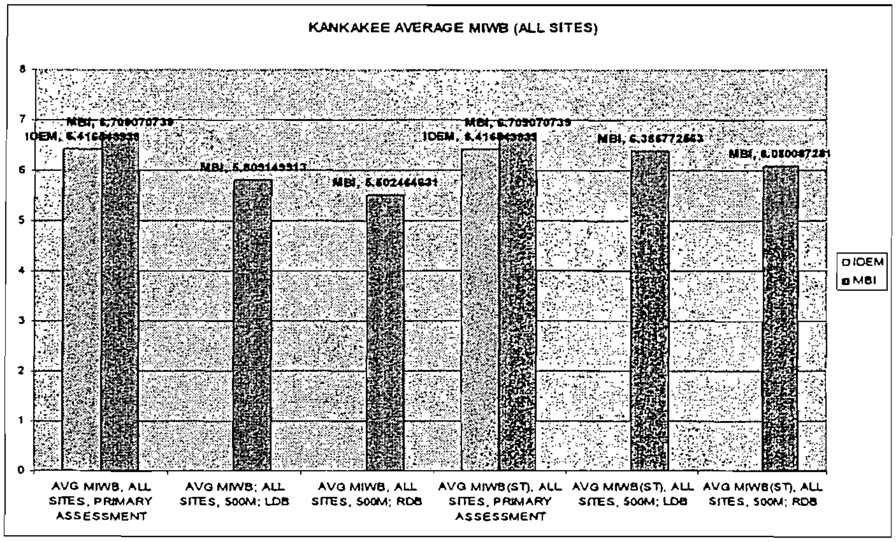


Figure 17. Average MIwb scores by MBI and IDEM across all 6 Kankakee River sites.

3.4.3. Bray-Curtis/ Community Similarity Analysis

Bray-Curtis community similarity scores differed across sites. One of the comparisons approached weak similarity (719), but did not meet the established criteria. Community composition exhibited variation between entities with none of the comparisons performed here yielding any degree of similarity (Table 25). This analysis suggests that methods employed by both agencies perform differently with respect to the community composition.

Table 25. Site/ Collector data, Bray-Curtis Coefficients, # species at 1km sites. Similar = Red.

site #	RM	bank	collector1	collector2	bray	#species; collector 1	# species; collector 2	shared_sp
INRB04-719	67.8	BOTH	MBI	IDEM	0.513	22	22	14
INRB04-725	85.3	BOTH	MBI	IDEM	0.452	22	24	15
INRB04-733	97	BOTH	MBI	IDEM	0.317	17	12	7
INRB04-717	98.3	BOTH	MBI	IDEM	0.406	18	19	9
INRB04-701	106.8	BOTH	MBI	IDEM	0.333	22	16	8
INRB04-706	110.6	BOTH	MBI	IDEM	0.409	16	13	6

Species richness comparisons yielded at least weakly similar relationships. Of the six comparisons made between entities, 1 was weakly similar, and 5 were similar (Table 26). These analyses suggest that methods employed by the two agencies involved produce similar results with respect to species richness.

Table 26. Site/ Collector data, , # species per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site #	RM	bank	collector1	collector2	#species; collector 1	# species; collector 2	difference	similarity
INRB04-719	67.8	BOTH	MBI	IDEM	22	22	0	S
INRB04-725	85.3	BOTH	MBI	IDEM	22	24	2	S
INRB04-733	97	BOTH	MBI	IDEM	17	12	5	S
INRB04-717	98.3	BOTH	MBI	IDEM	18	19	1	S
INRB04-701	106.8	BOTH	MBI	IDEM	22	16	6	WS
INRB04-706	110.6	BOTH	MBI	IDEM	16	13	3	S

MIwb scores varied between entities. Three of the six sites exhibited weak similarity (Table 27). Three of the seven were dissimilar. Of the three sites that were dissimilar, MBI produced higher MIwb scores. The results were mixed in terms of either entity producing higher MIwb scores and only one result was similar.

Table 27. Site/ Collector data, # MIwb score per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site #	RM	bank	collector1	collector2	MIwb score; collector 1	MIwb score; collector 2	difference	similarity
INRB04-719	67.8	BOTH	MBI	IDEM	7.2	8.15	0.95	WS
INRB04-725	85.3	BOTH	MBI	IDEM	6.69	8.1	1.41	D
INRB04-733	97	BOTH	MBI	IDEM	6.63	4.6	2.03	D
INRB04-717	98.3	BOTH	MBI	IDEM	6.49	7.2	0.71	WS
INRB04-701	106.8	BOTH	MBI	IDEM	7.36	5.24	2.12	D
INRB04-706	110.6	BOTH	MBI	IDEM	5.89	5.21	0.68	S

Numbers of individuals per km similarity exhibited little variation between entities. All pairings revealed similar results (Table 28). These analyses suggest that methods employed by the two agencies involved produce similar results with respect to numbers of individuals collected per km.

Table 28. Site/ Collector data, # individuals/ km per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site #	RM	bank	collector1	collector2	#ind/km; collector 1	#ind/km; collector 2	difference	similarity
INRB04-719	67.8	BOTH	MBI	IDEM	209	109	100	S
INRB04-725	85.3	BOTH	MBI	IDEM	199	116	83	S
INRB04-733	97	BOTH	MBI	IDEM	90	43	47	S
INRB04-717	98.3	BOTH	MBI	IDEM	95	47	48	S
INRB04-701	106.8	BOTH	MBI	IDEM	274	55	219	S
INRB04-706	110.6	BOTH	MBI	IDEM	93	39	54	S

3.5. KANKAKEE RIVER (Illinois DNR 2005)

Between June and September 2005, a total of twelve sites were sampled by MBI and Illinois DNR in the Kankakee River. Raw data generated by each entity can be found in Appendix 3. Although both entities use different equipment, sampling protocols, and sampling distances as their primary assessment unit, initial comparisons were made based on data generated by assuming a 500 m site comparison. MBI established a 500 m site based on the location of the IDNR site description. Each entity began their respective sampling runs as close to the exact geographical position of the sites established by Illinois DNR. A summary of the electrofishing data and electrofishing times can be found in table 13. Comparisons were also made using each entity's complete assessment unit for the purpose of demonstrating differences in sampling outputs (community similarity indices).

3.5.1. Species Composition / Metrics; #species, #individuals, electrofishing time per site (12)

Electrofishing data collected from the twelve sites on the Kankakee River (Appendix 3) revealed differences between the two entities. At six sites, MBI collected higher numbers of individuals and higher electrofishing times at all twelve sites (Table 29). MBI collected more species at five sites (Table 29). IDNR crews collected higher numbers of individuals at eight sites (Table 29). At all twelve sites IDNR produced higher average numbers of species and individuals (Table 30). IDNR produced higher average electrofishing times at all sites.

Table 29. Site/ Collector data, # of individuals; # of species collected and electrofishing time (sec). High scores = Red.

Site #	Collector	RM	Zonelength (km)	C-Date	Bank	D/N	#Ind	# Species	E-Time
F-01	IDNR	NA	0.5	7/21/2005	NA	DAY	477	37	3600
	MBI	NA	0.5	9/30/2005	NA	DAY	486	34	2431
F-02	IDNR	NA	0.5	7/19/2005	NA	DAY	349	23	3600
	MBI	NA	0.5	9/23/2005	NA	DAY	766	30	2109
F-03	IDNR	NA	0.5	7/19/2005	NA	DAY	354	32	3600
	MBI	NA	0.5	9/23/2005	NA	DAY	190	22	2277
F-04	IDNR	NA	0.5	7/21/2005	NA	DAY	371	29	3600
	MBI	NA	0.5	9/29/2005	NA	DAY	627	32	2595
F-06	IDNR	NA	0.5	7/19/2005	NA	DAY	343	32	3600
	MBI	NA	0.5	9/27/2005	NA	DAY	220	29	2097
F-07	IDNR	NA	0.5	7/20/2005	NA	DAY	443	34	3600
	MBI	NA	0.5	9/28/2005	NA	DAY	280	26	1994
F-08	IDNR	NA	0.5	7/21/2005	NA	DAY	442	30	3600
	MBI	NA	0.5	9/29/2005	NA	DAY	562	38	3163
F-09	IDNR	NA	0.5	7/20/2005	NA	DAY	549	33	3600
	MBI	NA	0.5	9/27/2005	NA	DAY	457	26	2509
F-12	IDNR	NA	0.5	7/20/2005	NA	DAY	390	34	3600
	MBI	NA	0.5	9/29/2005	NA	DAY	664	35	2136
F-13	IDNR	NA	0.5	7/20/2005	NA	DAY	267	27	3600
	MBI	NA	0.5	9/27/2005	NA	DAY	338	25	2052
F-14	IDNR	NA	0.5	7/22/2005	NA	DAY	866	31	3600
	MBI	NA	0.5	9/28/2005	NA	DAY	290	27	2673
F-15	IDNR	NA	0.5	7/19/2005	NA	DAY	264	31	3600
	MBI	NA	0.5	9/30/2005	NA	DAY	190	29	2758

Table 30. Average # of individuals; # of species collected and EF time (sec) per 500m at all 12 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG E-TIME
MBI	423	29	2400
IDNR	427	31	3600

3.5.2. Bray-Curtis/ Community Similarity Analysis

Bray-Curtis similarity scores differed across sites. Community composition exhibited variation between entities, however only one of the comparisons (F-14) yielded any degree of similarity (Table 31).

Table 31. Site/ Collector data, Bray-Curtis Coefficients, # species at 1km sites. Similar = Red.

site #	RM	bank	collector1	collector2	bray	#species; collector 1	# species; collector 2	shared_sp
F-01	NA	NA	IDNR	MBI	0.478	36	35	28
F-02	NA	NA	IDNR	MBI	0.556	22	32	21
F-03	NA	NA	IDNR	MBI	0.416	31	24	19
F-04	NA	NA	IDNR	MBI	0.353	28	34	24
F-06	NA	NA	IDNR	MBI	0.418	31	29	19
F-07	NA	NA	IDNR	MBI	0.327	33	28	20
F-08	NA	NA	IDNR	MBI	0.57	29	40	25
F-09	NA	NA	IDNR	MBI	0.326	32	27	20
F-12	NA	NA	IDNR	MBI	0.388	33	36	27
F-13	NA	NA	IDNR	MBI	0.362	27	27	20
F-14	NA	NA	IDNR	MBI	0.714	31	27	19
F-15	NA	NA	IDNR	MBI	0.446	30	30	20

Species richness similarity exhibited little variation between agencies. All but one of the comparisons yielded at least weak similarity with respect to species richness. Of the twelve comparisons made between agencies, 3 were weakly similar, and 8 were similar, and only 1 was dissimilar (Table 32).

Table 32. Site/ Collector data, , # species per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	#species; collector 1	# species; collector 2	difference	similarity
F-01	NA	NA	IDNR	MBI	36	35	1	S
F-02	NA	NA	IDNR	MBI	22	32	10	WS
F-03	NA	NA	IDNR	MBI	31	24	7	WS
F-04	NA	NA	IDNR	MBI	28	34	6	WS
F-06	NA	NA	IDNR	MBI	31	29	2	S
F-07	NA	NA	IDNR	MBI	33	28	5	S
F-08	NA	NA	IDNR	MBI	29	40	11	D
F-09	NA	NA	IDNR	MBI	32	27	5	S
F-12	NA	NA	IDNR	MBI	33	36	3	S
F-13	NA	NA	IDNR	MBI	27	27	0	S
F-14	NA	NA	IDNR	MBI	31	27	4	S
F-15	NA	NA	IDNR	MBI	30	30	0	S

Numbers of individuals per km similarity exhibited little variation between entities. All but two pairings revealed at least weak similarity (Table 33). Two of the twelve were dissimilar. These analyses suggest that methods produced consistently similar results with respect to numbers of individuals collected per km.

Table 33. Site/ Collector data, # individuals/ km per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

site id	RM	bank	collector1	collector2	#ind/km; collector 1	#ind/km; collector 2	difference	similarity
F-01	NA	NA	IDNR	MBI	954	972	18	S
F-02	NA	NA	IDNR	MBI	698	1532	834	D
F-03	NA	NA	IDNR	MBI	708	380	328	S
F-04	NA	NA	IDNR	MBI	742	1254	512	WS
F-06	NA	NA	IDNR	MBI	686	440	246	S
F-07	NA	NA	IDNR	MBI	886	560	326	S
F-08	NA	NA	IDNR	MBI	884	1124	240	S
F-09	NA	NA	IDNR	MBI	1098	914	184	S
F-12	NA	NA	IDNR	MBI	780	1328	548	WS
F-13	NA	NA	IDNR	MBI	534	676	142	S
F-14	NA	NA	IDNR	MBI	1732	580	1152	D
F-15	NA	NA	IDNR	MBI	528	380	148	S

3.6. ST. JOSEPH RIVER (Indiana)

Between June and September 2005, a total of fifteen sites were sampled by MBI at sites sampled by Elkhart OPW (EPW) in 2003, 2004, and 2005. Raw data generated by each entity can be found in Appendix 3. Initial comparisons were made based on data generated by sampling a 500 m electrofishing zone. Sites were sampled by each entity by sampling the best habitat and structure for a total distance of 500m. Each entity began their respective sampling runs at the same approximate geographical position. The primary difference between the two entities was sampling direction; MBI sampled in a downstream direction while EPW sampled in an upstream direction. All comparisons represented each entity's complete assessment protocol.

3.6.1. Species Composition / Metrics; #species, #individuals, electrofishing time per site (12)

Electrofishing data taken from the fifteen sites on the St. Joseph River (Appendix 3) showed marked differences between the two entities. At all sites, MBI collected higher numbers of individuals (Table 34). MBI collected more species at eight sites (Table 34). At all fifteen sites MBI exhibited higher average numbers of species and individuals per site (Table 35). EPW did not report electrofishing times.

Table 34. Site/ Collector data, # of individuals; # of species collected and electrofishing time (sec). High scores = Red.

Site #	Collector	RM	Zonelength (km)	CDate	Bank	D/N	#Ind	# Species	E-Time
100122	EPW	100	0.5	6/12/2003	L/R RUB	DAY	478	27	3340
(Nibbeyville)	MBI		0.5	8/18/2005	L/R RDB	DAY	770	33	3019
100100	EPW	95	0.5	8/4/2003	L/R RUB	DAY	414	24	3450
(Bulldog Crossing)	MBI		0.5	8/18/2005	L/R RDB	DAY	832	24	2031
100060	EPW	90	0.5	7/19/2004	L/R RUB	DAY	267	21	3030
(Sherman Street)	MBI		0.5	8/18/2005	L/R RDB	DAY	940	24	2733
100050	EPW	85	0.5	7/11/2003	L/R RUB	DAY	716	27	2890
(Lexington Ave.)	MBI		0.5	8/18/2005	L/R RDB	DAY	664	25	2779
100040	EPW	80	0.5	7/27/2005	L/R RUB	DAY	394	26	3410
(Bridge Street)	MBI		0.5	8/17/2005	L/R RDB	DAY	1008	26	2765
100035	EPW	75	0.5	6/6/2003	L/R RUB	DAY	208	18	2690
(McNaughton Pk.)	MBI		0.5	8/17/2005	L/R RDB	DAY	944	26	3242
100030	EPW	70	0.5	7/22/2003	L/R RUB	DAY	933	24	3370
(Nappanee Street.)	MBI		0.5	8/17/2005	L/R RDB	DAY	528	19	2133
300090	EPW	65	0.5	7/22/2003	L/R RUB	DAY	145	23	2597
(Capital Ave.)	MBI		0.5	8/16/2005	L/R RDB	DAY	896	25	3130
300070	EPW	60	0.5	7/17/2003	L/R RUB	DAY	259	19	2850
(Ironwood Drive)	MBI		0.5	8/11/2005	L/R RDB	DAY	1244	19	3254
300052	EPW	55	0.5	7/12/2005	L/R RUB	DAY	437	20	2858
(LaSalle Street)	MBI		0.5	8/11/2005	L/R RDB	DAY	758	21	2547
300050	EPW	50	0.5	7/29/2003	L/R RUB	DAY	240	17	2299
(Michigan Street)	MBI		0.5	8/10/2005	L/R RDB	DAY	586	23	2783
300045	EPW	45	0.5	8/2/2005	L/R RUB	DAY	351	23	2653
(Angela Ave.)	MBI		0.5	8/10/2005	L/R RDB	DAY	580	20	2746
300040	EPW	40	0.5	7/15/2003	L/R RUB	DAY	336	25	2741
(Keller Park)	MBI		0.5	8/10/2005	L/R RDB	DAY	694	22	2684
300028	EPW	35	0.5	7/8/2005	L/R RUB	DAY	374	26	2546
(Pinhook Pk)	MBI		0.5	8/9/2005	L/R RDB	DAY	734	27	3179
300020	EPW	30	0.5	7/23/2003	L/R RUB	DAY	315	25	3050
Darden Road	MBI		0.5	8/16/2005	L/R RDB	DAY	606	20	2931

Table 35. Average # of individuals; # of species collected and EF time (sec) per 500m at all 15 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG E-TIME
MBI	786	24	2797
EPW	404	23	NA

3.6.2. Bray-Curtis/ Community Similarity Analysis

Bray-Curtis similarity scores differed across sites. Community composition exhibited variation between entities. However, seven comparisons yielded at least weak similarity (Table 36).

Table 36. Site/ Collector data, Bray-Curtis Coefficients, # species at 1km sites. Similar = Red.

Site #	Collector1	Collector2	RM	Zonelength (km)	bray	species	species2	shared_sp
100035 (A)	EPW	MBI	80	0.5	0.649	23	20	16
100122	EPW	MBI	100	0.5	0.549	28	33	19
100050	EPW	MBI	85	0.5	0.563	30	26	23
100035 (B)	EPW	MBI	75	0.5	0.625	20	20	15
300040	EPW	MBI	40	0.5	0.695	26	23	19
300070	EPW	MBI	60	0.5	0.553	18	24	14
300020	EPW	MBI	30	0.5	0.413	20	20	14
300050	EPW	MBI	50	0.5	0.459	25	26	15
100100	EPW	MBI	95	0.5	0.733	17	24	14
100060	EPW	MBI	90	0.5	0.413	24	23	13
100030	EPW	MBI	65	0.5	0.576	21	25	15
300028	EPW	MBI	35	0.5	0.749	25	28	22
300052	EPW	MBI	55	0.5	0.752	20	21	16
100040	EPW	MBI	70	0.5	0.469	28	27	21
300045	EPW	MBI	45	0.5	0.761	22	21	16

Species richness exhibited little variation between entities. All of the comparisons yielded at least weak similarity. Of the fifteen comparisons made between entities, 2 were weakly similar, and 13 were similar (Table 37). These analyses suggest that methods employed by the two agencies involved produced similar results with respect to species richness.

Table 37. Site/ Collector data, , # species per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector2	RM	Zonelength (km)	#species	#species2	difference	similarity
100035 (A)	EPW	MBI	80	0.5	23	20	3	S
100122	EPW	MBI	100	0.5	28	33	5	S
100050	EPW	MBI	85	0.5	30	26	4	S
100035 (B)	EPW	MBI	75	0.5	20	20	0	S
300040	EPW	MBI	40	0.5	26	23	3	S
300070	EPW	MBI	60	0.5	18	24	6	WS
300020	EPW	MBI	30	0.5	20	20	0	S
300050	EPW	MBI	50	0.5	25	26	1	S
100100	EPW	MBI	95	0.5	17	24	7	WS
100060	EPW	MBI	90	0.5	24	23	1	S
100030	EPW	MBI	65	0.5	21	25	4	S
300028	EPW	MBI	35	0.5	25	28	3	S
300052	EPW	MBI	55	0.5	20	21	1	S
100040	EPW	MBI	70	0.5	28	27	1	S
300045	EPW	MBI	45	0.5	22	21	1	S

Numbers of individuals per km exhibited some variation between entities. All but five pairings revealed at least weak similarity (Table 38), but five were dissimilar.

Table 38. Site/ Collector data, # individuals/ km per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector2	RM	Zonelength (km)	#Ind/km colector1	#Ind/km colector2	difference	similarity
100122	EPW	MBI	100	0.5	956	1540	584	WS
100100	EPW	MBI	95	0.5	828	1664	836	D
100060	EPW	MBI	90	0.5	534	1880	1346	D
100050	EPW	MBI	85	0.5	1432	1328	104	S
100035 (A)	EPW	MBI	80	0.5	416	1888	1472	D
100035 (B)	EPW	MBI	75	0.5	680	1056	376	WS
100040	EPW	MBI	70	0.5	788	2016	1228	D
100030	EPW	MBI	65	0.5	1866	1792	74	S
300070	EPW	MBI	60	0.5	518	2488	1970	D
300052	EPW	MBI	55	0.5	874	1516	642	WS
300050	EPW	MBI	50	0.5	480	1172	692	WS
300045	EPW	MBI	45	0.5	702	1160	458	WS
300040	EPW	MBI	40	0.5	672	1388	716	WS
300028	EPW	MBI	35	0.5	748	1468	720	WS
300020	EPW	MBI	30	0.5	630	1212	582	WS

3.7. ST. JOSEPH RIVER (MICHIGAN)

Between June and September 2005, a total of four sites were sampled by MBI and Michigan Institute for Fisheries Research (MIFR). Raw data generated by each entity can be found in Appendix 3. Initial comparisons were made based on data generated by sampling a 1620 m electrofishing zone. Sites were sampled on a designated bank and performed in accordance with methods described by Lyons et al. (2001) and employed by MIFR. MBI divided each 1620 m sampling site into three subsets (500m, 500m, and 620m).

3.7.1. Species Composition / Metrics; #species, #individuals, electrofishing time per site (4)

Electrofishing data from the four sites on the St. Joseph River in Michigan (Appendix 3) showed marked differences between the two entities. At all sites, MBI collected higher numbers of individuals (Table 39). MBI collected more species at all sites (Table 39). As a results MBI data exhibited higher average numbers of species and individuals per site (Table 40). MIFR did not report electrofishing times.

Table 39. Site/ Collector data, # of individuals; # of species collected and electrofishing time (sec). High scores = Red.

Site #	Collector	Zonelength (km)	D/N	#Ind	# Species	E-Time (sec.)
145	MIFR	1.6	DAY	186	12	7200
(Mendon Mich.)	MBI	1.6	DAY	1879	32	7187
148	MIFR	1.6	DAY	111	13	5400
(Niles, Mich.)	MBI	1.6	DAY	965	32	9901
1921	MIFR	1.6	DAY	79	13	5400
(Buchanan, Mich.)	MBI	1.6	DAY	1247	29	8672
2184	MIFR	1.6	DAY	42	11	3600
(St. Joseph, Mich.)	MBI	1.6	DAY	1511	39	7838

Table 40. Average # of individuals; # of species collected and EF time (sec) per 1 mile at all 4 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG E-TIME
MBI	1400.5	33	8400
MIFR	104.5	12.25	NA

3.7.2. Bray-Curtis/ Community Similarity Analysis

Bray-Curtis community similarity scores differed across sites. Community composition exhibited variation between entities and none of the comparisons performed yielded any degree of similarity (Table 41).

Table 41. Site/ Collector data, Bray-Curtis Coefficients, # species at 1km sites. Similar = Red.

Site #	Collector1	Collector2	Zonelength (km)	bray	species	species2	shared_sp
145	MIFR	MBI	1.6	0.138	13	31	12
148	MIFR	MBI	1.6	0.121	13	37	11
1921	MIFR	MBI	1.6	0.108	12	29	11
2184	MIFR	MBI	1.6	0.076	11	32	10

Species richness similarity exhibited little variation between entities. All of the comparisons yielded dissimilar relationships with respect to species richness. These analyses suggest that methods employed by the two agencies do not produce data that is consistently comparable with respect to species richness.

Table 42. Site/ Collector data, , # species per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector2	Zonelength (km)	# Species1	# Species2	difference	similarity
145	MIFR	MBI	1.6	13	31	18	D
148	MIFR	MBI	1.6	13	37	24	D
1921	MIFR	MBI	1.6	12	29	17	D
2184	MIFR	MBI	1.6	11	32	21	D

Numbers of individuals per km similarity exhibited some substantial variation between entities. Two of the four pairings (50%) revealed weak similarity (Table 43). The other two (50%) were dissimilar. These analyses suggest that methods employed by the two agencies involved do not produce consistently similar results with respect to numbers of individuals collected per km.

Table 43. Site/ Collector data, # individuals/ km per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector2	Zonelength (km)	#Ind/km colector1	#Ind/km colector2	difference	similarity
145	MIFR	MBI	1.6	116.25	1174.375	1058.125	D
148	MIFR	MBI	1.6	69.375	603.125	533.75	WS
1921	MIFR	MBI	1.6	49.375	779.375	730	WS
2184	MIFR	MBI	1.6	26.25	944.375	918.125	D

3.8. CHICAGO AREA WATERWAY SYSTEM (CAWS)

Between June and September 2005, a total of eight sites were sampled by MBI; four of these sites were sampled by MWRD in 2002, 2003, and 2004, the remainder in 2005. Raw data generated by each entity can be found in Appendix 3. Initial comparisons were made based on data generated by each entity within their own established sampling distances. MWRD samples a 400 m electrofishing zone comprised of two, 200 m subzones on each bank. MBI sampled a distance of 500 m on a single bank. Each entity began their respective sampling runs at the same approximate geographical position. Additional comparisons using each entity's complete assessment unit were made for the purpose of demonstrating differences in end-line products (community similarity indices).

3.8.1. Species Composition / Metrics; #species, #individuals, electrofishing time per site (8)

Electrofishing data from eight sites on the Chicago Area Waterway System (CAWS) (Appendix 3) showed marked differences between the two entities. At all sites, MBI collected higher numbers of individuals (Table 44). MBI also collected a higher number of species at eight sites (Table 44). As a result MBI data exhibited higher average numbers of species, individuals and electrofishing times per site (Table 45).

Table 44. Site/ Collector data, # of individuals; # of species collected and electrofishing time (seconds). High scores = Red.

Site #	Collector	RM	Zonelength (km)	C-Date	Bank	D/N	#Ind	# Species	E-Time
46	MWRDGC	NA	0.4	7/18/2005	BOTH	DAY	79	5	2418
(Grand Avenue)	MBI	NA	0.5	8/30/2005	EITHER	DAY	376	13	2748
102	MWRDGC	NA	0.4	7/20/2005	BOTH	DAY	150	16	2696
(Oakton Avenue)	MBI	NA	0.5	8/31/2005	EITHER	DAY	277	18	2351
35	MWRDGC	NA	0.4	7/20/2005	BOTH	DAY	138	11	2156
(Central Avenue)	MBI	NA	0.5	8/31/2005	EITHER	DAY	477	15	2524
36	MWRDGC	NA	0.4	7/21/2005	BOTH	DAY	275	9	2795
(Touhy Avenue)	MBI	NA	0.5	8/31/2005	EITHER	DAY	351	13	2945
58	MWRDGC	NA	0.4	9/5/2003	BOTH	DAY	94	13	1908
(Cal-Sag, Ashland)	MBI	NA	0.5	9/1/2005	EITHER	DAY	362	15	2049
56	MWRDGC	NA	0.4	9/29/2003	BOTH	DAY	451	17	2258
(Little Calumet, Ind)	MBI	NA	0.5	9/1/2005	EITHER	DAY	616	20	2949
108	MWRDGC	NA	0.4	8/26/2002	RDB	DAY	75	10	1637
Loomis Avenue)	MBI	NA	0.5	8/30/2005	EITHER	DAY	357	15	2214
74	MWRDGC	NA	0.4	8/2/2002	BOTH	DAY	21	3	1556
(Lake Shore Drive)	MBI	NA	0.5	8/30/2005	EITHER	DAY	98	7	2456

Table 45. Average # of individuals; # of species collected and EF time (sec) at all 8 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG E-TIME
MBI	364.25	14.5	2530
MWRDGC	273.3	11.1	2178

3.8.2. Bray-Curtis/ Community Similarity Analysis

Bray-Curtis community similarity scores differed across sites. Community composition exhibited variation between entities and only one of the comparisons (57) performed here yielded any degree of similarity. At this time, this analysis does not support any clear correspondence between methods based on Bray - Curtis similarity (Table 46).

Table 46. Site/ Collector data, Bray-Curtis Coefficients, # species at 0.8km sites. Similar = Red.

Site #	Collector1	Collector2	RM	Zonelength (km)	bray	Species1	Species2	shared_sp	similarity
74	MWRDGC	MBI	NA	0.4; 0.5	0.199	8	7	4	D
58	MWRDGC	MBI	NA	0.4; 0.5	0.228	8	15	6	D
108	MWRDGC	MBI	NA	0.4; 0.5	0.337	10	15	8	D
102	MWRDGC	MBI	NA	0.4; 0.5	0.391	17	18	13	D
46	MWRDGC	MBI	NA	0.4; 0.5	0.407	5	13	5	D
36	MWRDGC	MBI	NA	0.4; 0.5	0.449	9	13	7	D
35	MWRDGC	MBI	NA	0.4; 0.5	0.45	12	15	9	D
56	MWRDGC	MBI	NA	0.4; 0.5	0.603	16	20	12	WS

Species richness similarity exhibited little variation between agencies. All comparisons yielded at least weak similarities with respect to species richness. Of the nine comparisons made between entities, 1 was weakly similar and 7 were similar (Table 47). These analyses suggest that methods employed by the two agencies involved produce similar results with respect to species richness. - -

Table 47. Site/ Collector data, , # species per collector similarity at 0.8km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector2	RM	Zonelength (km)	#species; collector 1	# species; collector 2	difference	similarity
46	MWRDGC	MBI	NA	0.4; 0.5	5	13	8	WS
102	MWRDGC	MBI	NA	0.4; 0.5	16	18	2	S
35	MWRDGC	MBI	NA	0.4; 0.5	11	15	4	S
36	MWRDGC	MBI	NA	0.4; 0.5	9	13	4	S
58	MWRDGC	MBI	NA	0.4; 0.5	13	15	2	S
56	MWRDGC	MBI	NA	0.4; 0.5	17	20	3	S
108	MWRDGC	MBI	NA	0.4; 0.5	10	15	5	S
75	MWRDGC	MBI	NA	0.4; 0.5	8	7	1	S

Numbers of individuals per km similarity exhibited little variation between agencies. All pairings revealed at least weak similarity (Table 48). Four sites were weakly similar, while the remaining four were similar. These analyses suggest that methods employed by the agencies involved produce consistently similar results with respect to numbers of individuals collected per km.

Table 48. Site/ Collector data, # individuals/ km per collector similarity at 0.8km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector2	RM	Zonelength (km)	#Ind/km colector1	#Ind/km colector2	difference	similarity
46	MWRDGC	MBI	NA	0.4; 0.5	197.5	752	554.5	WS
102	MWRDGC	MBI	NA	0.4; 0.5	375	554	179	S
35	MWRDGC	MBI	NA	0.4; 0.5	345	954	609	WS
36	MWRDGC	MBI	NA	0.4; 0.5	687.5	702	14.5	S
58	MWRDGC	MBI	NA	0.4; 0.5	235	724	489	WS
56	MWRDGC	MBI	NA	0.4; 0.5	1127.5	1232	104.5	S
108	MWRDGC	MBI	NA	0.4; 0.5	187.5	714	526.5	WS
75	MWRDGC	MBI	NA	0.4; 0.5	52.5	196	143.5	S

3.9. SCIOTO RIVER (Ohio)

Between June and October 2005, a total of six sites were sampled by MBI and EA. Raw data generated by each entity can be found in Appendix 3. Initial comparisons were made based on a 500 m sampling distance that was employed by both entities. Each entity began their respective sampling runs at the same approximate geographical position. Each entity completed two separate sampling runs at each of the six sites during different months.

3.9.1. Species Composition / Metrics; #species, #individuals, electrofishing time per site (6)

Electrofishing data from the six sites on the Scioto River (Appendix 3) showed marked differences between the two entities. During the first pass (June/July), MBI collected higher numbers of individuals at five sites and higher species richness at all sites (Table 49). As a result MBI yielded higher average numbers of species and individuals across all six sites (Table 50). AEP did not report electrofishing times.

During the second pass in October, both entities collected higher numbers of individuals and slightly higher species richness compared to the first pass (Table 49). MBI collected higher numbers of individuals at five sites (Table 50). MBI collected higher numbers of species at three sites (Table 49). As a result MBI collected higher average numbers of both individuals and species (Table 51). When considering both sampling events as a whole, MBI collected higher average numbers of individuals and species in two passes across all six sites (Table 52).

Table 49. Site/ Collector data, # of individuals; # of species collected and electrofishing time (seconds). First Pass (a); Second Pass (b). High scores = Red.

Site #	Collector	RM	Zonelength (km)	C-Date	Bank	D/N	#Ind	# Species	E-Time
1a	EA	118	0.5	Jun-05	LDB	DAY	106	20	NA
1a	MBI	118	0.5	7/20/2005	LDB	DAY	71	22	2280
2a	EA	117.3	0.5	Jun-05	LDB	DAY	171	23	NA
2a	MBI	117.3	0.5	7/20/2005	LDB	DAY	228	39	3527
3a	EA	117.1	0.5	Jun-05	LDB	DAY	125	21	NA

Table 49. (cont'd).

3a	MBI	117.1	0.5	7/20/2005	LDB	DAY	150	26	2553
4a	EA	116.5	0.5	Jun-05	LDB	DAY	92	20	NA
4a	MBI	116.5	0.5	7/21/2005	LDB	DAY	157	25	2115
5a	EA	115.6	0.5	Jun-05	LDB	DAY	121	24	NA
5a	MBI	115.6	0.5	7/21/2005	LDB	DAY	146	30	2029
6a	EA	115	0.5	Jun-05	LDB	DAY	75	18	NA
6a	MBI	115	0.5	7/21/2005	LDB	DAY	181	30	2291
1b	EA	118	0.5	Aug-05	LDB	DAY	987	31	NA
1b	MBI	118	0.5	10/17/2005	LDB	DAY	1162	30	2299
2b	EA	117.3	0.5	Aug-05	LDB	DAY	648	26	NA
2b	MBI	117.3	0.5	10/17/2005	LDB	DAY	1059	34	2519
3b	EA	117.1	0.5	Aug-05	LDB	DAY	528	29	NA
3b	MBI	117.1	0.5	10/13/2005	LDB	DAY	461	28	2978
4b	EA	116.5	0.5	Aug-05	LDB	DAY	458	28	NA
4b	MBI	116.5	0.5	10/17/2005	LDB	DAY	1113	40	2246
5b	EA	115.6	0.5	Aug-05	LDB	DAY	519	32	NA
5b	MBI	115.6	0.5	10/13/2005	LDB	DAY	676	37	3352
6b	EA	115	0.5	Aug-05	LDB	DAY	510	33	NA
6b	MBI	115	0.5	10/17/2005	LDB	DAY	706	26	2100

Table 50. Average # of individuals; # of species collected and EF time (sec); first pass; 6 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG ETIME
MBI	156	29	2466
EA	115	21	NA

Table 51. Average # of individuals; # of species collected and EF time (sec); second pass; 6 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG ETIME
MBI	863	33	2582
EA	608	30	NA

Table 52. Average # of individuals; # of species collected and EF time (sec); both passes; 6 sites. High scores = Red.

Collector	AVG #IND	AVG #SPECIES	AVG ETIME
MBI	509	31	2524
EA	362	25	NA

3.9.2. Bray-Curtis/ Community Similarity Analysis

Bray-Curtis similarity scores differed across sites. Community composition exhibited variation between entities and only one of the comparisons (3b, second pass) yielded any degree of similarity (Table 53). Although each entity collected higher numbers of individuals and species during the second pass at each of the six sites, Bray-Curtis values based on these data were consistently dissimilar. This analysis suggests that methods employed by both agencies, do not produce data that is consistently comparable in terms of the BC index.

Table 53. Site/ Collector data, Bray-Curtis Coefficients, # species at 1km sites. Similar = Red.

Site #	Collector1	Collector 2	RM	Date1	Date2	bray	Species1	Species2	shared_sp
1a	MBI	EA	118	10/17/2005	06/15/2005	0.126	28	21	12
2a	MBI	EA	117.3	07/20/2005	06/15/2005	0.519	38	23	21
3a	EA	MBI	117.1	06/15/2005	07/20/2005	0.591	21	25	17
4a	EA	MBI	116.5	06/15/2005	07/21/2005	0.42	20	25	15
5a	EA	MBI	115.6	06/15/2005	07/21/2005	0.592	24	30	19
6a	EA	MBI	115	06/15/2005	07/21/2005	0.477	19	30	13
1b	MBI	EA	118	07/20/2005	08/15/2005	0.106	22	32	16
2b	MBI	EA	117.3	07/20/2005	08/15/2005	0.323	38	27	23
3b	EA	MBI	117.1	08/15/2005	10/13/2005	0.708	29	35	19
4b	EA	MBI	116.5	08/15/2005	10/17/2005	0.512	28	40	23
5b	EA	MBI	115.6	08/15/2005	07/21/2005	0.301	32	30	21
6b	EA	MBI	115	08/15/2005	10/17/2005	0.62	33	32	22

Species richness similarity exhibited wide variation between agencies. During the first pass, four sites were at least weakly similar. The same can be seen for the second pass (Table 54). It should be noted that similar results between the entities did not necessarily correspond between the two passes. These analyses suggest that methods employed by the two entities involved produce somewhat similar results with respect to species richness.

Table 54. Site/ Collector data, , # species per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector 2	RM	date1	date2	#species; collector 1	# species; collector 2	difference	similarity
1a	MBI	EA	118	10/17/2005	06/15/2005	28	21	7	WS
2a	MBI	EA	117.3	07/20/2005	06/15/2005	38	23	15	D
3a	EA	MBI	117.1	06/15/2005	07/20/2005	21	25	4	S
4a	EA	MBI	116.5	06/15/2005	07/21/2005	20	25	5	S
5a	EA	MBI	115.6	06/15/2005	07/21/2005	24	30	6	WS
6a	EA	MBI	115	06/15/2005	07/21/2005	19	30	11	D
1b	MBI	EA	118	07/20/2005	08/15/2005	22	32	10	WS
2b	MBI	EA	117:3	07/20/2005	08/15/2005	38	27	11	D
3b	EA	MBI	117.1	08/15/2005	10/13/2005	29	35	6	WS
4b	EA	MBI	116.5	08/15/2005	10/17/2005	28	40	12	D
5b	EA	MBI	115.6	08/15/2005	07/21/2005	32	30	2	S
6b	EA	MBI	115	08/15/2005	10/17/2005	33	32	1	S

Numbers of individuals per km similarity exhibited little variation between entities. All pairings during the first pass revealed similar relationships (Table 55). Two of the six pairings during the second pass were dissimilar. These analyses suggest that methods employed by the two entities during the first pass produce similar results with respect to numbers of individuals collected per km. During the second pass, method performance with respect to numbers of individuals collected per km fell off slightly, as four pairings revealed at least weakly similar relationships. Overall it appears that the methods employed by each entity were generally comparable in terms of numbers of individuals.

Table 55. Site/ Collector data, # individuals/ km per collector similarity at 1km sites. S - similar; WS - weakly similar; D - dissimilar.

Site #	Collector1	Collector2	RM	Zonelength (km)	#Ind/km collector1	#Ind/km collector2	difference	similarity
1a	EA	MBI	118	0.5	212	142	70	S
2a	EA	MBI	117.3	0.5	342	456	114	S
3a	EA	MBI	117.1	0.5	250	300	50	S
4a	EA	MBI	116.5	0.5	184	314	130	S
5a	EA	MBI	115.6	0.5	242	292	50	S
6a	EA	MBI	115	0.5	150	362	212	S
1b	EA	MBI	118	0.5	1974	2324	350	S
2b	EA	MBI	117.3	0.5	1296	2118	882	D
3b	EA	MBI	117.1	0.5	1056	922	134	S
4b	EA	MBI	116.5	0.5	916	2226	1310	D
5b	EA	MBI	115.6	0.5	1038	1352	314	S
6b	EA	MBI	115	0.5	1020	1412	392	WS

4.0. DISCUSSION

The purpose of this section is to discuss and summarize the observed results and attempt to reflect on the potential issues involved with the similarities and dissimilarities in those results. Each entity was compared to the results obtained by MBI each applying their standard boat electrofishing protocols independent of any observations by MBI and without prior knowledge of the results obtained by MBI. The comparisons were normalized as much as was possible mostly by MBI adapting to the entity site distance and configuration without compromising the MBI protocols. The results are discussed by major study area and were subjected to graphical analysis using frequency plots of the results obtained by MBI compared to each entity. We used box-and-whisker plots of the results obtained by MBI and each cooperating entity to compare the results on a study reach basis in an attempt to visually reveal the extent of comparability. A site-by-site (i.e., "paired sample") comparison by assemblage parameter was accomplished in Section 3.0. All results were normalized to the same sampling distance as the primary basis of comparability. We did not compare the results between protocols that represented "unequal" effort, but that would be of value as part of future analyses that focus on comparing the overall bioassessment produced by each.

4.1. St. Croix River

Comparisons were made at 10 sites between river miles 92 and 28 in the St. Croix River that borders Minnesota and Wisconsin. The two participating entitles (MPCA and MDNR) each used different boat electrofishing protocols and equipment. The MBI standard distance of 500m was used as the basis for comparison of method performance, even though both agencies sample longer distances as part of their respective protocols.

The principal differences between the MBI, MPCA, and MDNR protocols included site distance, electrofishing equipment, electrode configuration, and intensity of effort (expressed as time electrofished in seconds). MDNR and MPCA sampled 500m subsets of their longer sites to provide the data for use in the comparisons. MDNR typically samples a 1620m site following the protocol of Lyons et al. (2001). MPCA samples three 500m electrofishing transects; right bank, left bank and mid channel to accumulate a site distance of 1500 m.

The distribution of species richness results from all sites was generally similar, especially for the median values (Figure 18). The MBI results occupied a narrower range than MNDNR and MPCA. MBI had more species in common with MNDNR than MPCA, about 75% of the total species richness based on the median values. Although the catch statistics are different, it appears that MPCA, MDNR, and MBI all performed comparably, collecting nearly identical median numbers of species per site. Only 10% of the pairings were dissimilar. Both MNDNR and MPCA collected higher numbers/km (Figure 18), but the differences were not dissimilar based on the expected variation for this parameter. All comparisons were similar, and only 3 of 30 comparisons were weakly similar.

The distribution of MIwb scores was similar for MBI and MPCA, each of which was higher than MNDNR (Figure 19). MBI and MNDNR were weakly similar in all but two of the ten comparisons (80%). MBI and MPCA were at least weakly similar in six of ten comparisons (60%) and MPCA and MNDNR were at least weakly similar in all but four (60%) comparisons (Table 5). MPCA had some higher scores, but the range of MBI scores was more compressed. Bray-Curtis similarity scores between MBI and MPCA were slightly

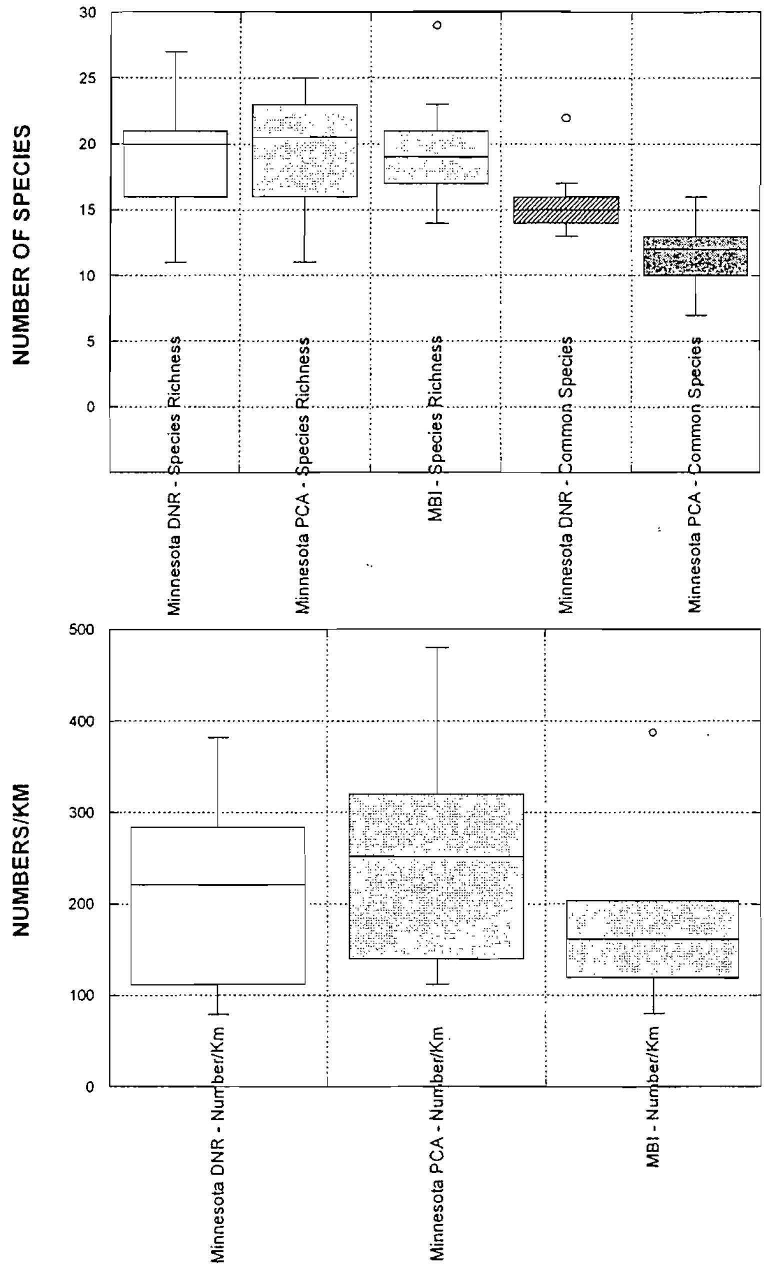


Figure 18. Frequency comparison of species richness values and species in common (upper panel) and numbers/km (lower panel) results based on electrofishing conducted by MBI, MPCA, and MNDNR at 10 sites in the St. Croix River, July – September 2004 (normalized to a 500 meter site distance).

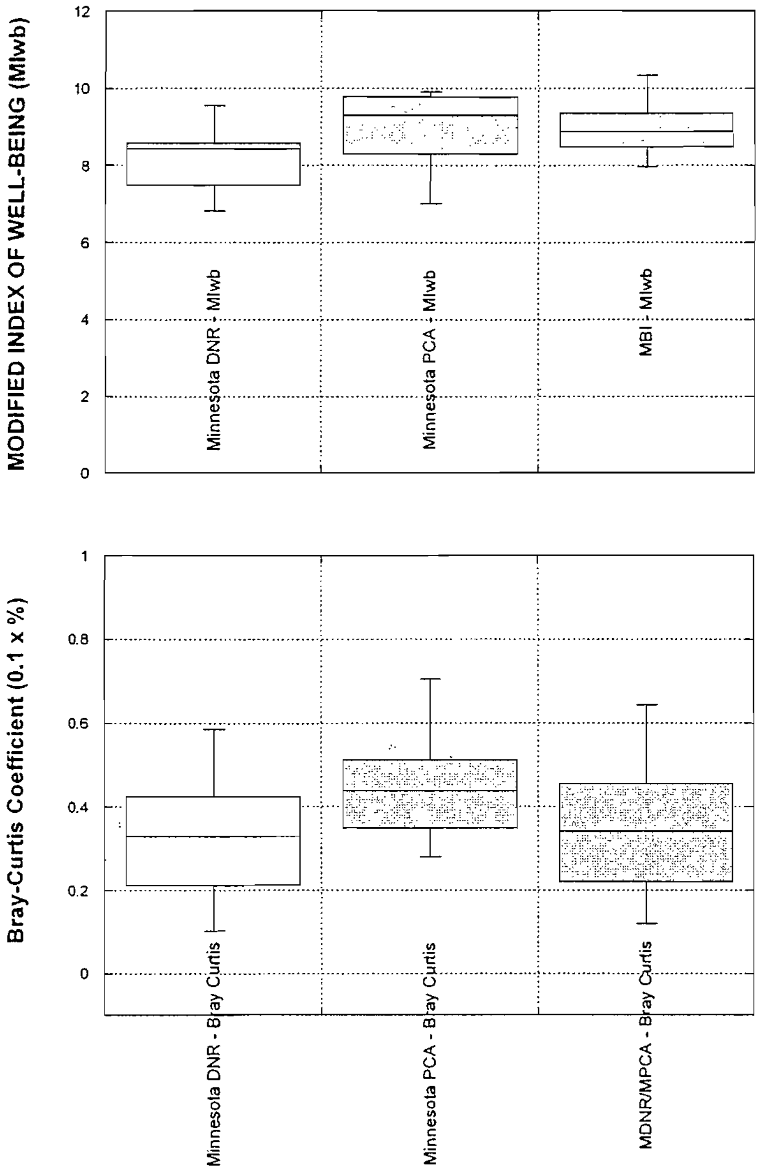


Figure 19. Frequency comparison of modified Iwb values (upper panel) and Bray-Curtis similarity coefficients (lower panel) based on electrofishing conducted by MBI, MPCA, and MNDNR at 10 sites in the St. Croix River, July – September 2004 (normalized to a 500 meter site distance).

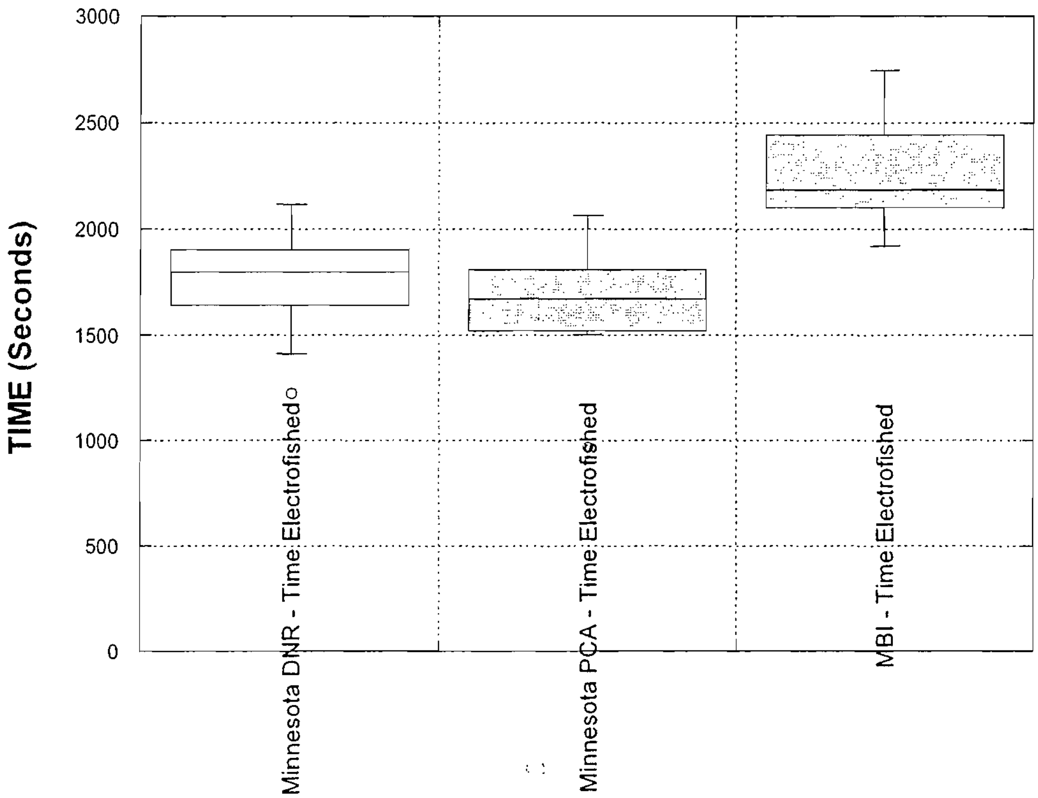


Figure 20. Frequency comparison of electrofishing times by MBI, MPCA, and MNDNR at 10 sites in the St. Croix River, July – September 2004 (normalized to a 500 meter site distance).

higher than the comparisons of both MBI and MPCA with MNDNR. Only two of 30 comparisons yielded similar results based on our criteria for delineating similarity of results (Table 6). This may be an indication that a different part of the fish assemblage was being sampled by each entity or it could be that our "expected" variation is not representative. MBI exhibited higher average electrofishing times than MPCA and MDNR (Figure 20). While this parameter may relate in some respects to sampling "thoroughness", the results do not indicate that the longer time fished by MBI necessarily produced substantially higher catches, especially as compared to MPCA. The observed differences in normalized catch results between MBI and MPCA seem to be close to that which would have been expected by sampling the same site on different dates. Where it was conducted, night sampling did not produce substantially different results and may owe to the shallower nature of the lower mainstem. The differences were more apparent between MBI and MDNR and seem to be the result of how each entity samples a site.

4.2. Wabash River

Comparisons were made at 7 sites between river miles 257 and 23 in the Wabash River in Indiana with the Indiana DEM (IDEM). A 1.0 km electrofishing zone was used as the basis for comparison of method performance – MBI sampled two 0.5 km sites to accumulate the 1.0 km distance sampled by IDEM. The results are portrayed for MBI as both a 0.5 km and 1.0 km site. The other principal difference between the MBI and IDEM protocols are day vs. night sampling, electrofishing equipment, and sampling direction.

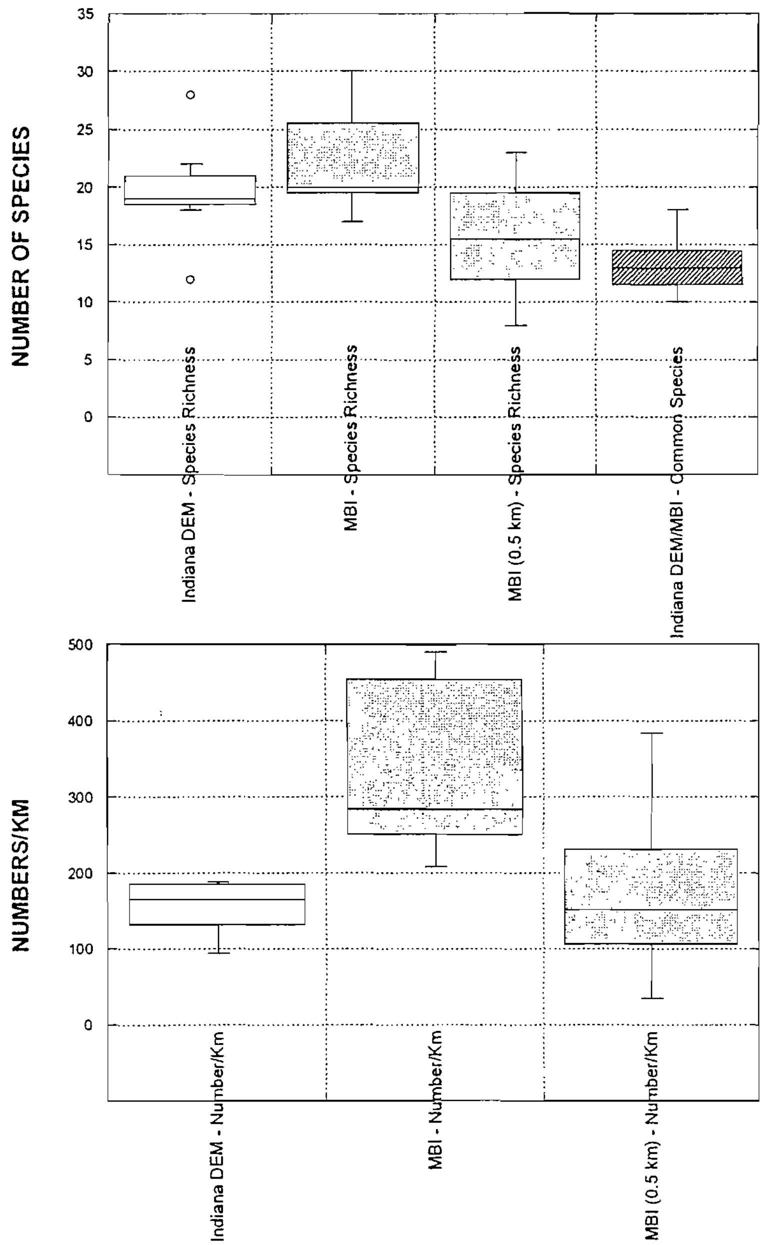
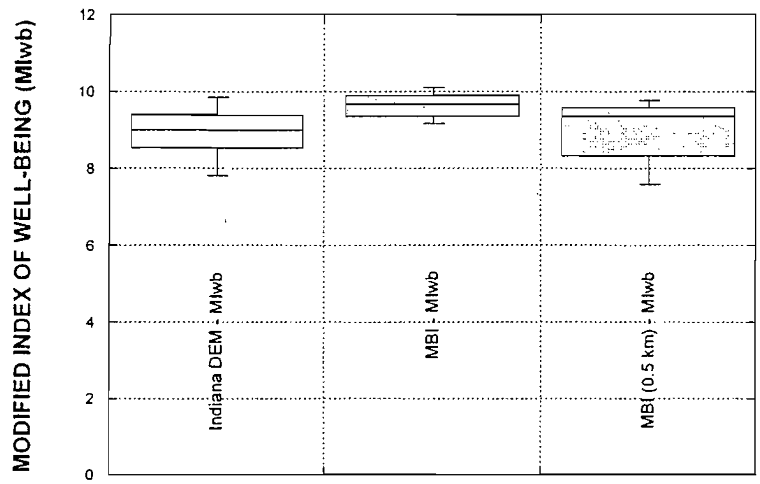


Figure 21. Frequency comparison of species richness values and species in common (upper panel) and numbers/km (lower panel) results based on electrofishing conducted by MBI (0.5 and 1.0 km) and Indiana DEM(1.0 km) at 7 sites in the Wabash River, July – September 2004.



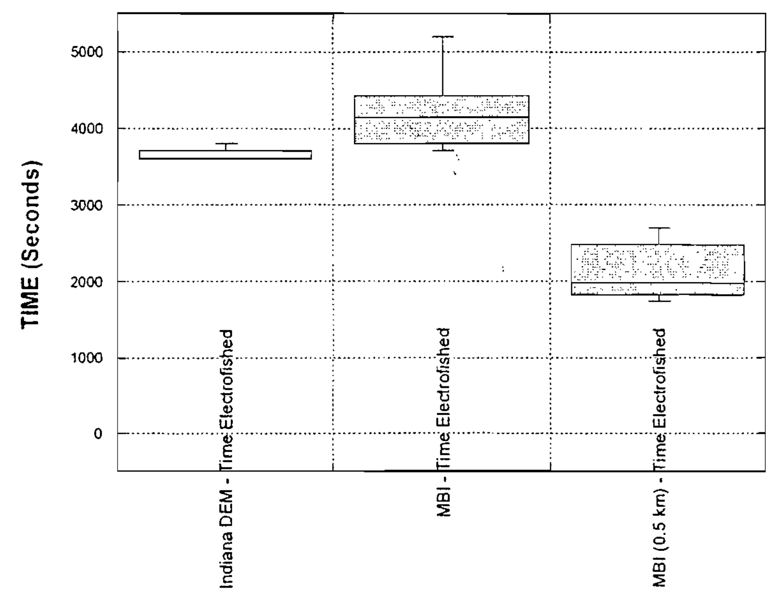


Figure 22. Frequency comparison of modified Iwb values (upper panel) and time electrofished (lower panel) results based on electrofishing conducted by MBI(0.5 km and 1.0 km) and Indiana DEM (1.0 km) at 7 sites in the Wabash River, July – September 2004.

On a 1.0 km comparison basis MBI collected slightly more species, but more than twice as many individuals (Figure 21). With regard to individual sample comparisons, MBI collected more species and individuals at 6 of 7 sites. However, the results were similar or weakly similar for species richness and relative density (Table 14). An MBI effort of 0.5 km produced fewer species, but similar numbers/km.

MBI's MIwb scores on a 1.0 km comparison basis were higher and were dissimilar for 3 sites (Table 15; Figure 22). The MBI 0.5 km results were similar to the IDEM 1.0 km results. Only two of 7 Bray-Curtis comparisons yielded similar results (Table 13). Species in common was on the order of 60-65%. MBI exhibited higher average electrofishing times by 15% compared to IDEM on a 1.0 km comparison basis, which is not a substantial difference in sampling effort.

At this time, the higher catch rates by MBI are attributable to night electrofishing based on what we know about day vs. night application of boat electrofishing in large and great rivers (Sanders 1991). However, other factors such as sampling direction, time electrofished, and general execution of the protocol may also have contributed to the observed differences. The overall data suggest that the results are not consistently comparable, with significant differences apparent in both individual site and aggregate site comparisons.

4.3. Wisconsin River

Comparisons were made at 9 sites between river miles 90 and 4 in the lower Wisconsin River with the Wisconsin DNR (WDNR). A 1620m baseline electrofishing zone was used as a basis for comparison of method performance - MBI sampled two 500 m and one 620 m subsites to allow analysis of the MBI protocol and also accumulate the same aggregate distance sampled by WDNR. The principal difference between the MBI and WDNR protocols include site distance, electrofishing equipment, power output, dip net mesh size, and unit settings.

MBI collected more species and more than four times as many individuals on average (Table 18) and a higher range of species at all sites at both the 1620m and 500m site distances (Figure 23). As a result, less than 50% of the species collected were in common. The results were dissimilar or weakly similar for species richness at 8 of 9 sites. In terms of individual sample comparisons, MBI collected more species and numbers/km at all 9 sites (Table 17). The range of MBI number/km was wider than WDNR, but substantially higher at some sites. WDNR results were remarkably similar at all 9 sites. However, the comparisons with MBI were weakly similar or similar for numbers/km at 7 of 9 sites (Table 20). Time electrofished was 4 times higher for MBI. None of the 9 Bray-Curtis comparisons yielded similar results with all coefficients less than 0.35 (Table 19).

At this time, the higher MBI catch rates are attributable to electrofishing time, unit settings, power output, dip net mesh size, and possibly the execution of the sampling protocol. WDNR standardizes the power output at consistent 25% duty cycle whereas MBI maximizes power output depending on relative conductivity, resulting in duty cycles of 50-100%. Power is produced for the WDNR unit at 3000W compared to 5000W for

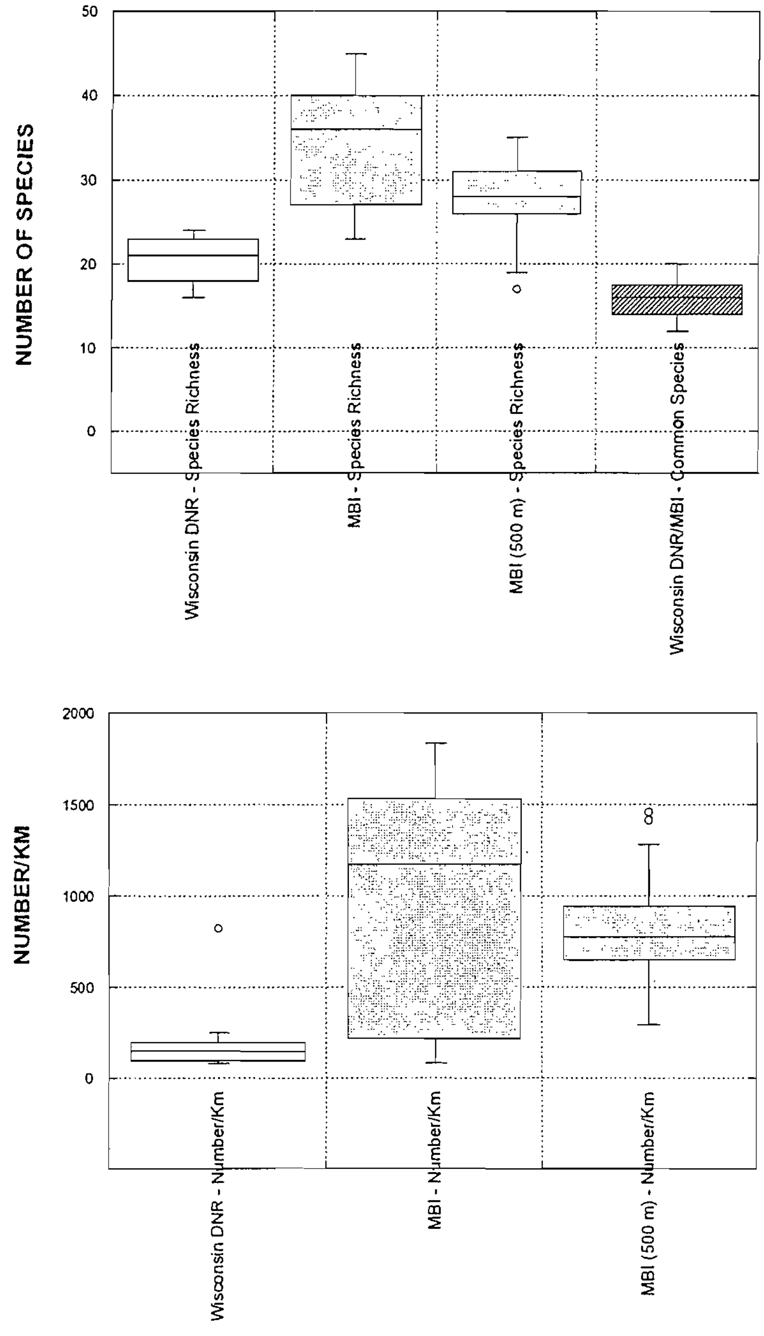


Figure 23. Frequency comparison of species richness values and species in common (upper panel) and numbers/km (lower panel) results based on electrofishing conducted by MBI (0.5 and 1.62 km) and Wisconsin DNR (1.62 km) at 9 sites in the Wisconsin River, July – September 2005.

the MBI unit. WDNR samples at 60Hz compared to 120 Hz for MBI. WDNR dip net mesh size is 3/8" stretch mesh compared to ¼" Ace mesh for MBI. Taken together these differences likely explain the higher catch rates by MBI.

It should be noted that Wisconsin DNR has successfully developed and applied a calibrated, statewide river fish assemblage index based on the principles of IBI (Lyons et al. 2001). It has been useful in discriminating between categorical stressors including both pollutant and non-pollutant stressors. The influence of the results generated by MBI should be determined on the Wisconsin IBI as it is likely to be non-linear, i.e., it may increase the discrimination of the IBI along *parts* of the biological condition gradient that is represented by the current IBI. This will require further analysis to more precisely determine.

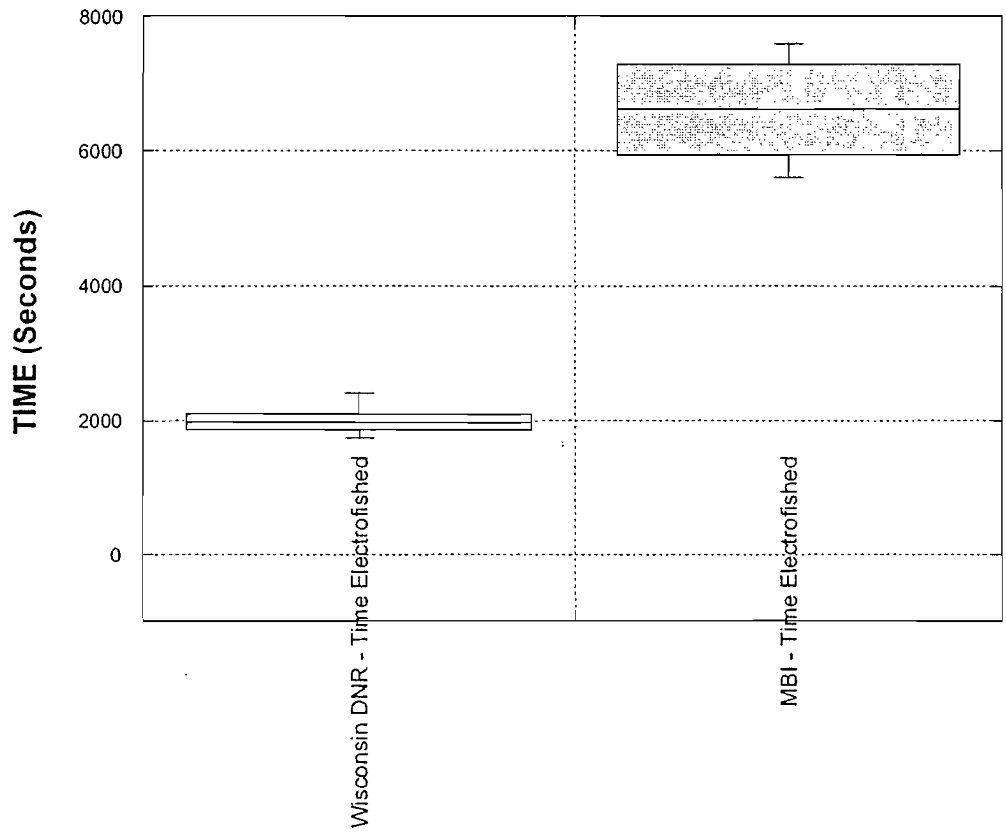


Figure 24. Frequency comparison of electrofishing times by MBI and Wisconsin DNR at 9 sites in the Wisconsin River, July – September 2005.

4.4. Kankakee River (2004)

Comparisons were made at 6 sites between river miles 111 and 67 in the Kankakee River in Indiana with the Indiana DEM (IDEM). A 1.0 km baseline electrofishing zone was used as the primary basis for comparison of method performance – MBI sampled two

0.5 km sites to accumulate the same distance sampled by IDEM along opposite banks. The principal difference between the MBI and IDEM protocols include site distance, electrofishing equipment, and sampling direction (upstream vs. downstream).

MBI species richness was higher and more consistent than IDEM on a 1.0 km comparison basis and yielded a similar median value for the 0.5 km basis (Figure 25). Species in common was about 70-75%. MBI numbers/km was higher for the 1.0 km effort and similar to the IDEM 1.0 km for the MBI 0.5 km effort (Figure 25). The MIwb results were similar in terms of median values for the 1.0 km comparison, but the variability was higher for the IDEM results (Figure 26). The MBI 0.5 km distance produced slightly lower MIwb scores. MBI electrofishing times were 1500-2000 seconds (40%) higher for the 1.0 km distance and similar to the IDEM 1.0 km distance at the MBI 0.5 km distance.

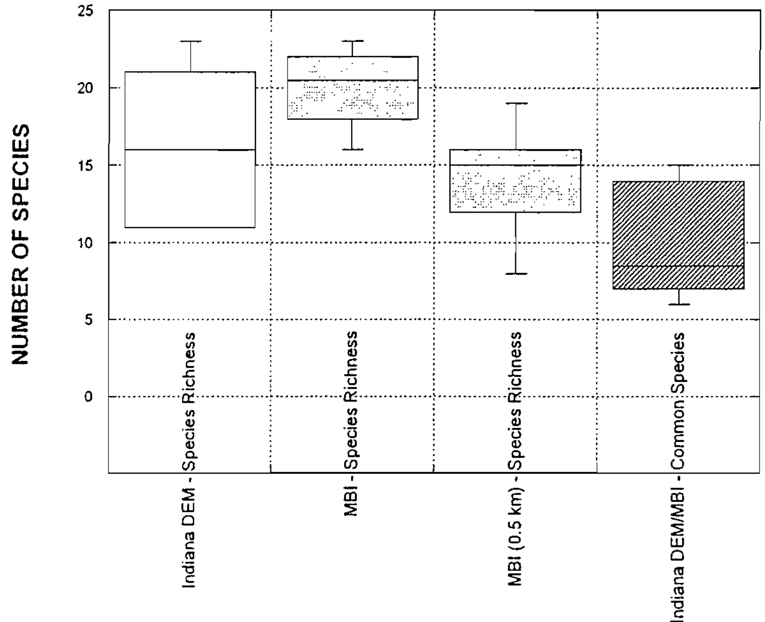
On average MBI collected more species and more than twice as many individuals and had significantly longer electrofishing times (Table 23). In terms of sample comparisons, MBI collected more species and individuals at all 6 sites (Table 22). The MIwb results were mixed with IDEM achieving higher scores at 3 of 6 sites (Table 24), but their results were more variable (Figure 26). Results were similar or weakly similar for species richness and relative density (Table 26), but were dissimilar for the MIwb at 3 sites (Table 27); MBI produced significantly higher MIwb scores in each instance. None of the 6 Bray-Curtis comparisons yielded similar results being less than 0.5 (Table 25).

At this time, the higher catch rates by MBI are attributable to sampling time, sampling direction, and general execution of the protocol. The overall results suggest that the methods are not consistently comparable, with significant differences apparent in the overall range, averages, and individual site comparisons.

4.5. Kankakee River (2005)

Comparisons were made at 12 sites in the Kankakee and Iroquois Rivers in Illinois with the Illinois DNR (IDNR). A 0.5 km baseline electrofishing zone was used as a basis for comparison of method performance. However, sampling distance is assumed for the Illinois DNR results since they measure effort based on time sampled, hence their actual distance sampled may have been different. The principal differences between the MBI and IDNR protocols include sampling protocol (time vs. fixed distance) and electrofishing equipment (3-phase AC vs., pulsed DC). All other aspects are similar.

IDNR collected slightly and consistently higher numbers of species (Figure 27). About 75% of the species collected were in common. On average MBI and IDNR collected nearly identical species and individuals, but IDNR incurred significantly longer electrofishing times (Table 30), perhaps an indication of a greater accumulated sampling distance. In terms of sample comparisons, each entity had nearly equally split results in terms of numbers of species and individuals collected at the 12 sites (Table 29). Numbers/km was similar with MBI having greater variability in the results (Figure 27), perhaps a reflection of a consistent time weighted CPUE basis used by IDNR. IDNR exhibited higher average electrofishing times by 1000-1500 seconds compared to MBI (Table 30; Figure 28). Bray-Curtis results were dissimilar, but just less than 0.60.



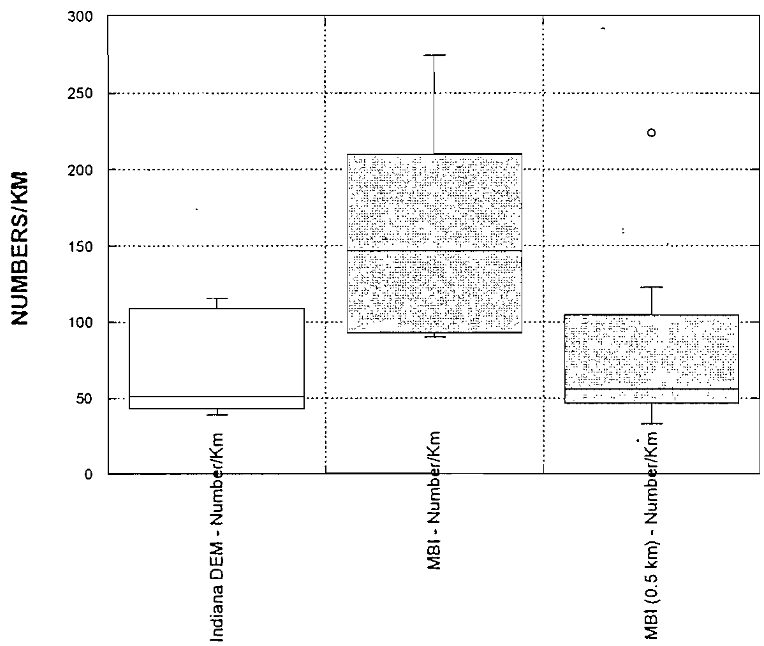
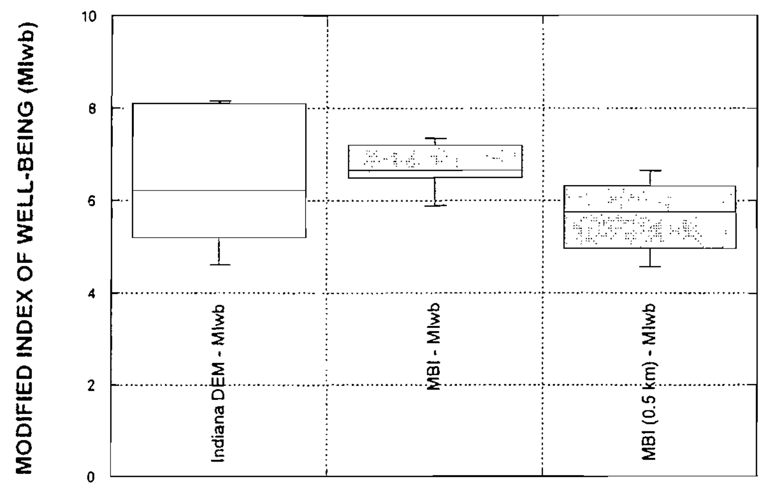
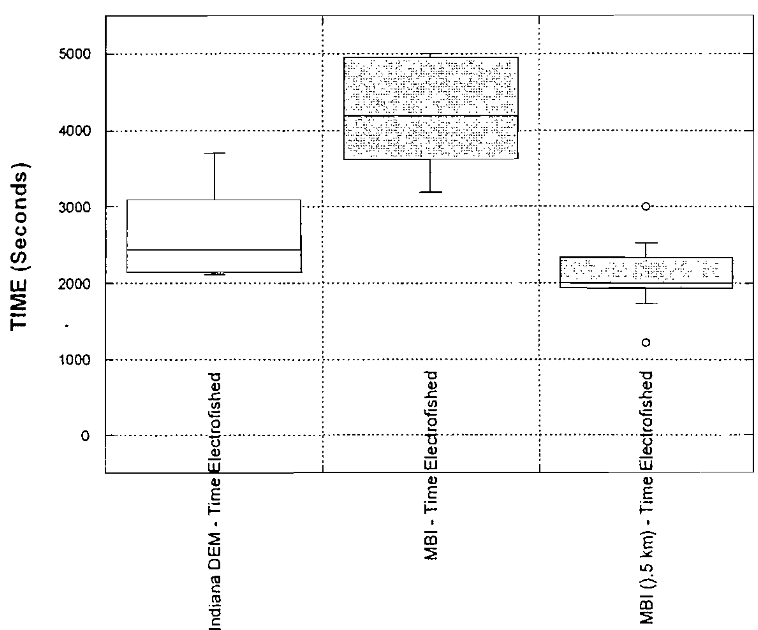


Figure 25. Frequency comparison of species richness values and species in common (upper panel) and numbers/km (lower panel) results based on electrofishing conducted by MBI (0.5 and 1.0 km) and Indiana DEM(1.0 km) at 6 sites in the Kankakee River, July – September 2004.


MODIFIED INDEX OF WELL-BEING (MIwb)
0
2
4
6
8
10
Indiana DEM - MIwb
MBI - MIwb
MBI (0.5 km) - MIwb


TIME (Seconds)
0
1000
2000
3000
4000
5000
Indiana DEM - Time Electrofished
MBI - Time Electrofished
MBI ().5 km) - Time Electrofished

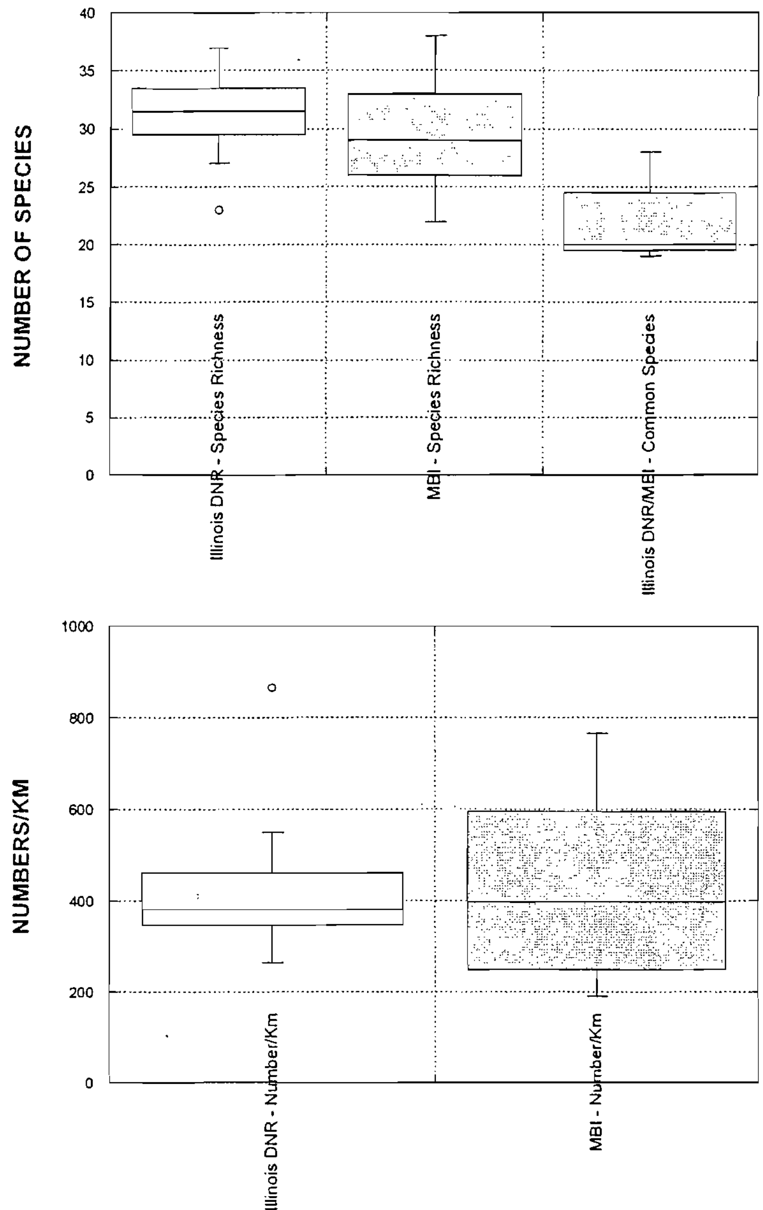


Figure 27. Frequency comparison of species richness values and species in common (upper panel) and numbers/km (lower panel) results based on electrofishing conducted by MBI and Illinois DNR at 12 sites in the Kankakee and Iroquois Rivers, July – September 2005.

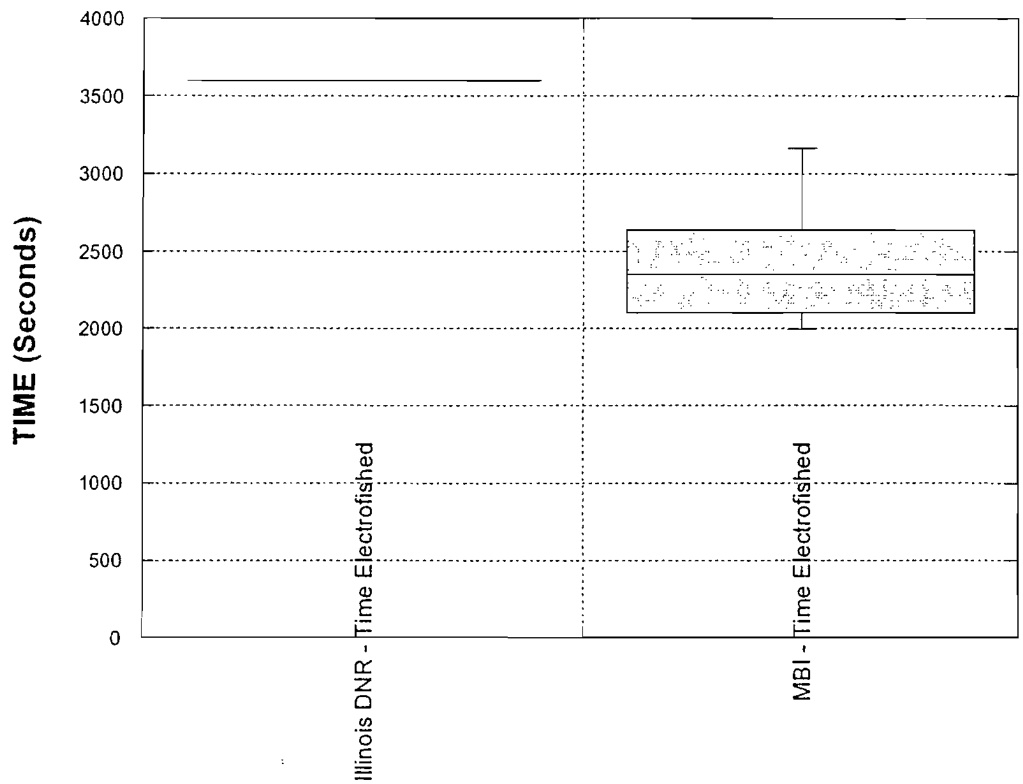


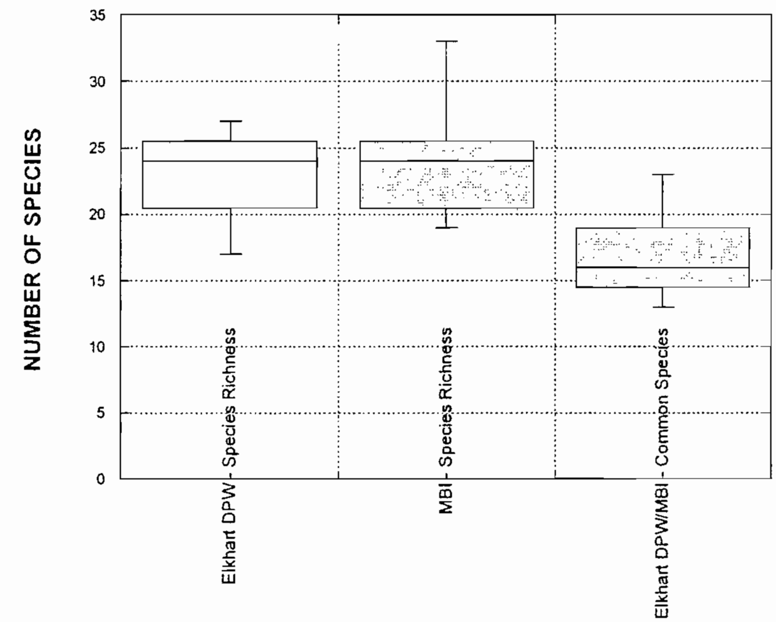
Figure 28. Frequency comparison of electrofishing times by MBI and Illinois DNR at 12 sites in the Kankakee and Iroquois Rivers, July – September 2005.

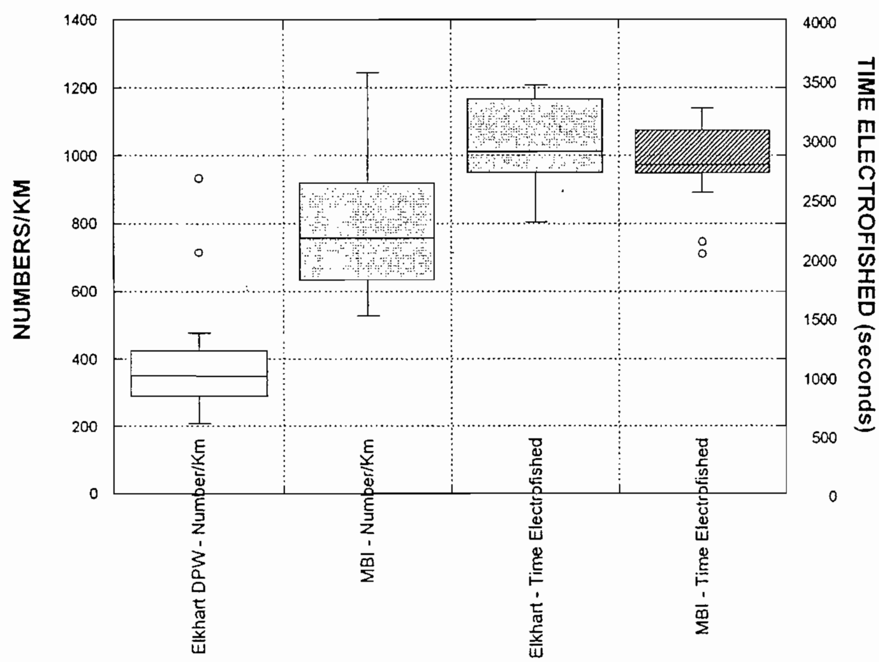
The overall results suggest that the methods are comparable on average, with site differences within the range of similarity for species richness and relative density. However, some of this may be influenced by a comparatively greater effort expended by IDNR based on the fixed time protocol.

4.6. St Joseph River (Indiana)

Comparisons were made at 15 sites in the St. Joseph River in Indiana with the City of Elkhart Public Works (EPW). A 0.5 km baseline electrofishing zone was used as a basis for comparison of method performance. The principal differences between the MBI and EPW protocols include sampling direction and site protocol.

MBI and EPW species richness results were very similar in terms of frequency plots and median values (Figure 29). On average MBI and EPW collected nearly identical species richness. Species in common was about 75-85%. MBI produced nearly twice the number of individuals (Table 35; Figure 29). Bray-Curtis results were some of the highest


NUMBER OF SPECIES
0
5
10
15
20
25
30
35
Elkhart DPW - Species Richness
MBI - Species Richness
Elkhart DPW/MBI - Common Species


NUMBERS/KM
0
200
400
600
800
1000
1200
1400
TIME ELECTROFISHED (seconds)
0
500
1000
1500
2000
2500
3000
3500
4000
Elkhart DPW - Number/Km
MBI - Number/Km
Elkhart - Time Electrofished
MBI - Time Electrofished

observed with half of the values greater than 0.60, but still below the threshold for similar results. In terms of sample comparisons, MBI produced more species at 7 sites with EPW sampling more species at 4 sites - the remaining 4 sites were identical (Table 34). MBI produced more individuals at all 15 sites (Table 34) (no MIwb results were available for EPW). Time electrofished was not recorded by EPW. Although seven of the fifteen Bray-Curtis comparisons yielded at least weakly similar results (Table 36) it is difficult to make a determination of similarity based on these analyses. Results were similar or weakly similar for species richness and relative density (Table 37).

The overall results suggest that the methods are comparable for species richness, but not comparable for numbers of individuals. The fact that EPW and MBI employ the same equipment suggests differences in the application of that equipment in the field. EPW samples in both an upstream and downstream direction compared to downstream only for MBI.

4.7. St Joseph River (Michigan)

Comparisons were made at 4 sites in the lower St. Joseph River in Michigan with the Michigan Institute for Fisheries Research (MIFR). A 1.62 km baseline electrofishing zone was used as the primary basis for comparison of method performance - MBI sampled two 0.5 km and one 0.62 km sites to accumulate the same distance sampled by MIFR, which follows the methods of Lyons et al. (2001). The principal difference between the MBI and MIFR protocols include site distance and electrofishing equipment and settings.

MBI collected approximately 20 more species and about 1200-1500 more numbers/km than MIFR (Figure 30). As a result, the only species in common were those collected by MIFR. On average MBI collected nearly 3 times as many species nearly 10 times the number of individuals (Table 40). In terms of sample comparisons, MBI produced more species and higher numbers of individuals at all 4 sites (Table 39). Results were dissimilar for species richness numbers/km, and the Bray-Curtis coefficient (Table 42).

The overall results show that the results are not comparable on average or at specific sites based on species richness and numbers of individuals, even though there were only 4 sites involved. The lower catch rates by MIFR are attributable to differences in equipment settings, dip net mesh size, and execution of the sampling protocols. MIFR used 3/8" stretch mesh on their dipnets compared to ¼" inch ace mesh used by MBI. MBI sampling times were nearly twice that of MIFR at 3 of the 4 sites. Electrofishing was conducted at >10-15 A compared to 4-6 A for MIFR. Taken together these seem to explain the differences in the observed results.

4.8. Chicago Area Water System (CAWS)

Comparisons were made at 8 sites in the Chicago Area Waterway System (CAWS) in Chicago with the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). A 0.8 km baseline electrofishing zone was used as the basis for comparison of method performance - MBI sampled each 0.4 km MWRD subzone in a downstream

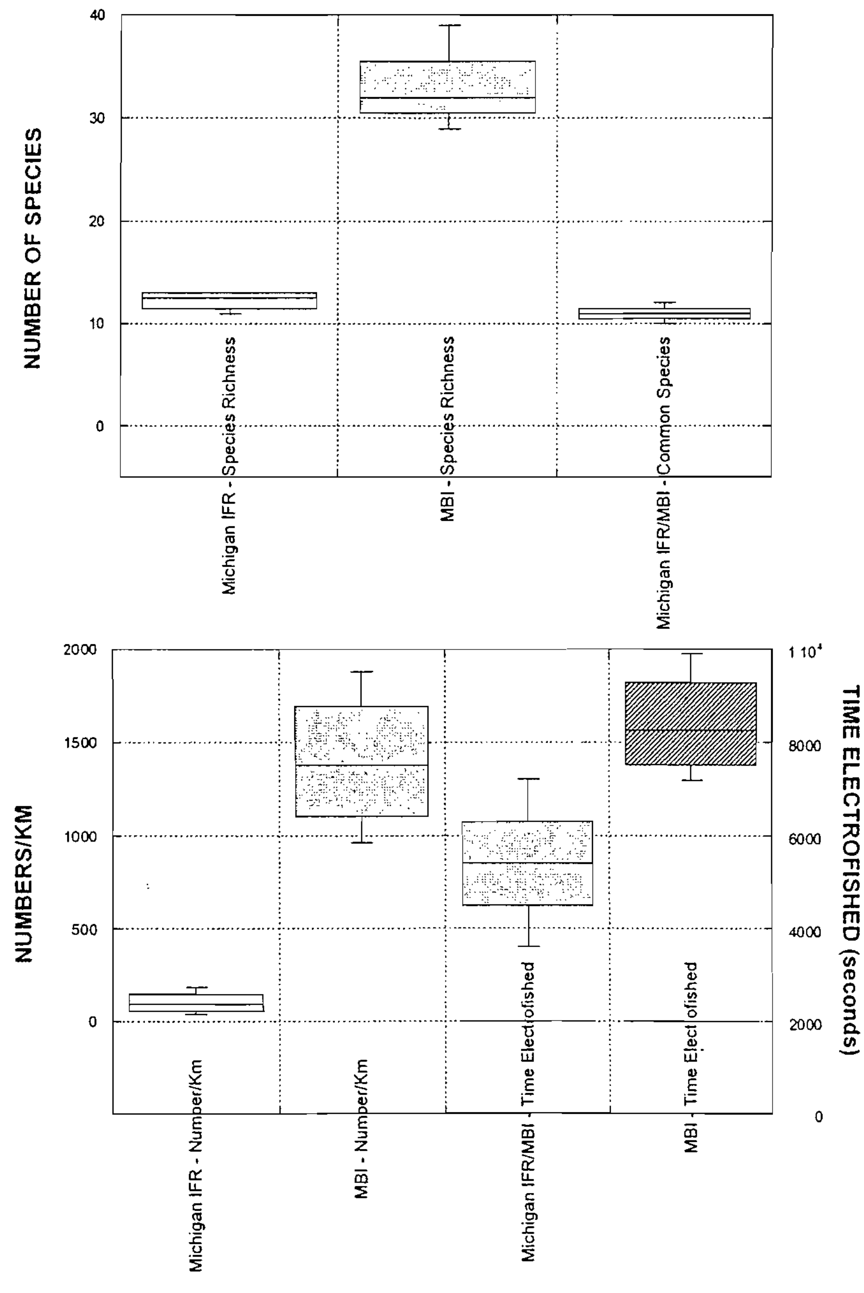


Figure 30. Frequency comparison of species richness values and species in common (upper panel) and numbers/km and time electrofished (lower panel) results based on electrofishing conducted by MBI and Michigan IFR at 4 sites in the St. Joseph River, July – September 2005.

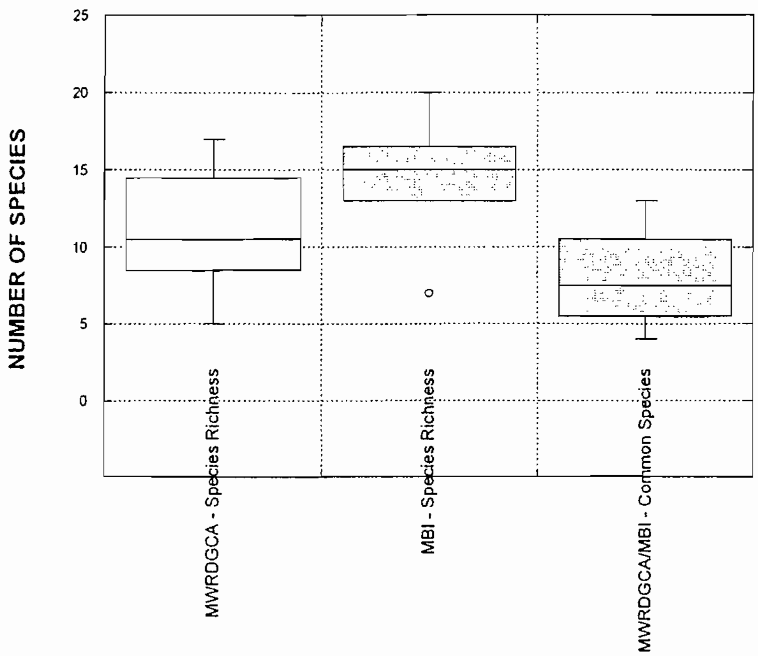
direction. The principal differences between the MBI and MWRDGC protocols include sampling direction and equipment configuration, electrofishing equipment and settings, and execution of the protocol. MBI produced slightly higher species richness results with some overlap in the frequency distribution (Figure 30). The species in common was about 70-75%. MBI produced higher numbers/km results by more than 2-3 times MWRD (Figure 30). On average MBI collected more species and more than twice as many individuals (Table 45). In terms of sample comparisons, MBI produced higher numbers of individuals at all 8 sites and higher numbers of species at seven of eight sites (Table 44). MBI also had higher time electrofished at all except one site; times were about 200-300 seconds (15-20%) longer (Table 45; Figure 31). Despite the visual differences the results were weakly similar to similar for species richness and number/km (Table 47). Bray-Curtis coefficients were less than 0.5.

The overall results suggest that the methods are perhaps comparable on average or at specific sites based on species richness and less comparable for numbers of individuals, but not entirely dissimilar by the criteria used herein. Some of the differences may reflect short term water quality impacts from combined sewer overflow discharges especially at sites sampled in different years.

4.9. Scioto River

Comparisons were made at 6 sites on the Scioto River in Ohio with sampling conducted by American Electric Power (AEP). A 0.5 km baseline electrofishing zone was used as a basis for comparison of method performance. Each entity sampled each of the six sites twice (two separate runs) during different months between June and October 2005. The MBI and AEP protocols are similar in terms of distance, sampling direction, and generally in terms of equipment. However, AEP's site configuration was different and consisted of sampling all sites along the same shoreline. MBI sampled additional sites that were historically established by Ohio EPA, some of which overlapped with portions of the AEP sites. The configuration of these sites was different than AEP in that they are located on the bank with the best available habitat, usually the outside bends and deeper runs. This afforded the opportunity to evaluate the potential effects of site configuration on the results. Sampling was compared during two different time periods - June/July and August/October with AEP sampling in the earliest month.

The median MBI species richness was higher in each comparison of the duplicate sites by 9 and 5 species (Figure 33). Species richness was higher yet at the MBI zones, a probable indication of the effect of site configuration. Only about 50% of the species were in common (Figure 33). MBI produced 2.5-3 times higher numbers/km in all comparisons and that followed the same general pattern for species richness (Figure 33). Bray-Curtis coefficients ranged mostly between 0.40-0.60 indicating dissimilar results. On average MBI collected 26% and 30% more species and 27% and 10% higher numbers of individuals during the first and second sampling passes respectively (Tables 50 and 51). With regard to sample comparisons, MBI collected higher numbers of individuals and species at all six sites during the first pass (Table 49). During the second sampling pass MBI collected higher numbers of individuals at five of six sites (Table 49). Results for species richness



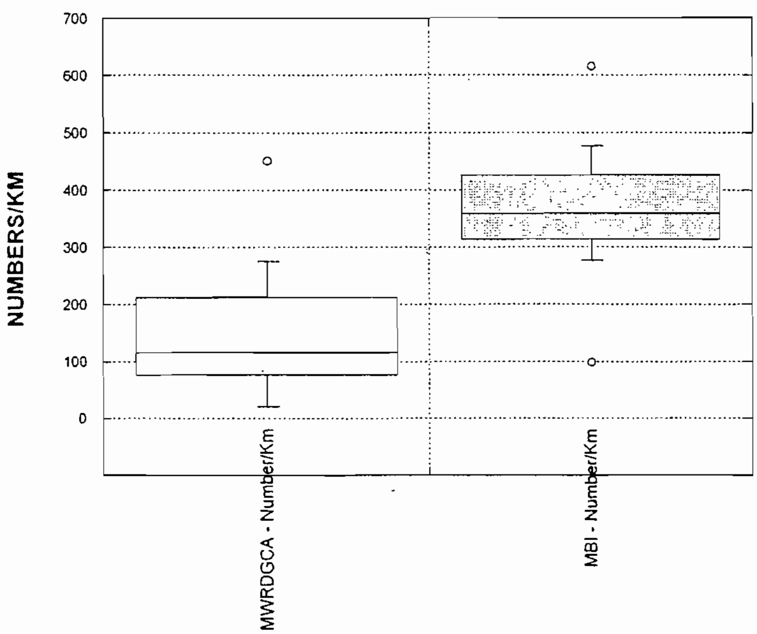


Figure 31. Frequency comparison of species richness values and species in common (upper panel) and numbers/km (lower panel) results based on electrofishing conducted by MBI and MWRD at 8 sites in the Chicago Area Waterways System, July – September 2005.

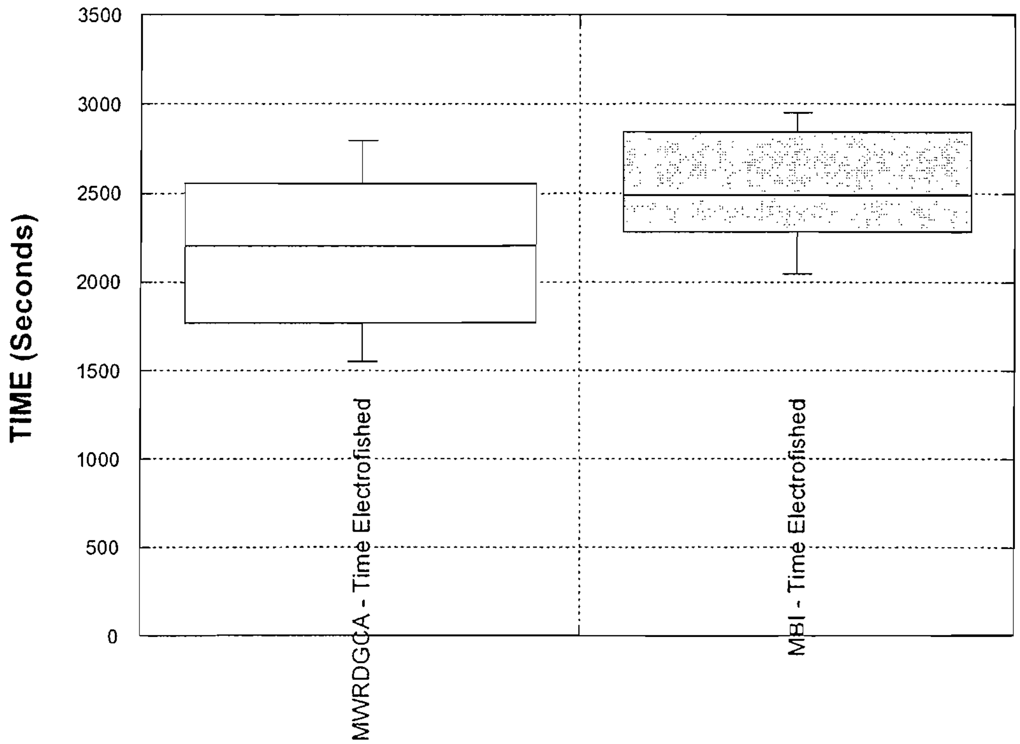


Figure 32. Frequency comparison of electrofishing times by MBI and MWRD at 8 sites in the Chicago Area Waterway System, July – September 2005.

were mixed as each entity collected higher numbers at three of six sites (Table 49). With respect to both sampling passes combined, MBI collected 29% and 19% higher average numbers of species and individuals respectively (Table 52). Time electrofished was not reported by AEP. The two comparisons yielded largely dissimilar results based on the frequency comparisons, but were more similar based on the criteria developed with the multiple pass data.

The results also show the effect of intra-seasonal sampling. In this case the June/July period is "early" for this river based on historical comparisons with Ohio EPA results. Flows were somewhat elevated during this period compared to the late summer-early fall passes. During the later passes, MBI collected on average more than five times as many individuals per site as was collected during the first pass. AEP demonstrated a similar increase. Likewise, average numbers of species collected by MBI increased by 13% during the second pass (Table 51). AEP's average number of species increased nearly 30% during the second pass (Table 51). Similarity results for species richness and relative density showed 33% dissimilarity between entities during each pass (Table 54). Bray-Curtis results were largely dissimilar during both passes. The increased sampling productivity by each entity was largely similar. The methods are similar in design and execution, and are likewise comparable on average with respect to output. The analyses were limited by the lack of biomass and time electrofished data from AEP.

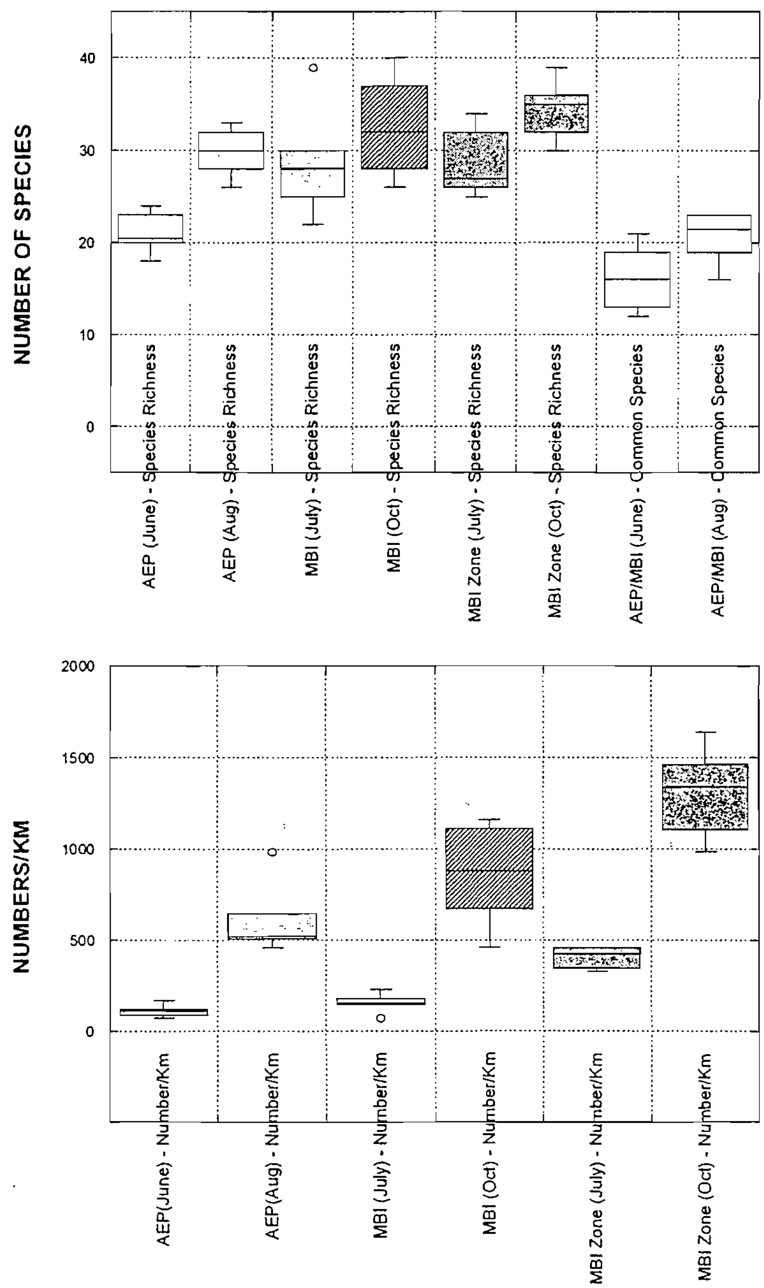


Figure 33. Frequency comparison of species richness values and species in common (upper panel) and numbers/km (lower panel) results based on electrofishing conducted by MBI and American Electric Power (AEP) DEM) at 6 sites in the Scioto River, July – October 2005.

5.0 SYNTHESIS OF RESULTS

Some general patterns were evident from the preceding analyses. In terms of species in common between comparisons, about 75% is the highest that can be expected. In other words, 1 of every 4 species collected by the comparable entities is likely to be different. This is in line with what could be expected between two different samples collected by the same entity within the same seasonal index period. While 3 of 8 entities (Minnesota PCA, Minnesota DNR, and Illinois DNR) were deemed to have produced comparable results, some entities produced partially comparable results. In each of these cases, species richness was comparable and relative numbers were not. In the comparisons where the results were not wholly comparable and where the cooperating entity protocol included distances of greater than 0.8-1.0 km, MBI could generally produce similar or higher species richness, numbers/km, and MIwb scores in a distance of 0.5 km.

Only one of the variables that we used in this study was amenable to making a standardized comparison across all of the cooperating entities. The Bray-Curtis coefficient of similarity results suggested a greater degree of dissimilarity between MBI and the cooperating entities than other parameters on an entity by entity comparison basis (see Section 3.0). This may be more of an issue with where the threshold for similarity is presently set as it was based on a set of very high quality rivers in Ohio. Most of the comparisons in this study were conducted in areas of variable quality hence the added variability of that factor may have influenced the results. Regardless, the analysis at least shows the comparative similarity in this index between the participating entities (Figure 34).

Taken together the results of this study at least partially show that different applications of a generically similar sampling protocol (i.e., boat electrofishing) can produce substantially different data in terms of baseline assemblage sample parameters. The factors involved in these differences that were most apparent include the execution of the sampling of a site, selected aspects of the sampling protocol, dip net mesh size, and in some cases equipment specifications and settings. In most cases it was a combination of one or more of these factors.

By "thoroughness" we are referring to the intensity of the sampling at a site that seems to be reflected in the time electrofished. Since the comparisons were normalized over a standard lineal distance, time sampled reflects how much time was spent sampling a site. More time spent sampling a site strongly suggests that the electrofishing platform was maneuvered in a manner that enhanced the likelihood of collecting more species and more individuals resulting in a more complete cross-section of the assemblage. At the same time, there were instances where higher catches were produced at lesser sampling times. However, there is likely a threshold of effort and thoroughness beyond which spending more time within a site has diminishing returns in terms of useful and cost-effective information. A better perspective about this factor could be had by observing the sampling being performed by each entity by a consistent observer. Nevertheless, it is probably the single most important factor involved in the observed differences in our judgment and experience.

In some cases, the sampling protocol is likely a co-factor in some of the observed differences. This would include sampling direction, site configuration, and in one case day vs. night sampling. Again, the study itself does not offer complete information, but our experience with other comparative studies that focused on these issues and our experience in general is the basis for this conclusion.

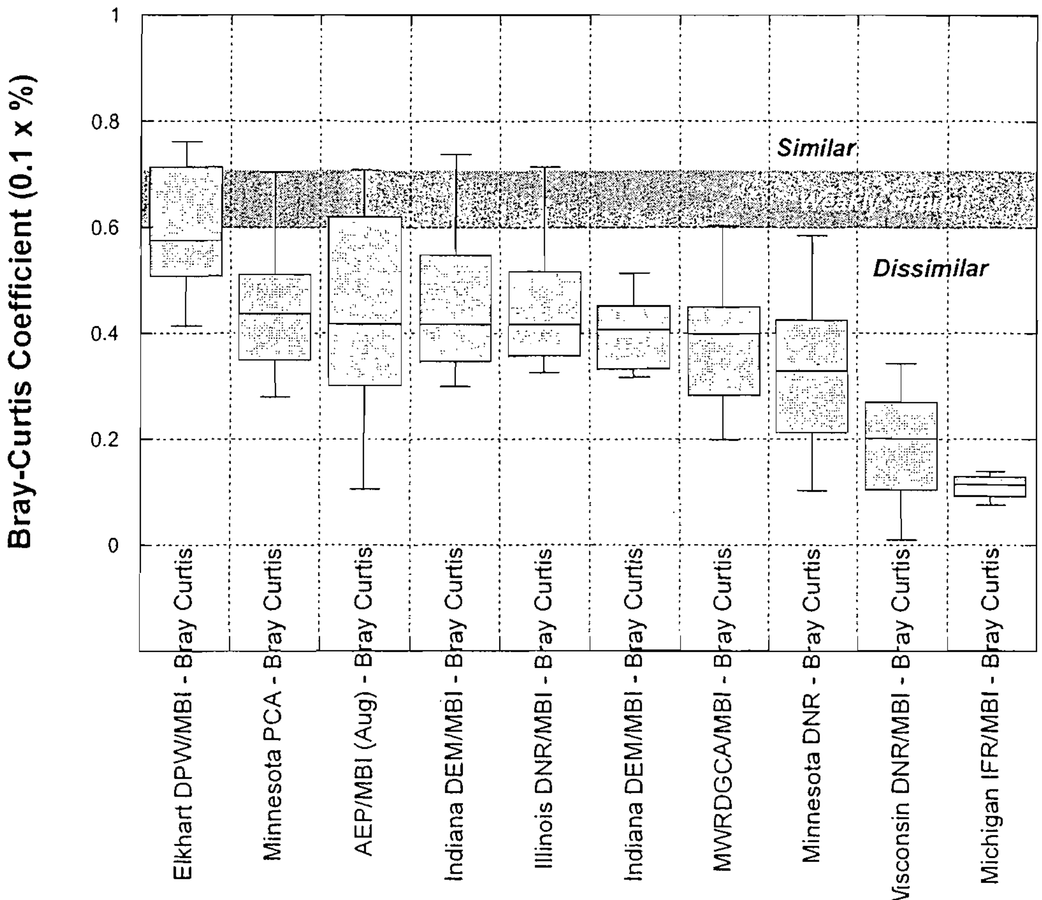


Figure 34. Box-and-whisker plots of Bray-Curtis coefficient of similarity results between each of the nine cooperating entities and MBI in each of 10 study reaches. The thresholds of similarity were derived from an independent data set available from Ohio EPA.

Conditions at the time of sampling are a potential cause of some differences and pertain largely to short-term water quality and in one case sampling at the "edge" of the seasonal index period. River levels and flow are another critical factor that can affect the efficiency of boat electrofishing due to the temporal influence on fish distribution within a site and the ability to execute the sampling protocol that includes current velocity and visibility (i.e., turbidity). At least qualitative guidelines about how to deal with these factors should be a part of large river electrofishing protocols.

Equipment settings may have been a factor in at least two of the comparisons and is an issue that needs further investigation. Power output, pulse settings, electrode configuration, and operation of the electrofishing unit (on-off sequence) are some of the variables that are likely to be important in a cumulative sense.

The principal basis of comparison used in this study was the 500 meter distance sampled by MBI and ORSANCO. This was done to normalize effort and make the comparisons "equal". In some cases MBI conformed to the longer cumulative distances sampled by most of the cooperating entities, but the effort comparisons were equal. An additional set of analyses comparing essential "unequal" protocols would have been possible, but that was not the primary focus of this study. It is recommended that additional analyses be performed to evaluate the effect of the overall protocol on the bioassessment outcome.

6.0. REFERENCES

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