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PLATFORM PROGRAM SCHEDULE

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08:20 AM SAMPLING BENTHOS IN LARGE RIVERS: CONSIDERATIONS OF SAMPLE EFFORT, POWER AND SITE MISCLASSIFICATION. **Lynn A. Bartsch**, William B. Ricahrdson and Teresa J. Naimo

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09:40 AM GENETIC ADAPTATION TO POLLUTION AND RESPONSE TO A BOTTLENECK BY FINGERNAIL CLAMS *Musculium transversum*. **Brian L. Sloss**, Michael A. Romano, and Richard V. Anderson

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11:20 AM DIFFERENCES IN SHELL MORPHOLOGY BETWEEN A RIVERINE AND LACUSTRINE POPULATION OF ZEBRA MUSSELS. **W. Gregory Cope**, Ronald R. Hayden, and Michelle R. Bartsch

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02:20 PM GROWTH OF GROUND COVER ON FLOODPLAIN HABITAT FOLLOWING SEDIMENT DEPOSITION BY FLOOD WATERS. **Richard V. Anderson** and Tracey L. Leigh

02:40 PM AMPHIBIAN MONITORING USING A BREEDING CHORUS SURVEY METHOD AT TWO MISSISSIPPI RIVER BOTTOMLAND SITES. **Michael Bornstein**, Kelly McKay, and Mike Coffey

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POSTER PROGRAM SCHEDULE

THURSDAY, APRIL 27, 1995
04:20-06:15 PM
Concourse and Pettibone Room

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STABLE ISOTOPE ANALYSIS AS A TOOL FOR IDENTIFYING TROPHIC GUILDS AND SOURCES OF ORGANIC MATTER. **J.D. Maurer**, M.D. Delong, M.C. Miller, and D. Wehr

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ABSTRACTS OF PLATFORM PRESENTATIONS

(listed in order of presentation)

SAMPLING BENTHOS IN LARGE RIVERS: CONSIDERATIONS OF SAMPLE EFFORT, POWER, AND SITE MISCLASSIFICATION.

Lynn A. Bartsch, William B. Richardson, and Teresa J. Naimo
National Biological Service, Upper Mississippi Science Center, La Crosse, WI 54603

Quantification of the benthic macroinvertebrate fauna in large floodplain rivers is complicated by large spatial scales, habitat heterogeneity, and high variability in the abundance of zoobenthos. Such factors have hampered the estimation of population size and species assemblages. To evaluate spatial variability in benthic fauna we sampled benthos of Navigation Pool 8 of the upper Mississippi River, during September 1991. To reduce the influence of habitat heterogeneity the pool was stratified into two areas, contiguous backwater and channel border. We employed the ARC/INFO Geographic Information System (GIS) to partition each strata into 2500 m^2 cells (50 m x 50 m) from the 1989 aquatic areas GIS data base at the Environmental Management Technical Center. Thirty-six cells in each stratum were randomly selected by GIS. The location (latitude and longitude) of the center of each cell (sample site) was determined by GIS. Sampling sites were located in the field with hand-held Global Positioning units (Magellan Navpro 1000 GPS). Three ponar-grab samples (525 cm^2 each) were collected at each site. We simulated the effect of various sampling efforts on power (1-beta, the ability to detect real differences in abundances between habitats) through resampling our data. Sample size (*n*) and sample area (525 cm^2 to 1575 cm^2) was varied in the simulation, and power was estimated with the Wilcoxon Rank-sum test. Power increased slightly as the area of the samples increased from 525 cm^2 to 1575 cm^2 but not sufficiently to justify the increased cost of sample processing. Power to detect differences in the abundance of Oligochaeta, Chironomidae, and total invertebrates was nearly identical for a given sample area. *Hexagenia* and *Musculium*, commonly used bioindicators of community health, occurred too infrequently in our samples to compute power. Discriminant analysis based on transformed Oligochaeta, Chironomidae, and total invertebrate abundance indicated that an average of 20 percent of the sites were misclassified. Most site misclassification was attributed to GPS positioning errors near strata boundaries, intermixing of strata in the Goose Island complex, and possible habitat misdesignation in the original GIS data base. Overall, results indicated that stratified random approach employing GIS technology to identify, and GPS technology to locate sites, can be a useful tool for allocating sampling effort for benthos in a large riverine pool.

BIOACCUMULATION OF CADMIUM BY NYMPHS OF THE BURROWING MAYFLY *HEXAGENIA BILINEATA* AS AN INDICATOR OF EXPOSURE TO SEDIMENT-ASSOCIATED CADMIUM

Michelle R. Bartsch[1,2], W. Gregory Cope[1], and Ronald G. Rada[2], [1]National Biological Service, Upper Mississippi Science Center, P.O. Box 818, La Crosse, WI 54602, [2]River Studies Center, Department of Biology and Microbiology, University of Wisconsin-La Crosse, La Crosse, WI 54601.

We examined the bioaccumulation of cadmium by nymphs of the burrowing mayfly *Hexagenia bilineata* exposed to cadmium-spiked sediment in laboratory microcosms. Surficial sediments (uppermost 5 cm) were collected from a relatively uncontaminated (0.98 µg Cd/g dry weight) site in Pool 7 of the upper Mississippi River and spiked with cadmium to achieve target sediment concentrations of 3, 8, and 16 µg Cd/g dry weight. The experimental design was completely randomized, with three cadmium-spiked sediment treatments and a reference-sediment control, with six replicates per treatment. In each replicate, 10 mayfly nymphs were exposed to the sediment treatments for 21 d. Total cadmium concentrations were measured in samples of bulk sediment, overlying test water (unfiltered), and mayfly nymphs. Mean measured concentrations of cadmium in spiked-sediment treatments were 2.6, 6.9, and 14.6 µg/g dry weight. Cadmium concentrations in the unfiltered, overlying test water ranged from 0.06 to 3.2 µg/L (ppb). Mayfly nymphs accumulated significant quantities of cadmium over the 21 d exposure period. Mean concentrations of cadmium in mayfly nymphs, which varied from 0.22 to 6.24 µg/g dry weight, was correlated with the cadmium concentration in unfiltered test water and bulk sediment. Cadmium concentrations in bulk sediments from many lakes and rivers in the Northern Hemisphere are within the range tested here, and mayflies exposed to sediment within this range rapidly accumulate cadmium, which represents a potentially substantial dietary source for the transfer of cadmium to higher trophic levels.

THREE YEARS OF FINGERNAIL CLAM (SPHAERIIDAE) AND MAYFLY (EPHEMEROPTERA) SAMPLING IN THE UPPER MISSISSIPPI RIVER SYSTEM

Jennifer S. Sauer National Biological Service, Environmental Management Technical Center, 575 Lester Avenue, Onalaska, Wisconsin 54650

The Long Term Resource Monitoring Program (LTRMP) completed 3 years of macroinvertebrate sampling in Pools 4, 8, 13, 26, the Open Reach of the Mississippi River, and La Grange Pool of the Illinois River in 1994. The objectives of LTRMP macroinvertebrate sampling are to monitor and report trends in the status and distribution of key macroinvertebrate populations. The populations of fingernail clams (Sphaeriidae), mayflies (Ephemeroptera), midges (Chironomidae), and *Corbicula* sp. were compared over the 3-year period. Sampling was based on a stratified random design and was conducted at 2,056 sites. Population numbers of fingernail clams and mayflies differed significantly between years ($P < 0.05$). Variations in organism densities were seen among study reaches, aquatic areas, and substrate types. Although at this time the causal factors of these variations are unknown, it is hoped that continued long-term monitoring will help determine the reasons for these spatial and temporal changes.

DOES WATER VELOCITY AND DEPTH AFFECT FINGERNAIL CLAM DISTRIBUTIONS IN LAKE ONALASKA?

Randy Burkhardt. National Biological Service, Environmental Management Technical Center, Onalaska, WI 54650.

Twenty-four standard ponar grabs were collected near Arrowhead Island at 100-m, 300-m and 500-m intervals along 8 transects during September 1993 and 1994. In 1994, four additional transects were sampled near Broken Gun and Cormorant Islands. Bathymetry coverages were used to estimate water depth. FastTABS was used to estimate water velocities based on average discharges from Lock & Dam 6 during June, July, August, and September 1993 (80,000 cfs) and 1994 (30,000 cfs). Fingernail clam densities were significantly ($P<0.001$) associated with water velocity and depth. However, fingernail clam density and bulk sediment density were uncorrelated ($P>0.05$). These data suggest that fingernail clams may prefer specific ranges of water velocities and depths in Lake Onalaska. These criteria may be used to determine other locations of FNC's using FastTABS and bathymetry coverages.

GENETIC ADAPTATION TO POLLUTION AND RESPONSE TO A BOTTLENECK EFFECT BY FINGERNAIL CLAMS (*Musculium transversum*)

Brian L. Sloss, Michael A. Romano, and Richard V. Anderson
Department of Biological Sciences, Western Illinois University, Macomb, IL 61455.

For nearly fifty years, the fingernail clam *(Musculium transversum*) was believed to be virtually eliminated from the Illinois River. However, in 1991, workers began finding substantial populations of *M. transversum* in the Illinois River. The new findings included several beds of clams in and around the Chicago Sanitary District in the Northern section of the Illinois River. The populations in the Chicago area occupy sediments which contain high levels of toxic substances (ammonia, heavy metals, assortment of petroleum hydrocarbons, etc...). Un-ionized ammonia has been shown to adversely affect the growth and survival of *M. transversum* in both laboratory and field tests. Therefore, clams occurring in the Chicago area must be more resistant to ammonia than those from other sections of the Illinois River.

The objectives of this project were as follows: (1) examine the genetic structure of several populations of *M. transversum* for any apparent changes due to the population crash and (2) determine if Chicago area *M. transversum* exhibited any genetic adaptations to the high levels of toxins. Starch-gel electrophoresis was performed on *M. transversum* from three Illinois River localities and one Mississippi River location.

The populations produced an $F_{IS}=0.874$ indicating the populations are highly inbred. Despite the high F_{IS} value, some outcrossing is apparent (complete inbreeding would produce an $F_{IS}=1.00$). The results of a mild bottleneck is apparent by an $F_{ST}=0.144$. This bottleneck effect occurred when small populations of clams became isolated within the Illinois River. This isolation resulted in an increased F_{ST} value. However, the bottleneck was not severe enough to result in erosion of genetic variability (an F_{ST} between 0.05 and 0.15 illustrates moderate genetic differentiation).

The isozyme *Glucose-phosphate isomerase-2 (Gpi-2)* produced allelic frequency patterns which are consistent with expected patterns of a pollution-tolerant allele. The $Gpi\text{-}2^{100}$ allele appeared in frequencies of 0.821 and 0.867 at River Mile 292.5 and RM 318.5 (Chicago area) respectively. The frequency drops to 0.406 at RM 6.0 (Grafton, IL) and 0.657 at Mississippi River mile 525.2 (Pool 13). This frequency pattern suggests natural selection is occurring in populations under severe toxic pressures (RM 292.5 and 318.5) leading to the increase in the frequency of the allele $Gpi\text{-}2^{100}$. In other words, the $Gpi\text{-}2^{100}$ is a possible pollution-tolerant adaptation in *M. transversum*.

MUSSEL DISTRIBUTION PATTERNS IN HABITATS OF POOL 19, MISSISSIPPI RIVER

Richard V. Anderson, Dept. Biological Sciences, Western Illinois University, Macomb, IL 61455, Jack Grubaugh, Dept. of Biology, Division of Ecology and Organism Biology, University of Memphis, Memphis, TN 38152, Jennifer L. Owens, Dept. of Botany, Iowa State University, Ames, IA 50010, and Dave Day, IL.DOC, Fisheries Analysis Section, Springfield, IL 62706

Distribution patterns in animals may reflect habitat use and/or life history patterns. Mussel communities are found in 3 to 4 habitat types in Pool 19 of the Mississippi River; shallow channel border, adjacent channel border, side channel, and channel. Plot sampling was used to determine density and distribution patterns of mussels at 8 locations covering these habitat types and in the pool. In general mussels were randomly distributed in shallow channel border habitats, tended toward clumping in side channel and adjacent channel border habitat and were often clumped in channel habitats. Within pool location of a habitat, tested on shallow channel border habitat, did not change the distribution pattern. However, mussel density in this habitat did increase with downstream location of the site. The dominant species at all sites was the threeridge, *Amblema plicata*. This species tended to exhibit random distribution pattern in all habitat types and locations in the study, though some tendency toward clumping was found in channel habitat. Because of the lower density of mussels in shallow channel border habitat, the dominance of threeridge effected the overall distribution pattern of the mussel community in this habitat type. While densities were low in shallow channel border habitat some species did show a tendency toward clumping, particularly the giant floater (*Pyganodon grandis*) and fragile papershell (*Leptodea fragilis*). In the case of the fragile papershell there was some indication of seasonal shift in distribution pattern with clumping occurring toward late summer or early fall. Clumping may occur do to alluvial sorting, particularly in habitats with higher current velocities, or reproductive need. Random distribution may reflect homogeneous habitat conditions.

ARE UNIONID TRANSLOCATIONS A VIABLE MITIGATION TECHNIQUE? THE WOLF RIVER, WI, EXPERIENCE, PART III: AUGUST 1994.

Marian E. Havlik and Michael G. Havlik, Malacological Consultants, 1603 Mississippi Street, La Crosse, WI 54601-4969.

In August 1992, 8120 marked unionids of 13 taxa were translocated from County A bridge, Wolf River, N of Shawano, WI. Ten - 1.0 m^2 quads from two bridge piers areas yielded a mean of 9.7 unionids/m^2. At the 461 m^2 translocation site pre-project mean densities were 20.7/m^2 (10 - 1.0 m^2 quads). Unionids were out of water 15 minutes to identify and mark, then stored in mesh bags in the river before same day translocation. One goal was to double translocation site densities. Malacological Consultants funded followup. In 1993 we collected 373 living unionids from 6 - 1.0 m^2 quads (mean density 62.2/m^2); 120 were marked specimens including 2 threatened specimens. One year survival was 98.36% (2 dead marked unionids). "Marked" mussel density of 20.3/m^2 confirmed we nearly doubled the original translocation site density. 32.2% of the (tripled) densities were from marked unionids; 33.3% were from the pre-project (ambient) density; the other 34.5% (21.2/m^2) of the densities were from an unknown source. Perhaps pre-project densities were the result of diver efficiency, or we simply did not sample areas of unionid concentrations, and/or densities increased after the 1993 floods. No mortalities were found among 33 translocated, threatened unionids. Anodonta imbecillis Say, 1829, was added to the site species list. The seventh quadrat sampled (data excluded above) yielded 74% of 100 specially marked unionids from a 1.0 m^2 quad; pre-project density in this quad was represented by 31 unmarked unionids found in 1993. No dead specimens were in this quad.

The Conchologists of America co-sponsored the August 1994 translocation followup. 31 random 0.25 m^2 quadrats yielded 478 living unionids (mean 61.9/m^2), including 152 living (plus 2 dead) marked unionids. Site density was just slightly lower than in 1993, but 9 juveniles were found. All hash marks, on anterior valve ends, were clearly legible after 2 years, even on the three dead specimens; one additional dead marked mussel was found during a random site search. 1994 survival among marked unionids was 98.9% (mean density 19.9/m^2; 31.8% of total living). 326 unmarked living unionids were found; two unmarked Alasmidonta viridis (Raf., 1820) were numbered. Since 1992 Elliptio dilatata (Raf., 1820) have increased from 71.4% > 73.3% (1993) > 78.9% (1994). Few fresh-dead were among 152 empty shells; most were sub-fossil or fragments. Ten of the 100 specimens from the 1992 special quadrat were recovered a second time, even though these specimens (74) were returned to the river from the surface in 1993 because divers ran out of air; none of those uniquely marked unionids have been found dead. These data show our methods resulted in a successful translocation, 2 years post-project, even at doubled to tripled densities, although the relative abundance of the dominant species has increased slightly.

TEMPORAL PATTERNS IN THE DENSITY, SIZE-DISTRIBUTION, AND SETTLEMENT OF ZEBRA MUSSEL VELIGERS IN THE ILLINOIS RIVER.

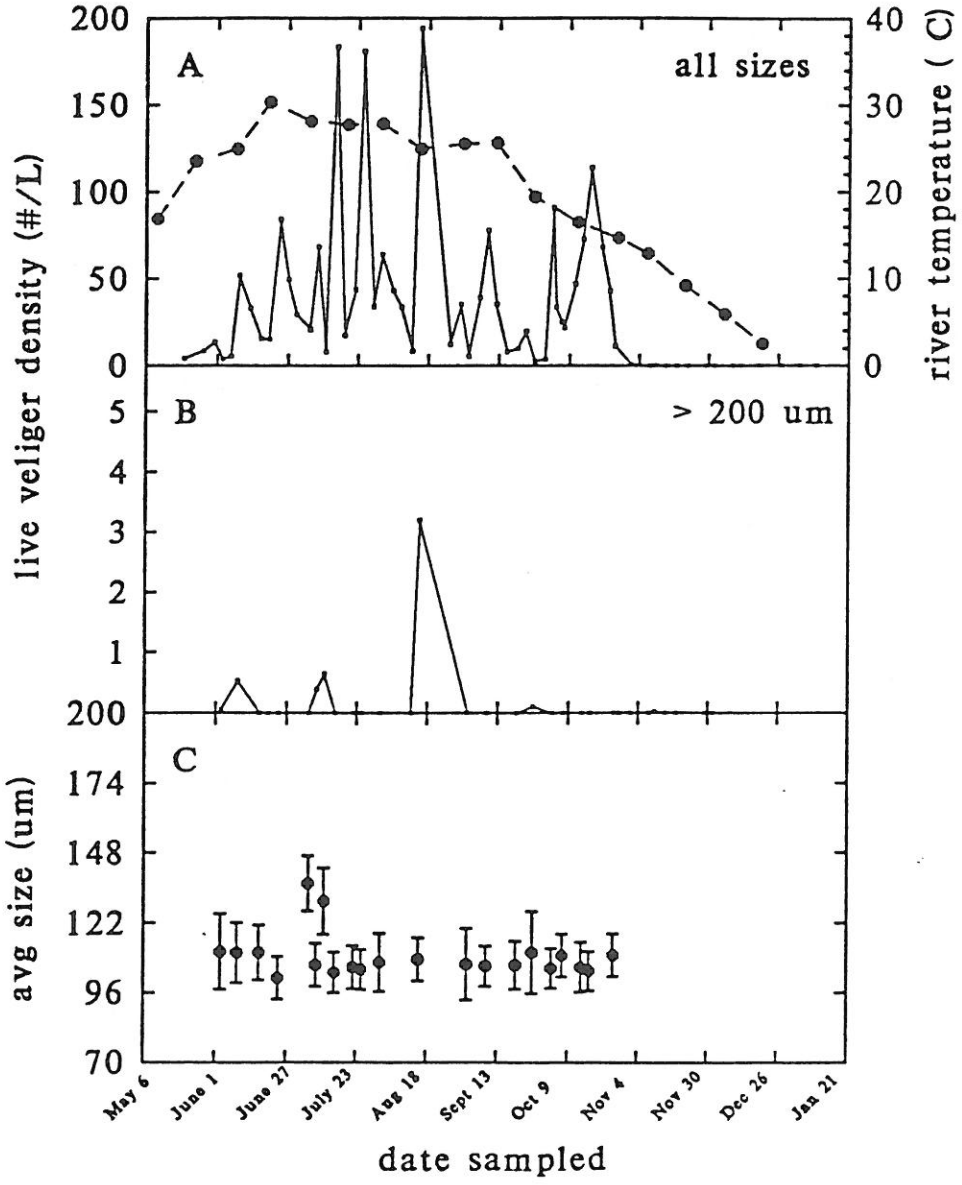
James A. Stoeckel, Lori Camlin, K. Douglas Blodgett, and Richard E. Sparks
Illinois Natural History Survey, Long Term Research Monitoring Program, 704 N. Schrader Ave., Havana, Illinois 62644

Due to the planktonic nature of zebra mussel veligers, recruitment to the adult zebra mussel population in a particular stretch of a river is dependent upon the production and drifting rates of veligers spawned by upstream adults. This contrasts with lake systems in which reduced water flow allows local populations to "self-recruit." In 1993, zebra mussels had reached a mean density of 61,126/m^2 in a downstream portion of the Illinois River, making it one of the most heavily infested rivers in North America. The small size and uniform size-structure of mussels in this downstream population suggested that the majority had come from a single, massive settling event earlier in the year. However, no data on veliger production and distribution in the Illinois River were available. To develop effective and economical management strategies for riverine zebra mussel populations, it is necessary to understand production rates and the drift and settlement characteristics of riverine veligers.

Beginning in May, 1994, zebra mussel veliger drift at a single site (river mile 121) in the Illinois River was monitored weekly to characterize the temporal and spatial distributions of the various veliger stages throughout the year. Live veligers were found continuously from May through October (water temp >12° C) and sporadically from November through December (water temp <12° C) . Veliger densities at a single site in the Illinois River often exhibited dramatic fluctuations within a few days (i.e. from 20/L to 200/L to 30/L in 6 days) indicating the passage of distinct veliger pulses produced by upstream populations (fig. 1a). Greater than 90% of live veligers collected on each date (excepting two July dates) were still in the D-stage. Average size of veligers collected on these dates was <120 *um* (fig. 1c). Densities of veligers >200 *um* never exceeded 4/L (fig. 1b). Because veligers rarely settle before attaining sizes in excess of 200 *um*, the chances of a major settling event occurring at this site were considered remote. Settling plates were monitored weekly from August through December. No settlers were found attached to any of the plates.

Distinct veliger pulses containing similar sized individuals should result in highly localized settling sites in downstream stretches of the river, such as the previously described site found in 1993. If these veliger drift characteristics hold true in subsequent years, recruitment to zebra mussel populations in the Illinois River will probably exhibit a high degree of spatial heterogeneity with some patches receiving heavy recruitment and other patches receiving almost no recruitment during any given year. Power plants and other industries along infested rivers may be able to reduce zebra mussel control costs by monitoring veliger drift and controlling for veligers only when large-sized (>200 *um*) individuals are present.

Figure 1. Seasonal changes in size and densities of zebra mussel veligers in the Illinois River (river mile 121)



DIFFERENCES IN SHELL MORPHOLOGY BETWEEN A RIVERINE AND LACUSTRINE POPULATION OF ZEBRA MUSSELS.

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While studying the population dynamics of zebra mussels *Dreissena polymorpha* in the upper Mississippi River (near La Crosse, Wisconsin), we observed that the shell morphology of the riverine mussels appeared ventrally compressed relative to mussels of similar size from the Great Lakes. To assess potential differences in shell morphology, we examined the shell characteristics of a riverine and lacustrine population of zebra mussels. A composite sample of zebra mussels, each containing about 1,100 organisms and ranging in shell length from 2 to 40 mm, was collected from Pool 7 of the upper Mississippi River (near Trempeleau, Wisconsin) and from Lake Michigan (near Racine, Wisconsin). The shell of each zebra mussel was measured for length, height, ventral width, and mid-shell width to the nearest 0.01 mm with digital calipers. Because the shell morphology measurements of a given mussel are inter-correlated, variation between sites in shell morphology of zebra mussels was evaluated with multivariate statistical procedures. The shell morphology of zebra mussels varied significantly between sites (MANOVA, Wilks' Lambda Statistic; $p < 0.01$), with differences only occurring in ventral width (univariate results of one-way multivariate ANOVA; $p < 0.01$). The zebra mussels from the upper Mississippi River were wider or more ventrally compressed than mussels of similar length from Lake Michigan, possibly an adaptation for becoming more hydraulically efficient in flowing waters. Although this discovery will not affect the overall management options for zebra mussels in the Mississippi River, it further illustrates the adaptability and genetic plasticity of this invasive, introduced species.

EFFECTS OF ZEBRA MUSSEL COLONIZATION OF NATIVE UNIONIDS IN THE ILLINOIS RIVER

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Native unionid mussels of the Illinois River, likely will be one of the first riverine mussel populations in the Mississippi River drainage to experience the devastating impacts of a zebra mussel (*Dreissena polymorpha*) population explosion. Zebra mussels may not only reduce biological diversity (there are 23 species of native mussels in the Illinois River alone) but also endanger up to 10,000 U.S. jobs and $80 million worth of shell exports to the Pacific cultured pearl industry. Since the summer of 1993, we have monitored the effects of zebra mussels on unionid mussels in five main channel beds along the lower 180 miles of the Illinois River (Figure 1). Following the tremendous spawn and settlement of zebra mussels in the spring and early summer of 1993, infestation of native unionids at river mile (RM) 5.5 increased to 99.4% (n=160) with a mean of 254.5 attached zebra mussels per unionid, whereas in 1992, 27% (n=63) averaged only 2.2 attached zebra mussels. Similarly, overall unionid mortality at RM 5.5 increased from 0.01% in August 1993 to 22.4% in June 1994. Overall unionid mortalities at the five sites showed a significant positive correlation (r^2=.9689) with fall 1993 zebra mussel densities. Native mussels identified as recent dead generally had their soft parts intact, as the shells were held shut by the overwhelming number of attached zebra mussels. Individual species differed greatly in their susceptibility to zebra mussel infestation (Table 1). Negative impacts on native mussels will be more accurately assessed by analyzing both acute and chronic effects of zebra mussel infestations. Therefore, besides the endpoint of death, we are also measuring more subtle effects such as the amount of glycogen, the primary energy storage product of native mussels, present in the tissue of several mussel species.

By August 1994, zebra mussels in the lower Illinois River had experienced a population crash, likely due to overpopulation in 1993 coupled with poor environmental conditions in 1994. Similarly, infestation of native unionids at RM 5.5 declined to 80.3% (n=234) in 1994, with an average of 22.5 zebra mussels per unionid. The overall mortality of native unionids at the five Illinois River sites in 1994 is more closely correlated with the fall 1993 zebra mussel densities (r^2=.9689) rather than those from June 1994 (r^2=.3720). This correlation suggests delayed unionid mortality possibly due to reduced fitness, resulting in increased susceptibility to additional stressors. Time will tell whether the zebra mussel crash in the Illinois River during the summer of 1994 will serve as a temporary reprieve in the seemingly inevitable demise of riverine unionid mussels.

Figure 1. *Zebra mussel and native unionid sample sites in the Illinois and Mississippi Rivers (1993-94).*

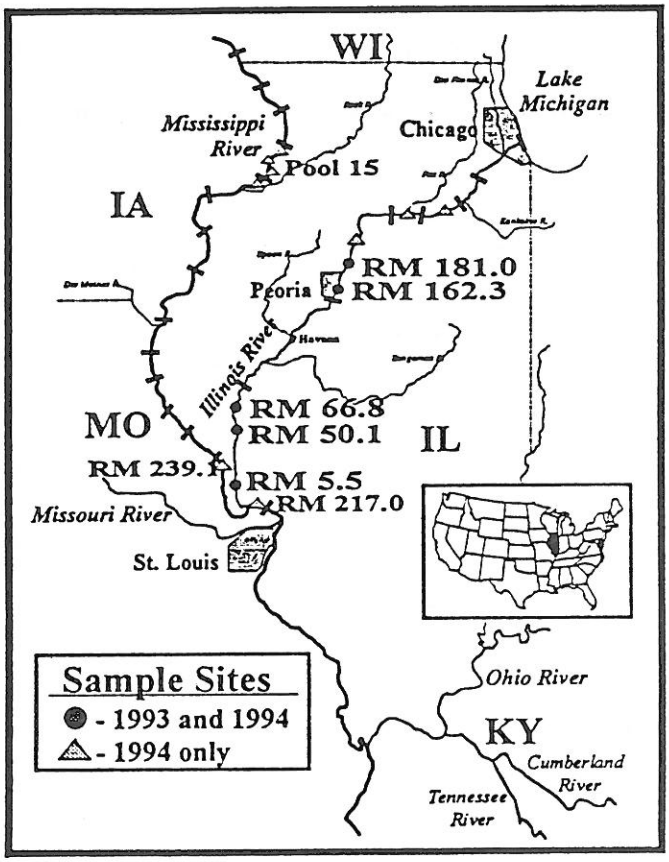

Table 1. *Impacts of zebra mussels (ZBM) on native mussels in the Illinois River during 1993 and 1994.*

Site	RM 162.3 (Peoria)			RM 66.8 (Meredosia)			RM 50.0 (Montezuma)			RM 5.5 (Grafton)		
Native Mussels / Date	7/15/93	6/13/94	10/17/94	7/11/93	6/18/94	10/13/94	10/01/93	6/7/94	10/11/94	8/18/93	6/27/94	10/1/94
Overall Mortality (%)	0.0	0.0	4.6	2.1	6.0	47.7	1.8	2.1	9.5	1.6	22.2	16.6
Avg. Infestation (%)	88.2	90.7	71.3	95.0	59.0	56.8	89.4	88.2	95.2	99.5	85.6	59.1
Avg. No. ZBM/Unionid	7.7	59.4	14.2	105.3	38.4	4.3	28.0	34.5	—	254.5	24.7	3.9
Common Species	Average Mortality (%) by Species											
Amblema plicata	0.0	0.0	4.5	3.8	0.0	21.4	2.4	0.9	6.8	4.2	6.8	9.9
Leptodea fragilis	0.0	0.0	12.5	1.7	13.3	77.8	0.0	3.6	33.3	0.0	50.0	25.0
Quadrula quadrula	0.0	0.0	0.0	0.0	0.0	66.7	0.0	1.4	7.1	0.0	0.0	0.0
Obliquaria reflexa	0.0	0.0	0.0	0.0	0.0	33.3	11.1	10.0	0.0	0.0	24.0	28.6
Truncilla truncata	0.0	0.0	5.7	2.9	14.3	60.0	2.4	4.5	—	0.0	77.4	90.9

CHANGES IN ZEBRA MUSSEL DENSITIES IN THE UPPER MISSISSIPPI RIVER: 1991-1994.

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We have used two sampling procedures to make yearly assessments of zebra mussel densities: 1) collections of rocks from two wing dams in Pool 10 near Prairie Du Chien, and 2) unionids collected from several pools in the upper Mississippi River. No zebra mussels were present in the wing dam samples in 1991 or in 1992. Zebra mussels were present in the wing dam samples in 1993, although in low densities. The wing dam collections in 1994 showed a marked increase in zebra mussel densities, e.g. 1994 had a mean of 118 *D. polymorpha* per m^2 of rock surface on the downstream side of wing dam #1, as compared to a density of 6 individuals per m^2 at the same site in 1993. Zebra mussel densities on unionids in 1994 also exceeded the densities of earlier years. Infestation rates of unionids by *D. polymorpha* (the percent of unionids colonized by at least one zebra mussel) varied markedly among the river's pools in 1994. For example, less than 1% of the unionids in Pool 24 were colonized by zebra mussels, while the infestation rate of the unionids collected in Lake Pepin was approximately 25%. Our data indicate that, as of 1994, zebra mussel densities in the upper Mississippi River were relatively low compared to densities observed in the Illinois River and in the lower Ohio River. However, the data also clearly show that *Dreissena* densities have been steadily increasing in the upper Mississippi River through time, and are likely to continue to increase in the near future.

FOREST DISTURBANCE WITHIN THE UPPER MISSISSIPPI RIVER FLOODPLAIN FOLLOWING THE 1993 FLOOD.

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Definitions of disturbance within large river-floodplain ecosystems include unpredictable events in time and in magnitude that disrupt ecosystem, community, or population structure. Flooding within the Upper Mississippi River (UMR) during 1993 was unusual in terms of its timing, duration, and magnitude. Despite the atypical conditions, few experts predicted the flood would have long-lasting effects on floodplain forests until the real impacts became evident in the spring of 1994 when many trees failed to leaf out. We investigated seven reaches of the UMR to assess flood induced tree mortality. The seven river reaches were navigation Pools 4, 8, 13, 17, 22, and 26, and an open river reach near Cape Girardeau, Missouri. Within each river reach, fifteen transects were established perpendicular to the river and across the floodplain. Sampling points along each transect were systematically spaced at either every 30 m or 60 m of forest, depending on extent of forest cover. At each sampling point, four trees and four saplings were sampled using the point-centered quarter method. A total of 4,564 trees and 3,529 saplings were sampled. Results reveal that from near the UMR headwaters (Pool 4), downriver to the confluence with the Missouri River (Pool 26), tree mortality rates increased progressively from 1.1% to 37.2% and sapling mortality rates increased from 1.8% to 80.1%. Further downriver, in the open river reach, mortality rates were similar to those in Pool 26 with 32.2% of mature trees dead and 77.2% of saplings dead. The degree of forest disturbance throughout the UMR correlated well with the degree of flooding during 1993 (Figure 1). The forests along the Pool 26 floodplain were the most severely impacted among the river reaches investigated. On a population level, several tree species exhibited over 50% mortality throughout the entire floodplain. On a community level, many oak-hickory forests of the Pool 26 floodplain exhibit near 100% mortality.

Field observations indicate that first year seedlings were abundant in the summer of 1994. Most of these seedlings were silver maple (*A.saccharinum*) and boxelder (*A. negundo*). However, in Pools 17, 22, and 26, and in the open river reach, sizable patches of black willow (*S. nigra*), eastern cottonwood (*Populus deltoides*), and sycamore (*Platanus occidentalis*) were also frequently encountered. These patches occurred exclusively on areas where all layers of above ground vegetation had been killed and new sediments were deposited. Abundant bur oak (*Q. macrocarpa*) regeneration was observed while sampling within an oak-hickory forest community of Pool 26.

Impacts of the 1993 flood demonstrate that an unusual and prolonged high amplitude flood event can dramatically affect the composition and structure of forests within a large river-floodplain ecosystem. One implication is that infrequent and unusual flood events may represent an important natural disturbance mechanism necessary for the establishment of early successional tree species and forest communities.

Overall mortality rates varied among species and were negatively correlated with tree diameter and positively correlated with flood duration and flood amplitude. The impacts of the 1993 flood demonstrate that an extreme flooding in a single growing season is enough to constitute a severe disturbance to the river-floodplain ecosystem, whose effects may last for decades to come.

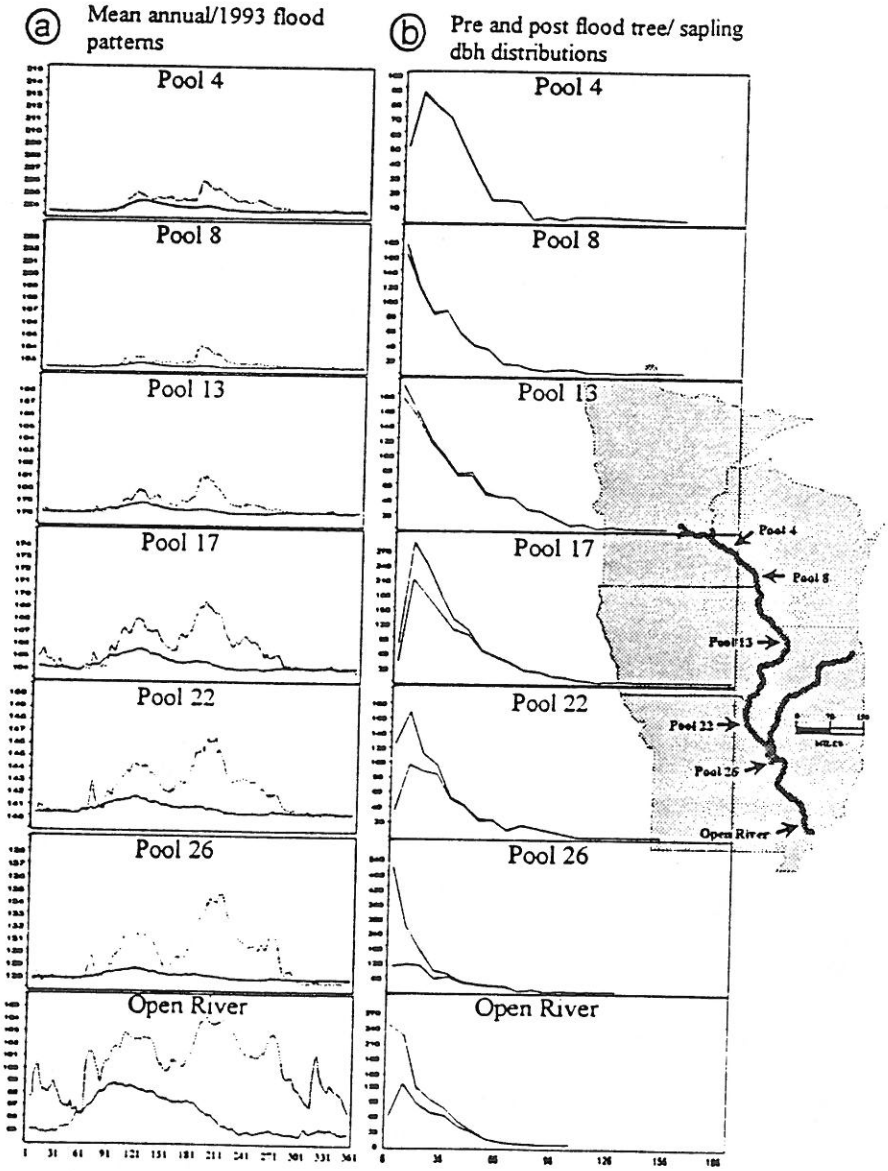

Figure 1. Hydrographs and tree/sapling dbh distributions for each navigation reach sampled in this study. Column (a) shows mean annual hydrograph (solid line) vs. the 1993 flood hydrograph (dashed line) per study reach. Y-axies are water surface elevation (m) and X-axies are day of year. Column (b) shows pre and post 1993 flood tree/sapling dbh distributions per study reach. Y-axies are number of trees/saplings and X-axies are dbh size classes (cm). The gap between the pre and post flood curves represents flood induced mortality.

COMMUNITY SHIFTS IN SHALLOW CHANNEL BORDER HABITAT OF POOL 19, FOLLOWING THE FLOOD OF 1993

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Aquatic macrophyte beds which had developed in the lower portion of Pool 19 were absent in the year following the flood of 1993. A series of benthic dredge samples were taken in an area previously covered with aquatic macrophytes to determine what effect the habitat shift had on the macroinvertebrate community. The benthic invertebrate community prior to the flood was characterized by low density but high diversity and a conspicuous absence of burrowing mayflies and fingernail clams. During the 1994 sampling, high densities of fingernail clams (several 1000/m^2) and burrowing mayflies (several 100/m^2) were present in most samples. These organisms had rapidly colonized areas from which they had been excluded. Diversity in this habitat remained high with many snail and insect species also present. Similar to conditions prior to the flood, organic matter content of the substrate was high, providing an abundant food resource for the benthic organisms. However, dissolved oxygen was also high due to some current in the area. Thus, optimum conditions were present for the development of dense benthic communities. Whether these communities will persist may depend on the rate of recovery of the aquatic macrophytes is these shallow channel border habitats.

GROWTH OF GROUND COVER ON FLOODPLAIN HABITAT FOLLOWING SEDIMENT DEPOSITION BY FLOOD WATERS

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As a result of the 1993 flood large amounts of sediment were deposited in floodplain habitats. Burial by deposited sediment as well as the duration of floodwater inundation resulted in the elimination of most ground vegetation through 1993 and into 1994. While a relatively rich seedbank was present in the deposited sediments, revegetation occurred slowly. Evaluation of the seedbank and developing plant communities in forested and open floodplain areas below Lock and Dam 19 was done using field and greenhouse plots. Most flood deposited seeds were present in the deepest sediments or on the sediment surface. In greenhouse studies, few plants developed from intermediately deposited sediments. While surface sediments contained large quantities of seeds, plants that developed were probably primarily due to aeolian deposition. Few surface plants grew in the forested area in spite of good plant growth in greenhouse plots using sediments collect from forested habitat. Greenhouse germination of seeds in sediments from the forest habitat produced communities similar to those found in open fields. Propagules of shade tolerant plants had not yet accumulated in forest floor sediments either in the seedbank or through other delivery mechanisms. Development of ground plants in the open field habitat of the floodplain produced dense stands of annual plants and some grasses. While seeds for some of these plants could be found in the seed bank, many were probably delivered to the area after flood waters had receded. The seedbank in deposited sediments does not appear to account for much of the new plant development in these floodplain habitats following major flooding.

AMPHIBIAN MONITORING USING A BREEDING CHORUS SURVEY METHOD AT TWO MISSISSIPPI RIVER BOTTOMLAND SITES

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Amphibian populations were monitored for species richness and relative abundance using a nocturnal breeding chorus survey method during 1993 and 1994 at the Big Timber and Keithsburg Divisions of Mark Twain National Wildlife Refuge. The Big Timber Division is a contiguous backwater complex with the Upper Mississippi River (UMR), dominated by mature bottomland hardwood forest. The Keithsburg Division is a leveed backwater complex adjacent to the UMR, dominated by early successional forest. Both of these sites experienced prolonged flooding as a result of the 1993 Flood. Three locations at each site were surveyed for ten minutes during three distinct time periods. Abundance values were assigned to each species based on the relative number of calling individuals, following Iowa Department of Natural Resources protocol. Seven species of amphibians were found on the Big Timber Division during 1993, while eight species were found during 1994. Eight amphibian species were identified on the Keithsburg Division in 1993, and eight species were heard during 1994. Abundance values indicated some amphibian species such as *Hyla versicolor*, *Pseudachris triseriata*, and *Bufo americanus* may have experienced decreased productivity in the contiguous UMR backwaters of Big Timber Division. These habitats were adversely impacted by prolonged flooding and associated increased currents. Abundance values indicated impacts may have been less severe at floodplain backwaters non-contiguous with the UMR, such as the Keithsburg Division.

LOCAL AND REGIONAL HABITAT ASSOCIATIONS OF UPPER MISSISSIPPI RIVER FLOODPLAIN FOREST BIRDS AND EFFECTS OF FOREST FRAGMENTATION.

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Population declines for some Neotropical bird species have raised concerns about loss of songbird breeding habitat in the continental U.S. Large floodplain forests represent one wetland habitat reduced in extent by 70-90% since the 1800's. These forested wetlands provide breeding habitat for some bird species which are uncommon or declining in upland forests of the central Midwest. Our study of Upper Mississippi River floodplain forests conducted during 1992-1994 examined the floodplain forest breeding bird community and its habitat associations. Census data were collected over three breeding seasons. This information is of value as a benchmark for evaluating future change in the bird community over the study area. One objective was to examine the effect of floodplain forest fragmentation on Neotropical migrant birds. Vegetation data were collected at the plot level and regional patterns of habitat interspersion were assessed using GIS analysis. Significant trends in single species relative abundance vs. levels of forest fragmentation were not found. Multivariate analysis of the bird community and plot and regional habitat variables results in significant habitat associations. Plot-level vegetation variables and characteristics of the landscape surrounding bird census plots were used to cluster plots into forest habitat sub-types. Bird species relative abundances were used in a discriminant analysis to classify the plots. Agreement between the habitat clusters and bird data was high, meaning that bird species differ in their affinity for floodplain forest sub-types. Analysis of the landscape variables alone results in some significant bird associations and can yield information useful for managing floodplain forests for avian diversity.

Table 1. Percent of plots floodplain forest bird species were identified from in 1992.

Common Name	Scientific Name	Percent	Common Name	Scientific Name	Percent
American Robin	*Turdus migratorius*	98	Mourning Dove	*Zenaida macroura*	29
House Wren	*Troglodytes aedon*	97	Ruby-throated Hummingbird	*Archilochus colubris*	19
Great Crested Flycatcher	*Myiarchus crinitus*	95	Pileated Woodpecker	*Dryocopus pileatus*	17
Northern Oriole	*Icterus galbula*	95	Cedar Waxwing	*Bombycilla cedrorum*	14
American Redstart	*Setophaga ruticilla*	94	Veery	*Catharus fuscescens*	14
Eastern Wood-Pewee	*Contopus virens*	94	Barred Owl	*Strix varia*	11
Yellow-bellied Sapsucker	*Saphyrapicus varius*	92	Cerulean Warbler	*Dendroica cerulea*	11
Song Sparrow	*Melospiza melodia*	90	Chimney Swift	*Chaetura pelagica*	11
White-breasted Nuthatch	*Sitta carolinensis*	89	European Starling	*Sturnus vulgaris*	11
Brown-headed Cowbird	*Molothrus ater*	87	Wood Duck	*Aix sponsa*	11
Downy Woodpecker	*Picoides pubescens*	84	Scarlet Tanager	*Piranga olivacea*	10
Prothonotary Warbler	*Protonotaria citrea*	84	Belted Kingfisher	*Megaceryle alcyon*	8
Red-bellied Woodpecker	*Melanerpes carolinus*	83	Acadian Flycatcher	*Empidonax virescens*	6
Northern Cardinal	*Cardinalis cardinalis*	83	Bald Eagle	*Haliaeetus leucocephalus*	6
Common Grackle	*Quiscalus quiscula*	81	Least Flycatcher	*Empidonax minimus*	6
Common Yellowthroat	*Geothlypis trichas*	79	Mallard	*Anas platyrhynchos*	6
Red-winged Blackbird	*Agelaius phoeniceus*	79	Ovenbird	*Seiurus aurocapillus*	6
Gray Catbird	*Dumetella carolinensis*	75	Red-shouldered Hawk	*Buteo lineatus*	5
Blue-gray Gnatcatcher	*Polioptila caerulea*	73	American Woodcock	*Philohela minor*	3
American Crow	*Corvus brachyrhynchos*	68	Brown Thrasher	*Taxostoma rufum*	3
Northern Flicker	*Colaptes auratus*	68	Carolina Wren	*Thryothorus ludovicianus*	3
Black-capped Chickadee	*Parus atricapillus*	67	Eastern Bluebird	*Sialia sialis*	3
Blue Jay	*Cyanocitta cristata*	63	Eastern Kingbird	*Tyrannus tyrannus*	3
Hairy Woodpecker	*Picoides villosus*	63	Hooded Merganser	*Lophodytes cucullatus*	3
Warbling Vireo	*Vireo gilvus*	62	Purple Martin	*Progne subis*	3
Tree Swallow	*Iridoprocne bicolor*	59	Willow Flycatcher	*Empidonax traillii*	3
Yellow-throated Vireo	*Vireo flavifrons*	56	Wood Thrush	*Hylocichla mustelina*	3
American Goldfinch	*Carduelis tristis*	54	Black-billed Cuckoo	*Coccyzus erythropthalmus*	2
Brown Creeper	*Certhia familiaris*	51	Chipping Sparrow	*Spizella passerina*	2
Red-eyed Vireo	*Vireo olivaceus*	51	Eastern Tufted Titmouse	*Parus bicolor*	2
Red-headed Woodpecker	*Melanerpes erythrocephalus*	46	Field Sparrow	*Spizella pusilla*	2
Yellow Warbler	*Dendroica petechia*	44	Great Horned Owl	*Bubo virginianus*	2
Yellow-billed Cuckoo	*Coccyzus americanus*	41	Rufous-sided Towhee	*Pipilo erythrophthalmus*	2
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	37	Sandhill Crane	*Grus canadensis*	2
Great Blue Heron	*Ardea herodias*	30	Wild Turkey	*Meleagris gallopavo*	2
Indigo Bunting	*Passerina cyanea*	30			

A COMPARISON OF AVIFAUNAL MONITORING TECHNIQUES AT TWO MISSISSIPPI RIVER SITES USING POINT COUNT AND AREA SEARCH METHODS

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Avian diversity was monitored in 1994 using two survey methods at the Big Timber and Keithsburg Divisions of Mark Twain National Wildlife Refuge. The Big Timber Division is a contiguous backwater complex with the Upper Mississippi River, Pool 17, dominated by mature bottomland hardwood forest. The Keithsburg Division is a leveed backwater complex adjacent to the Upper Mississippi River, Pool 18, dominated by early successional forest. Each site was surveyed twice each week for three weeks during spring and fall migration, and twice each month during the breeding season. One survey used a ten-minute point count method at ten permanently marked points. The second survey used a four-hour area search technique. At Big Timber 113 species were identified, including 53 neotropical migrants. At Keithsburg 124 species, including 48 neotropical migrants, were identified. Neither differences in species diversity nor diversity of neotropical migrants was found to be significant based on chi-square analysis. In addition to site comparisons of avifaunal diversity, we also analyzed bird diversity between methods, comparing the 100 minutes of search effort from point counts to the first 100 minutes of area search. In fifteen of the sixteen comparisons, species diversity was greater during point counts than the first 100 minutes of area search. These results suggest point counts may be a preferred method for sampling avifaunal diversity since they produce similar results to area search techniques, and also provide fixed reference points which serve as the basis for habitat comparisons.

DID THE WILD TURKEY CROSS THE MISSISSIPPI JUST TO GET TO THE OTHER SIDE?

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During the course of our research on the genetics of reestablished populations of wild Turkey, *Meleagris gallopavo silvestris*, we discovered an unanticipated effect of the Mississippi and Ohio Rivers on the birds. We determined that stocking history can roughly explain the genetic structure of reestablished populations throughout Illinois. For example, an inverse relationship exists between the total number of trapped birds used to found a new colony and the proportion of polymorphic loci, P ($r^2 = 0.279$, $p = 0.007$).

Counties lining the Mississippi and Ohio Rivers seemed to deviate noticeably from this pattern. When 12 river counties are considered separately, the relationship disappears ($r^2 = 0.169$, $p = 0.184$); however, the relationship remains for 13 inland counties ($r^2 = 0.333$, $p = 0.039$). States across the two river systems from Illinois (Iowa, Missouri and Kentucky) have reestablished wild turkey populations also. However, those states have stocked birds from different sources than those used to stock Illinois. We hypothesized that dispersal back and forth across the river would result in elevated levels of gene flow that would obscure the effect of stocking history on the genetic structure of river counties.

To test this premise, we utilized Sewell Wright's F-statistic, F_{st}. F_{st} measures the amount of genetic differentiation among isolated subpopulations that occurs over time because of random changes in those subpopulations. Gene flow prevents subpopulations from becoming differentiated resulting in a relatively low F_{st}. Inland counties showed an $F_{st} = 0.085$ while river counties demonstrated a lower $F_{st} = 0.050$. Estimates of the number of migrants moving among subpopulations based on these values were 2.69 individuals/generation for the inland counties and 4.75 individuals/generation for counties lining the two river systems. The rivers apparently enhance dispersion despite the assumption that wild turkeys are reluctant to cross water. Our data suggest that this assumption be false. Anecdotal observations indicate that wild turkey forage on islands in Pool 19 suggesting that they do indeed fly to such islands. We propose that wild turkeys frequently cross rivers to seek habitat, to forage and to escape predation.

EFFECTS OF WATER LEVEL AND LEVEE MANAGEMENT ALTERNATIVES ON HABITATS IN POOL 25

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We investigated the effects of various combinations of water level and levee management alternatives, at different discharges, on habitats in Pool 25. Two conditions were investigated for levees, the present levee system and all levees removed. Five water level management plans were studied; the present plan, two plans with higher water levels, and two plans with lower water levels. The two management variables, levee and water level management plans, result in a total of 10 unique management alternatives (two levee conditions times five water level management plans). Impacts on habitat for each of the 10 management alternatives were determined at four selected discharge regimes (19,000 to 135,000 cfs), resulting in 40 scenarios. Historical water level data were used to estimate how often each water level management plan may be used. Data for the study included bathymetric surveys, aerial photography, satellite imagery, 1:24,000 scale maps, and historical water level and discharge data. Thirteen classes were used to define original habitats (as of 1989), eight representing aquatics and five representing terrestrial types. Two additional predicted classes were formed, a dewatered aquatic and a inundated terrestrial type. A hydrologic model was used to predict water levels for each scenario. A geographic information system (GIS) was then used to integrate the various forms of data and to predict the effects of various management alternatives on habitats. Results were in the form of tables listing acreages of change and maps. The area between the levees (35,000 acres), under the current water level management plan at relatively low discharges, is dominated by open water (38%), woody terrestrial (33%), and agriculture (19%). The entire floodplain area (84,000 acres) is dominated by agriculture (48%), woody terrestrial (20%), and open water (17%). Changes in aquatic areas ranged from a reduction of 8,000 acres to an increase of 22,000 acres under various scenarios. The greatest area of change was in the lower third of the pool.

A broad range of alternatives was selected for the study to provide coarse resolution information to be used later to develop specific recommendations for ecosystem management. Recommended actions that finally emerge may be a suite of plans that changes from one year to the next, between seasons, or as a function of certain predefined conditions.

CHARACTERISTICS OF SUSPENDED MATERIAL IN THE UPPER MISSISSIPPI RIVER SYSTEM.

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Suspended particulate material plays a significant role in the ecological structure and functioning of the Upper Mississippi River System (UMRS). For example, suspended particulate organic matter (POM) is the primary food resource utilized by filter-feeding organisms (including mussels, other invertebrates, and several fish species). Many contaminants adsorb readily to particles, thus the transport and deposition of contaminants is tied closely to particle movement.

The Long Term Resource Monitoring Program (LTRMP) has, since 1991, monitored the levels of total suspended particulate material (TSS), organic suspended particulate material (POM) , and planktonic chlorophyll in five sections of the UMR and in the LaGrange pool of the Illinois River. These data show that the concentration of total suspended material (TSS) increased in a downstream direction, and that the concentration of TSS in backwaters was generally lower than in the main channel. The data also indicate that the contribution of organic particulate (POM) to the total suspended load declined by about half (from 15% to 7%) from upstream (Pools 4, 8, and 13) to downstream (Pool 26 and Open River). Phytoplankton (estimated by chlorophyll) appeared to be a significant portion of POM in backwaters (on the order of 50% by weight) , but organic material other than phytoplankton appeared to dominate the POM of the main channel. The contribution of phytoplankton to POM varied among study areas. Chlorophyll and POM were both maximal in the Illinois River. In the mainstem of the Mississippi River, average chlorophyll and POM concentrations were highest in Pool 8 and generally declined in the downstream direction. Although the total quantity of TSS increased downstream in the UMRS, its nutritive value to filter feeders (as suggested by chlorophyll and POM fractions) appeared to decrease.

AN EMPIRICAL MODEL OF SEDIMENT DISTRIBUTION IN LAKE ONALASKA, A BACKWATER LAKE OF THE UPPER MISSISSIPPI RIVER.

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An artificial island construction program was carried out in Lake Onalaska, a backwater lake of Pool 7 on the Upper Mississippi River near La Crosse, Wisconsin. The islands were constructed as a habitat rehabilitation and enhancement project as part of the Environmental Management Program. The islands were constructed to (1) reduce wind fetch and sediment resuspension, (2) provide improved habitat for aquatic biota, and (3) increase nesting area for waterfowl. One facet of the multi-year study program has been directed at understanding the physical changes in current velocity and sedimentation patterns that take place after island construction. Sediment type characterization over a limited portion of the lake bed was performed with an *in situ* sediment penetrometer and sediment cores. Data from the field sampling program were combined with lake bathymetry, the historical record of wind velocity and direction, and a fetch model for analysis with the geographic information system, ARC/INFO. Aaron Buesing (St. Paul District, U.S. Army Corps of Engineers) provided estimated current velocities from his application of the hydrodynamic model, FastTABS. The combination of field data, GIS analyses, and the output from the hydrodynamic model were used to extend the sediment mapping to the entire lake bed. Preliminary results suggest that the combination of current velocity, depth, and fetch can satisfactorily describe sediment type and bottom dynamic characteristics.

THE MACKINAW RIVER SURVIVES.

Susan Peitzmeier-Romano[1], Michael A. Romano[1,2], Becky Powell[3], David Day[4], and Cynthia J. Olmstead[5]. [1]Wildland Research and Management, Inc., Macomb, IL 61455 [2]Western Illinois University, Macomb, IL 61455 [3]Monsanto Company, St. Louis, MO 63167 [4]Illinois Department of Conservation, Fisheries Analysis Section, Springfield, IL 62706 [5]The Nature Conservancy, Peoria, IL 61602.

The Mackinaw River has maintained an unusually high level of biological integrity in a drainage basin of extensive agricultural use. This has drawn attention to the Mackinaw River by environmental agencies and agricultural industry. Combining their expertise, Monsanto Company, The Nature Conservancy, Illinois Department of Conservation (IDOC), the Environmental Protection Agency (EPA) and Wildland Research and Management, Inc., have investigated various aspects of Mackinaw River ecology. During 1994, fishes of the Mackinaw River were sampled by the IDOC. Fisheries sampling of the Mackinaw River basin in the past found it to have some of the most valuable fisheries in the area, rated good to excellent (Smith 1971, Day et al. 1990, Day et al. 1993). This evidence of quality is also supported by sampling by the Illinois EPA, which has completed fish and macroinvertebrate habitat sampling, sediment chemistry analysis, physical habitat assessment and aquatic life use (Ettinger 1987) and repeated their sampling again in 1994. Monsanto Company and Wildland Research and Management, Inc. are investigating the reasons for such a high quality river system. In September and October, 1994, they surveyed the vegetation and land use surrounding 11 IEPA and IDOC sampling sites. Vegetation of the riparian zone and land use were delineated using color infrared photography and field verification. Preliminary observations indicate that riparian zones, particularly in the upper corridor, may be a factor involved in the high quality of the river. Water flow patterns and the lack of channelization in many portions of the river may also be a factor (Ettinger, personal communication). This study ties together quality data and expertise from several agencies and institutions. The information contained in the final survey will provide valuable baseline data necessary for the development of a workable land use management plan for the Mackinaw River Basin, and an understanding of how we can reach this standard of ecological quality in other, more degraded river systems.

MOBILE ISLAND REVISITED

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Mobile Island and its associated sand mass are located near LaMoille, MN, 3km upstream from Lock and Dam No. 6. Typical of moving islands, Mobile Island has an elongated tear-drop shape, resulting from erosion on the upstream end and deposition on the lower end. The oldest vegetation occurs on the upstream end, and the youngest on the lower end. This study documents the rapidity of island movement and sediment accumulation in lower Pool 6. Historical maps and photographs, and surveys provide evidence for changes in island and streambed morphology. Mobile Island formed from a small island that was submerged 2m with the completion of Lock and Dam No. 6 in 1936. A large sand flat had accumulated around this older island, as a result of the placement of a wing dam and a closing dam about 1880. Between 1940 and 1973, the head of Mobile Island moved 140m downstream. In 1969, a second sand bar emerged just downstream of Mobile Island and subsequently formed a new island segment, extending the entire island to 510m. From 1966 through 1973, Mobile Island was surveyed as an ecology class project and an assessment was made of vegetation diversity and density. In 1972, with the assistance of the civil engineering class from Winona Area Vocational Technical School, a detailed survey was made and reference posts were established. In 1994, two of the posts were found and changes in island location, morphology, and sediment accumulation calculated. Elevation or water depth, plant composition, and sediment profiles were determined. The rise in the elevation of the island and its sand mass was dramatic. Between 1936 and 1973, the sand mass had risen 1m - 2.5m, with the island ridge rising 1.2m above pool level. A conservative estimate of average bed rise is 1.2m. By 1994, the island ridge had risen an additional 0.15m - 0.9m, and the submerged sand mass had risen 0.3m - 1.8m, with an estimated average increase of 0.6m. Upper end erosion, lower end elongation, and probably elevation increases, occurred most rapidly during flood years 1952, 1965, 1969, 1985, and 1993. During 1993, Upper Mobile Island reversed its shrinkage, increasing 0.1ha, and Lower Island increased 0.5ha. Between 1975 and 1994 the upstream tip of Upper Mobile Island had eroded another 57m, and the island complex extended 652m. Vegetation contributes significantly to the capture and sorting of suspended sediments during high water. Bathymetric mapping of the sand mass reveals that the area is apparently approaching the configuration that existed in 1927, after the emplacement of wing and closing dams, but before the completion of Dam No. 6. The whole sand mass has moved downstream, and a new island is emerging just north of Lower Mobile Island.

RED-SHOULDERED HAWK REPRODUCTIVE SUCCESS WITHIN POOLS 9-11 OF THE UPPER MISSISSIPPI RIVER FROM 1983-1994

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The red-shouldered hawk (*Buteo lineatus*) is a little known raptor which inhabits even-aged, medium to mature floodplain forests within the Upper Mississippi River Region. In recent decades, this species has been declining throughout the Upper Midwest and many populations are no longer viable. Consequently, the red-shouldered hawk is now considered an endangered species in several midwestern states including Iowa and Illinois, and threatened or of special concern in others such as Wisconsin and Minnesota. One of the largest populations remaining on the Upper Mississippi River is located in the McGregor District of the Upper Mississippi River National Wildlife and Fish Refuge (pools 9-11). We conducted area searches during the breeding season throughout this district between 1983 and 1994, in locations containing adequate nesting habitat. We documented the presence of red-shouldered hawks in a particular area by visual encounters and listening for call-back responses to a tape recording of their call. Our primary objective was to locate nest sites and monitor them to determine reproductive success. Between 1983 and 1994, we monitored 84 red-shouldered hawk nesting attempts at 15 known territories within this district. Of these, 43 were successful (71.7%), 17 were unsuccessful (28.3%), and we were unable to determine the final outcome of the other 24 nesting attempts. The 43 successful nesting attempts produced 91 red-shouldered hawk fledglings, for an average of 2.12 per successful nest and 1.52 per nesting attempt. Production between 1983 and 1989 appeared favorable, with 31 nesting attempts confirmed; 20 were successful (83.3%), 4 were unsuccessful (16.7%), and 7 outcomes were unknown. A total of 49 fledglings were produced, for an average of 2.45 per successful nest and 2.04 per nesting attempt. However, between 1990 and 1994 production was considerably lower among the 53 known attempts. Of these, 23 were successful (63.9%), 13 were unsuccessful (36.1%) and 17 outcomes were unknown. A total of 42 fledglings were produced, for an average of 1.83 per successful nest and 1.17 per nesting attempt. Red-shouldered hawk reproduction was especially poor during the record flood year of 1993. We documented only 4 successful (36.4%) and 7 unsuccessful (63.6%) nesting attempts, and found only 5 fledglings (1.24 per successful nesting attempt and 0.45 per nesting attempt). Also, during the following season (1994), at least 6 confirmed nesting territories were abandoned and only 1 juvenile red-shouldered hawk was observed. Consequently, we suspect that replacement rates within the study area may not be satisfactory.

INFLUENCE OF HUMAN ACTIVITY ON THE REPRODUCTIVE SUCCESS OF BALD EAGLES NESTING WITHIN THE MCGREGOR DISTRICT OF THE UPPER MISSISSIPPI RIVER

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Bald Eagle (*Haliaeetus leucocephalus*) populations in the Upper Midwest Region are recovering, and eagles are again nesting along the Upper Mississippi River. Many of these areas experience substantial amounts of various human activities throughout all or part of the breeding season. Research was conducted in 1994 to assess the effects of human activity on bald eagle reproductive success. We monitored 10 of the 28 active nests located within the McGregor District of the Upper Mississippi River National Wildlife and Fish Refuge (pools 9-11) during two-hour observation periods. Additionally, we monitored two unoccupied sites which contained seemingly adequate nesting habitat, but were nevertheless not utilized by a breeding pair of eagles. Observations were conducted at each of the twelve study sites once a week and every other weekend. All human activity units (HAU) occurring within one mile of the nest were recorded, along with the closest distance that the activity approached the nest. Also, we noted the amount of time the HAU remained within one mile of the nest, as well as any observed reactions by the birds towards the activity. For the purpose of this project, only human activities occurring within the river corridor itself, from shoreline to shoreline, were monitored. Bald eagle productivity from the five nest sites with the lowest number and per hour rate of HAU was compared to the five nest sites with the highest number and per hour rate. The total number of HAU ranged from 9 to 125 at the low traffic sites. This produced a per hour rate of 0.21 - 4.46 HAU, with an average of 2.16. HAU which caused adults to depart the nest were classified as human disturbance units (HDU). Three HDU were recorded at low traffic nests. These activities kept adults away from the nest for 19 minutes. The five low traffic nests produced 10 fledglings (2.0 per nest). The total number of HAU ranged from 143 to 364 at the high traffic sites. This resulted in a rate of 5.03 - 10.11 HAU per hour, with an average of 7.68. Fourteen HDU were observed at the high traffic nests, keeping adults away for 144 minutes. The five high traffic nests produced 5 fledglings (1.0 per nest). The total number of HAU at the two unoccupied sites were 254 and 348, producing per hour rates of 6.68 and 10.88, respectively. As a result, both unoccupied sites would have been classified as high traffic locations. Based on this research, increased levels of human activity near bald nests seemed related to decreased productivity. However, eagles rarely departed the nest due to human activity. Therefore, it appears the impact to eagle productivity occurs indirectly. Additionally, various pairs of birds exhibited substantially differing levels of tolerance to human activity, which probably greatly influenced each pair's reproductive success.

FALL RAPTOR MIGRATION COUNT AT EAGLE VALLEY NATURE PRESERVE IN SOUTHWEST WISCONSIN, 1994.

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A fall raptor migration count was conducted at Eagle Valley Nature Preserve, along the Mississippi River in southwest Wisconsin, between August 29, 1994 and January 3, 1995 in order to document the number, diversity, and timing of raptor species using the Mississippi River Valley as a migrational avenue. A standardized count format was utilized from August 29 through November 14, after which non-standardized, opportunistic counts were performed.

In 595.65 hours of observation, of which 563.3 were conducted during the standardized portion, 14,603 raptors of sixteen species were tallied (13,557 during the standardized portion). The overall rate of 24.52 raptors per hour (standardized = 24.07) resembles the 1992 and '93 exploratory, non-standardized counts of 28.03, and 29.01, respectively.

Four species comprised 83.78% of the count total. They are, in order of decreasing numbers, Sharp-shinned Hawk (Accipiter striatus), Broad-winged Hawk (Buteo platypterus), Red-tailed Hawk (Buteo jamaicensis), and Bald Eagle (Haliaeetus leucocephalus). A significant portion (41.49%) of the Bald Eagles were observed migrating during the late, non-standardized segment of the count.

Correlations between weather phenomenon and migration are addressed, and individual species accounts, including migration timing trends, and age/sex information will be discussed.

ILLINOIS COMMERCIAL FISHING DATA, A LONGTERM DATA SET FOR TREND ANALYSIS.

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As we experience major events and developments on the Mississippi River, the value of longterm data sets is becoming increasingly apparent. One of these data sets which may have both ecological and management applications is the commercial fishing records maintained by the Illinois Department of Conservation. A 40+ year continuous record of harvest has accumulated for the major river systems in Illinois, including the Mississippi River along Illinois western border. The data include total annual harvest weight, harvest by navigation pool, total number of full and part time fisherman, dollar value of harvest and the amount and value of the various types fishing equipment used to harvest the fish. The data are further broken down by different fish species harvested for the above parameters. There is no significant trend in the total amount of fish harvest over the 40 year period, and that includes some target species such as catfish (Fig. 1). Patterns within navigation pools are similar to those for the entire river whether dealing with pools which account for a large portion of the harvest such as Pools 18 and 19, or those where the harvest is minimal, Pool 14 and 15. A small amount of the variation in reported annual harvest may be accounted for by river events such as magnitude and duration of flooding. The relative constancy of annual harvest occurs in spite of a significant decline in numbers of fulltime fisherman (Figs. 1 and 2) or an increase in value of the harvested fish (Fig. 2) particularly catfish (Fig. 2).

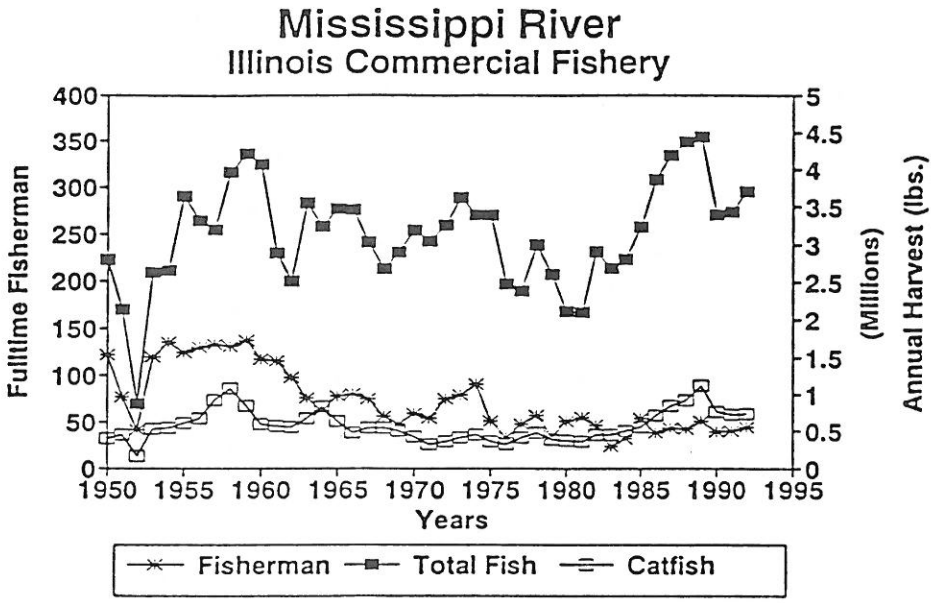

Figure 1. The number of fisherman and total fish harvest, Mississippi River, Illinois.

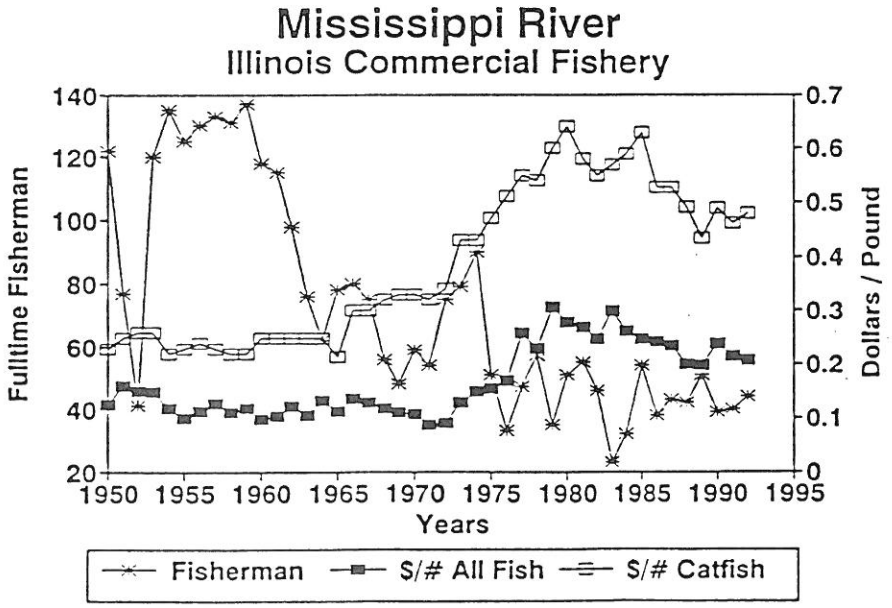

Figure 2. Number of fisherman and dollar value of harvested fish, Mississippi River, Illinois.

SMALL FISHES ASSOCIATED WITH SAND ISLAND HABITATS IN THE LOWER MISSISSIPPI RIVER, MO

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Our objective was to determine the assemblage structure of fishes suitable as forage for least terns in relation to defined aquatic habitats in the Lower Mississippi River reach bordering Missouri, during seasons relating to the least tern's reproductive period. Three gears designed to sample small fishes in the upper 1 m of the water column were tested. Six habitats were sampled on a regular basis from May through July 1993 and March through July 1994. Differences among habitats and seasons, as well as between years, were demonstrated. In 1994 species richness in all habitats decreased, as well as the relative abundance of fishes in deep-water habitats, compared to 1993. Significantly higher relative abundances of small fishes were found in shallow-water habitats compared to deep-water habitats during 1993 and 1994. Due to time limitations, this presentation will focus on two shallow-water habitats surrounding sand islands: the main channel interface and the side channel interface. They could not be differentiated on the basis of water temperature or clarity. River stages were consistently lower and water temperature and clarity were significantly higher during 1994 than 1993. Despite this, the side channel interface had significantly higher relative fish densities and a higher average species richness than the main channel interface across years. In addition, both habitats contained large numbers of juvenile fish, indicating that they are functioning as fish nurseries.

FISH COMMUNITIES OF CHANNEL AND BACKWATER SHORELINE HABITATS IN POOL 6, UPPER MISSISSIPPI RIVER.

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During July and August 1994, fish communities in Pool 6 of the upper Mississippi River were examined to compare species composition, diversity, and abundance between backwater and channel habitats. Fish were collected by shoreline electrofishing with a Coffelt CPS boomshocker during daylight hours. Seven channel and five backwater sites were sampled. Shocker on-time for the project exceeded 7 hours. Thirty-nine species of fish representing 14 families were collected. Channel sites held 30 species, whereas backwater locations contained 32 species. Nine species (e.g., largemouth bass, yellow perch, spotted sucker) were collected only in backwaters, and seven species (e.g., river darter, blue sucker, crystal darter) were restricted to channel habitats. Taxa richness per site averaged 14 for channel sites and 17 for backwater sites. Species diversity (Simpson and Shannon indices) also was slightly higher in backwater sites. In backwaters, 12 species each represented more than 1% of the total catch, with emerald shiner (30.0%), gizzard shad (21.6%), and largemouth bass (13.2%) being the most abundant. In channels, nine species represented 1% or more of the catch, with emerald shiner (68.6%) dominating collections. Common carp (68.1%) dominated the biomass of backwater communities, whereas redhorses (49.1%) and common carp (31.2%) dominated the biomass in channels. Catch per unit effort measures for both abundance and biomass were nearly twice as high in backwaters as in channels. Despite these differences, Spearman rank correlation comparisons indicated significant correlations between channel and backwater locations for both species abundances and species biomass. Fish are more abundant in backwater shoreline habitats than in similar channel habitats, and some species are restricted in their distribution, but overall the fish communities occupying channel and backwater shoreline habitats are very similar.

INFLUENCES OF HABITAT MODIFICATIONS ON AN UPPER MISSISSIPPI RIVER BACKWATER FISH COMMUNITY

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Changes from predominance by bluegill (*Lepomis macrochirus*) and black crappie (*Pomoxis nigromaculatus*) to a shared predominance by bluegill, black crappie, gizzard shad (*Dorosoma cepedianum*), and white bass (*Morone chrysops*) were related to habitat modifications in Weaver Bottoms, a 1,620-hectare backwater of the Upper Mississippi River (UMR) navigational Pool 5.

The influence of side channel closure and artificial island construction in 1986-1987, and systemic perturbations that occurred during the study period, on fish species diversity, size composition, and relative abundance were studied. The fish community was sampled in late summer and early fall 1984-94 by trap nets, experimental gill nets, and electrofishing at 11 sites in, and 6 reference sites outside of, Weaver Bottoms. During the pre-construction period (1984-86) 8,754 fish of 69 species were collected versus 25,508 fish of 69 species in the post-construction period (1988-94). Species richness differed (Wilcoxon rank sum, $p < 0.05$) between sites in Weaver Bottoms and the reference area during the study with consistently fewer counts recorded in the reference area. Length distribution differed (chi-square, range $X^2_{df} = 7\text{-}21$, $p < 0.001$) between pre and post-construction periods for common carp (*Cyprinus carpio*), northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*), and black crappie, but not for yellow perch (*Perca flavescens*), sauger (*Stizostedion canadense*), bluegill, or white bass. Common carp exhibited a wider range of length classes while northern pike, black crappie, and walleye, exhibited a narrower range with fewer fish of smaller length classes. However, both bluegill and black crappie exhibited strong carryover of year classes at some sites throughout the study. Relative abundance was positively related to river stage ($r^2 > 0.50$, $p < 0.05$) for shorthead redhorse (*Moxostoma macrolepidotum*), black crappie, bluegill, northern pike, common carp, yellow perch, gizzard shad, and white bass, but not for silver redhorse (*Moxostoma anisurum*), emerald shiner (*Notropis atherinoides*), walleye, and sauger. Multiple regression models incorporating river stage as a covariate, temporal effects related to habitat modification, and spatial effects related to sampling stations, were significant ($R^2 > 0.83$, $p < 0.05$) for common carp, gizzard shad, northern pike, black crappie, white bass, and bluegill. Analysis of effects indicated that increased relative abundance, related to habitat modifications, were significant ($p < 0.10$) for black crappie, white bass, and gizzard shad.

AN EXPERIMENT WITH ZEBRA MUSSELS, FRESHWATER DRUM AND JUVENILE BLUEGILLS.

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In a mesocosm experiment we attempted to evaluate 1) the role of freshwater drum predation on zebra mussel population size, and 2) subsequent food web responses to reductions of zebra mussel populations in the presence of drum.

In 4,000-L mesocosms we combined all possible combinations of the presence or absence of 1) 3,370 zebra mussels/m^2, 2) 2 freshwater drum (average: 340 mm tl, 550 g wet weight), and 3) 160 juvenile bluegill sunfish (average: 55 mm tl, 280 mg wet weight). These combinations resulted in 8 treatment combinations. The experiment was conducted in 24 mesocosms, supplied with Black River water at renewal rates of once every 24 h. The experiment lasted for 60 days (8/20 - 10/20/94) and was conducted at the Upper Mississippi Science Center, La Crosse.

At the end of the experiment, all fish, zebra mussels, benthos and filamentous algae were collected for determination of biomass. Taxonomic analysis was performed on final fish diets, benthos, and zooplankton samples taken through time. Nutrient analysis was performed on samples taken biweekly by personnel at the Environmental Management Technical Center, Onalaska.

Bluegill gained more weight in zebra mussel tanks; drum lost weight under all conditions. Final zebra mussel mass was less than initial mass in all zebra mussel tanks, suggesting carrying capacity for mussels was exceeded in this experiment. However, mussels lost less weight in the presence of either bluegill or drum, but lost the greatest weight in the presence of both fish. Turbidity, suspended solids and chlorophyll *a* were lowest in zebra mussel tanks, intermediate in drum tanks and highest in bluegill tanks. Ammonia concentrations were highest in drum tanks, perhaps a result of catabolic processes associated with weight loss. Carbon (algal+benthic ash-free dry weight) was greatest in zebra mussel tanks, slightly elevated in either bluegill or drum tanks, and lowest in tanks with both bluegill and drum.

Zebra mussels appear to be fixing a greater amount of carbon tanks, and bluegill we able to utilize some form of this carbon (probably non-planktonic invertebrates) and grow, while drum did not. There was clear evidence of a trophic cascade, caused by bluegill feeding on large cladocerans (from preliminary zooplankton data), and leading to elevated chlorophyll concentrations. Drum may have caused increased turbidity by disturbing particles accumulated on the bottom of tanks. Elevated particles in the water column associated with fish probably supplied some food for zebra mussels, resulting in less loss of mass of zebra mussels in tanks with fish. The lack of feeding by drum was probably an artifact of captivity that must be overcome before definitive tests of drum effects on zebra mussels can be accomplished.

GROWTH OF JUVENILE BLUEGILL SUNFISH IN THE PRESENCE OF ZEBRA MUSSELS: A MESOCOSM EXPERIMENT.

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Cascading trophic effect models support the hypothesis that juvenile bluegill (omnivorous) will exhibit decreased growth if zooplankton populations decline in the presence of reduced phytoplankton density. Zebra mussels, at high densities, can significantly reduce phytoplankton, as well as some of the zooplankton taxa commonly found as bluegill prey (e.g. Bosmina and copepod nauplii).

We hypothesized that, if juvenile bluegill feed on primarily on zooplankton, bluegill growth will be proportionally diminished with increasing zebra mussel densities due to indirectly suppressed zooplankton densities. As a test of this hypothesis we experimentally manipulated 4 levels of zebra mussel densities (0, 2,000, 12,500 & 25,000/m^2) in the presence/absence of juvenile bluegills (50 mm tl, 210 mg wet weight). This design resulted in 8 treatment combinations with 3 replicates per treatment. These manipulations were carried out in 24, 1100-L, outdoor mesocosms (tanks) located at the Upper Mississippi Science Center. The experiment ran from mid-July through mid-September, 1994 (60 D).

At the end of the experiment, all fish, zebra mussels, benthos and filamentous algae were collected for determination of biomass. Taxonomic analysis was performed on final fish diets, benthos, and zooplankton samples taken through time.

Contrary to our predictions, at the end of the experiment juvenile bluegill in zebra mussel tanks weighed significantly more than those in tanks without zebra mussels. Zebra mussel tanks generally contained higher densities of non-planktonic invertebrates (e.g. Chydorid cladocerans) and lower planktonic invertebrates (e.g. rotifers and *Daphnia*); bluegill switched from planktonic prey (e.g. *Daphnia*) that declined during the experiment, to abundant benthic prey, resulting in higher growth. Elevated benthic production associated with zebra mussels has also been found in Lake Erie and in European lakes. Results from our experiment, and data from U.S. and European lakes, suggests that benthic feeding fishes (including fish that can switch from zooplanktivory) may be able to capitalize on zebra mussel-associated benthic communities to attain higher growth rates than without zebra mussels. However, obligate zooplanktivores, including most larval fishes, may suffer reduced prey availability, and ultimately lower growth rates, in the presence of dense zebra mussel populations. We will test this hypothesis in experiments planned for 1995.

EXPERIMENTAL ANALYSIS OF THE IMPACT OF WATER MOVEMENT AND MACROPHYTES ON NORTHERN PIKE (*Esox lucius*) GROWTH AND FOOD WEB INTERACTIONS

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Northern pike (*Esox lucius*) use vegetated habitats on the upper Mississippi River during all life history stages. Juvenile pike may encounter moving water as they emigrate from nesting sites, as spawning areas fill and drain during spring flooding, and in vegetated channel border habitats. An enclosure study was conducted to experimentally evaluate the effect of water movement on the trophic interactions between northern pike, bluegill (*Lepomis macrochirus*), and invertebrates, and how structure (simulated macrophytes) moderates this effect. A three-factor cross-classified experimental design was used with each factor having two levels-presence or absence. The three factors-northern pike (Age 0+), flow, and structure-were applied in eight treatment combinations (n=3) in four ponds (0.004 ha). Northern pike and structure treatments were randomly distributed among flow and no flow enclosures. Mean current velocities in flow treatments ranged from 1.5-3.0 $cm \cdot s^{-1}$. Invertebrates were stocked and allowed to aerially colonize the test facility for four weeks, prior to the four week experiment. Fish growth was measured by comparing final weight measurements and invertebrates were sampled at day 0, 15 and 30. A bioenergetics model was used to differentiate between the effects of increased metabolic rates due to water current and the effects of prey consumption on growth of pike. Pike growth was reduced in enclosures with flowing water alone ($P<0.06$), but not reduced in enclosures with structure and flow together ($P=0.05$). The bioenergetics model accurately predicted the lower pike growth due to water movement. Zooplankton abundance was reduced in flowing water ($P<0.001$) and elevated in structure ($P<0.01$). The abundance of two zooplankton taxa, *Daphnia* sp. and *Polyphemus pediculus* were greater in the presence of pike ($P<0.01$ and $P=0.06$, respectively). Pike indirectly affected zooplankton independent of flow and structure by releasing *Daphnia* and *Polyphemus* from bluegill predation. Water movement and structure may have independent effects on invertebrate abundance in large rivers. Aquatic macrophytes may reduce the energetic demand on northern pike exposed to moving water.

BLUEGILL GROWTH IN *VALLISNERIA*: A POND ENCLOSURE EXPERIMENT.

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We examined the interaction between aquatic vegetation and fishes in a manipulative mesocosm study. The 70-d mesocosm experiment had four treatments (CONTROL, *VALLISNERIA*, BLUEGILL, and BLUEGILL+*VALLISNERIA*). Juvenile bluegills *Lepomis macrochirus* (43-66 mm) were marked with unique combinations of fluorescent elastomer to determine growth of individual fish. Bluegill growth was 10% greater in enclosures with *Vallisneria* than in nonvegetated enclosures. Bioenergetic analyses of bluegill diet showed that the caloric consumption of bluegills in vegetated enclosures was higher than the caloric consumption in nonvegetated enclosures. Trophic resources (zooplankton and macroinvertebrates) were greater in enclosures with vegetation and offset the effects of bluegills feeding on invertebrate prey. However, the response of each invertebrate taxa varied. For example, densities of *Ceriodaphnia* spp. were reduced in the presence of bluegills but unaffected by vegetation, whereas densities of *Hyallela azteca* were increased by vegetation but unaffected by the presence of bluegills. Aquatic macrophytes provided a source of trophic resources and enhanced growth of juvenile bluegill in this study.

ALTERNATE PLATFORM PAPER

POTENTIAL FOR ZEBRA MUSSEL TRANSPORT BY DIVERS

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After their successful introduction into North America about 1986, zebra mussels (Dreissena polymorpha) spread rapidly through the Great Lakes and into inland waterways. In addition to effective natural dispersal, especially downstream drift of larval veligers, their spread has been facilitated by human-mediated transport mechanisms which also can move them upstream and overland. Of the first 18 inland bodies of water requiring overland transport for colonization, 3 were quarries frequented by SCUBA divers but offering limited opportunities for angling, boating, or other recreational activities. This led us to investigate the potential for passive transport of zebra mussels, especially veligers, by divers. We exposed divers in wetsuits ("farmer john" pants, jackets, boots, and gloves) to naturally occurring concentrations of zebra mussel veligers and adults in the Illinois River on four separate occasions. After dives of 30 to 195 min, divers surfaced and wet suits were removed and stowed separately in plastic bags. Suits were returned to the laboratory in 2 to 5 hrs, where we hand washed them in water for 5 min, and the wash water was filtered through 60-micron netting. Material retained in the netting was subsampled and inspected under 30- to 110-x magnification using cross-polarized light. Calculated veliger concentrations in the water column on the four occasions ranged from 7 to 68 veligers per liter. From a total of eight dives, calculated numbers of veligers collected from suits ranged from 0 to 514 per suit. The number of veligers on a suit did not correlate with the density of veligers in the water column or dive duration. In some subsamples, up to 40% of the veligers were obviously alive (i.e., swimming) over 3.5 hrs after the divers came out of the water. During over 300 hrs of diving in zebra mussel infested waters (concentrations up to 61K per square meter) of the Illinois River, we never observed an adult zebra mussel attached to our divers or their associated diving equipment. However, zebra mussels less than 15 mm have attached to our steel sampling frames on the river bottom in less than 24 hrs. The number of zebra mussels, either veligers or adults, needed to establish a reproducing population is unknown, but results of this work indicate viable veligers can be transported by divers. While zebra mussels may increase water transparency and visibility, their negative impacts, both economic and environmental, should prompt precautions to reduce their spread. The potential foraccidental transport by divers can be reduced significantly if they subscribe to any of a number of simple precautionary measures (e.g., rinsing in hot and/or chlorinated water or thorough drying of equipment) after diving in infested waters. Therefore divers and other wetsuit users, such as jet-ski riders, need to be educated to reduce their potential for contributing to the spread.

ABSTRACTS OF POSTER PRESENTATIONS
(listed in alphabetical order by first author)

DO MIGRATING DUCKS AFFECT THE POPULATION DYNAMICS OF FINGERNAIL CLAMS?

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I conducted an in situ experiment of affects of predation by migrating diving ducks (primarily scaup *Aythya* sp., canvasback *Aythya valisineria* and ring-necked *Aythya collaris*) on the densities of fingernail clams (*Musculium transversum*). Ponar samples were taken prior to waterfowl migration (October) and post migration (November) from four control and eight duck exclosure sites within a 200-m area during 1994 in Lake Onalaska, Mississippi River. Diving ducks were denied access to food sources within the exclosures. Mean adult (>3 mm) fingernail clam populations decreased from pre-migration ponar samples (5,135 m^{-2}, standard deviation = 127) to post migration samples (192 m^{-2}, standard deviation = 17) while changes in young (1-2 mm) fingernail clam populations remained relatively unchanged (47,173 m^{-2}, standard deviation = 1,223; to 36,019 m^{-2}, standard deviation = 956). There were no significant differences between control and exclosure sites for fingernail clam prior to and post migration, suggesting that predation by diving ducks was not a factor in the decline of adult fingernail clams.

POPULATION DYNAMICS OF ZEBRA MUSSELS IN THE UPPER MISSISSIPPI RIVER THREE YEARS AFTER INVASION.

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We examined the population dynamics of zebra mussels *Dreissena polymorpha* in Pool 8 of the upper Mississippi River for the third consecutive year following invasion. Two habitat types were studied, main channel border and backwater, with two sites in each type. At each site, 18 concrete blocks were deployed in a randomized block design in May 1994. There were six treatments (time periods) and three replicates (concrete blocks) per treatment. Settlement and growth rate of zebra mussels on two of the blocks selected at random were measured at 30 ± 10 d intervals at each site by analyzing shell morphology characteristics (length, width, height). The third block for each time period was retained in the river at the site until the final sampling period (October), to obtain an estimate of overall seasonal settlement and growth rate. From June through October 1994, we documented two periods of reproduction and settlement and found an average of 480 zebra mussels/m^2 on our samplers. In contrast, for this same time period in 1993, we documented only one period of reproduction and settlement and had a density of 6 zebra mussels/m^2 on our samplers. In 1992, a density of 3 zebra mussels/m^2 was measured on our samplers during which at least two main periods of reproduction and settlement occurred. In 1994, 78% of all zebra mussels were found at main channel border sites, whereas in 1993, 96% of all mussels were found at main channel border sites. The overall growth rate of zebra mussels averaged 0.15 mm/d in 1994, and has been similar among the three years following invasion. Our results indicate that zebra mussel populations are rapidly increasing in the upper Mississippi River and are extending their range from main channel border habitat to backwater habitat.

A SURVEY OF VEGETATION COMMUNITIES AND SOIL TYPES IN A RECENTLY CONSTRUCTED MITIGATION WETLAND

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The Iowa Department of Natural Resources in conjunction with the City of Dubuque, constructed a mitigation wetland in the Mississippi River floodplain, near Dubuque Iowa. As part of the monitoring effort, the vegetation of the area was surveyed and mapped. We present an evaluation of the successional stage of the wetland and comment on the success of efforts to revegetate.

The soil type was determined to be Dorchester Silt Loam, characteristic of a recently flooded area. The predominant plant communities consisted of early successional stage vegetation, primarily colonizing species and surviving forest species greater than ten years in age (eg. unconsolidated bottom, scrub-shrub, and forest broad-leaved communities). No evidence of wetland species planted following the construction phase was detected. It is our impression that the most critical factor in determining the successional stage of the vegetation was the flooding in 1993. This occurred shortly after planting of both wetland and prairie species, and was of sufficient size and duration have a negative influence on this effort. The present vegetation communities appear to be similar to other early successional stage wetlands, and the development of the community should follow the expected pattern.

EFFECT OF ZEBRA MUSSEL DENSITY ON MACROINVERTEBRATE COMMUNITY STRUCTURE ON HARD SUBSTRATA IN THE UPPER MISSISSIPPI RIVER.

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An exotic species, the zebra mussel, *Dreissena polymorpha*, has found its way into the upper Mississippi River and is becoming a dominant inhabitant of hard substrata. The objective of this study was to assess the impact of the zebra mussels on the macroinvertebrate community colonizing the hard substrata in the Upper Mississippi River. Two locations were chosen along the main channel of the river; the first location was in an area associated with slow flow and sandy bottom substratum, whereas the second location was in an area associated with higher current velocities and a cobble substratum. Two types of cages were deployed at each location: cages completely enclosed in 1.5-cm diameter mesh and cages where a single side was covered with mesh to prevent clogging. Each cage was stocked with either 12 clay tiles or 12 bundles of young willow trunks, for a total of four experimental treatments. Cages were placed at each location in five completely randomized blocks (n = 40). One sample was removed from each cage monthly from July-October 1994. Preliminary analysis indicates that as the zebra mussel densities increased during the study period, invertebrate taxa richness and density decreases. This was particularly evident in closed cages with the tile substrata where the zebra mussel densities were the highest. Community composition shifted markedly with Chironomidae abundance increasing in response to increasing zebra mussel densities. From this study, it appears that zebra mussels will alter the structure of native invertebrate communities on hard substrata in the upper Mississippi River. This has particular relevance given the importance of hard substrata in large rivers and its limited abundance in the upper Mississippi River.

SMALL MAMMAL POPULATIONS IN A RECENTLY ESTABLISHED MITIGATION WETLAND

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The reclamation of land for subsequent use in the construction of mitigation wetlands has increased throughout the Upper Mississippi River Valley. Monitoring of the spread of natural populations into previously unoccupied habitat is an important step in the determination of the success or failure of the project. Small mammal populations are key in the establishment of terrestrial vertebrate ecosystems. We censused the small mammal populations and habitat use in the Schmitt Island Wetland Area, Dubuque, Iowa in October 1994. Our initial hypothesis was that small mammal species density would be similar in the two major habitat types, forest and grassland, and the ecotone area between. We also tested for differences in population numbers and structure between these habitat types, using a mark-recapture study. We found that the major species using the area was the northern deer mouse, Peromyscus maniculatus. A single vole, Microtus Pennsylcanicus was captured in the grassland area.

Small mammal habitat use was heaviest in the ecotone and woods areas. Little use of the grassland habitat was recorded. The primary dispersers into the area appeared to be subadult males based on recorded sizes and weights. The small number of recaptures indicates either a large population of deer mice in the area, or perhaps more likely, dispersal into or through the region during the time of greatest population in the surrounding areas. Also of interest is the lack of voles in the grassland area. This suggests that recolonization has only just begun for this species following the summer floods of 1993.

COLONIZATION RATE OF ZEBRA MUSSELS ON HARD SUBSTRATA IN THE UPPER MISSISSIPPI RIVER

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Colonization rates of zebra mussels, *Dreissena polymorpha*, on hard substrata were examined on the upper Mississippi River between river kilometers 1150 and 1158. Two types of cages were placed at two locations along the main channel of the upper Mississippi River. One cage type was completely enclosed in 1.5- cm diameter mesh while the other type of cage had a single mesh panel placed on the upstream side to prevent clogging. Each cage was stocked with either 12 clay tiles or 12 bundles of willow dowels, resulting in a total of four experimental treatments. Five blocks of cages were set at each location (4 cages/block) using a randomized block design. One substratum sample was removed from each cage monthly from July - October 1994. Substrata were placed in bags, preserved, and returned to the laboratory where samples were cleaned and sorted for invertebrate identification. Large zebra mussels were carefully removed from tiles and snags while smaller mussels were found by sorting samples under 10X magnification. Two cohorts of zebra mussels were identified from 1994 samples, with a possible third cohort in early September. Tiles were colonized much more rapidly than snags and possessed a significantly higher number of mussels throughout the duration of this study. Zebra mussel densities were also higher in closed than open cages for tile substratum. Further, the number of large size-class mussels (>25 mm) were higher in closed cages. Preliminary analysis indicates that the colonization of zebra mussels occurs on hard surface substrates more rapidly than snag substrates. Data also indicate a difference in the size of mussels found in open and closed cages, with much larger mussels found in the closed tile cages, suggesting that fish predation may influence zebra mussel population structure in the upper Mississippi River.

HABITAT CHARACTERISTICS AND MUSSEL ASSEMBLAGES ASSOCIATED WITH THE FEDERALLY ENDANGERED MUSSEL *LAMPSILIS HIGGINSI* IN THE LOWER SAINT CROIX RIVER, MN AND WI.

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This study was designed to examine mussel community structure in the Saint Croix R. from the Kinnickinic Sand Bar (River Mile 6) to its confluence with the Mississippi R. (RM 0). We examined the habitat characteristics of areas where *L. higginsi* was found. We also tested whether there were associations between the presence of *L. higginsi* and other mussel species inhabiting the area.

Qualitative data were obtained from 15 locations within the study area. Searches were conducted at 5m intervals along 75m-long transects oriented perpendicular to the water flow at each of the 15 locations. Depth was measured and substrate type was qualitatively assessed at each station. A total of 1145 individuals representing 26 species were collected. The greatest mussel density (21.5 mussels per station) and species richness (5.5 species per station) were found at Pt. Douglas. The dominant species in the area was *Amblema plicata*. ANOVA indicated that both species richness and population density varied significantly with upstream-to-downstream location (transect) and depth, but not with proximity to shore (station) or substrate type. Community composition varied significantly with transect and proximity to shore when examined using a χ^2 analysis. *L. higginsi* were later found in areas where data from transects indicated greater species richness and population density.

In an effort to determine whether or not *L. higginsi* occupies a unique habitat, ten 0.25 m^2 quadrats were taken at each of ten locations at Pt. Douglas, MN; five near shore and five away from shore. Community structure, substrate mean phi (particle size), and depth at each station were measured. A total of 194 individuals representing 20 species were encountered in the quantitative sampling. Because only one *L. higginsi* was found in the quantitative sampling, species-specific searches for *L. higginsi* were conducted at both Pt. Douglas and a nearby site to which *L. higginsi* were relocated due to a bridge construction project. When *L. higginsi* was found, the location was marked and a 0.25 m^2 quadrat was taken. Thirteen *L. higginsi* were found as a result of species-specific searches. *L. higginsi* was found in areas of high species richness and larger substrate size. Population densities in areas where *L. higginsi* were found were higher, but not significantly so. χ^2 analysis indicated that the mussel community structure found in the presence or absence of *L. higginsi* differed significantly and that the presence of *Truncilla truncata* was significantly associated with the presence of *L. higginsi*.

Qualitative sampling suggests that, in the study area, mussel density is greatest near RM 0 - Pt. Douglas. Quantitative sampling suggests associations between both community composition and physical factors surrounding *L. higginsi*. It also appears that *L. higginsi* distribution may, in part, be related to that of other unionaceans.

BIVALVE SURVEY OF THE SANDY RIVER DRAINAGE, MINNESOTA

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Few surveys have been conducted on tributaries to the Mississippi River upstream of St. Anthony Falls in Minneapolis, Minnesota. A qualitative survey of the Sandy River basin, located primarily in Aitkin County, was conducted during August - September, 1994. The Sandy River drainage, comprised of the Savanna, Prairie, Tamarack, and Sandy rivers, was sampled at thirty-two sites for freshwater bivalves. Pill clams (*Sphaerium*) and nine species of unionids were observed, including: *Actinonaias ligamentina*, *Anodonta grandis*, *A. imbecillis*, *Anodontoides ferussacianus*, *Lampsilis ovata*, *L. siliquoidea*, *Lasmigona compressa*, *Ligumia recta*, and *Strophitus undulatus*. Numerous populations of *Lampsilis siliquoidea*, *Anodonta grandis*, *Anodontoides ferussacianus*, and *Sphaerium* were observed throughout the drainage. Populations of *Lasmigona compressa*, *Ligumia recta*, and *Anodonta imbecillis* were scattered between tributaries. Very few *Lampsilis ovata*, *Strophitus undulatus* were observed; only one dead *Actinonaias ligamentina* was found. Greatest unionid diversity occurred in the Prairie River, which is located in a state forest. Highest CPUEs were recorded at sites in the Savanna River, situated primarily in the Savanna State Park. Lowest unionid diversity and CPUEs were observed in channelized reaches of the Sandy River.

SUITABLE FISH HOSTS OF SIX FRESHWATER MUSSELS

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Most freshwater mussels (unionids) must briefly attach to a fish in order to complete their life cycle. Management of rare unionids frequently demands knowledge of the their fish host(s). Studies were conducted in 1994 to determine suitable fish hosts of the following unionids: purple wartyback (*Cyclonaias tuberculata*), creek heelsplitter (*Lasmigona compressa*), fluted-shell (*L. costata*), black sandshell (*Ligumia recta*), cylindrical papershell (*Anodontoides ferussacianus*), and squawfoot (*Strophitus undulatus*). Suitable fish hosts were determined by artificially exposing fish to mussel glochidia and determining if they facilitated glochidia metamorphosis to the juvenile stage. Six fish species were infested with *C. tuberculata* glochidia, but only the yellow bullhead (*Ameiurus natalis*) served as a suitable host. Four of ten fish species tested were found to be suitable hosts for *Lasmigona compressa*: spotfin shiner (*Cyprinella spiloptera*), slimy sculpin (*Cottus cognatus*), black crappie (*Pomoxis nigromaculatus*), and yellow perch (*Perca flavescens*). Juvenile *Lasmigona costata* were collected from one (slimy sculpin) of four fish species tested. Of eight fish species tested, *Ligumia recta* glochidia completed metamorphosis only on bluegill (*Lepomis macrochirus*). Six of eleven species tested were found to be suitable hosts for *S. undulatus* glochidia: spotfin shiner, fathead minnow (*Pimephales promelas*), bluegill, largemouth bass (*Micropterus salmoides*), yellow bullhead, and black bullhead (*Ameiurus melas*). Juvenile *Anodontoides ferussacianus* were collected from aquaria holding spotfin shiner and black crappie. Studies in 1994 combined with earlier studies at the University of Minnesota have identified several previously unknown suitable fish hosts for a variety of unionids.

SEDIMENTATION IN TREMPEALEAU BAY, POOL 6, MISSISSIPPI RIVER.

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Trempealeau Bay, located 2 km upstream of Lock and Dam #6, provides a natural experiment in human-mediated sedimentation at a tributary mouth. This project described, analyzed, and documented sedimentation and delta development in Trempealeau Bay. Manipulation of the rate and pattern of sedimentation occurred in two phases: diversion of the 300 km Trempealeau River into the bay in 1912, followed in 1936 by a 2.0 m increase in water level with construction of Dam #6. Prior to 1912 Trempealeau Bay, 1.5 sq. km in area, had little ongoing sediment accumulation. In 1928 emergent land filled 85% of the bay, and, following the 1936 submersion, 85% of the bay was again emergent by 1991. Along 11 transects with 200 sites, we recorded elevation, water table depth, and plant cover in 50 x 50 cm plots, and we collected 1-3 m deep soil cores, from which we measured depositional layers and texture types. At aquatic sites, we recorded current velocity, benthic sediments, and depth. We analyzed a subset of sediment samples for the amount of organics and sediment size classes. All together, 4000 samples were examined. We used aerial photographs and maps dating from 1898 to interpret chronology of change in location of channels, growth and shifting of emergent bars and delta deposits, vegetational development, and rate of accumulation. A thick layer of silt deposited over emergent land in 1936 served as a marker indicating depth of subsequent deposition. Between 1936-1993, 190 ha-m of sediment accumulated in the bay, at a rate of 3.3 ha-m per year. From 1913-1935, 525 ha-m of sediment accumulated in the bay, at an annual rate of 24 ha-m. Between 1913-1936 sedimentation rate in Trempealeau Bay was 7.3 times that of 1936-1993. Sedimentation rates were comparable to elsewhere in the region. Decreased sedimentation probably resulted from improved erosion control practices. The Trempealeau River Delta is a Gilbert-type delta with several distributaries. Sediment cores indicated extensive topset beds and limited foreset beds. Distributaries bifurcated, and all of them rejoined the main channel before it entered the Mississippi River. Deposition occurred in fluvial, fluvial-marine, and paludal environments. Fluvial deposits dominated the bay. Natural levees occurred along the main channel and distributaries of the Trempealeau River. Point bars were located on the main channel of the Trempealeau River. Abandoned distributaries and their sediments occurred throughout the bay. The fluvial-marine deposits included interdistributary sediments near the distributary mouths. Evidence of a paludal depositional environment was shown in marsh and lacustrine deposits throughout the bay. Marsh deposits have accumulated since the emergence of land in the bay, principally since 1979. Lacustrine sediments, mostly silts, were deposited during the period of submergence, beginning in 1936. Flooding was indicated by sand lenses and splays amidst finer sediment. We also interpreted sedimentation history through plant communities shown in photographs. Dominant plants in Trempealeau Bay were *Typha latifolia, T, angustfolia, Sagittaria latifolia, Sparganium eurycarpum, Carex* sp., *Leersia oryzoides, Lemna minor, Salix nigra, S. interior,* and *Acer saccharinum*. Stands of *Typha, Sagittaria, Sparganium,* and *Carex* grow in shallow standing water or water near the surface. *Leersia* grows on the natural levees of sand and loam. Trees grew on land that was not submerged in 1936, or had emerged by 1951. A readily visible plume of sediment from Trempealeau Bay is being deposited in the navigation channel of the Mississippi River. Sedimentation in the Mississippi will accelerate as storage space in Trempealeau Bay becomes limited.

BARCODES FOR DATA ENTRY

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In studies that require field data collection forms, a barcode reader and appropriate barcodes can improve both the speed and accuracy of data entry into microcomputer datafiles. In our study of bird species, numbers, and use of habitats within Navigation Pools 8 and 13, the number of bird and plant species and the number of quantitative and descriptive values were limited. We used barcode software to generate titled barcodes for all possible responses for bird species, activity, sex, detection distance, detection time, and habitat descriptions. Our layout of responses corresponded to the layout of our data collection forms. We scanned data directly into a word processing software file and still had the capability to enter data from the keyboard. Learning the locations of barcodes was accomplished within an hour of work, and scanning the codes was more rapid than keyboard entry and included fewer errors. Scanning errors were more easily recognized than keyboard entry errors. This off-the-shelf technology is applicable to many other types of data entry.

PLANT COLONIZATION OF FLOOD CREATED LAND ON THE UPPER MISSISSIPPI RIVER

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Deposition by the 1993 flood on the Upper Mississippi River resulted in the emergence of numerous parcels of land to elevations sufficient to support terrestrial vegetation. Plants colonized these sandbars immediately upon recession of the 1994 spring flood waters. In August and September of that year, we quantitatively surveyed seventeen sandbar communities. Sites are distributed from river mile 801 near Red Wing, MN to river mile 744 near Buffalo City, WI. Their sizes range from 348 to 10,426 m^2, their substrates are composed of greater than 85% sand, and they each contain from 17 to 57 species. A total of one hundred-fourteen species were encountered on the seventeen sites. Mean elevations are at less than .70 m above summer water surface levels at all sites. Seven species that occurred with moderate to high frequency at nearly all sites are cottonwood (Populus deltoides), peach-leaved willow (Salix amygdaloides), silver maple (Acer saccharinum), black willow (Salix nigra), sandbar willow (Salix exigua), and two species of flatsedge (Cyperus odoratus and C. squarrosus). In order to generate hypotheses concerning factors responsible for differences in composition among the seventeen sites, frequencies of occurrence of twenty common species were used to ordinate the sandbar communities based on their dissimiliarity (Bray-Curtis). Species richness, percent sand, sampling date (phenology), and geographical position do not appear to be correlated to site arrangement along either axes. However, composition does appear to be influenced by a site's position within a navigation pool. Communities clustered in the upper right quadrant of the ordination are found in the impounded/downstream portion of a navigation pool, while those outside that quadrant are tailwater/upstream communities. Locally, microtopographical differences as small as 3 cm may influence community composition. Rice-cutgrass (Leersia oryzoides) clearly decreases, and peach-leaved willow (Salix amygdaloides) increases with increasing elevation. These trends occur within an elevation range of less than .30 m.

EFFECT OF LATE-WINTER DRAWDOWN OF A RESERVOIR ON THE VERTICAL DISTRIBUTION AND ABUNDANCE OF BENTHIC MACROINVERTEBRATES.

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Lakes associated with hydropower generation often experience a late-winter drawdown of water levels in anticipation of snowmelt. This practice has serious implications for habitat structure and availability for littoral-zone benthic macroinvertebrates. This study was performed to assess the effects of late-winter drawdown on the abundance and distribution of littoral-zone benthic invertebrate communities, in Lake Wissota,WI, created by impoundment of the Chippewa River. The lake is subjected to drawdowns of up to 3 m annually from mid-February through mid-April. Samples were taken at four depths (0.6, 1.5, 3.3, and 4.5 m) at each of 24 transects using a Petersen dredge in Nov. 1993 and April 1994. Substrate, dissolved oxygen, and the presence of macrophytes were recorded for each sample. Densities of macroinvertebrates were significantly lower at depths of 0.6 and 1.5 m in post-drawdown samples than in pre-drawdown samples. The only exception were in shallow areas with high quantities of detritus, where densities and taxa richness were comparable to pre-drawdown levels. Samples from 3.3 and 4.5 m exhibited low diversity and were dominated by Chironomidae. The results of this study indicate that late-winter drawdown is affecting the distribution of benthic invertebrates. While it does not appear that benthic invertebrates are migrating to deeper areas during drawdown, results of this study suggest that shallow areas which retain large quantities of detritus may serve as refugia when these areas are dewatered by drawdown.

LONG-TERM TRENDS (1959-1994) IN FISH POPULATIONS OF THE ILLINOIS RIVER WITH EMPHASIS ON UPSTREAM-TO-DOWNSTREAM DIFFERENCES

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Twenty-six stations were electrofished during late summer-early autumn for most years since 1959. Three river segments were recognized: the upper 80 kilometers near Chicago; the next 242 kilometers (middle river); and the final 128 kilometers (lower river). The upper segment has been the most impacted by industrial wastes and sewage, while the lower/middle segments have been more degraded by excessive siltation. Catch rates (number collected per hour) for indicator species with different tolerances to pollution and data on external abnormalities for all species were analyzed for trends. Common carp and goldfish were considered tolerant of low DO and toxicants. Centrarchids, treated as a group because of similar interspecific habitat needs, were considered pollution-intolerant relative to carp or goldfish. Green sunfish data were not included with other centrarchid data because of green sunfish tolerance to degraded conditions.

From 1962 to 1994, carp catches decreased for all river segments, and centrarchid catches increased on the lower and upper river (Fig.1); goldfish decreased in upper river catches, and were absent or collected in small numbers elsewhere. The number of species making up 95% of the total catch for the middle and upper river was greater in recent years compared with the 1960s (Table 1). In 1963, for example, the 95% list consisted of 10 species on the middle river and just four species on the upper. In 1994, the 95% list consisted of 15 species on the middle river and 16 species plus one hybrid on the upper. The number of species on the 95% lists for the lower river were similar in 1963 (11) and 1994 (10); carp ranked first in 1963 (comprising 34% of the total catch), while bluegill were consistently first since 1991, ranging from 25 to 40% of the total catch (Table 1 and Fig.1). Increases in catches of centrarchids are probably related to increases in DO and decreases in ammonia concentrations since the 1960s. Declines in carp and goldfish may be due in part to higher predation on young-of-the-year by some centrarchids. Centrarchid numbers may not have changed in the middle river because increased production in some areas may have been offset by decreases in other areas that had more extensive losses of spawning habitat from siltation.

Benthic fishes (e.g., carp) had higher incidences of external abnormalities than pelagic fishes (e.g., bluegill) for all years in the upper river, and for most years in other reaches. Percentages of benthic fishes with abnormalities increased in the upstream direction, and concentrations of toxicants in sediments of the upper river were higher than in other reaches, which suggests abnormalities on benthic fishes are related to contact with contaminated sediments. The percentage of pelagic fishes with abnormalities decreased from 1959 to 1994 in all river segments, possibly reflecting better water quality

Figure 1. Non-parametric rank trend analysis.
Numbers above data points are the percentages each catch was of the total catch for all species collected for that year and river segment. ----- no data.

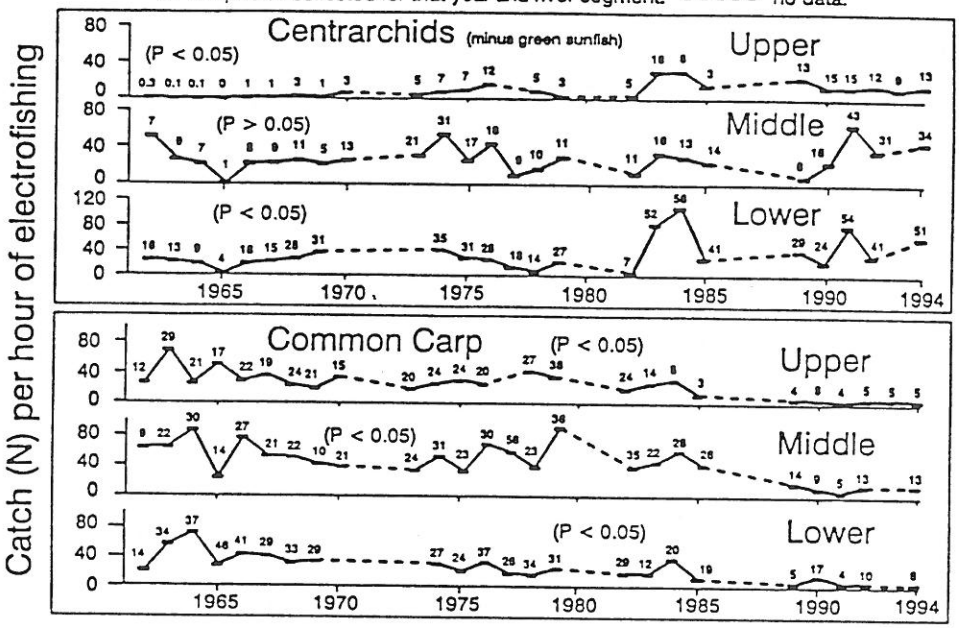

Table 1. Species that made up 95% of the total catch per hour in 1963 and 1994 and their ranks. Catches from these two years were fairly typical of their respective time periods. NC indicates the species was not collected in the specified river segment and year. Blanks indicate the species was collected, but was not on the 95% list for the specified river segment and year.

		1963			1994		
Common Name	Scientific Name	Lower	Middle	Upper	Lower	Middle	Upper
Gizzard Shad	*Dorosoma cepedianum*	2	1	4	3	5	3
Threadfin Shad	*Dorosoma petenense*	NC	NC	NC		13	NC
Common Carp	*Cyprinus carpio*	1	2	2	7	2	5
Carp x Goldfish	*C. carpio x Carassius auratus*	NC			NC	NC	15
Goldfish	*Carassius auratus*	NC		1	NC		
Bluntnose Minnow	*Pimephales notatus*	NC		NC	NC	NC	1
Bullhead Minnow	*Pimephales vigilax*	NC	NC	NC	NC		8
Emerald Shiner	*Notropis atherinoides*	5	3	3		4	2
Red Shiner	*Cyprinella lutrensis*	NC		NC	NC		16
Sand Shiner	*Notropis ludibundus*	NC		NC	NC	NC	9
Spottail Shiner	*Notropis hudsonius*	NC			NC		7
Bigmouth Buffalo	*Ictiobus cyprinellus*		5	NC	10	10	NC
Golden Redhorse	*Moxostoma erythrurum*	NC	NC	NC	NC		17
River Carpsucker	*Carpiodes carpio*			NC	NC	15	
Shorthead Redhorse	*Moxostoma macrolepidotum*	NC			NC	14	
Smallmouth Buffalo	*Ictiobus bubalus*		9	NC	8	9	10
Channel Catfish	*Ictalurus punctatus*	3	10	NC	2	12	14
White Bass	*Morone chrysops*	7		NC	9	6	13
Yellow Bass	*Morone mississippiensis*	11		NC	NC	NC	NC
Black Crappie	*Pomoxis nigromaculatus*	6	8	NC	5	7	
Bluegill	*Lepomis macrochirus*	4	4		1	1	4
Green Sunfish	*Lepomis cyanellus*		7			8	6
Largemouth Bass	*Micropterus salmoides*		6	NC	6	11	11
Orangespotted Sunfish	*Lepomis humilis*	8		NC			
Smallmouth Bass	*Micropterus dolomieu*	NC		NC	NC		12
White Crappie	*Pomoxis annularis*	10		NC	NC		NC
Freshwater Drum	*Aplodinotus grunniens*	9		NC	4	3	

ESTABLISHING A FIVE-YEAR VOLUNTEER WATER QUALITY MONITORING NETWORK FOR SPRING LAKE AND LAKE PEPIN ON THE MISSISSIPPI RIVER: FIRST YEAR RESULTS

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The Citizen Lake Monitoring Network was established in 1994 by the Minnesota-Wisconsin Boundary Area Commission as part of the Metropolitan Council Wastewater Services 1994-1998 Mississippi River Phosphorus Study. Its goal is to enable the public to be informed about and involved in monitoring water quality conditions in Lake Pepin and Spring Lake. It will supplement ongoing scientific and technical research while also providing citizen perception information that might help evaluate a lake water quality goal established in 1992. Eleven volunteers were recruited to monitor 13 sites on Lake Pepin and three sites on Spring Lake. Most sites were relatively close to shore, complementing open lake sites of other ongoing water quality studies. Monitoring kits were supplied to volunteers for bi-weekly data collections that began in early July. At each site, volunteers measured surface water temperature and Secchi transparency depth, and collected a 2-liter water sample for laboratory analysis. Water samples were analyzed for total phosphorus, total suspended solids, volatile suspended solids, and viable chlorophyll-a. Monitors also made judgments of the water's algae content, recreational suitability, and suspended sediment.

The project's first-year results are too preliminary for establishing conclusive findings. Future years' sampling will increase the statistical reliability of the data, allowing more deductions to be made. Even so, the 1994 data preliminarily indicated more chlorophyll-a, total phosphorus, and suspended sediment, and lower Secchi depths in the upstream third of Lake Pepin than in the downstream two-thirds of the lake. This is consistent with findings from other studies. The average river flow from June through August, 1994 was 26,000 cubic feet per second (cfs). This flow has been exceeded in about 25 percent of the summers on record and corresponds to a lake residence time of about nine days.

MACROINVERTEBRATE RECOLONIZATION OF DEWATERED SHORELINE FOLLOWING LATE-WINTER DRAWDOWN OF A RESERVOIR

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A common practice with man made impoundments in north temperate areas is to drawdown water levels in anticipation of spring snow melt. This strategy is of special concern because it dewaters the highly productive littoral zone, potentially impacting the benthic invertebrate community. Lake Wissota, created by impoundment of the Chippewa River near Chippewa Falls, WI, is subjected to water drawdowns of as much as 3 m from mid-February to mid-April. We collected samples in November 1993 and April-June 1994 to assess the effects of the late winter drawdown on density and distribution of benthic macroinvertebrates and to examine the recolonization of the littoral zone. Samples were collected using a Petersen dredge along 24 linear transects, at depths of 0.6 m, 1.5 m, 3 m, and 4.5 m. Transects were placed at specific sites on the lake proportional to sample abundance of the different substrata of the lake (sand, cobble, detritus). Samples taken immediately following ice-out (April 15) contained significantly fewer individuals and taxa than samples collected prior to drawdown. Only areas where detritus was a primary or secondary substrate did invertebrate densities and richness remain high. Substratum type influenced recolonization of dewatered areas, with shallow cobble areas recolonizing faster than gravel and sand areas. Preliminary results indicate that recolonization of the dewatered littoral zone does not occur by migration from deeper areas of the lake. Results of this study suggest that recolonization occurs by lateral migration from littoral areas where large quantities of detritus serve as refugia while the littoral zone is dewatered and covered in ice.

MACROINVERTEBRATE COMMUNITY STRUCTURE ON SNAGS FROM MAIN CHANNEL AND BACKWATER HABITATS OF THE UPPER MISSISSIPPI RIVER.

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We collected samples from woody debris (snags) to compare invertebrate community structure in backwater and main channel habitats of the upper Mississippi River. Samples were taken from two sites (near RK 1155 and 1172) in August and September 1993 using a DTH snag sampler. Mean number of individuals was higher in backwater snags with total mean densities of 8,477 and 16,023 individuals/m^2, for August and September, respectively. Backwater snags were dominated by collector-gatherers (Gammarus fasciatus, Crangonyx sp. and Hyallela azteca), while collector-filterers, represented by Hydropsychidae, were the most abundant fauna on main channel snags. MANOVA showed significant differences ($p \leq 0.05$) among habitats for all major taxa except Coleoptera and Annelida, as well as for all functional feeding groups except predators. Results of partial correlation analysis indicate that differences in bottom substrate, current velocity, and sample depth were among the major contributing factors to the differences of backwater and main channel macroinvertebrate community structures.

STABLE ISOTOPE ANALYSIS AS A TOOL FOR IDENTIFYING TROPHIC GUILDS AND SOURCES OF ORGANIC MATTER.

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Much of the current debate on the dynamics of large river ecosystems pertains to the origin of sources of organic matter in the food web. One method of determining original sources of organic matter is through the measurement of stable isotope signatures. Stable isotopes can be useful in identifying original sources because, unlike gut content analysis, they are related directly to assimilation. We collected samples for 26 sources of organic matter and organisms from different levels within the food web to measure delta ^{13}C and delta ^{15}N signatures. The samples were taken from the Mississippi River, near Louisiana, MO, in October 1993. Delta ^{15}N and $^{13}C/^{15}N$ ratios provided better resolution for distinguishing among sources of organic matter as well as among trophic levels for fish and invertebrates. Significant differences were found between C^3 and C^4 plants from the riparian and floodplain area. Significant differences also existed between different particle sizes of benthic organic matter and transport organic matter. Delta ^{15}N and $^{13}C/^{15}N$ ratios also demonstrated differences among benthic invertebrate groups. Significant differences among fish were few; however separation by stable isotope signatures appears to be sufficient for determining sources of organic matter. The results of this study demonstrate that stable isotope signatures can be used to distinguish between different sources of organic matter and among trophic groups of fish and invertebrates.

SPATIAL SURFACING OF POINT DATA - *MYRIOPHYLLUM* INVESTIGATIONS.

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Eurasian watermilfoil (*Myriophyllum spicatum* L.) has become a nuisance plant species in North America. It has become increasingly abundant in the Upper Mississippi River (UMR) ecosystem and has colonized areas which previously supported wildcelery (*Vallisneria americana* Michx.). In the summer of 1993, efforts were undertaken to understand the environmental requisites of *Myriophyllum* in the UMR. A sampling grid was established within a *Myriophyllum* bed in pool 7 near La Crosse, Wisconsin. Transects were spaced at 60-ft intervals, with sample sites (164) 30-ft apart. Information was collected on plant biomass, water depth, sediment moisture content, and sediment organic content. The data were examined via geographic information systems (GIS) software. Goals were to examine the functionality of using GIS to visualize and analyze riverine data and to determine whether additional understandings relative to *Myriophyllum*'s growth requisites could be elucidated. The data were interpolated to create continuous surfaces with five methods available in ARC/INFO Version 6.1 (ESRI, Redlands, CA): trend, inverse distance weighted (IDW), spline, krige, and triangular irregular network (TIN). Numerical and graphical comparisons were done for each method. Trend and IDW were found to be unacceptable as they failed to capture the character of the data, with others offering varying strengths and weaknesses. The TIN interpolated surface was chosen as the best *Myriophyllum* biomass predictive coverage (Fig. 1 and 2), the kriged surface as best for depth, the TIN surface as best for sediment moisture content, and the spline interpolated coverage as best for sediment organic content. Analysis indicated that a spatial representation of plant biomass that replicated the known patchiness of the bed could be interpolated as well as a spatial representation of related physical parameters. However, the occurrence of *Myriophyllum* is not easily predicted by depth, sediment moisture content, or sediment organic content. For each parameter, a zone of preferred conditions existed but the plant was tolerant and occurred in quite different conditions as well (Table 1).

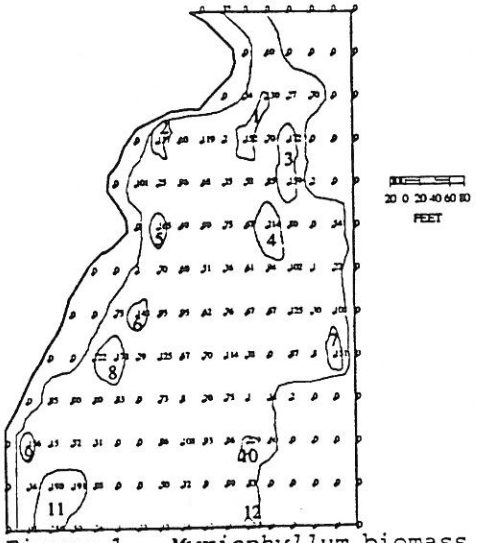

Figure 1. *Myriophyllum* biomass patches greater than 125 g/.2 m^2 and point data.

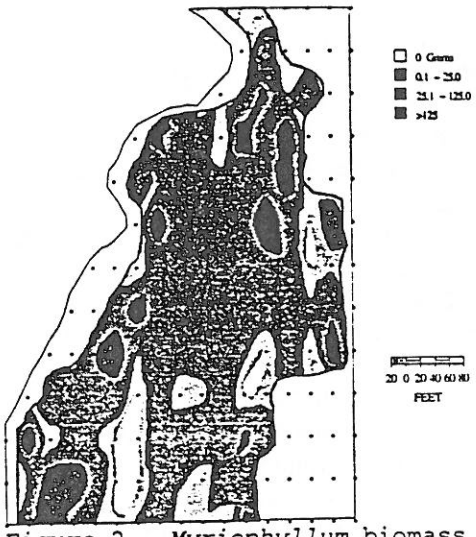

Figure 2. *Myriophyllum* biomass (g/.2 m^2) as predicted by a Triangular Irregular Network (TIN) interpolation.

Table 1. Depth, sediment moisture content and sediment organic content for 12 *Myriophyllum* patches with a biomass > 125 g/.2 m^2. Results presented are means and standard deviations. Area is presented in ft^2.

Patch Number	Area (ft^2)	Mean Depth (cm)	Depth STD	Mean Moisture (%)	Moisture STD	Mean Organic (%)	Organic STD
1	1733	91.14	3.32	25.25	0.85	1.99	0.10
2	916	106.04	2.29	23.26	0.87	1.27	0.50
3	2455	77.04	9.22	22.84	1.74	1.92	0.73
4	2283	81.25	2.01	22.62	1.33	1.45	0.50
5	842	109.46	4.90	21.97	1.27	0.77	0.66
6	887	90.45	0.58	25.22	0.71	2.77	0.42
7	976	98.24	2.71	37.23	3.85	4.09	0.66
8	2009	95.52	2.19	28.36	1.98	0.97	0.18
9	651	99.64	1.77	23.11	0.46	1.93	0.25
10	380	107.23	2.43	32.83	0.95	2.51	0.50
11	4578	104.42	3.44	23.46	1.54	1.08	0.28
12	130	102.47	1.94	31.66	0.82	2.98	0.15

INFLUENCE OF ICE COVER ON BALD EAGLE DISTRIBUTION WITHIN THE UPPER MISSISSIPPI RIVER REGION.

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Bald eagles *(Haliaeetus leucocephalus)* winter sporadically along the Upper Mississippi River (UMR). This project was conducted over two winters (1988-1989 and 1989-1990) in pools 14, 15 and upper 16 of the UMR. This study area included 45.5 miles of river the first year (river mile 477.0-522.5) and was increased to 47.5 miles the second year (river mile 475.0-522.5). The objective was to examine the possible influence of ice cover on bald eagle distribution within the study area. During weekly surveys, eagle numbers and locations were recorded on U.S. Army Corps of Engineers navigation charts, along with ice cover patterns. The locations of eagles and existing ice cover were approximated as accurately as possible using visible landmarks. Each chart represented a two-six mile study area. For the purpose of analysis, total ice cover for each increment was estimated to the nearest 25%. Ice cover greater than 20% was considered significant. Comparisons between eagle numbers and the amount of ice cover present were examined for potential relationships. In 1988-1989, 53% of the surveys experienced significant ice cover. This cover averaged 46.4%. During these particular surveys, 79.3% of all eagle observations occurred. In 1989-1990, significant ice cover was present on only 25% of the surveys. However, the average of this ice cover increased substantially to 72%. These surveys accounted for 69.3% of all eagle observations. Based on these results, bald eagle numbers within the study area appeared to increase when significant ice cover was present. However, when the data were examined in relation to river mile increments, we found that the increment itself more than the amount of ice cover present influenced bald eagle distribution. Nevertheless, a large proportion of the total number of eagles encountered within most increments were during surveys with significant ice cover. The results of this research indicate that ice cover is probably related to bald eagle distribution on the UMR. Although, it is also obvious that other environmental factors appear to influence this distribution.

INFLUENCE OF FORAGING-PERCH HABITAT ON BALD EAGLES IN WEST-CENTRAL ILLINOIS

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This research project was conducted in order to document wintering bald eagle *(Haliaeetus leucocephalus)* population size, age ratio characteristics, and seasonal population fluctuations along the Upper Mississippi River in west-central Illinois during the winters of 1988-1989 and 1989-1990. Additionally, the influence of foraging-perch habitat (FPH) availability and quality on bald eagle distribution was examined. The study area for this project included 45.5 miles of river (river mile 477.0-522.5) the first year, and 47.5 miles the second year (river mile 475.0-522.5). Data were collected via weekly censuses. The number and location of each eagle was plotted directly on data sheets, which consisted of U.S. Army Corps Engineers navigation charts. Eagle locations were approximated as accurately as possible using visible landmarks. The total number of birds censused within the study area was very similar each year (1214 and 1216, respectively). Adults were more common both years. The adult/immature ratio was 1.32 and 1.26, respectively. The populations experienced bimodal seasonal peaks both winters. The major peak (middle December-early January) was followed by a minor peak (middle February-early March). Bald eagle distribution within the study area was clumped into two similar sized sections (upriver and downriver) based on the number of eagles present. These sections also differed in the amount and quality of FPH available. More abundant and higher quality FPH, along with greater eagle numbers, were located in the upriver section. FPH (large trees) is an essential habitat component for wintering eagles as foraging flight initiation and termination sites. The influence of FPH on distribution was examined as the relationship between tree-perched eagle locations and use of specific sites containing at least minimally adequate habitat. Individual sites of FPH were classified as "minimally adequate", "adequate", or "more than adequate", depending on the number and arrangement of perch trees and the amount of buffer they provided from human activities. The results of this research indicated that FPH quality did influence bald eagle distribution within the study area. However the correlation was not statistically significant, probably due to the limited number of sites sampled coupled with the inherent variability of individual sites. In addition to FPH, other environmental factors probably influence bald eagle habitat use and distribution.

SECONDARY EFFECTS OF TREATMENTS OF THE HERBICIDE FLURIDONE ON INVERTEBRATE COMMUNITY STRUCTURE IN LAKE ECOSYSTEMS.

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An exotic species, Eurasian milfoil, has become a problem in many Minnesota lakes. It overruns the native macrophyte species, becoming a dominant macrophyte within many lentic systems. In addition, the leaves of Eurasian milfoil are smaller than the leaves of many native aquatic macrophytes, reducing the amount of surface area available for invertebrate colonization. These changes in macrophyte community structure should lead to corresponding changes in structure of aquatic invertebrate communities. One alternative treatment for the control of milfoil is application of the herbicide fluridone, which kills all aquatic macrophytes for at least one growth season. To identify the secondary effects of fluridone, Auburn Lake was designated a control, while Zumbra Lake was treated with the herbicide on May 1994. Both lakes are located in north Carver County, Minnesota. Samples were taken in 1993, (June and August), and in 1994, (June, July, August, and September), from macrophyte beds of both lakes to assess changes in invertebrate community structure. Three sample sites were identified within each lake before treatment on the basis of the amount of milfoil present in relation to native macrophyte species. Each lake contained one sample site with: native vegetation; mix of native vegetation and milfoil; and solely milfoil. Samples were collected using a plastic tube with a sieve at each end. Macrophyte samples were gathered from three transects per sample site at 1-m, 2-m, and 3-m depths, with three repetitions at each transect. Preliminary analysis of data shows a decrease in the number and diversity of invertebrates inhabiting macrophytes in treated Zumbra Lake when pretreatment (1993) and posttreatment (1994) are compared. Densities and taxa richness differed between both lakes following treatment, with both being lower in Zumbra Lake. Reduction in the diversity and densities of invertebrates inhabiting macrophytes in Zumbra Lake were a response to the loss of many of the native macrophytes and milfoil following herbicide application. The study will continue into 1995 to monitor the return of macrophytes and macrophytic invertebrates in Zumbra Lake.

A METHOD FOR MEASURING THE SPATIAL ACCURACY OF COORDINATES COLLECTED USING THE GLOBAL POSITIONING SYSTEM

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Evaluating locational accuracy of spatial data is important to determine the appropriate use of these data. However, a good method has not been documented to measure locational accuracy. We have found that the Global Positioning System (GPS) ameliorates the difficulty of measuring the location of objects and enables non-surveyors to determine their location with relative ease and accuracy. This study devised a straight-forward, repeatable, and statistically sound method of estimating the horizontal accuracy of GPS-derived locational data. We concentrated on the spatial accuracy of points, because points represent simple locations and not cartographic abstractions such as lines or polygons.

When GPS coordinates are taken at surveyed locations, the quantity of interest is the difference from the surveyed (assumed true) coordinates. This difference in coordinates is a bivariate quantity and the probability distribution function (PDF) can be described by an ellipse with the center at $\bar{X}$ and $\bar{Y}$. An ellipse is an appropriate shape for a PDF; it has two dimensions but is not rectangular because the joint probability of points occurring in the corners is very small, and it is generally not circular because X and Y are not necessarily the same. There are three ellipses of interest: the standard ellipse, the confidence ellipse, and the tolerance ellipse. The standard ellipse is a descriptive tool used to visualize the ellipse's shape and orientation. It contains about 40% of the sample, is not dependent on the sample size, and cannot be used for statistical inference. The other two ellipses have identical shapes and orientation but different major and minor axes. The confidence ellipse is an estimate of accuracy; the sample mean is or is not significantly different from the survey locations at a given α. The tolerance ellipse is an estimate of precision; a given percentage of the population sampled is enclosed in the tolerance ellipse at a given α.

Thirty-six locations were measured and compared to surveyed locations. The average offset was -1.05 m in the northing (Y) direction and 0.74 m in the easting (X) direction. Hotelling's one sample test determined that H_o (no significant departure from the survey locations exists) was rejected at the 0.05 level, which indicates there was a systematic error in the sample. The sample mean was offset in the south and east directions. Ninety-five percent of the population sampled (at the 0.05 level) was contained in an ellipse that was centered on (0.74, -1.05), had a major axis of 9.06 m, and a minor axis of 6.83 m with an angle of 31.68°. Thus, if an additional point were taken, we are 95% confident that it would fall within this ellipse.

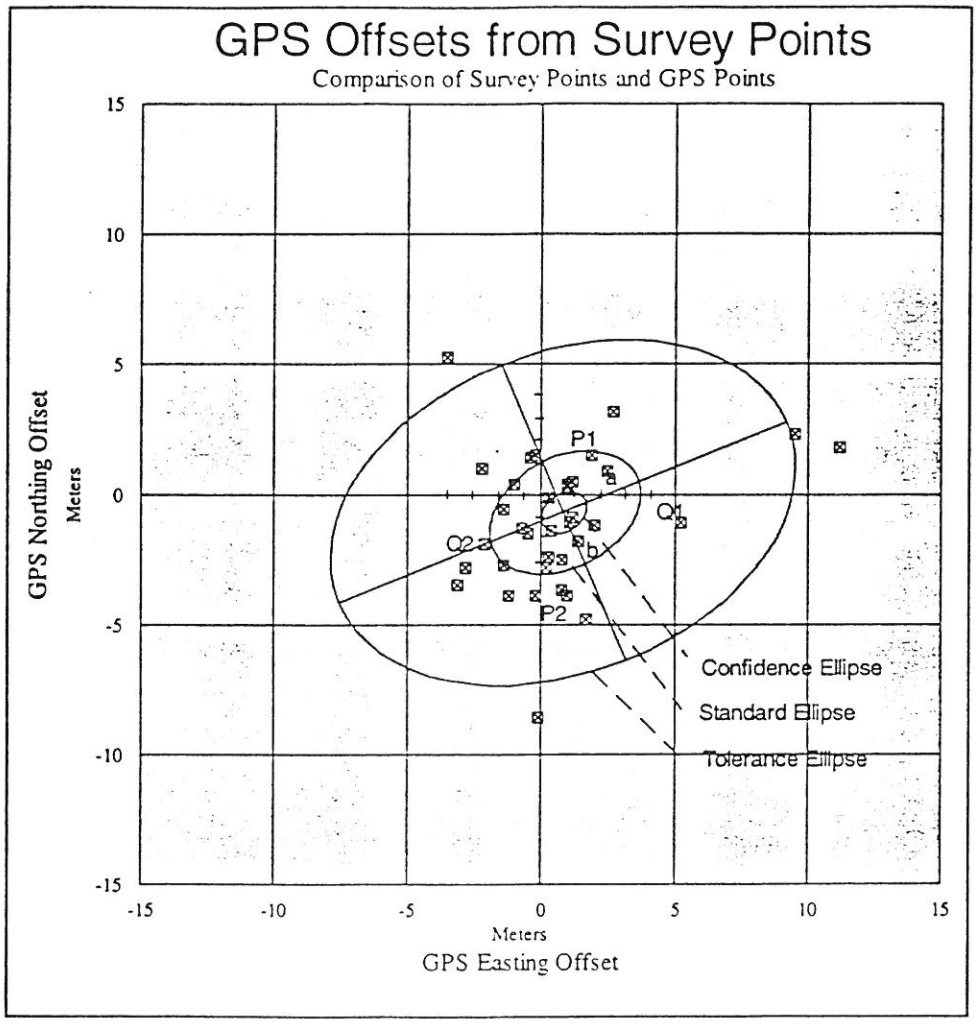

Table 1. Distribution of distances of coordinates collected using GPS receivers from survey coordinates and the ellipses which describe the accuracy (the confidence ellipse) and the precision (the tolerance ellipse) of these GPS coordinates

INTEGRATING HYDRAULIC AND SPATIAL MODELS FOR STUDYING THE EFFECTS OF MANAGEMENT OPTIONS ON HABITATS

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The Environmental Management Technical Center is assisting conservation agencies in Illinois and Missouri in developing an ecosystem management strategy for Pool 25. One of the objectives of work performed in 1994 was to develop tools that would predict types and amounts of habitat affected by various water level and levee management alternatives. Forty scenarios were developed for a range of management options dealing with two levee alternatives and five water level alternatives, each at four discharge regimes. A geographic information system (GIS) was used to investigate the amounts and types of habitat affected in the 40 scenarios. The investigation required developing GIS coverages of water levels, floodplain elevations, levees, and habitat types. A coverage of water level was created using data estimated for each scenario using HEC-2, a hydrologic model used to predict backwater curves. Data obtained from bathymetric surveys, USGS quadrangle maps, and satellite imagery were used to interpolate elevation across the floodplain. A 13 class habitat coverage was developed from 1989 aerial photography. An existing levee coverage was slightly modified to represent areas protected by levees. These four data sets were integrated through GIS overlay to predict changes in habitats for each scenario. Changes were tabulated and mapped. A computer program was written to automate much of this model, thus providing managers an opportunity to investigate a wide variety of management alternatives with a minimal amount of effort.

TEMPORAL AND SPATIAL TRENDS IN THE LENGTH-WEIGHT RELATION OF *HEXAGENIA* MAYFLIES IN THE UPPER MISSISSIPPI RIVER.

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We analyzed temporal and spatial trends in the dry biomass and total length of *Hexagenia* mayflies to critically assess the relation between dry weight and length. We were interested in whether a single regression equation would adequately describe this relation, and how factors such as sex, time, and site influence this regression. Mayflies were sampled monthly from June through October, 1994, at four backwater sites in Pool 8 of the upper Mississippi River. On each sampling event, we obtained 10 male and 10 female mayflies, ranging from 10 to 25 mm in length, from each site. Sex was determined in the field with a dissecting microscope, and length and weight were measured in the laboratory. Individual dry weights ranged from 0.4 to 21 mg for females (mean 5.8 mg) and from 0.4 to 25 mg for males (mean 6.3 mg). In general, mean biomass was greatest in July and September and lowest in October. Spatially, mean biomass was greatest at site 4 and lowest at site 1. When length was adjusted to a common length of 15 mm, dry weights were greatest in September at all four sites, but lowest in July at sites 1, 2, and 3, and lowest in June at site 4. The log-transformed slopes of the linear regression lines were not significantly different between males and females among the four sites or five months sampled. After combining the data for males and females, we found a significant difference in the slopes and intercepts of the regressions among months, but not among sites. Thus, the relation between dry weight and total length was best explained as five separate regression equations--one for each of the five months sampled. This suggests that using a single regression equation to describe the relation between dry weight and length, as is frequently done, may not be incorporating temporal patterns in these variables.

PHYTOPLANKTON POPULATION DYNAMICS IN TWO BACKWATER LAKES OF THE UPPER MISSISSIPPI RIVER

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[1]Augustana College Biology Department, Rock Island, IL 61201 [2]U.S. Fish and Wildlife Service, Rock Island, IL 61201

Phytoplankton populations were studied in two backwater lakes: Keithsburg Refuge a self-contained backwater lake in Pool 18 that receives most of its runoff from agricultural tributaries and Big Timber connected directly to the Mississippi River in Pool 17. Monthly samples were taken starting April 1, 1994. Six plankton samples were taken at each site on each date. Water samples were also taken to test nutrient and herbicide levels. Big Timber had at least three times the phytoplankton density of Keithsburg through the end of May but similar densities in late June and July. At both sites Chrysophyta had higher relative abundance in spring than in summer. Even though relative abundances indicated a spring diatom bloom at both sites as expected, actual chrysophyte abundance at Keithsburg was lower in spring than summer. Cyanophytes had a higher relative abundance in the summer at Keithsburg and their actual abundance had an inverse relationship with nitrogen as expected. Big Timber's cyanophyte density however, did not show a relationship with nitrogen levels. In both habitats, total phosphorus levels were high relative to nitrogen during the summer indicating nitrogen limiting systems. Thus, high levels of Cyanophyta are expected. This nitrogen limitation was unexpected at Keithsburg, however, because of the high agricultural input of nitrogen at the north end of the lake. The major differences between the two sites were found in the spring when there was a low total level of algae, especially chrysophytes at Keithsburg. Thus, it is possible that contaminants from agricultural fields during spring runoff affect phytoplankton populations at the Keithsburg site.

DO ARTIFICIAL ISLANDS CREATE A SUITABLE HABITAT FOR BENTHIC MACROINVERTEBRATES?

Eric Olson[1,2], **Tanya Stellmach**[1,2], and Randy Burkhardt[1].
[1]National Biological Service, Environmental Management Technical Center, Onalaska, WI 54650 [2]University of Wisconsin-La Crosse, La Crosse, WI 54601.

Macroinvertebrate densities around the artificial islands in Lake Onalaska were compared with densities in other backwaters of pools 7 and 8 during May and June, 1994. Twelve standard ponar grab samples were taken from sites near the artificial islands in Lake Onalaska and 74 samples were collected from eight nearby backwaters. Fingernail clams, mayflies, and oligochaetes were significantly higher for Lake Onalaska Islands ($P < 0.001$) than for the other backwaters. These data suggest that the Lake Onalaska Islands HREP may provide a more suitable habitat for fingernail clams, mayflies, and oligochaetes then do backwaters sampled in the Upper Mississippi River during the spring of 1994.

DISTRIBUTION OF SUBSMERSED AQUATIC VEGETATION: RESULTS OF POOL 8 UPPER MISSISSIPPI RIVER SURVEYS 1991-1993.

Shawn E. Weick[1], Sara Rogers[2], David R. McConville[1,2], and Heidi A. Langrehr[3], [1]Saint Mary's College of Minnesota, Winona, MN 55987, [2]National Biological Service and [3]Wisconsin Department of Natural Resources, Environmental Management Technical Center, 575 Lester Avenue, Onolaska, WI 54650 USA.

Distribution, abundance, and diversity of submersed macrophytes in Pool 8, of the Upper Mississippi River System (UMRS), were analyzed using geographic information systems (GIS) software. A pool-wide survey of vegetation was conducted by the Wisconsin Department of Natural Resources during the 1991-1993 field seasons. Species composition, approximate bed size, water depth, substrate type, and Universal Transverse Mercator (UTM) coordinates were recorded for each bed located. This data was overlaid on existing aquatic areas and bathymetry base maps using EPPL7, a GIS software. The resulting maps gave a spatial representation of distribution and abundance of vegetation beds for each year. Frequency of bed location was compared by an aquatic area classification as well as by year. Diversity was analyzed by overlaying vegetation beds composed of three or more species and comparing to all beds for each year. Three aquatic macrophyte species were specifically targeted for spatial and temporal patterns: *Myriophyllum spicatum* L. (eurasian watermilfoil), an exotic invader, *Vallisineria americana* Michx. (wild celery), an important source of food for waterfowl, and *Potamogeton pectinates* L. (sago pondweed), an abundant species in Pool 8 as well as an important food source for waterfowl. Comparison of data from all three years suggests that 1992 was the most diverse and abundant. High water levels in the spring of 1991 and the flood of 1993 were likely disturbances affecting distribution.

POPULATION DYNAMICS OF ZEBRA MUSSELS IN THE LOWER ILLINOIS RIVER, 1993-94.

Scott D. Whitney, K. Douglas Blodgett, and Richard E. Sparks
Illinois Natural History Survey, LTRMP Field Station, 704 N. Schrader Avenue, Havana, IL 62644

Since 1993, we have quantitatively assessed the demographics of newly established zebra mussel (Dreissena polymorpha) populations in the lower and middle Illinois River. This research is designed to provide a better understanding of riverine zebra mussel populations and their impacts on specific riverine species and on the riverine ecosystem. Zebra mussel populations exploded in the lower Illinois River during the summer of 1993, only two years after their initial discovery in this waterway. By August, the 1993 Flood had carried veligers from up river populations to the lower Illinois River, where newly settled zebra mussels averaged 10,905·m^{-2} and 61,126·m^{-2} at river miles (RM) 66.8 and 5.5, respectively (Table 1). These downriver populations consisted almost entirely (>99%) of similarly small zebra mussels resulting from the first settlement of 1993. By October 1993, zebra mussels had experienced significant mortality, averaging 47.6% at RM 66.8 and 21.9% at RM 5.5. By October 1994, both RM 5.5 and 66.8 had suffered a population crash, with greater than 99% reduction in both populations --- live zebra mussel densities averaged 74·m^{-2} at RM 66.8 and 657·m^{-2} at RM 5.5. Length frequency distributions and settling block data from Illinois River sites indicate very poor recruitment of juvenile zebra mussels during 1994. Conversely, at least two recruitment periods were observed at a Mississippi River site (RM 217), just 1.5 river miles below the confluence with the Illinois River. Dissolved oxygen concentrations as low as 1.7 ppm and temperatures as high as 31.2°C were recorded near the bottom of the main channel at RM 5.5 during sampling in late June 1994. Low dissolved oxygen, high water temperatures, and low water levels persisted throughout most of July 1994, and may explain the poor recruitment and increased mortality of the lower Illinois River populations.

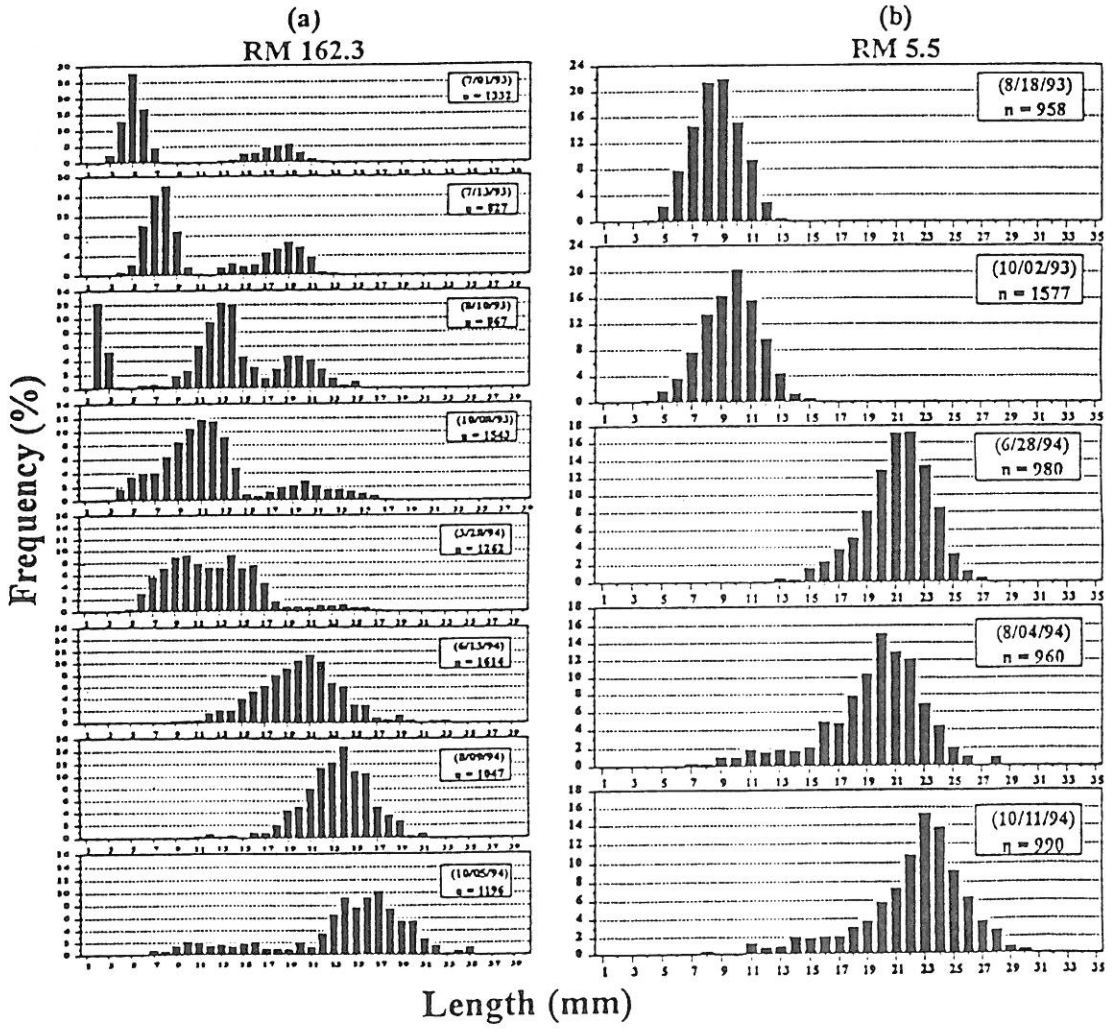
Further upriver, live zebra mussel densities at RM 162.3 increased from 1,793·m^{-2} in August 1993 to 6,998·m^{-2} in October 1993, and have remained relatively stable through August 1994 (5836·m^{-2}). Mortality remained low from July 1993 through June 1994, averaging between 0% and 2.4%. However, mortality suddenly increased to 37.3% by August and 56.7% by October 1994. Comparisons of zebra mussel length frequency distributions from upriver (Fig. 1a) and downriver (Fig. 1b) sample sites, illustrate differential growth rates and recruitment between these two populations during the past two years. We believe the upriver/downriver differences in mortality, growth, and recruitment have been greatly influenced by overpopulation and poor environmental conditions. Dramatic fluctuations in flow and water quality factors in the Illinois River are expected to produce significant fluctuations in zebra mussel populations. However, zebra mussel densities of a few thousand individuals·m^{-2} appear to be sustainable over the wide range of environmental conditions experienced during the past two years.

Table 1. *Zebra mussel densities at selected sites in the Illinois River during 1993 and 1994.*

Zebra Mussels	Site	RM 162.3 (Peoria)						RM 66.8 (Meredosia)				
	Date	8/18/93	10/8/93	3/28/94	6/13/94	8/9/94	10/05/94	7/21/93	9/30/93	6/10/94	8/05/94	10/13/94
Avg. Live Density (m²)		1793	6998	4165	3268	5836	1816	10905	12587	1144	420	74
Avg. Dead Density (m²)		0	25	89	92	3611	2914	0	8219	9691	25110	—
Avg. % Dead Shells		0.0	0.4	2.4	2.4	37.3	56.7	0.0	40.8	89.9	98.1	—
Avg. Live Biomass (g/m²)		447.6	782.4	—	1704.9	4038.3	1828.5	498.2	2286.2	768.7	367.0	53.3

Zebra Mussels	Site	RM 50.0 (Montezuma)				RM 5.5 (Grafton)				
	Date	10/01/93	6/12/94	8/3/94	10/12/94	8/18/93	10/2/93	6/27/94	8/04/94	10/11/94
Avg. Live Density (m²)		8443	3103	2603	1630	61126	34812	1528	3807	657
Avg. Dead Density (m²)		1123	2496	8518	5520	12	10254	2232	5262	156
Avg. % Dead Shells		10.8	47.9	77.0	74.3	0.0	22.1	66.6	52.5	17.0
Avg. Live Biomass (g/m²)		1614.3	2047.7	1675.0	1356.7	1283.2	1577.6	699.8	1522.8	141.1

Figure 1. *Length frequency distributions for two Illinois River zebra mussel populations sampled from 1993-94.*



1995 BUSINESS MEETING AGENDA
MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC.
27th ANNUAL MEETING

FRIDAY APRIL 28, 1995
11:00 AM

HOLIDAY INN, LA CROSSE, WISCONSIN

1. Call to Order

2. Announcements and Acknowledgements
   a. Presentation of 1994 Best Paper Awards

3. Secretary's Report
   a. Approval of the Minutes of the 1994 Business Meeting

4. Treasurer's Report
   a. Final 1994 Financial Report
   b. Preliminary 1995 Financial Report

5. Old Business

6. New Business
   a. Nomination and Election of the 1995-96 Board of Directors
   b. Meeting Notice for the 28th (1995) Annual Meeting
      1. April 25-26, 1996, Holiday Inn, La Crosse
   C. Other?

7. Raffle

8. Adjourn

MISSISSIPPI RIVER RESEARCH CONSORTIUM
TREASURER'S REPORT
5 MARCH 1995

Accounts as of 30 June 1992		$4,627.88
Accounts as of 30 June 1993		$4,983.94

Transactions, 1 July 1993 to 30 June 1994

INCOME		
1994 Registration and dues	$5,435.00	
Raffle	$ 316.00	
Interest	$ 37.41	
Total	$5,788.41	
EXPENSES		
Holiday Inn (1994 meeting)	$5,564.23	
Holiday Inn (1995 deposit)	$ 100.00	
1994 Proceedings	$ 552.70	
Corporation fee	$ 10.00	
1994 Raffle prizes	$ 60.00	
1994 Meeting photographs	$ 21.32	
Office and meeting supplies	$ 11.18	
Total	$6,319.43	
Accounts as of 30 June 1994		$4,452.92

Transactions, 1 July 1994 to 5 March 1995

INCOME		
1994 Registration and dues	$ 926.41	
Interest	$ 187.73	
Book sale	$ 5.00	
Total	$1,119.14	
EXPENSES		
Large Rivers Conference	$1,000.00	
Corporation fee	$ 10.00	
Total	$1,010.00	
Accounts as of 5 March 1995		$4,562.06

Accounts

Checking account	$ 359.18
Savings account	$4,202.88
Total	$4,562.06

MINUTES OF THE BUSINESS MEETING, 26th MEETING OF THE MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC., APRIL 29, 1994

1. CALL TO ORDER

   The meeting was called to order at 11:00 AM by President Teresa Naimo. Vice-President Mark Sandheinrich, Treasurer Neil Mundahl, and Secretary Chuck Theiling, along with approximately 80 members, were in attendance.

2. ANNOUNCEMENTS AND ACKNOWLEDGEMENTS

   The President acknowledged everyone who helped prepare and conduct the 26th Annual Meeting including moderators, judges, presenters and co-sponsors. She encouraged others to become co-sponsors to continue to keep the costs of the meetings low. Awards were presented to the winners of the best poster, best paper, and best student paper at the 25th Annual Meeting of the MRRC.

3. SECRETARY'S REPORT

   Joe Wlosinski moved, Mark Sandheinrich seconded, and those present unanimously agreed to approve the minutes of the 1993 (25th) Annual Business Meeting, as presented in the 1994 Proceedings. Chuck Theiling reported on letters sent Congressional members supporting bills related to the Mississippi River including potential flood recovery and the Interjurisdictional Rivers Bill.

4. TREASURER'S REPORT

   Neil Mundahl reported the satisfactory results of an audit conducted during the transition between Joe Wlosinski's and his own terms as Treasurer. Because all bills and income from the 26th Annual Meeting had net been received, a final report for 1994 was not yet available. As of April 15, 1994 $7,862.60 was available in the Consortium accounts. Marion Havlik moved, Joe Wlosinski seconded, and those present voted unanimously to accept the Treasure's report.

5. OLD BUSINESS

   The only item listed under old business was a report that $1,000 had been donated to help support the upcoming International Large Rivers Conference to be held in LaCrosse, WI.

6. NEW BUSINESS

   A. Nomination and election of the 1994-1995 Board of Directors - The nomination committee was made up of the 1993-1994 Board of Directors. The nominations were:

   1. Robert Maher for a one year term as Vice-President followed by a one year term as President.

   2. Mike Delong for a two year term as Secretary.

   The Vice-President, Mark Sandheinrich will assume the President role for a one year term.
   The President asked for nominations from the floor. Tom Claflin moved to accept the recommendations of the nominating committee;

Marian Havlik seconded the motion which passed by a unanimous vote of the members.

B. Meeting notice for the 25th (1995) Annual Meeting - The Holiday Inn, LaCrosse was the only venue considered for the 1995 Annual Meeting. The Board announced that the meeting would be held 27 - 28 April, 1995.

Yao Yin - commented that lighting in the poster display area was very poor and should be improved in the future.

Mark Sandheinrich - said the new Board of Directors would rectify lighting problems for future meetings.

Marion Havlik - commented that she was not pleased that the Proceedings were not spiral bound and that each abstract was not on a separate page.

Mark Sandheinrich - commented that the cost of spiral binders drives up the cost of the Proceedings considerably and would increase the cost of the meeting for the membership.

Marion Havlik - commented she would be willing to pay more and that removing the by-laws from the Proceedings might save some costs.

The new Board of Directors will decide the format for 1995.

C. The President notified the membership that a photo record from the Annual Meetings was going to be maintained by the Board. Dr. David Kennedy agreed to serve as the photographer. The Secretary will maintain the photos as part of the duties as historian.

D. Paul Hansen (Issak Walton League) described a bill to be included under the reauthorization of the Clean Water Act. The bill called for a special designation for the Upper Mississippi River System along with increased regulatory controls.

E. Mark Sandheinrich presented the outgoing Board members with T-shirts bearing the MRRC logo. He also suggested that they would be available for sale to members at the next Annual Meeting.

Joe Wlosinski - asked how many might be needed.

Teresa Naimo - commented that many members had expressed interest in obtaining the T-shirts.

Donna Wilson - agreed to coordinate activities related to T-shirts.

The President asked for other new business. With no response from the members, the raffle was held.

7. ADJOURNMENT

The meeting was adjourned at 11:40 AM.

CONSTITUTION OF THE MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC.

ARTICLE I. NAME AND OBJECT

1. This organization shall be named Mississippi River Research Consortium, Inc.

2. The objective of this organization shall be:

   a. To establish and encourage communication between river scientists and between the scientific community and the public.

   b. To encourage pure and applied research concerning the water and land resources of the Mississippi River and its valley.

   c. To provide an annual meeting where research results can be presented, common problems can be discussed, information can be disseminated, and where river researchers can become acquainted with each other.

   d. To encourage cooperation between institutions and to encourage the sharing of facilities.

   e. To function as an advisory group to other agencies.

   f. To aid in the formation of a concerted and organized research effort on the Mississippi River.

ARTICLE II. ORGANIZATION

1. The organization of the Mississippi River Research Consortium shall be provided for by the enactment of suitable bylaws.

2. The bylaws of this organization shall designate the officers and standing committees, the provisions for the election of officers, the conduct of meetings, and for any other matters which are necessary for the government of this organization.

ARTICLE III. MEMBERSHIP AND DUES

1. The membership of this organization shall consist of any persons who demonstrate an interest in any aspect of the Mississippi River and who express a desire to join the organization.

ARTICLE IV. AMENDMENTS

1. The constitution or the bylaws of the MRRC may be amended by an affirmative vote of two-thirds of the eligible voting members present at the annual meeting.

BYLAWS OF THE MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC.

ARTICLE I: NAME, PURPOSES, AND DUTIES

1.01 There is hereby established a Board under the name of the Mississippi River Research Consortium, Inc., having the purpose and duties of governing all matters relating to this corporation. These shall be deemed to include the following without limitation:

(a) To have the ultimate decision making authority for any and all affairs of the Mississippi River Research Consortium, Inc. which includes, but is not limited to, the authority to create and terminate the corporation, to determine the budget and expenditure of funds, to manage affairs, to determine the manner, location, and extent of services performed by the corporation, to determine the number of, location, and job duties of any employees, and to do all other and necessary work for the benefit of the corporation.

(b) To formulate all policies necessary for the effective and continuous operation of the corporation.

(c) To coordinate and make decisions regarding priorities of services.

1.02 The purposes of the organization shall be as follows:

(a) To establish and encourage communication between river scientists and between the scientific community and the public.

(b) To encourage pure and applied research concerning the water and land resources of the Mississippi River and its valley.

(c) To provide an annual meeting where research results can be presented, common problems can be discussed, information can be disseminated, and where river researchers can become acquainted with each other.

(d) To encourage cooperation between institutions and to encourage the sharing of facilities.

(e) To function as an advisory group to other agencies.

(f) To aid in the formation of a concerted and organized research effort on the Mississippi River.

ARTICLE 2: OFFICES

2.01 Principal and Business Offices.

The corporation may have such principal and other offices, either in or out the State of Wisconsin as the Board of Directors may designate or as the business of the corporation may require from time to time.

2.02 Registered Office.

The registered office of the corporation required by the State of Wisconsin corporation law to be maintained in the State of Wisconsin may be, but need not be, identical with the principal office in the State of Wisconsin, and the address of the registered office may be changed from time to time by the Board of Directors or by the Registered Agent. The business office of the registered agent of the corporation shall be identical to such registered office.

ARTICLE 3: OFFICERS AND BOARD OF DIRECTORS

3.01 General Powers, Responsibility, and Number.

The business and affairs of the corporation shall be managed by its Board of Directors. It shall be the responsibility of the Board to carry out the objectives of the organization and to jointly organize, hold, and preside over the annual meeting. The Board of Directors of the corporation shall consist of an elected president, vice-president, secretary, and treasurer.

3.02 Election and Terms of Officers.

Each Board member will be elected for a two year term after the 1991 election. In odd numbered years a treasurer and a vice-president will be elected, with at least one being a representative of either a state or federal agency. In even numbered years a secretary and a vice-president will be elected, with at least one being a representative of an academic institution. After a vice-president serves for one year, he or she shall become president for the next year. In 1991 all four officers will be elected. The term for president and secretary elected in 1991 will be for one year. The term for the treasurer elected in 1991 will be for two years. The vice-president elected in 1991 will become president in 1992. The term of each officer begins at the annual meeting.

3.03 Removal From Office.

Any officer may be removed by the Board of Directors whenever in its judgment the best interests of the corporation shall be served thereby, but such removal shall be made without prejudice to the contract rights of any person so removed. Election or appointment shall not of itself create contract rights. An officer may be removed from office by affirmative vote of a majority of the Board of Directors, taken at a meeting by the Board of Directors for that purpose. A director may resign at any time by filing a written resignation at the registered office. Any officer who is absent from three (3) consecutive meetings of the Board shall, unless excused by action of the Board, cease to be a member of the Board of Directors and shall be removed forthwith.

3.04 Meetings.

The Board of Directors shall meet on the times and dates to be established by them but at least once during the annual meeting. Meetings of the Board of Directors may be called by or at the request of any officer. The president or secretary may fix the place of the meeting and if no other place is designated or fixed the place of the meeting shall be at the principal business office of the corporation in the State of Wisconsin. Telephone conference calls can be used in place of regular meetings except during the annual meeting.

3.05 Notice; Waiver.

Notice of such meetings of the Board of Directors shall be given by written or verbal notice delivered personally, by phone or mailed or given by telegram to each director at such address or telephone number as such director shall have designated with the secretary, not less than ten (10) days, or a number of days to be decided by the Board, prior to such meeting. Whenever any notice whatever is required to be given to any director of the corporation under the Articles of Incorporation or By-Laws or any provision of law, a waiver thereof in writing, signed at any time, whether before or after the time of the meeting, by the director entitled to such notice, shall be deemed equivalent to the giving of such notice. The attendance of a director at a meeting shall constitute a waiver of notice of such meeting, except where a director attends a meeting and objects to the transaction of any business because the meeting is not lawfully called or convened. Neither the business to be transacted at, nor the purpose, or any regular or special meeting of the Board of Directors need be specified in the notice or waiver.

3.06 Quorum.

A majority of the elected members of the Board is necessary for the transaction of business at any meeting and a majority vote of those present shall be sufficient for any decision or election.

3.07 Conduct of Meetings.

The president, and in his or her absence, a vice-president, and in their absence, any director chosen by the directors present shall call meetings of the Board of Directors to order and shall act as the presiding officer of the meetings. The secretary of the corporation shall act as secretary of all of the meetings of the Board of Directors, but in the absence of the secretary, the presiding officer may appoint any assistant secretary or any director or other person present to act as secretary of the meeting.

3.08 Vacancy.

Any vacancy occurring in the Board of Directors because of death, resignation, removal, disqualification, or otherwise, shall be filled as soon as possible by the majority action of the Board. If the president vacates office, the vice-president shall become president and the Board shall fill the vice-president position. A vacancy shall be filled for the unexpired portion of the term.

3.09 Executive Director of the Corporation.

The Board may retain, compensate, and give directives to an executive officer. Said executive director shall not be considered as a member of the Board of Directors.

3.10 Duties of Officers.

All officers have the responsibility of carrying out the objectives of the organization, assisting in the organization of the annual meeting, and preparing a Procedures Manual for the organization. In addition:

The president shall:

(a) Act as chairperson of the Board and of any executive committee,
(b) Appoint all committees unless otherwise specified by the Board,
(c) Be executive on behalf of the Board of all written instruments except as provided or directed by the Board,
(d) Be responsible for the agenda to be used at the meeting,
(e) Perform all duties incident to the office of a president and such other duties as shall from time to time be assigned to him by the Board.

The vice-president shall:

(a) Perform the duties and exercise the functions of the president at the request of the president and when so acting shall have the power of the president,
(b) Be responsible for the preparation and updating of the Procedures Manual for the organization,
(c) Perform such other duties as delegated by the president.

The secretary shall:

(a) Keep the minutes of the meetings of the Board,
(b) See to it that all notices are fully given in accordance with the provisions of the By-Laws,
(c) Be custodian of the records of the Board,
(d) Perform all duties incident to the office of the secretary of the Board and such other duties as from time to time may be assigned by the president of the Board.

The treasurer shall:

(a) Be responsible for financial record keeping and assessment of dues as established by the Board of Directors,
(b) Supervise the preparation of the annual budget,
(c) Receive all funds paid to the organization and shall pay all bills incurred by the Consortium,
(d) Perform other duties as from time to time may be assigned by the president.

3.11 Other Assistance to Acting Officers.

The Board of Directors shall have the power to appoint any person to act as an assistant to any officer, or agent for the corporation in his stead, or to perform the duties of such officer when for any reason it is impractical for such officer to act personally, and such assistant or acting officer or other agent so appointed by the Board of Directors shall have the power to perform all of the duties of the office to which he or she is so appointed to be assistant or to which he or she is so appointed to act, except as such powers may be otherwise defined or restricted by the Board of Directors.

ARTICLE 4: MEMBERSHIP AND DUES

4.01 Membership and Eligibility.

Membership to include anyone interested in the research and study of the Mississippi River and its valley.

4.02 Membership and Dues.

Membership to be for one (1) year with annual dues determined by the Board of Directors.

ARTICLE 5: COMMITTEES

5.01 Nominating Committee.

The Board of Directors shall serve as the nominating committee and file its report with the members at the annual meeting.

5.02 Other Committees.

The Board may, by resolution, provide for such other committees as it deems advisable and may discontinue the same at its pleasure. Each entity shall have the power and shall perform such duties as may be assigned to it by the Board and shall be appointed and the vacancies filled in the manner determined by the Board. In the absence of other direction, the president shall appoint all committees.

ARTICLE 6: MEETING OF MEMBERSHIP

6.01 Annual Meeting.

The annual meeting of the organization shall be held in La Crosse, Wisconsin. The time of the meeting shall be established by the Board of Directors and announced at the previous annual meeting. Reports of officers and committees shall be delivered at the meeting. The Board of Directors shall be elected from those individuals nominated by the Nominating Committee and those nominated from the floor with prior consent of the nominee. All persons attending the annual meeting shall be required to pay membership dues for that year and be a member of the organization in order to participate. Notice of the annual meeting shall be sent in writing to all members.

6.02 Special Meetings.

Special Meetings may be called by the president or by a majority of the Board and shall be called by the secretary on request of five (5) members in writing. The time and place of special meetings shall be announced at least two (2) weeks in advance.

6.03 Quorum.

At all meetings the members of the corporation present shall constitute a quorum for the transaction of business.

ARTICLE 7: AMENDMENTS

7.01 By The Membership.

These By-Laws may also be altered, amended or repealed and new By-Laws may be adopted by the Board of Directors by affirmative vote of two-thirds (2/3rds) of the members present at a meeting at which a quorum is in attendance.

PAST MEETINGS AND OFFICERS OF THE MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC.

Meeting	Year	Location	President
1st	1968	St. Mary's College, Winona	Brother George Pahl
2nd	1969	Wisconsin State Univ., La Crosse	Dr. Thomas Claflin
3rd	1970	Winona State College, Winona	Dr. Calvin Fremling
4th	1971	St. Cloud State College, St. Cloud	Dr. Joseph Hopwood
5th	1972	Loras College, Dubuque	Dr. Joesph Kapler
6th	1973	Quincy College, Qunicy	Rev. John Ostdiek
7th	1974	No Meeting	---
8th	1975	Monmouth College, Monmouth	Dr. Jacob Verduin
9th	1976	St. Mary's College, Winona	Mr. Rory Vose
10th	1977	Winona State University, Winona	Dr. Dennis Nielsen
11th	1978	Univ. of Wisconsin-La Crosse	Dr. Ronald Rada
12th	1979	Cancelled	Dr. Edward Cawley
13th	1980	Loras College, Dubuque	Dr. Edward Cawley
14th	1981	Ramada Inn, La Crosse	Mr. M. Vanderford
			Executive Committee
15th	1982	Radisson Hotel, La Crosse	Dr. Richard Anderson Dr. Dave McConville Dr. Jim Wiener
16th	1984	Radisson Hotel, La Crosse	Dr. Ken Lubinski Ms. Rosalie Schnick Dr. M. Smart
17th	1985	Radisson Hotel, La Crosse	Mr. Ray Hubley Dr. John Nickum Ms. Pam Thiel
			Board of Directors
18th	1986	Radisson Hotel, La Crosse	Dr. Jim Eckblad Dr. Carl Korschgen Dr. Jim Peck
19th	1987	Univ. of Wisconsin-La Crosse	Mr. Hannibal Bolton Dr. Leslie Holland Dr. Mike Winfrey

Meeting	Year	Location	Board of Directors
20th	1988	Univ. of Wisconsin-La Crosse	Mr. John Pitlo Mr. Verdel Dawson Dr. Nani Bhowmik
21st	1989	Holiday Inn, La Crosse	Dr. Larry Jahn Mr. Jerry Rasmussen Dr. Bill LeGrande
22nd	1990	Island Inn, La Crosse	Mr. Doug Blodgett Dr. John Ramsey Mr. John Sullivan
23rd	1991	Holiday Inn, La Crosse	Mr. Kent Johnson Dr. Mike Romano Dr. Joe Wlosinski
25th	1993	Holiday Inn, La Crosse	Dr. Richard Anderson Dr. Teresa Naimo Mr. Charles Theiling Dr. Joe Wlosinski
26th	1994	Holiday Inn, La Crosse	Dr. Teresa Naimo Dr. Mark Sandheinrich Mr. Charles Theiling Dr. Neal Mundahl
27th	1995	Holiday Inn, La Crosse	Dr. Mark Sandheinrich Mr. Rob Maher Dr. Michael Delong Dr. Neal Mundahl

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Local Meeting Arrangements, Meeting Announcements, and Mailings

Mark Sandheinrich, River Studies Center, Department of Biology & Microbiology, University of Wisconsin-La Crosse, La Crosse, Wisconsin

Rob Maher, Illinois Natural History Survey and Long Term Resource Monitoring, Pool 26, West Alton, Missouri

Program and Proceedings

Mark Sandheinrich, River Studies Center, Department of Biology & Microbiology, University of Wisconsin-La Crosse, La Crosse, Wisconsin

Registration Table

Neal Mundahl, Department of Biology, Winona State University, Winona, Minnesota

Georginia Ardinger, National Biological Service,, Environmental Management Technical Center, Onalaska, Wisconsin

Visual Aids

Aquatic Science Students, Department of Biology & Microbiology, University of Wisconsin-La Crosse, Wisconsin

Judges for Best Paper Awards and Best Poster Award

Names of the judges for best platform papers and best poster paper awards were unavailable at the time of printing. Their considerable effort is greatly appreciated.

Logo Art

Dorothia Rohmer, Ames, Iowa

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Illinois Natural History and Long Term Resource Monitoring, Pool 26
West Alton, Missouri

National Biological Service
Environmental Management Technical Center
Onalaska, Wisconsin

River Studies Center
Department of Biology & Microbiology
University of Wisconsin-La Crosse
La Crosse, Wisconsin