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MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC.

26TH ANNUAL MEETING
APRIL 28-29, 1994
Holiday Inn
La Crosse, Wisconsin

Contents

PLATFORM PROGRAM SCHEDULE

THURSDAY, APRIL 28, 1994

07:15 AM Registration (Mississippi Room)

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08:20 AM FISH IN MACROPHYTE BEDS OF A BACKWATER LAKE: SPATIO-TEMPORAL DISTRIBUTIONS AND FOOD WEB INTERACTIONS. **Michael R. Dewey**, William B. Richardson, and Steven J. Zigler

08:40 AM EXPERIMENTAL ANALYSIS OF THE IMPACT OF WATER MOVEMENT AND MACROPHYTES ON JUVENILE BLUEGILL (*Lepomis macrochirus*) GROWTH AND PREY AVAILABILITY. **Mark C. Hausler**, William B. Richardson, and Lynn A. Bartsch

09:00 AM BIOLOGICAL SIGNIFICANCE OF NAVIGATION-INDUCED SHEAR AND TURBULENCE ON SURVIVAL OF LARVAL FISHES OF THE UMRS. **Roland Sigurdson**, Mary G. Henry, and Melbourne C. Whiteside

09:20 AM MACROPHYTE INFLUENCES ON SEDIMENT RESUSPENSION IN A SHALLOW RIVERINE IMPOUNDMENT. **John W. Barko** and William F. James

09:40 AM DEPTH EFFECTS ON THE DISTRIBUTION OF AQUATIC PLANTS IN POOL 8 OF THE UPPER MISSISSIPPI RIVER SYSTEM. **Donald C. Williams**, Jim Rogala, John Barko, and Sara Rogers

10:00 AM **BREAK (Mississippi Room)**

SESSION II - BENTHIC INVERTEBRATES (MODERATOR: **Bill Richardson**)

10:20 AM SUITABLE FISH HOSTS OF THREE FRESHWATER MUSSELS FROM THE ST. CROIX RIVER, MINNESOTA. **Mark C. Hove**, Robin A. Engelking, Erin M. Long, Margaret E. Peteler, and Laurie A. Sovell

10:40 AM UNIONIDS AND MARGARITIFERIDS (MOLLUSCA: BIVALVIA), SAINT CROIX RIVER, AFTON AND WILD RIVER STATE PARKS, MINNESOTA, JUNE 1992. **Marian E. Havlik**

11:00 AM FINGERNAIL CLAM POPULATION DENSITIES IN RELATION TO THE ARROWHEAD ISLAND REHABILITATION AND ENHANCEMENT PROJECT. **Randy Burkhardt** and Robert Gaugush

11:20 AM TEMPORAL AND VERTICAL DISTRIBUTION OF UN-IONIZED AMMONIA IN SEDIMENT PORE WATER IN POOL 8, UPPER MISSISSIPPI RIVER.
Bradley E. Frazier, Teresa J. Naimo, and Mark B. Sandheinrich

11:40 AM BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN TWO UPPER MISSISSIPPI RIVER BACKWATER LAKES: A COMPARISON OF 1991 AND 1992. **B. Will Green**, David C. Beckett, Andrew C. Miller, and Robert Gaugush

12:00 PM **LUNCH** (On your own)

SESSION III - LIMNOLOGY (MODERATOR: **Terry Dukerschein**)

01:20 PM THE EFFECTS OF WIND SPEED ON TOTAL SUSPENDED SOLIDS AND LIGHT PENETRATION IN WEAVER BOTTOMS, POOL 5 UPPER MISSISSIPPI RIVER. **John F. Sullivan** and Dennis Anderson

01:40 PM THE CHANGING RELATIONSHIP BETWEEN DISCHARGE AND WATER LEVELS IN THE OPEN RIVER PORTION OF THE UPPER MISSISSIPPI RIVER. **Joseph Wlosinski**

02:00 PM LIMNOLOGICAL MONITORING: SOME COMMON PROBLEMS AND SOLUTIONS. **David M. Soballe**

02:20 PM ESTIMATING FRESHWATER FLOW VELOCITIES USING THE DISSOLUTION OF GYPSUM CYLINDERS. **Robert F. Gaugush** and Harry L. Eakin

02:40 PM **BREAK**

SESSION IV - HABITAT & WATER QUALITY
(MODERATOR: **Teresa Naimo**)

03:00 PM PLANS FOR A WATER QUALITY ASSESSMENT OF THE UPPER MISSISSIPPI RIVER BASIN. **James R. Stark**

03:20 PM CAN THE INDEX OF BIOTIC INTEGRITY INDICATE DEGRADATION OF STREAMS AND RIVERS? **Steve Gutreuter**, Kenneth S. Lubinski and Kevin Callen

03:40 PM DYNAMIC AQUATIC HABITAT CONDITION IN THE FINGER LAKES, MISSISSIPPI RIVER POOL 5. **Daniel B. Wilcox** and Douglas A. Olsen

04:00-06:00 **POSTERS AND SOCIAL**

06:00-09:00 **BARBECUE**

FRIDAY, APRIL 29, 1994

SESSION V - THE GREAT FLOOD OF '93 (MODERATOR: **Thomas Claflin**)

08:20 AM — AN ANALYSIS OF FLOODING OF THE MISSISSIPPI RIVER AT DUBUQUE, IOWA. **Joseph E. Kapler**

08:40 AM — THE GREAT FLOOD OF 1993: CAUSES, CONSEQUENCES AND IMPACTS ON WATER QUALITY IN THE LOWER ILLINOIS RIVER. **Charles Theiling** and Eric Ratcliff

09:00 AM — *HEXAGENIA* IN BACKWATER LAKES OF THE UPPER MISSISSIPPI RIVER: THE 1993 GREAT FLOOD BONANZA. **David C. Beckett**, B. Will Green, Andrew C. Miller, and Robert F. Gaugush

09:20 AM — **BREAK**

SESSION VI - THE GREAT FLOOD OF '93 (MODERATOR: **John Sullivan**)

09:40 AM — INVERTEBRATE RESPONSES TO EXTREME FLOODING ON THE LOWER ILLINOIS RIVER. **Charles Theiling**, Patricia Gannon, and John Tucker

10:00 AM — REVEGETATION IN FLOODED HABITATS: THE POTENTIAL IMPORTANCE OF SEED BANKS. **R. V. Anderson** and M. C. Anderson

10:20 AM — FISH RESPONSE TO EXTREME FLOODING ON THE LOWER ILLINOIS RIVER. **Robert Maher** and Charles Theiling

11:00 AM — **BUSINESS MEETING** (Mississippi Room)

12:00 PM — **LUNCH AT THE HOLIDAY INN** (Concourse)

SESSION VII - AQUATIC MEDLEY (MODERATOR: **Bradley Frazier**)

01:00 PM — SHORT-TERM BED ELEVATION CHANGES DETECTED IN POOLS 4, 8, AND 13 OF THE UPPER MISSISSIPPI RIVER. **James T. Rogala**

01:20 PM — CHARACTERIZATION OF GREAT BLUE HERON AND GREAT EGRET NEST SITES IN POOLS 20 AND 26, MISSISSIPPI RIVER. L. L. Browning-Hayden, **R. V. Anderson**, M. A. Romano, and F. Cronin

01:40 PM — RECREATIONAL USE SURVEY OF MISSISSIPPI RIVER POOL 13. **Russ Gent**

02:00 PM — **BREAK**

SESSION VIII - ZEBRA MUSSELS (MODERATOR: **Greg Cope**)

02:20 PM UPDATE ON ZEBRA MUSSELS IN THE ILLINOIS RIVER. **Scott D. Whitney**, Douglas Blodgett, and Richard Sparks

02:40 PM SETTLEMENT, GROWTH RATE, AND HABITAT COLONIZATION OF ZEBRA MUSSELS IN THE UPPER MISSISSIPPI RIVER. **W. Gregory Cope**, Teresa J. Naimo, and Michelle R. McPeak

03:00 PM THE SPREAD OF ZEBRA MUSSELS THROUGH THE INLAND WATERWAY SYSTEM, 1993. **Andrew C. Miller**, Barry S. Payne, Douglas Blodgett, and David C. Beckett

03:20 PM EFFECTS OF ZEBRA MUSSELS, YOUNG BLUEGILLS, AND WATER RETENTION TIME ON EXPERIMENTAL FOOD WEBS. **William B. Richardson** and Lynn A. Bartsch

03:40 PM **ADJOURNMENT**

POSTER PROGRAM SCHEDULE

THURSDAY, APRIL 28, 1994
04:00-06:00 PM
Concourse

CANDIDATE ANTIOXIDANTS FOR PREVENTING ZEBRA MUSSEL ATTACHMENT: TOXICITY TO FISH. W. Gregory Cope and **Michelle R. McPeak**

LEAF DECOMPOSITION IN MAIN CHANNEL AND BACKWATER HABITATS OF THE UPPER MISSISSIPPI RIVER. **Meredith Duellman** and Michael Delong

DISTRIBUTION OF LANDSAT-DERIVED LAND COVER THROUGH THE UMRS. **Mark Laustrup**

ACROSS CHANNEL HABITAT USE BY MACROINVERTEBRATES SUBJECTED TO HYDROPOWER PEAKING IN THE LOWER CHIPPEWA RIVER. **Christine Lynch**, Michael Delong, and Neal Mundahl

CHANGES IN INVERTEBRATE COMMUNITY COMPOSITION ALONG THE LONGITUDINAL GRADIENT OF A RIVER SUBJECTED TO HYDROPOWER PEAKING. **Joseph Marley**, Michael Delong, and Neal Mundahl

POPULATION ASSESSMENT, MOVEMENT AND HABITAT USE OF LARGEMOUTH BASS IN LA GRANGE POOL, ILLINOIS RIVER. **Paul T. Raibley**, Kevin S. Irons, Timothy M. O'Hara, K.D. Blodgett and Richard E. Sparks

BOLTNIA DECURRENS, A FEDERALLY THREATENED PLANT SPECIES. **Angela Redmond** and Marian Smith

SPATIAL AND TEMPORAL VARIABILITY IN AQUATIC VEGETATION IN THE FINGER LAKES. **Sara Rogers**, Jennifer Sauer, and John Barko

FINGERNAIL CLAMS: HAVE THEY CHANGED AFTER THE CRASH AND DO THEY LIKE POLLUTION? **Mike Romano**, Brian L. Sloss, Richard V. Anderson, Richard E. Sparks and Teresa J. Naimo

INITIATION OF MACROINVERTEBRATE MONITORING ON THE UPPER MISSISSIPPI RIVER SYSTEM. **Jennifer Sauer**, Pam Thiel, and Ken Lubinski

WALLEYE AND SAUGER SPAWNING HABITAT SURVEY IN POOL 16 OF THE UPPER MISSISSIPPI RIVER. **Gary Siegwarth**, John Pitlo, and Dave Willis

EFFECT OF WATER TEMPERATURE ON LOCOMOTION AND BURROWING IN UNIONID MUSSELS. **Diane Waller** and Jeffrey Rach

EFFECTS OF ZEBRA MUSSELS ON NATIVE UNIONID MUSSELS IN THE ILLINOIS RIVER. **Scott Whitney**, Douglas Blodgett, and Richard Sparks

PRESETTLEMENT AND PRESENT FOREST CONDITIONS AT THE SOUTHERN TERMINUS OF THE UPPER MISSISSIPPI RIVER SYSTEM. **Yao Yin** and John Nelson

FLUORESCENT ELASTOMER FOR SHORT-TERM MARKING OF FISH. **Steven Zigler** and Michael Dewey

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ABSTRACTS OF PLATFORM PRESENTATIONS

(listed in order of presentation)

FISH IN MACROPHYTE BEDS OF A BACKWATER LAKE: SPATIO-TEMPORAL DISTRIBUTIONS AND FOOD WEB INTERACTIONS.

Michael R. Dewey, William B. Richardson and Steven J. Zigler
National Biological Survey, National Fisheries Research Center, La Crosse, Wisconsin 54602.

We studied temporal and spatial patterns in use of macrophyte beds by fish populations in Lake Onalaska, a backwater lake in the upper Mississippi River. Fish were sampled with block nets in vegetated and artificially devegetated habitats and by diel electrofishing from mid-summer to fall of 1992. Young-of-the-year centrarchids dominated the block-net catches at vegetated sites, whereas cyprinids and atherinids were abundant at devegetated sites. There was little diel variation in total catch within the macrophyte bed although diel and seasonal patterns in the use of the macrophyte bed varied among fish taxa and life stages. Gizzard shad *Dorosoma cepedianum*, which typically feed in pelagic areas, were abundant throughout the macrophyte bed only at night in the fall. Regression analyses of catch data from block-net sampling showed that the abundance of 11 of 24 taxa was correlated with macrophyte biomass, whereas fish diversity was inversely correlated with macrophyte biomass. There was considerable overlap in the diet of adult and juvenile bluegill *Lepomis macrochirus*. Seasonal changes in the diet of bluegill seemed to reflect changes in life stages of insect prey. Fish were the primary prey (biomass) of juvenile largemouth bass *Micropterus salmoides*. The consumption of fish by juvenile largemouth bass declined in October and November, possibly due to reduced prey availability (principally juvenile bluegill) due to the limited gape of juvenile bass. We hypothesize that habitat use of juvenile bluegill was a function of predation by juvenile largemouth bass. In summer, most juvenile bluegills were vulnerable to predation by juvenile largemouth bass and their abundance was correlated ($r^2 = 0.79$, $P = 0.001$) with vegetation biomass. In fall, lowered predation risk weakened the relation between the abundance of juvenile bluegill and vegetation ($r^2 = 0.42$, $P = 0.062$)

EXPERIMENTAL ANALYSIS OF THE IMPACT OF WATER MOVEMENT AND MACROPHYTES ON JUVENILE BLUEGILL (*Lepomis macrochirus*) GROWTH AND PREY AVAILABILITY.

Mark C. Hausler[1], William B. Richardson[2] and Lynn A. Bartsch[2]
[1]Dept. of Biology and Microbiology, University of Wisconsin - La Crosse, La Crosse, WI 54601.
[2]National Fisheries Research Center, National Biological Survey, La Crosse, WI. 54602.

Backwater areas of large rivers contain highly productive biological communities which may interact in a velocity gradient from standing to flowing water. A mesocosm study was conducted to experimentally analyze the ecological interactions occurring within aquatic macrophyte beds, where flowing water may affect trophic interactions. The effects of flowing water on juvenile bluegill (*Lepomis macrochirus*) growth, bluegill predation on macroinvertebrates, macroinvertebrate abundance and how the interactive effects of aquatic macrophytes moderate these factors was analyzed. A three factor cross-classified design was used with the factors: flow, structure (simulated macrophytes) and fish applied in eight treatment combinations ($n = 3$). Fish and structure treatments were randomly distributed among flow and no flow environments. Macroinvertebrates were stocked and allowed to colonize the test facility for four weeks, prior to the four week experiment. Fish growth was analyzed by comparing final weight measurements and macroinvertebrates were sampled at the beginning, middle and end of the experiment. Fish growth was highest in enclosures with structure ($P = 0.03$), while flowing water had no significant effect. The presence of structure in flowing water did not significantly affect bluegill growth. Total macroinvertebrate abundance was higher in the presence of bluegills ($P = 0.02$, mainly chironomidae), and in treatments with flowing water ($P < 0.01$). Lack of significant statistical

interactions suggests water movement and aquatic macrophytes may have independent effects on bluegill growth. Flowing water may increase potential prey availability, however, in this experiment bluegill did not utilize greater prey abundance.

BIOLOGICAL SIGNIFICANCE OF NAVIGATION-INDUCED SHEAR AND TURBULENCE ON SURVIVAL OF LARVAL FISHES OF THE UMRS.

Roland E. Sigurdson[1,2], Mary G. Henry[2], and Melbourne C. Whiteside[1]
[1]Department of Biology, University of Minnesota-Duluth, Duluth, MN 55812,
[2]Minnesota Cooperative Fisheries & Wildlife Research Unit, University of Minnesota, Department of Fisheries & Wildlife, St. Paul, Minnesota 55108.

Encounters with commercial navigation-induced shear stress and turbulent flow are thought to be responsible for a decrease in the survival of larval fishes in the upper Mississippi River system. Commercial transport is expected to triple in the next 30 years based on current estimates. Therefore, understanding the actual and potential impact of these navigation vessels on this highly complex system is important. Information on navigation-induced shear and turbulence is critical for understanding the effects that the predicted increase in barge traffic may have on larval fish mortality and implications of year-class recruitment. A test chamber was used to simulate shear stress and turbulent flow on larval walleye, fathead minnow and green sunfish. We examined the immediate mortality and short term trauma on larval fish following simulated navigation-induced shear and turbulence. Turbulence caused significant reductions in survival, whereas shear stress did not. Protolarvae, mesolarvae, and metalarvae of the three species examined displayed significant decreases in survival ($p<0.05$) when exposed to turbulence. Turbulence caused elevated levels of mortality when larvae were subjected to multiple exposures.

MACROPHYTE INFLUENCES ON SEDIMENT RESUSPENSION IN A SHALLOW RIVERINE IMPOUNDMENT.

John W. Barko and William F. James
U.S.A.C.E. Waterways Experiment Station, Vicksburg, MS and
N.B.S. Environmental Management Technical Center, Onalaska, WI.

Sediment accretion provides nutrients required to maintain the vigor of rooted macrophyte communities, but excessive sedimentation and/or sediment resuspension may result in macrophyte declines due to burial or to light limitation. We investigated relationships between macrophyte abundance and wind-induced sediment resuspension in an impoundment (Marsh Lake) on the Upper Minnesota River. The impoundment is very susceptible to sediment resuspension due to its shallow depth (mean = 0.9 m) and large effective fetch. As estimated from a wave model, nearly the entire sediment surface area can be disturbed by waves generated at wind velocities as low as 10-15 km/h. In 1991, as an apparent result of very dense macrophyte coverage, sediment resuspension in Marsh Lake was much less frequent than in 1992 when macrophytes were essentially absent. During periods of sediment resuspension, concentrations of total seston and chlorophyll increased significantly in the water column. Both water quality and sediment dynamics in this system are closely linked with the wax and wane of macrophyte communities. By reducing the frequency of sediment resuspension and transport, macrophytes potentially maximize their use of sediment nutrients, while improving water quality conditions.

DEPTH EFFECTS ON THE DISTRIBUTION OF AQUATIC PLANTS IN POOL 8 OF THE UPPER MISSISSIPPI RIVER SYSTEM.

Donald C. Williams, Jim Rogala, John Barko, and Sara Rogers
North Central Division, U.S. Army, Corps of Engineers, Chicago, IL 60606, and
Environmental Management Technical Center, National Biological Survey, Onalaska, WI 54650

Analysis of Geographic Infomation System overlays of plant distribution and bathymetry showed that distribution patterns of both emergent and submerged vegetation were closely related to depth through Pool 8. Depth distribution thus accounted for most of the differences in plant distribution in the upper, middle, and lower pool. The depth relationship is apparently related to light penetration as related Secchi Disc Transparency. There was no preliminary evidence that wind-generated trubidity in the lower pool affected the depths reached by submergent plants in that area.

SUITABLE FISH HOSTS OF THREE FRESHWATER MUSSELS FROM THE ST. CROIX RIVER, MINNESOTA.

Mark C. Hove, Robin A. Engelking, Erin M. Long, Margaret E. Peteler and Laurie A. Sovell
Department of Fisheries and Wildlife, University of Minnesota, 1980 Folwell Ave., St. Paul, MN 55108.

Most species of freshwater mussels must briefly parasitize a fish in order to complete their life cycle. Management of rare mussel species frequently demands knowledge of the mussel's fish host(s). Suitable fish hosts of *Cyclonaias tuberculata*, *Lasmigona costata*, and *Ligumia recta* were determined by artificially exposing fish species to mussel glochidia and then determining if juvenile mussels were produced. Fifty-one fish species were infested with *C. tuberculata* glochidia, but only the yellow bullhead (*Ameiurus natalis*) and channel catfish (*Ictalurus punctatus*) served as hosts (Table 1). Six of eight fish species tested were found to be suitable hosts for *Lasmigona costata*: bowfin (*Amia calva*), northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*) (Table 2). Juvenile *Ligumia recta* were collected from only two (largemouth bass and walleye) of thirteen fish species tested (Table 3). Suitable fish hosts identified for *C. tuberculata* and *Lasmigona costata* were previously unknown. This is the first time the walleye has been identified as a suitable host for *Ligumia recta*.

Table 1. Fish species exposed to *Cyclonaias tuberculata* glochidia in 1993.

number tested	juveniles recovered	number tested	no juveniles collected
2	yellow bullhead	1	common carp
		1	black bullhead
		2	channel catfish*
		4	tadpole madtom
		1	burbot
		4	banded killifish
		1	freshwater drum

* - Fish died before end of test.

(Channel catfish and yellow bullheads were identified as suitable hosts for *C. tuberculata* glochidia in 1992.)

Table 2. Fish species exposed to *Lasmigona costata* glochidia in 1993.

number tested	juveniles recovered	number tested	no juveniles collected
1	bowfin	3	yellow bullhead
3	northern pike	3	bluegill
2	bluegill	1	largemouth bass
2	largemouth bass	2	black crappie
2	yellow perch		
4	walleye		

Table 3. Fish species exposed to *Ligumia recta* glochidia in 1993.

number tested	juveniles recovered	number tested	no juveniles collected
2	largemouth bass*	1	black bullhead
		1	yellow bullhead
4	walleye	1	channel catfish
		3	northern pike
		1	green sunfish*
		2	pumpkinseed
		6	bluegill*
		1	black crappie
		3	Iowa darter
		2	Johnny darter
		3	yellow perch

*-This species has been identified as a fish host *Ligumia recta* by other researchers.

Further host tests will be conducted on fish species with fewer than three individuals tested and tests with conflicting results.

UNIONIDS AND MARGARITIFERIDS (MOLLUSCA: BIVALVIA), SAINT CROIX RIVER, AFTON AND WILD RIVER STATE PARKS, MINNESOTA, JUNE 1992.

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

Over 40 bivalve mollusk species have been reported from the St. Croix River since the mid-1980's, but large areas have never been sampled. From 8 - 17 June 1992 we did semi-quantitative, quantitative, and random sampling by wading and SCUBA diving near the Minnesota shorelines of Wild River and Afton State Parks to determine the presence and habitat of rare bivalves. A total of 1560 living margaritiferids and unionids were found, representing 20 species (Tables 1, 2). Four additional species were among 391 empty shells. Aquatic habitats differed greatly. No Dreissena polymorpha (Pallas, 1771), Zebra Mussel, were found. Wild River State Park sites were up to two meters deep, and had a diverse, abundant mussel fauna, particularly in sand, gravel, and cobble areas that also served as habitat for submergent aquatic vegetation. Thirteen sites (32 sub-sites) along the 18.7 mile border of Wild River Park yielded 1480 living unionid and margaritiferid mollusks with densities to 74/m2 representing 19 living species. Elliptio dilatata (Rafinesque, 1820), Spike (32.0%) and Actinonaias ligamentina carinata (Barnes, 1823), Mucket (30.8%) dominated the fauna. Proposed as federally endangered, 40 large, old Cumberlandia monodonta (Say, 1829), Spectacle Case, were found at Wild River Park. The largest was 235 mm long and about 70 years old (independently aged three times). Their unique habitat of large boulders was limited. Since the smallest C. monodonta was 165 mm long, the absence of young adults strongly suggests a host fish problem. C. monodonta is reproducing below the Northern States Power dam, St. Croix Falls, WI. Other rare living unionids at Wild River Park were Cyclonaias tuberculata (Rafinesque, 1820), Purple Warty-Back (23 specimens up to 50 years of age), Alasmidonta marginata Say, 1818, Elk Toe (29 specimens) and Pleurobema sintoxia (Rafinesque, 1820), Round Pig-Toe (17 specimens). Six species showed evidence of recruitment. Two species were represented by empty shells only. Unionid diversity decreases downstream of the south boat landing due to the effects of the St. Croix Falls power dam. Afton Park's unionid habitat was limited, and the fauna sparse in numbers and diversity. Depths were six or more meters near the shoreline. Twelve sites (14 sub-sites) along the two mile border of Afton Park yielded 80 living unionids (eight species). Three additional species were represented by empty shells, including a federally endangered, female Lampsilis higginsi (Lea, 1857), Higgins' Eye, found near Afton's north boundary. Recruitment was minimal, and some specimens were slow growing (stunted length and height for age). Project was supported by MNDNR Nongame Wildlife Program & Tax Checkoff, and MN Division of Parks and Recreation.

TABLE 1. BIVALVE MOLLUSKS, SAINT CROIX RIVER PARKS, MN, 1992

		WILD RIVER	AFTON	TOTAL		% ABUNDANCE
1	Cumberlandia monodonta (Say, 1829), Spectacle Case	40		40	*	2.56%
2	Anodonta imbecillis Say, 1829, Paper Pond Shell	D		D		
3	Anodonta grandis f. corpulenta Cooper, 1834, Stout Floater		D	D		
4	Strophitus u. undulatus (Say, 1817), Squaw Foot	29		29		1.86%
5	Alasmidonta marginata Say, 1818, Elk Toe	29		29	*	1.86%
6	Lasmigona complanata (Barnes, 1823), White Heel Splitter	D		D		
7	Lasmigona costata (Rafinesque, 1820), Fluted Shell	38		38		2.44%
8	Quadrula p. pustulosa (Lea, 1831), Pimple Back	34	1	35	J	2.24%
9	Amblema p. plicata (Say, 1817), Three-Ridge	17	37	54		3.46%
10	Fusconaia flava (Rafinesque, 1820), Pig-Toe	41	27	68	J	4.36%
11	Cyclonaias tuberculata (Rafinesque, 1820), Purple Warty-Back	23		23	*	1.47%
12	Pleurobema sintoxia (Rafinesque, 1820), Round Pig-toe	17		17	*	1.09%
13	Elliptio dilatata (Rafinesque, 1820), Spike	500		500	J	32.05%
14	Obliquaria reflexa Rafinesque, 1820, Three-Horned Warty-Back	2	3	5		0.32%
15	Actinonaias ligamentina carinata (Barnes, 1823), Mucket	481		481	J	30.83%
16	Obovaria olivaria (Rafinesque, 1820), Hickory Nut	49		49		3.14%
17	Truncilla truncata Rafinesque, 1820, Deer Toe	10	1	11		0.71%
18	Leptodea fragilis (Rafinesque, 1820), Fragile Paper Shell	9		9		0.58%
19	Potamilus alatus (Say, 1817), Pink Heel Splitter	10	1	11		0.71%
20	Toxolasma parvus (Barnes, 1823), Lilliput Shell		5	5		0.32%
21	Ligumia recta (Lamarck, 1819), Black Sand Shell	10		10		0.64%
22	Lampsilis radiata luteola (Lamarck, 1819), Fat Mucket	90	5	95	J	6.09%
23	Lampsilis higginsi (Lea, 1857), Higgins' Eye		D	D	*	
24	Lampsilis ventricosa (Barnes, 1823), Pocketbook	51	D	51	J	3.27%
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	TOTAL (* = MN/WI SPECIAL STATUS SPECIES):	1480	80	1560		100.0%
	LIVING SPECIES (J = JUVENILES):	19	8	20		
	D = EMPTY SHELLS ONLY:	2	3	4		

TABLE 2. BIVALVE MOLLUSKS, ST. CROIX RIVER PARKS, BY SITE

WILD RIVER PARK (UPSTREAM TO DOWNSTREAM)				AFTON PARK (UPSTREAM TO DOWNSTREAM)			
SITE #	#SPECIMENS	#SPECIES ALIVE	#SPECIES DEAD	SITE #	#SPECIMENS	#SPECIES ALIVE	#SPECIES DEAD
1	34	9	2	1	53	7	1
2	239	16		2	3	1	2
3	44	4		3	-		
4	300	13	3	4	1	1	1
5	54	9	1	5	-		
6	413	15		6	1	1	
7	93	10	2	7	5	2	2
8	16	6	10	8	-		
9	208	17	1	9	2	1	
10	2	2	5	10	3	2	
11	73	7		11	9	4	
12	2	1	5	12	3	3	
13	2	1			--	--	--
	----	--	--	TOTAL:	80	8	3
TOTAL:	1480	19	2				

FINGERNAIL CLAM POPULATION DENSITIES IN RELATION TO THE ARROWHEAD ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT.

Randy Burkhardt[1], Robert Gaugush[1], and Carl Korschgen[2]
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Variations in population densities (number/m^2) of fingernail clams were related to distance and direction from the Arrowhead Island Habitat Rehabilitation and Enhancement Project (HREP) in Pool 7 of the Mississippi River. Twenty-four standard ponar grabs were collected at 100-m, 300-m, and 500-m intervals along eight transects during September 21 to September 23, 1993. All eight transects radiated from a common starting point located at the center of the island. Water velocities were estimated using the hydro-dynamic model FastTABS and sediment densities were based on sampling with a sediment penetrometer and sediment cores. Fingernail clam densities suggested differentiation of four distinct spatial regions. The first region was characterized by high fingernail clam densities (median=14,250/m^2), median bulk sediment densities of 0.64 g/ml and high water velocities (0.11 to 0.14 m/s). The second region was characterized by moderate fingernail clam densities (median=3,576/m^2), median bulk sediment densities of 0.69 g/ml and higher water velocities (0.15 to 0.18 m/s). The third region was characterized by moderate fingernail clam densities (median=1,077/m^2), median bulk sediment densities of 0.55 g/ml and lower water velocities ($<$0.01 to 0.04 m/s). The fourth region is characterized by low fingernail clam densities (median=96/m^2), median bulk sediment densities of 0.65 g/ml and low water velocities ($\leq$0.01 m/s). Region, distance, sediment bulk density and water depth had combined significant effects ($P<0.0001$) on fingernail clam densities ($R^2=0.79$). Pre-HREP fingernail clam data collected in 1979 were overlaid on a FastTABS model created for pre-HREP velocities in Lake Onalaska and compared to 1993 data. Significant ($P<0.001$) changes in fingernail clam denisties have occurred over time in relation to water velocity and dpeth changes ($R^2=0.53$). These observations suggest that the Arrowhead Island HREP may have affected fingernail clam densities within a 500-m radius, depending on current, by introducing localized variations in sediment deposition and scouring.

TEMPORAL AND VERTICAL DISTRIBUTION OF UN-IONIZED AMMONIA IN SEDIMENT PORE WATER IN POOL 8, UPPER MISSISSIPPI RIVER.

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Recently, populations of the fingernail clam *Musculium transversum* have significantly decreased in the upper Mississippi River. Although the causal factors contributing to this decline are unknown, high concentrations of un-ionized ammonia (NH_3) in pore water have been associated with reductions in fingernail clam populations in other large river systems. Our objectives were: (1) to examine the temporal and vertical distribution of total ammonia nitrogen (TAN) and NH_3 in sediment pore water; (2) to compare the temporal patterns of TAN and NH_3 in overlying surface water with those in pore water; (3) to examine the influence of physical features of sediment on TAN in pore water. Pore water was obtained by core extraction and subsequent centrifugation. TAN and NH_3 in pore water were measured from February through October, 1993, at four sites in Pool 8, upper Mississippi River, at depths of 0-4, 4-8, and 8-12 cm below the sediment-water interface. TAN and NH_3 in pore water were significantly different among sampling periods ($\rho=0.0001$); the greatest concentrations occurred in summer. TAN and NH_3 in pore water increased significantly with increasing sediment depth ($\rho=0.0001$). Greatest concentrations were

found in the 8-12 cm depth. TAN and NH_3 in surface water were significantly less than those in pore water from all sediment depths ($p<0.05$). TAN concentrations in pore water were positively correlated with silt and volatile matter content, temperature, and hydrogen ion concentration, negatively correlated with sand content, but not correlated with clay content. NH_3 in summer, but not winter, exceeded 36 $\mu g/L$–the concentration demonstrated to inhibit growth of fingernail clams in laboratory studies. However, the fraction of NH_3 in pore water that is biologically available to invertebrates needs to be addressed. Because of the variability of NH_3 concentrations in pore water, we recommend that sediment toxicity studies take into account the season and depth at which sediments are obtained.

BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN TWO UPPER MISSISSIPPI RIVER BACKWATER LAKES: A COMPARISON OF 1991 AND 1992.

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Thumb Lake and McGregor Lake are located west of Prairie DuChien in pool 10 of the upper Mississippi River, and are within a mile of each other. The benthic invertebrate fauna of these two lakes was sampled on July 20, 1991, and on July 17 and 18, 1992. In both years, ten inshore (nearshore) and ten offshore samples were taken from each lake using a petite ponar. In Thumb Lake, a small, shallow lake, the mean weights of particulate matter (mostly of plant origin) in the inshore and offshore samples were relatively high and remained fairly constant over the two years. Particulate matter in the offshore areas of McGregor Lake, a large, deep lake, remained low in 1992 as it was in the previous year. For chironomid larvae, the general pattern observed in 1991 in which inshore densities were significantly greater than offshore densities in both lakes, held true in 1992 as well. Mean larval chironomid densities remained remarkably similar over both years, with the exception of increased densities inshore at McGregor Lake in 1992. In 1991, leeches were abundant in Thumb Lake (mean densities inshore = 572 leeches/m^2, mean densities offshore = 167 leeches/m^2). Mean leech densities in Thumb Lake in 1992 were much lower than in 1991. Conversely, relatively high numbers of leeches were present inshore at McGregor Lake in 1992. Mean leech density had been very low inshore in McGregor in 1991. For leeches, one factor remained constant, they were abundant only in shallow areas which possessed large amounts of particulate matter. McGregor Lake was only marginally suitable for *Hexagenia* nymphs in both 1991 and 1992. In 1991, *Hexagenia* was present in only 10 % of the offshore samples; in 1992, *Hexagenia* was not found in any of the offshore or inshore samples. *Hexagenia* was present in the inshore and offshore samples from Thumb Lake in both years, but was much more abundant in 1991 than in 1992.

THE EFFECTS OF WIND SPEED ON TOTAL SUSPENDED SOLIDS AND LIGHT PENETRATION IN WEAVER BOTTOMS, POOL 5, UPPER MISSISSIPPI RIVER.

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Wind resuspension of bed sediments can be an important factor influencing water quality, sediment transport and fish and aquatic life habitat. Several Upper Mississippi River habitat rehabilitation projects have been designed and constructed with the objectives of reducing wind-induced sediment resuspension. The purpose of this work was to test methods for obtaining more detailed information on factors influencing total suspended solids (TSS) and to assess the affects of wind speed on sediment resuspension, light penetration and other water quality variables. This work was done in conjunction with a TSS mass balance study of Weaver Bottoms, Pool 5, by the U.S. Army Corps of Engineers. A continuous water quality monitoring platform was placed in an open water area (1m deep) in the northern portion of Weaver Bottoms in late summer of 1993. Water quality data (total suspended solids, total volatile solids, dissolved oxygen, water temperature and underwater photosynthetically active radiation (PAR)) and meteorological data (surface PAR, wind speed and direction) were continuously sampled or recorded for 57 days between August 5 and October 1, 1993 (Figures 1a-1d). In addition, sediment traps were deployed mid-depth near the monitoring platform to estimate gross sedimentation rates. Water temperature and dissolved oxygen measurements yielded results consistent with previous continuous monitoring surveys conducted in Weaver Bottoms since 1986. The depth of mid-day (10-1400 hr) 1% PAR varied between 0.3 and 2 meters and correlated linearly to wind speed ($P<0.05$, $r^2=0.44$-0.48). The relationship between TSS and wind speed was more complex and preliminary evaluation indicates a non-linear response. Daily composite TSS samples ranged from 18 to 223 mg/l. TSS concentrations at the platform site consistently exceeded side channel inflows entering Weaver Bottoms. TSS levels exceeded 200 mg/l on days with daily average wind speeds exceeding 12 mph with maximum hourly averages ranging from 18.5 to 30 mph. Weekly average gross sedimentation rates ranged from about 250 to 600 g m^{-2} d^{-1} and appeared to be directly related to TSS concentrations.

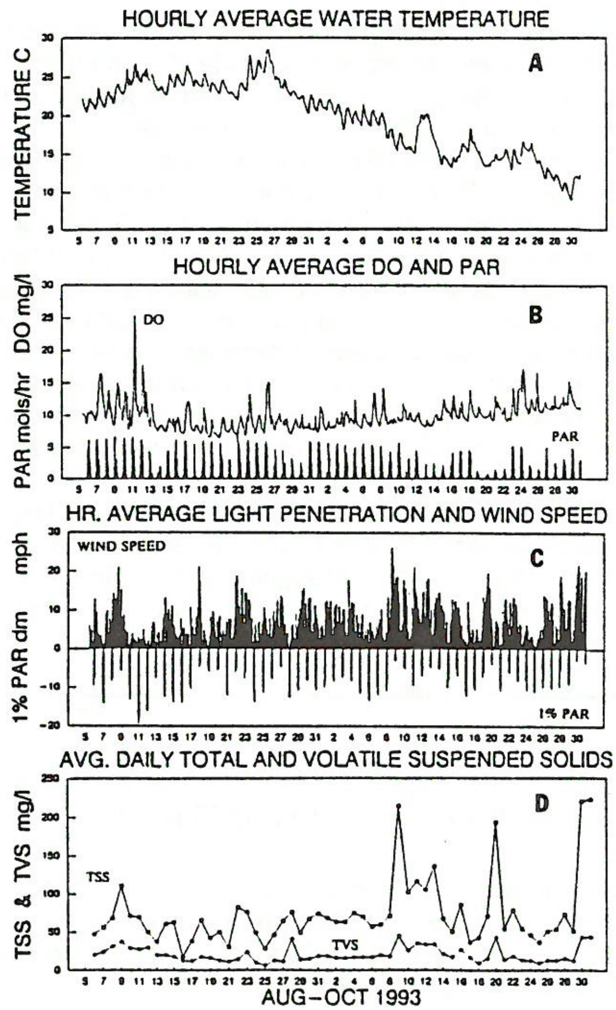

Figure 1. Continuous water quality, physical and meteorological data collected at Weaver Bottoms, Pool 5, by the Wisconsin Department of Natural Resources and the US Corps of Engineers during late summer and early fall of 1993.

THE CHANGING RELATIONSHIP BETWEEN DISCHARGE AND WATER LEVELS IN THE OPEN RIVER PORTION OF THE UPPER MISSISSIPPI RIVER.

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The U.S. Geological Survey and the U.S. Army Corps of Engineers have measured daily discharges and water surface elevations at three sites on the main stem of the Upper Mississippi River. Data for these two variables are available since 1861, 1933, and 1942 at St. Louis, MO, Thebes, IL, and Chester, IL, respectively. Analysis included provisional data from the Flood of 1993. These long-term daily data sets were analyzed to evaluate changes in the relationship between the two variables. Analysis was performed by developing regression equations of water surface elevations and discharges at each station on a yearly basis. Data for years with relatively low R-squared values were investigated for possible errors.
At St. Louis, the station with the longest record, water surface elevations associated with relatively low discharges (50,000 cubic feet per second) have dropped approximately 8 feet over the period of record. However, water surface elevations associated with relatively high discharges (780,000 cubic feet per second) have risen about 8 feet over the period of record. The decline in water surface elevations at low discharges has been somewhat gradual, but the increase in water surface elevations at high discharges appears more abrupt, with the greatest change occurring between 1927 and 1947. Changes in the relationship are discussed as they pertain to data collection methods and the history of watershed practices and floodplain management on the Upper Mississippi River.

LIMNOLOGICAL MONITORING: SOME COMMON PROBLEMS AND SOLUTIONS.

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Monitoring, as a method to detect changes, patterns, or trends in water quality may seem relatively straightforward. However, the interpretation of monitoring data can be fraught with peril. Data from the Long Term Resource Monitoring Program on the Upper Mississippi River and from Lake Okeechobee, Florida illustrate some difficulties that are encountered commonly when an attempt is made to transform monitoring data into useful information for resource managers. Examples based on actual monitoring data are used to clearly demonstrate that the three major phases of a monitoring program (i.e., program design, program execution, and data interpretation) form a logical, tightly-linked sequence. and that difficulties in one phase can propagate insiduously to the others. Actual and simulated data are presented to show how lack of consideration for a monitoring program's design limitations or for the scale of spatial and temporal effects can lead to impressive blunders in data interpretation.

ESTIMATING FRESHWATER FLOW VELOCITIES USING THE DISSOLUTION OF GYPSUM CYLINDERS.

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Weight loss per unit surface area of small (1.9 cm diameter and 9 cm length) cylinders of gypsum ($CaSO_4 \bullet 2H_2O$) has been shown to be linearly related ($r^2 > 0.94$) to flow rate at flows of 0-10 cm/sec and at temperatures between 3 and 25° C (Petticrew and Kalff, 1991). This method requires considerable effort in measuring the cylinder's surface area both before and after exposure. Our calibration was made using larger (3.8 cm diameter and 10 cm length) cylinders over flows of 0 - 15 cm/sec and at temperatures between 10 and 35° C. Gypsum flux, based on weight loss per unit surface area was linearly related to percent weight loss ($r^2 > 0.99$). Given these results, measurements of cylinder surface area are considered unnecessary to determine gypsum flux. Using these gypsum cylinders, integrated freshwater flow rates can be estimated over periods of 2-7 days in vegetated and non-vegetated aquatic environments. Flow rate estimates made around Arrowhead Island in Lake Onalaska, Pool 7 of the Mississippi River, were typically within 5 percent of instantaneous flow rates measured by an electromagnetic current meter (Marsh-Mcburney Model 2000). Flow rates in a vegetated (Eurasian water-milfoil bed), relatively quiescent, aquatic environment compared well with freshwater flows determined by fluorescent dye tracking. This technique represents an inexpensive and accurate tool for determining freshwater flow rates in a number of different aquatic environments.

Petticrew, E.L. and J. Kalff. 1991. Calibration of a gypsum source for freshwater flow measurements. Can. J. Aquat. Sci. 48: 1244-1249.

PLANS FOR A WATER QUALITY ASSESSMENT OF THE UPPER MISSISSIPPI RIVER RIVER BASIN.

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The Upper Mississippi River Basin is one of 60 areas selected to be studied under the second phase of the ongoing U. S. Geological Survey National Water Quality Assessment (NAWQA) program. Program goals are to describe the status and trends of a representative part or the nation's surface and ground water and to provide a scientific understanding of the primary natural and human factors affecting the quality of those water resources. The areas of èinvestigation, called study units, include major river basins and aquifer systems that represent a wide range of environmental settings, water use, and water-quality conditions. The Upper Mississippi River NAWQA study unit covers about 21,000 square miles and includes parts of the Minnesota River and the upper Mississippi River Basins, the entire St. Croix River Basin, and major sedimentary aquifers and glacial-drift deposit aquifers in the basin. The cities of Minneapolis and St. Paul are principal users of water from the Mississippi River. Suburban and rural areas generally use ground water. Water-quality issues in the Upper Mississippi River Basin include contamination of ground and surface water from industrial and agricultural activities. Specific issues will be prioritized through assistance from a liaison committee that will be formed in the near future.

CAN THE INDEX OF BIOTIC INTEGRITY INDICATE DEGRADATION OF STREAMS AND RIVERS?

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The Index of Biotic Integrity (IBI) is a commonly used indicator, based on fish community structure, of environmental health and degradation of streams and rivers. The IBI is the sum of several random variables that are scores for various aspects of fish community structure. The IBI incurs two major statistical deficiencies. First, the IBI collapses several random variables into a single number. Therefore, the original variables must be examined to interpret the IBI. Second, the IBI is a strongly increasing function of sample size because several variables are scores for numbers of species within functional groupings or catches of certain species. We examined this second problem using randomized resampling of the Long Term Resource Monitoring data from Navigation Pool 8 of the Mississippi River. The minimum and maximum attainable values of our IBI statistic were 12 and 60, respectively. In smaller random samples ($N \leq 500$), IBI values averaged 28, which to some might indicate degradation. In large samples ($N \geq 10{,}000$) from the same statistical population, all IBI values ranged from 40 to 46, which to most would be deemed satisfactory to good. Therefore, the IBI cannot produce a consistent and interpretable summary of fish community structure, and inferences based on the IBI warrant skepticism.

DYNAMIC AQUATIC HABITAT CONDITIONS IN THE FINGER LAKES, MISSISSIPPI RIVER POOL 5

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Physical and chemical conditions within the Finger Lakes, a backwater complex in upper Pool 5, have been studied since 1991 as part of the Upper Mississippi River System Environmental Management Program. Spatial water quality, bathymetric, sediment type, and vegetation data from the Finger Lakes were incorporated into a GIS program developed for visualization and analysis of aquatic habitat conditions. Aquatic habitat in the Finger Lakes is a dynamic mosaic, with marked spatial and temporal variations. The availability of suitable over-winter habitat for centrarchid fishes has been limited by cold water temperatures and insufficient dissolved oxygen. Monitoring of aquatic habitat conditions following experimental introductions of flow from the Mississippi River will allow quantification of habitat changes in the Finger Lakes. The GIS program has enabled analysis and visualization of seasonal changes in aquatic habitat within the Finger Lakes, and shows promise for application to other systems.

AN ANALYSIS OF FLOODING OF THE MISSISSIPPI RIVER AT DUBUQUE, IOWA.

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The flooding in 1993 in the upper midwest prompted an examination of past records in Dubuque to provide a better understanding of the problem. Records of flooding at Dubuque date back to 1851. Eight of the top ten flood crests recorded in Dubuque have occurred since 1951. The number of days the river was above flood stage has also increased in recent years. In the time that

such records are available (123 years), the number of flood days in the second half of this period is 2.7 times that of the first half, Fig. 1. The year 1993 was the most disastrous for flooding in the Upper Mississippi River Basin, with 60 days of flooding occurring at Dubuque. Flooding has become an increasing problem and factors affecting this are discussed. These factors include annual precipitation, deforestation, destruction of wetlands, changes in agricultural practices and increasing urbanization. The problem of flooding cannot be alleviated only by attempting to contain the river within its channel.

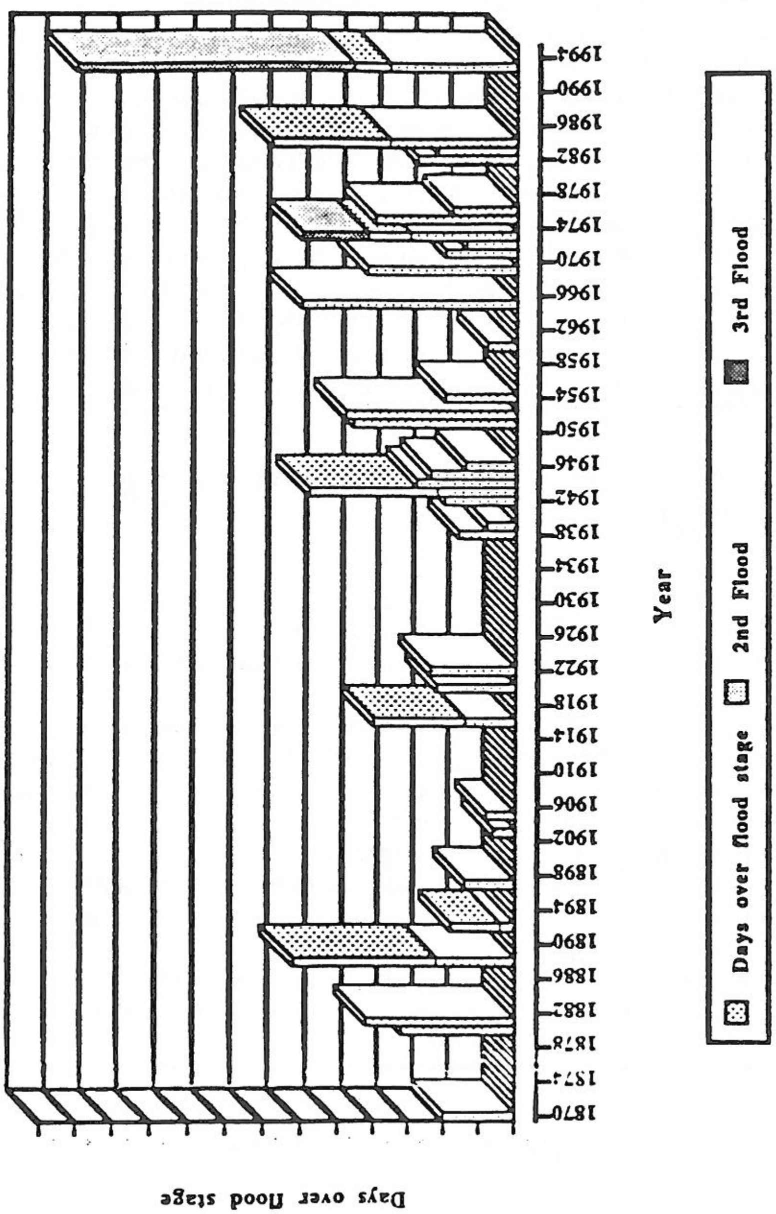

Figure 1. Days of Flooding at Dubuque

THE GREAT FLOOD OF 1993: CAUSES, CONSEQUENCES AND IMPACT ON WATER QUALITY IN THE LOWER ILLINOIS RIVER.

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Record flooding throughout the Upper Midwest during the spring and summer of 1993 caused tremendous personal and economic hardship for human inhabitants of the river-floodplain ecosystem. The same event, however, may have provided significant benefits for other river-floodplain inhabitants. Record flooding was caused by average April rains that grew stronger into May and culminated in June and July; rainfall exceeded normal by 150 - 200% at most locations monitored. The atypical rainfall was caused by the junction of a Southeastern high pressure system stalling at a low pressure system coming from the West. The pattern allowed the jet stream to dip down out of Canada causing heavy rains throughout the Midwest. The resulting floods on the Mississippi River and its tributaries were unlike anything seen by people of this era; in fact, one must go back to 1844 to find similar flood stages. Millions of acres of agricultural and urban property were damaged as flood waters overtopped or broke through levees. Entire towns were engulfed, and larger cities were impacted by damage to municipal infrastructure. Damage estimates exceed $10 billion and the U.S. Congress has authorized over $6 billion in financial aid to those hurt by the flood. Those creatures better adapted to the vagaries of the river may benefit, however, from the potential for land acquisitions and restoration. The concentration of agricultural chemicals was expected to decrease because of the huge volume of water being transported. When measured at several points in the Mississippi River Basin, Atrazine and nitrogen concentrations were either similar to or exceeded previous records. The total Atrazine load delivered to the Gulf of Mexico exceeded the 1992 load by 235% and nitrogen load exceeded 1992 levels by 112%. The increase in loads delivered was due to the occurrence of flooding during the planting season and because of the large areal extent of heavy rains. On the Lower Illinois River water surface elevations reached a record 134.7m above sea level. Average flood heights are about 1 m greater than "controlled pool" elevations, but during this flood event elevations were 7 m greater. We sampled randomly selected sites at shoreline and open water locations and recorded ancillary data regarding habitat conditions. Physical, chemical and biological aspects of water were monitored on the rise and the fall of the flood. Parameters discussed here include; dissolved oxygen, conductivity, Ph, Secchi disk transparency, temperature, turbidity, current velocity and depth. Analyses of chemical and biological data will proceed when data becomes available from laboratories. Sediment oxygen demand was measured at several locations. Physical data was compared to data collected over the five previous years at three sites in the same area sampled during the flood. Of the variables compared only temperature, turbidity, and current velocity were similar to measurements made during the June to October period of the previous years. For all other variables measured, 1993 measurements stood out as unique among the six year record. Of special interest were very low dissolved oxygen levels (mean=4.3ppm n=88) throughout the study area. The flood was certainly devastating to human communities and to the structures they built in the floodplain. The effects of the flood on the rest of the ecosystem is yet to be determined. Although it was a great human tragedy, this flood has forced policy makers to reconsider modern floodplain management. The end result of post-flood recovery may yield substantial environmental benefits.

HEXAGENIA IN BACKWATER LAKES OF THE UPPER MISSISSIPPI RIVER: THE 1993 GREAT FLOOD BONANZA.

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From a sociological and economic perspective the great Mississippi River flood in the summer of 1993 was extremely detrimental. However, for the burrowing mayflies of the genus *Hexagenia* (family Ephemeridae) in the backwater lakes of the upper Mississippi River, the flood provided a unique opportunity. Evidence for this supposition is based on sampling over three years (July 1991, July 1992, and September 1993) from three dissimilar lakes in Pools 8 and 10 of the upper Mississippi River. Thumb Lake, a small shallow lake, supported *Hexagenia* nymphs on each sampling occasion. Sampling of McGregor Lake, a large, fairly deep lake produced a few nymphs in a few of the samples taken in 1991, and no nymphs among the 20 samples taken in 1992. In contrast, sampling in 1993 showed large numbers of nymphs present in the bottom of the lake. Mean density of nymphs equaled 904 *Hexagenia*/m^2 at the near shore sampling sites, with mayfly nymphs present in all the samples. Similarly, our sampling of Lawrence Lake, a large, shallow, heavily vegetated lake in Pool 8 in 1992 did not yield any *Hexagenia*; yet the nymphs were abundant in the 1993 samples. We hypothesize that the flood of 1993 precluded the establishment of anoxic conditions which normally occur in the summer in the bottoms of McGregor Lake and Lawrence Lake (and other Mississippi River backwater lakes as well). Consequently, the massive elimination of nymphs by anoxia which normally occurs did not take place, and unprecedented numbers of *Hexagenia* continued to develop.

INVERTEBRATE RESPONSE TO EXTREME FLOODING ON THE LOWER ILLINOIS RIVER.

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Aquatic macroinvertebrates link river-floodplain producers (trees, grasses, aquatic macrophytes, and algae) and secondary consumers (vertebrate and invertebrate). Macoinvertebrates occur in all permanent and ephemeral aquatic habitats and many have reproductive strategies that allow them exploit ephemeral habitats. In river- floodplain ecosystems ephemeral habitats are produced with predictable regularity (i.e. spring flooding) as river floodwaters encroach laterally across the floodplain. When floodwaters inundate terrestrial habitats, plants become a food source for invertebrate detritivors. Plentiful food resources promote high population densities which ultimately benefit predator populations. The flood pulse concept theorizes that invertebrate densities should be greatest at the "moving littoral zone", or the land/water interface of rising floodwaters, where the greatest food resources are available. We sampled nektonic and epiphytic invertebrates using vertical plankton net tows along transects perpendicular from shore to test the theory on the Lower Illinois River. Extreme flooding occurred on the Lower Illinois River between June - September, 1993. Water surface elevations during the flood exceeded normal river elevations by 7 meters. The entire Lower Illinois River floodplain was inundated and was rapidly colonized by aquatic invertebrates. We sampled randomly selected transects in three predetermined areas of the Lower Illinois River. Approximately ten stations were sampled per transect with triplicate net tows. We spaced them such that shallow sites would be weighted more heavily because of suspected differences in species composition and abundance. The transects typically started in terrestrial grass communities, crossed an expanse of open water

overlying floodplain habitats, and ended in the gallery forests ringing permanent backwaters of the Lower Illinois River. Invertebrate density was much higher near the shore than at deeper stations (P=0.0001 for all comparisons) as was the Shannon-Weaver species diversity index. When examined by vegetation type, density was significantly higher in grass habitats than open water or forest habitats within and among all three areas (P=0.0001 for all comparisons). The same relationship and significance level occurred for comparisons of Shannon-Weaver species diversity index. Densities and species diversity also differed for comparisons of estimated vegetation coverage (% area). Invertebrate densities were highest when vegetation coverage was greater than 50%, species diversity was different among ranks of percent vegetation coverage within and among areas (P=0.0001 for all comparisons) but there was no clear relationship between percent vegetation coverage and species diversity. This study provides some interesting preliminary results from an investigation of the utility of the flood pulse concept on the Lower Illinois River. Our results indicate that flooding produces high river-floodplain invertebrate production. We suggest that river-floodplain natural resource managers promote restoration of natural flood and low flow cycles to take advantage of this high productivity. We further suggest that restoration of floodplain habitats including native prairies is important to maximize invertebrate production.

REVEGETATION IN FLOODED HABITATS, THE POTENTIAL IMPORTANCE OF SEED BANKS.

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During the 1993 flood on the upper Mississippi River, deep layers of sediment were deposited over much of the floodplain. The duration of the flooding and burial by the deposited sediments killed most of the nonwoody floodplain vegetation. This, in effect, leaves a new habitat available for colonization by plants, a necessary precursor to reestablishing animal communities. Plant development in these newly deposited sediments is likely to be predominantly by seeds. Seeds that were transported and deposited with the flood-delivered sediments become part of the reproductive potential, "seed bank", of the sediments and may account for much of the new herbaceous layer which develops. To determine how much the seed bank may contribute, sediments deposited in the floodplain of WIU's Kibbe Field Station during the 1993 flood were collected. Particle size, organic content, and soil nutrients were determined. All seeds were wet sieved from sediment samples, counted and identified. Collected sediment was also spread in greenhouse flats to a depth of 5.5 cm, depth to which The sediments had been deposited in the floodplain. Germination tests, germination distribution, and growth success was examined in a greenhouse study. Twenty-one species of plant seeds were found with grasses and moist-soil plants predominating the seed community. Of these only 7 species of plants developed. Approximately 19% of the seeds present germinated but, only 8% of those germinating survived more than 1 month. Seed distribution and germination was random and no competition between plants was apparent in the first 6 months of growth.

FISH REPSONE TO EXTREME FLOODING ON THE LOWER ILLINOIS RIVER.

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The life history strategies of large river floodplain plants and animals have evolved around a predictable, seasonal cycle of flooding and drying. Floodplain fishes migrate to inundated terrestrial habitats to feed, spawn and seek refuge from main channel currents. Channelization, impoundment for navigation and floodplain constriction through levee construction have disrupted these annual hydrologic cycles. The extreme and extended flooding during the spring and summer

of 1993 offered a rare opportunity to observe the migration of riverine fishes into flooded terrestrial habitats. Fish communities were sampled at three separate areas of the lower Illinois River floodplain. Each area contained four separate habitat types: a floodplain depression lake adjacent to the main channel, a forested area around the lake, an open area outside the forested area which was primarily agricultural and the shoreline as the flood waters rose and receded. A combination of gears were used to sample the fish community in each habitat type. Trammel nets, experimental gill nets, and large and small diameter hoop nets were used in all habitats. Shoreline and forested habitats were also sampled with an AC electrofishing boat and Wisconsin style fyke nets. Young of the year fishes were collected in shoreline habitats with minnow fyke nets and seines. A total of 52 species were collected in the three study areas. Fish density and species richness were highest in shoreline habitats. Catch rates were highest in the shoreline habitats for bluegill (*Lepomis macrochirus*), followed by gizzard shad (*Dorosoma cepedianum*), black crappie (*Pomoxis nigromaculatus*), golden shiner (Notemigonus *chrysoleucas*) and largemouth bass (*Micropterus salmoides*). Common carp (*Cyprinus carpio*) was the most abundant species in all other habitats. Channel catfish (*Ictaluris punctatus*) catch rates were highest in the forested areas. The duration of the flood allowed nest building sunfishes enough time to successfully spawn. This was reflected in high catches of young of the year largemouth bass and bluegill. Whether or not the fish produced during the summer flooding are recruited into the breeding population, will help answer some of the questions regarding factors limiting floodplain fish production. Restoration efforts should center around restoring the natural hydrologic cycle, such practices would enhance the natural reproduction of many floodplain river fishes and greatly reduce the need for supplemental stocking.

SHORT-TERM BED ELEVATION CHANGES DETECTED IN POOLS 4, 8, AND 13 OF THE UPPER MISSISSIPPI RIVER.

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To directly measure short-term changes in bed elevation, 52 sediment-range transects have been established and monitored between 1989 and 1993 in Pools 4, 8, and 13 of the Upper Mississippi River. Very precise techniques were used to enable detection of small (1 cm) amounts of change occurring over short time periods (1-2 years). Although along most transects sediment was accumulating, approximately 25 percent of the transects showed a net loss in bed elevation. Mean rates of change over the study period along all transects ranged from a loss of 2 cm/yr to a gain of over 5 cm/yr. Mean bed elevation changes for all transects in each of Pools 4, 8, and 13 were .97, .50, and 1.83 cm/yr, respectively. Bed elevation change was found to be extremely variable along some transects. Comparison of annual changes did not reveal any consistent trends to suggest that any particular year between 1989 and 1993 had more of an impact on bed elevation change for the transects as a whole. It is evident from these results that rates of change can not be extrapolated directly to unmeasured areas. However, if relationships between bed elevation change and either hydrologic characteristics or sediment type can be established, then more reliable estimations of bed elevation change over wide areas may be possible.

CHARACTERIZATION OF GREAT BLUE HERON AND GREAT EGRET NEST SITES IN POOLS 20 AND 26, MISSISSIPPI RIVER.

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As great blue heron (*Ardea herodias*) and great egret (*Casmerodius albus*) populations on the upper Mississippi River (UMR) expand the number of rookery sites and the size of rookeries have increased. In an attempt to determine quantifiable nesting habitat characteristics, 2 island rookeries were evaluated. One site on Eagle Island in upper Pool 20 was a relatively new rookery site, nesting at the site having begun in the mid 1980's. The rookery at the second site, Hat Island in the upper reach of Pool 26, has existed for over 20 years. Data collected for each tree containing a nest included species, height, height of the first branch, diameter at breast height, number of nests, height of the highest and lowest nests, and distance and angle to the nearest nesting tree. Similar data were also gathered for the habitat trees surrounding the nesting trees. Some trees were also cored to determine age. The woody community in the rookery area was characterized by point-quarter sampling. Importance values and relative importance as a nesting tree were calculated. The data were analyzed by principal component analysis. Four components were found to define nesting site preference: vegetation structure, tree preference, site specific characteristics and protection or access. Nest were found most often in the tallest and stoutest sycamores (*Platanus occidentalis*), cottonwood (*Populus deltoides*), silver maples (*Acer saccharinum*) and elms (*Ulmus americana*). The highest nest densities were found in areas where nesting trees were closest together and surrounded by between 6 and 14 habitat trees. Although silver maples were the most frequently used trees, sycamores consistently had the highest number of nests per tree. While the quantity and proximity of available foraging habitat and disturbance factors may contribute to the presence or absence of a rookery, woody habitat characteristics are a major factor in determining rookery presence. Management of floodplain forest and islands within the UMR should consider the potential use of these habitats by expanding wildlife populations.

RECREATIONAL USE SURVEY ON MISSISSIPPI RIVER POOL 13.

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Recreational use on Pool 13 of the Upper Mississippi River was estimated for a twelve month period, March 1991 through February 1992, using access based non-uniform probability sampling and data extrapolation techniques. During the study 18,950 individuals were interviewed yielding an estimated 237,896 recreational visits totaling 2,094,244 hours. Twenty-two recreational activities were identified in the sample taken. Open water fishing was the primary activity, with an estimated 104,278 trips and 44% of all visits. Recreational boating and ice fishing ranked second and third with 27,625 and 25,282 estimated trips. Camping, open water fishing and recreational boating accounted for most hours spent by activity with 1,255,069, 423,265, and 168,481 hrs. Sport anglers caught an estimated 757,319 fish for a mean catch rate of 1.35 fish/hr but released nearly half of the catch, harvesting an estimated 346,024 fish with a mean harvest rate of 0.62 fish/hr. Bluegill, black crappie and channel catfish accounted for 56%, 10% and 10% of the harvest. Waterfowl accounted for 95% of wildlife harvested with an estimated 10,978 birds taken. Recreationists surveyed traveled an average of 60 miles to reach Pool 13 with a mean trip duration of 8.8 hours, ranging from 0.7 hrs for sightseeing to 67.2 hrs for camping. A subsample of 1,021 recreationists were surveyed to estimate trip expenditures and durable goods purchased. Mean trip expense was $22.32 for a total annual expenditure of $5,310,368. Mean annual expenditure for durable goods relating to recreation activities was $1,388 per person.

UPDATE ON ZEBRA MUSSELS (*DREISSENA POLYMORPHA*) IN THE ILLINOIS RIVER.

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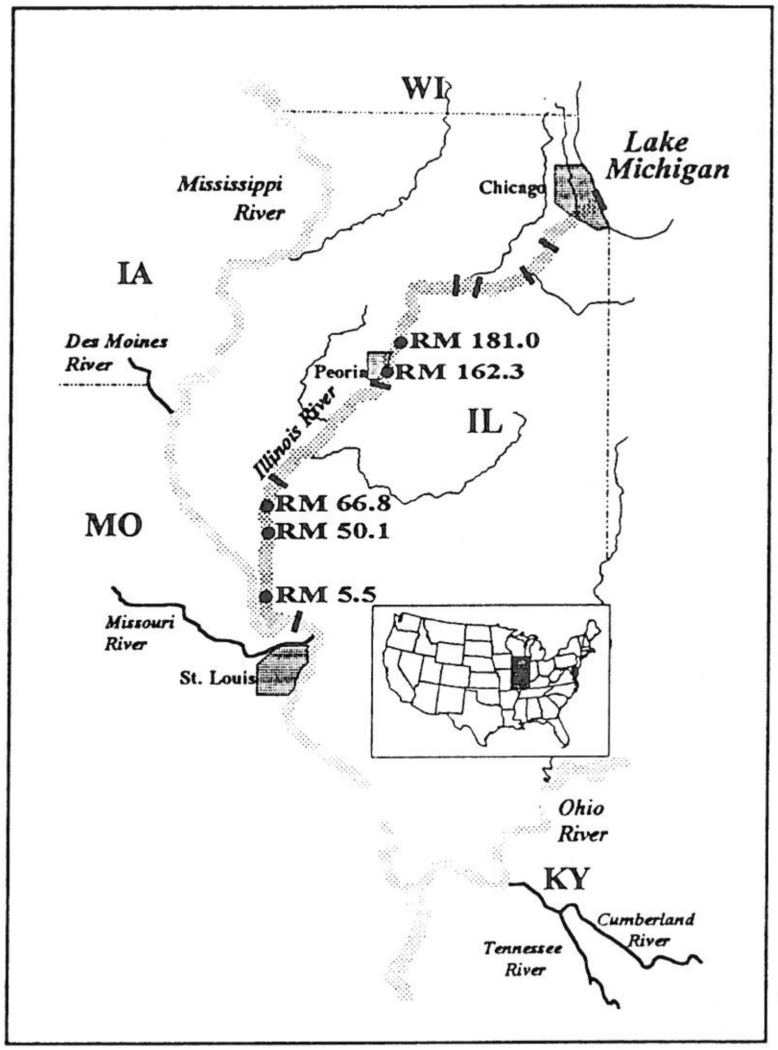
Zebra mussels (*Dreissena polymorpha*) probably invaded the Mississippi Basin via canals which divert water from Lake Michigan to form an artificial connection with the Illinois River. The first reports of zebra mussels in the basin were from these canals in 1989 and 1990, so it is not surprising that the greatest population expansion and most dramatic effects of zebra mussels are occurring first in the Illinois River.

During 1991, zebra mussels were collected on samplers at only one of five Illinois River sites. In 1992, they were collected at all sites sampled, and densities on samplers at one site averaged 647 per square meter with a maximum density equal to 1574 per square meter. During 1993, we used surface supply diving techniques to quantitatively sample zebra mussels at five sites along the lower 180 miles of the Illinois River (Figure 1). In July and August, mean densities ranged from 0 to 60,956 zebra mussels per square meter with numbers increasing in the downriver direction (Table 1). In general, zebra mussels were attached to all available solid substrates including gravel, cobble, woody debris, and native mollusks including gastropods, sphaeriid clams, and unionid mussels. At the site farthest downriver, zebra mussels formed a mat approximately 2.5 cm thick over a soft mud substrate. Over 99% of the zebra mussels collected at our downriver sites during midsummer were less than 15 mm long and probably resulted from the first settlement in 1993. At one site (RM 162.3) the average increase in shell length was 0.21 mm/day for zebra mussels in the 5- to 14-mm size range from 1 July through 10 August.

Additional quantitative samples were collected during the first week of October at the four downriver sampling sites. Partial analysis of these samples indicate: 1) high mortality (47-56%) of zebra mussels at RM 66.8; 2) significant increase in settlement at upriver sites following flood recession; 3) three settlement peaks during 1993; and 4) little to no growth of zebra mussels at RM 5.5 from mid-August to October. Zebra mussels have had dramatic environmental and economic impacts in and along the Illinois River during 1993. Although not yet fully realized, the severe negative impact on the native unionid mussel fauna is conveyed by our poster presentation at this meeting. Power companies and other users of river water are currently spending millions of dollars on chemical injection systems to prevent zebra mussel infestation of their facilities. Whether the cost is measured in clams or dollars, the fact remains that the zebra mussel is now a permanent part of the Illinois River. Detrimental impacts currently being assessed in the Illinois River will soon occur elsewhere, as zebra mussel populations continue to grow and spread in waterways throughout the Mississippi River drainage.

Figure 1: Locations of five zebra mussel study sites on the Illinois River. River Mile (RM) refers to the distance in miles from the confluence of the Illinois and Mississippi Rivers.



River Mile	Site	Collection Date	Zebra Mussels: Densities: Mean /m²	Densities: min./max. /m²	Size: < 15mm %	Size: > 15mm %	Native Unionids: Densities /m²	Native Unionids: Infestation %
181.0	Chillicothe	08/03/93	< 1	--- / ---	---	---	0.3	03
162.3	Peoria	08/10/93	1,793	588 / 3,572	61.6	38.5	5.2	88
66.8	Meredosia	07/20/93	10,905	4,948 / 25,988	99.5	0.5	11.0	95
50.1	Montezuma	10/01/93	Analysis Pending					
5.5	Grafton	08/18/93	60,956	27,936 / 94,504	99.7	0.3	12.2	99

Source: Illinois Natural History Survey (11/01/93). Unpublished data.
For further information contact S.D. Whitney or K.D. Blodgett.

Table 1. Densities and infestation rates of zebra mussels and native unionids at five sampling sites on the Illinois River.

SETTLEMENT, GROWTH RATE, AND HABITAT COLONIZATION OF ZEBRA MUSSELS IN THE UPPER MISSISSIPPI RIVER.

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We examined the settlement, growth rate, and habitat colonization of zebra mussels *Dreissena polymorpha* in Pool 8 of the Upper Mississippi River (near La Crosse, Wisconsin). Two habitat types were studied, main channel border and backwater, with two sites in each type. At each site, 15 concrete blocks were deployed in a randomized block design in June 1993. There were five treatments (time periods) and three replicates (concrete blocks) per treatment. Settlement and growth rate of zebra mussels on three blocks were measured at 30 $\pm$ 10 d intervals at each site. Zebra mussels on two of the blocks selected at random were removed and analyzed for shell morphology (length, width, height) and biomass (wet, dry, ash, and ash-free dry weight). Zebra mussels on the third block were measured (shell length) to the nearest millimeter and marked with a bee tag, and the block was returned to the site. During each subsequent sampling event, any concrete blocks with marked zebra mussels, as well as blocks replaced with no marked zebra mussels, were retrieved and inspected; marked zebra mussels were then re-measured, and the block again returned to the site. From August through October, we found 94 zebra mussels. Shell length averaged 4 mm in August, 6 mm in September, and 8 mm in October. We found 23 mussels at the main channel border sites in August, 41 in September, and 26 in October. No zebra mussels were found at the backwater sites in August or September, and only 4 mussels were found at the backwater sites in October. The growth rate of zebra mussels at the main channel border sites was 0.14 mm/d in August, 0.10 mm/d in September, and 0.03 mm/d in October. The mean ash-free dry weight of mussels increased from 0.8 mg in August to 3.9 mg in September and to 5.3 mg in October. The severe flooding and associated cool water temperatures on the Mississippi River in 1993 may have delayed the early spawning or decreased the recruitment of zebra mussels from an early spawn, but did not seem to impair growth.

THE SPREAD OF ZEBRA MUSSELS (*Dreissena polymorpha*) THROUGH THE INLAND WATERWAY SYSTEM, 1993.

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The first documented find of adult zebra mussels (*Dreissena polymorpha*) in the inland waterway system was from the Illinois River in early 1991; by late 1993 these bivalves were found in the Mississippi, Ohio, Cumberland, Tennessee, and Arkansas rivers. Recently established populations at the periphery of their range are characterized by few cohorts and low density (i.e., an abundance of large or small individuals). In May 1993, *D. polymorpha* was first collected in the lower Mississippi River at Harvey Lock, New Orleans, LA. Density (individuals/sq m) on a concrete wall was 31; minimum and mean shell lengths (SL) were 3.3 and 8.6 mm. In July 1993, a low density population was found at Byrd Lock near Huntington, VA, Ohio River Mile 279.2. Minimum and mean SL was 2.8 and 6.1 mm, respectively. Density in 1992-93 at rich and dense native mussel beds in the upper Mississippi River was less than 1 although moderately dense populations were found at Lock and Dam 6 and 9. Zebra mussels spread to the upper Ohio and Mississippi rivers by attaching to the hulls of commercial or recreational vessels. Great numbers of zebra mussel veligers are transported passively downriver and colonize the lower Ohio, Illinois, and Mississippi rivers. In August 1993, a well-established population with multiple cohorts at a native mussel bed at Illinois River Mile 162 had a density of 1,793; minimum, maximum, and mean SL were 0.5, 27.5 and 12.5 mm, respectively. In August 1992 less than 6 zebra mussels were collected in the lower Ohio River near its confluence with the Mississippi River; in

September 1993 maximum densities were approximately 200/sq m. Data on density and size demography of *D. polymorpha* as it colonizes the inland waterway system provides information necessary to document the environmental impacts of this nonindigenous bivalve on native mussels and other aquatic invertebrates.

EFFECTS OF ZEBRA MUSSELS, YOUNG BLUEGILLS, AND WATER RETENTION TIME ON EXPERIMENTAL FOOD WEBS.

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We evaluated the food web effects of zebra mussels at densities currently found at many sites in the upper Mississippi River. In 1135-L mesocosms we manipulated the presence and absence of zebra mussels ($2000 \cdot m^{-2}$), young-of-the-year bluegills *Lepomis macrochirus* (40/mesocosm) and retention time (1 or 5 day) in a cross-classified design. This design was meant to simulate conditions occurring in riverine backwater lakes. There were eight treatment combinations with three replicates per treatment. Water was drawn from the Black River, a tributary of the Mississippi River, and held in a supply reservoir that was renewed at 14-day intervals. The experiment ran for 45 d, starting 9 September 1993. Turbidity was less in 1-d retention time mesocosms with zebra mussels (2.5 ntu), than in those without mussels (3.0 ntu; $P = 0.018$). Chlorophyll *a* was also less in zebra mussel mesocosms with 1-d retention times (7.2 mg/m^3) than in similar mesocosms without mussels (10.7 mg/m^3; $P = 0.042$). Chlorophyll a in 5-d retention time mesocosms was not affected by the presence of mussels. Cyclopoid nauplii densities were depressed in the presence of zebra mussels ($P=0.025$). *Polyarthra* and *Keratella* were also suppressed in zebra mussel tanks, and more so in the presence of fish (ZMxFISH, $P=0.01$, 0.083, respectively). Fish growth and survival was not affected by zebra mussels or retention time. Under the experimental conditions used here, the effects of zebra mussel feeding on lower trophics did not seem to cascade up the food web to affect fish. We speculate that the low mussel density and low water temperatures of fall (mean: 13.5 °C, range: 5.3-21.4 °C) hindered the transmission of effects through the food web. These results suggest that effects of zebra mussel at low densities on trophic interactions may be dependent on seasonal variation in water temperature and water renewal rates.

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APRIL 28-29, 1994

ABSTRACTS OF POSTER PRESENTATIONS

(listed in alphabetical order by first author)

CANDIDATE ANTIOXIDANTS FOR PREVENTING ZEBRA MUSSEL ATTACHMENT: TOXICITY TO FISH.

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We identified and tested 47 antioxidants having potential for preventing the attachment of zebra mussels *Dreissena polymorpha*. In initial tests, 10 of the 47 chemicals tested inhibited the reattachment of zebra mussels. Eight of the ten chemicals had EC_{50} values ranging from 0.3 to 3.2 mg/L, two had EC_{50} values of 10.6 and 10.7 mg/L, and one had an EC_{50} value of 23.3 mg/L. The range of concentrations that inhibited reattachment was not lethal to the zebra mussels, which reattached after transfer to untreated water. Based on an analysis of chemical cost, anticipated treatment concentrations, solubility, and other chemical properties, four of the most promising chemicals (butylated hydroxyanisole, BHA; butylated hydroxytoluene, BHT; tert-butylhydroquinone, TBHQ; and tannic acid) were tested on two species of fish. Standard acute toxicity tests with rainbow trout *Oncorhynchus mykiss* and channel catfish *Ictalurus punctatus* showed that at least three of the chemicals were lethal to fish at the concentrations effective for preventing zebra mussel attachment (i.e., fish had a lower 48-h LC_{50} than the 48-h EC_{50} for zebra mussels). Although the attachment of zebra mussels may be prevented with selected antioxidants, an alternative formulation should be investigated to minimize effects on nontarget organisms such as fish.

LEAF DECOMPOSITION IN MAIN CHANNEL AND BACKWATER HABITATS OF THE UPPER MISSISSIPPI RIVER.

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Rates of leaf decomposition were examined for main channel and backwater habitats of the upper Mississippi River. The objective of this study was to assess the possible role of direct litterfall in the trophic dynamics of a large floodplain river. Approximately 5 g of Populus sp. leaves were attached to bricks and placed in a 4 x 25 brick matrix at each of two main channel and two backwater sites in the upper Mississippi River (near RK 1172). Leaves were removed every 5 d, gently washed to remove macroinvertebrates, dried at 105°C for 24 hr, ashed at 500°C, and weighed for determination of ash-free dry weight. While weight loss was initially low in both habitats, weight loss was significantly greater for main channel leaf packs. After two months, leaf packs from the main channel showed approximately 65% weight loss while packs from the backwater showed weight losses of slightly more than 40%. While rates of leaf decomposition for this study were less than those of smaller lotic systems, the results suggests that leaf litter is a source of organic carbon that can be exploited by macroinvertebrates inhabiting nearshore areas of large floodplain rivers.

DISTRIBUTION OF LANDSAT-DERIVED LAND COVER THROUGHOUT THE UMRS.

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A land cover/land use coverage of the Upper Mississippi River System (UMRS) was generated using 1989 Landsat Thematic Mapper data. The procedures used to create the coverage included:

image mosaicking, image rectification, atmospheric correction, floodplain extraction, classification, editing, quality assurance and distribution. The mapping classes include: water, aquatic vegetation, grasses/forbs, woody terrestrial, agriculture, urban/developed and sand. The data base provides resource managers throughout the UMRS with access to site specific land cover/land use information. In addition, these data will be used to verify the adequacy of Long Term Resource Monitoring Program sampling designs and to evaluate the spatial distribution of habitats throughout the system. Acreage summaries are provided for the 35 navigation pools as well as the open river reaches and comparisons are made between the average condition and the characteristics of each pool or river reach.

ACROSS CHANNEL HABITAT USE BY MACROINVERTEBRATES SUBJECTED TO HYDROPOWER PEAKING IN THE LOWER CHIPPEWA RIVER.

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Rivers regulated for hydropower peaking experience diel fluctuations in benthic habitat characteristics and availability. Changes in habitat availability and structure, in turn, should influence across channel invertebrate community structure. We collected samples along latitudinal transects of the Chippewa River at sites downstream of the hydropower dam at Eau Claire, Wisconsin, to determine the relationship between habitat use and macroinvertebrate community composition and ascertain the possible effects of hydropower peaking on habitat use and availability. Benthic samples were collected using an Hess sampler or petite Ponar grab at six points along transects at each of five locations. Locations were determined prior to sampling to represent primary habitats available throughout the tailwaters of Dells Dam in Eau Claire. Samples were collected during low-flow periods in August, 1993, to insure that areas sampled were always inundated. The primary and secondary substrata were characterized in addition to measurement of water depth and bottom and 0.6 depth current velocities. Current velocities were also measured during high flow periods in order to assess changes in habitat characteristics during periods of peaking. Preliminary analysis of data indicates that species richness and invertebrate densities are greatest in main channel areas with small to large cobble substrata. Invertebrate densities and species richness are lowest in main channel areas where sand is the primary substratum and in many nearshore areas. In river reaches where cobble was the primary substratum, nearshore areas possess fewer species and fewer individuals than comparable main channel habitats where current velocity remains high during daily periods of low-flow. Fauna in these nearshore areas are represented primarily by Chironomidae and highly mobile invertebrates, such as Corixidae. Preliminary results suggest that extensive nearshore areas are colonized by invertebrates that are either tolerant of drying and unfavorable habitat conditions or highly motile organisms that can disperse when conditions become unfavorable.

CHANGES IN INVERTEBRATE COMMUNITY COMPOSITION ALONG THE LONGITUDINAL GRADIENT OF A RIVER SUBJECTED TO HYDROPOWER PEAKING.

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Rivers regulated for hydropower peaking experience daily fluctuations in physical structure of the water column and river bed. These fluctuations should be evident throughout the tailwaters, with the degree of daily variation decreasing downstream of the dam. The tailwaters of Dells Dam on the Chippewa River, Eau Claire, Wisconsin, extend downstream approximately 60 km; a distance which allows the river to flow throughout different geomorphological areas within the river valley. Correspondingly, the river bed goes from consisting primarily of cobble and gravel to a nearly

entirely sand bottom near the end of the tailwaters. We collected samples across transects located throughout the tailwaters of Chippewa River below the hydropower dam at Eau Claire, Wisconsin, to approximately 60 km downstream to determine if macroinvertebrate community structure changed longitudinally in response to abiotic gradients and to ascertain if hydropower peaking practices influenced longitudinal patterns of macroinvertebrate communities. Benthic samples were collected using an Hess sampler or petite Ponar grab at six points along transects at each of five locations. Locations were determined prior to sampling to represent primary habitats available throughout the tailwaters of Dells Dam in Eau Claire. Samples were collected during low-flow periods in August, 1993, to insure that areas sampled were always inundated. The primary and secondary substrata were characterized in addition to measurement of water depth and bottom and 0.6 depth current velocities. Preliminary results suggest that changes in flow characteristics of the Chippewa River induced by hydropower peaking diminish as distance downstream increases. Furthermore, longitudinal changes in macroinvertebrate community structure are small, with primary changes resulting from changes in composition of bottom substrata. At sites where cobble and gravel are the primary substrata, both species richness and macroinvertebrate densities are high, while downstream areas with sand substrata possess fewer species, dominated by Chironomidae and Oligochaeta, and lower densities of macroinvertebrates. It appears, therefore, that longitudinal changes in macroinvertebrate community structure within the tailwaters of Dells Dam will be a function of substrate composition rather than physical changes induced by hydropower peaking.

POPULATION ASSESSMENT, MOVEMENT AND HABITAT USE OF LARGEMOUTH BASS IN LA GRANGE POOL, ILLINOIS RIVER.

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Little data is available on Illinois River largemouth bass (*Micropterus salmoides*) populations. In the late 1980s bass numbers seemed to increase and a quality fishery has developed. Tournaments are held regularly on the river and in 1993 the BASSMASTERS SuperStars tournament was held in Peoria, IL. In 1992 we began an assessment of the bass stock in La Grange Pool, Illinois River as a subproject of Long Term Resource Monitoring Program (LTRMP). Our objectives were: assess the present bass stock, estimate harvest rates and determine movement patterns using floy and radio tags, determine factors limiting reproduction and/or recruitment, and make management recommendations. Of 1240 bass collected in 1992, only 70 (6%) were less than 160 mmTL. Of 1754 bass collected in 1993, 1191 (68%) were less than 160 mmTL. Flood waters throughout Spring and Summer of 1990 and 1993 seem to have been conducive to bass reproduction and survival of age 0 fish. We observed little recruitment of the 1991 and 1992 year classes; those years were characterized by low water during spring and summer. Flood waters also made bass collection difficult in 1993 and our proposed population and standing stock estimates were not possible. PSDs were 46.3% in 1992 and 41.6% in 1993. With the help of IDOC biologists and the cooperation of bass clubs we floy tagged 1480 bass in 1992 and 1219 bass in 1993. Harvest rates for fish recaptured by non-tournament fishermen were estimated at 21% in 1992 and 45% in 1993. In 1992, 60% of fish were recaptured in the same location in which they were released, while 21% were captured upstream and 19% were recaptured downstream of their release points; dispersal of 1993 fish was nearly identical. In November and December of 1993 we radio tagged 17 bass to determine winter habitat use; preliminary results indicate bass wintered in off-channel areas which were 1-4 degrees C warmer than the main channel and lacked current.

BOLTONIA DECURRENS, A FEDERALLY THREATENED PLANT SPECIES.

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Boltonia decurrens, decurrent false aster, is an early successional, perennial member of the Asteraceae. The species was named for the decurrent growth of the long linear leaves down the stem, which gives the stem a winged appearance. The loose, leafy inflorescence is composed of flower heads with white ray flowers and central yellow disk flowers. The flowers produce two morphologically different seeds which are adapted for dispersal by wind and water. Plants flower from August to October. Vegetative reproduction occurs in the form of basal rosettes which are produced in the fall. First collected in 1841, *B. decurrens* historically populated a 250 mile stretch of the floodplains of the Illinois and Mississippi Rivers, from LaSalle, Illinois, to St. Louis, Missouri. Habitat consisted of open, wet, lowland areas. Due to habitat destruction and modification, the populations have declined to the point that *B. decurrens* was officially listed as a Federally threatened species in 1988. Existing and potential habitat was greatly reduced when agricultural development of the floodplain began, and as the rivers were impounded by locks and dams. The species now depends on human disturbance for survival. Studies have been conducted in order to determine life history characteristics and the habitat requirements of the species. A population study was conducted at a site at the U.S. Army Corps of Engineers Riverlands Environmental Demonstration Area in St. Charles, Missouri. Results showed that *B. decurrens* seeds have a 1 in 30,000 chance of surviving to maturity and flowering, that the population has a small seed bank with low viability, and that rosette survival rates are low.

SPATIAL AND TEMPORAL VARIABILITY IN AQUATIC VEGETATION IN THE FINGER LAKES.

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We studied the distribution and abundance of aquatic vegetation in the Finger Lakes during August and September in 1991, 1992, and 1993. Up to 13 species of submersed and floating-leaved aquatic plants were identified. *Ceratophyllum demersum* L., *Nymphaea tuberosa* Paine, and *Myriophyllum spicatum* L. were the most abundant species. During the three-year period, Third Lake maintained the densest and most extensive vegetation cover, while Clear Lake remained the most sparsely vegetated. The number of vegetated sites within the lakes declined from 58% in 1991 to 27% in 1993. The variations in spatial distribution of aquatic macrophytes among the Finger Lakes is likely influenced by factors such as light availability, physical and chemical qualities of the substrate, and flow. Factors influencing the declines are more difficult to determine. Potential explanations for declines in macrophyte abundance may be due to changes in the physical or chemical conditions of the habitat, competition for light and nutrients, or destruction by pathogens or herbivores.

FINGERNAIL CLAMS: HAVE THEY CHANGED AFTER THE CRASH AND DO THEY LIKE POLLUTION?

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During the drought years 1987-88, fingernail clams in the genera *Musculium* and *Sphaerium* underwent and apparent decline and were quite scarce. In 1991, many workers began finding populations in substantial numbers again. One such area included several beds in and around the Chicago Sanitary District in the northern reaches of the Illinois River. This area has extensive toxic sediment loads from nearby industrial developments and the city of Chicago. One reason proposed for the decline of populations in the late 80's was an increased toxic load in the Mississippi and its tributaries resulting from low flows associated with the drought. The major objectives of this study were twofold: (1) determine if the genetic structur of these populations revealed anything about the consequences of the apparent population crash and (2) investigate the possibility that populations in the Chicago area might be genetically adapted to a toxic-stressed habitat. In order to evaluate this hypoethesis *Musculium transversum* and *Sphaerium striatiunum* were collected for isozyme analysis from Illinois River localities near Chicago and Swan Lake near Grafton Illinois as well as Pool 13 of the Mississippi River. Preliminary data from the Illinois River populations of *M. transversum* produced and $F_{IS}=0.756$ showing that the populations are highly inbred; although, some outcrossing is evident (complete inbreeding would result in an $F_{IS}=1.00$). An $F_{ST}=0.122$ indicates that this species probably went through a mild bottlenneck resulting in small isolated populations throughout the river system before rebounding (an F_{ST} between 0.05 and 0.15 represents moderate genetic diffentiation). The bottleneck was not severe enough to result in an eerosion of variability since a valiue of 0.122 does not suggest an extensive period of isolation. Sample sizes of *S. striatiunum* are too small to draw similar conclusions; however, no heterozygous individuals were observed out of the 36 individual analyzed thus far. This shows a complete absence of outcrossin in the two localities from which these specimens were drawn. Patterns of allele freqency distributions at *Glucose-phosphate isomerase-2 (Gpi-2)* strongly suggest a pollutant-tolerant allele exists that allows *M. trnasversum* to thrive in localities with highly toxic sediments. The *Gpi-2*^{100} allele from a sample at River Mile 292.5 on the Illinois RIver possessed a frequency of 0.821. This allele drops to a frequency of 0.821. This allele drops to a freqeuncy of 0.600 at River Mile 318.5 and 0.406 at Swan Lake in the Grafton Pool. A sample from Pool 13 will be analyzed shotrly which will serve to support or refute this hypothesis. Our prediction is that if the alternative *Gpi-2*^{2} allele is the normal allele, it should occur at a frequency of 0.600 or greater in Pool 13. Therefore, natural selection is replacing the *Gpi-2*^{74} allele with *Gpi-2*^{100} in populatins under severe toxic stress. If our assertion about Pool 13 is correct, our data would be consistent with other studies involving such organisms as mosquistofish. Mosquitofish were shown to possess alleles at some isozyme loci enabling them to live in toxic-stress habitats. Therefore, it might be possible to utilize *M. transversum* as an indicator organism for toxic sediments.

INITIATION OF MACROINVERTEBRATE MONITORING ON THE UPPER MISSISSIPPI RIVER SYSTEM.

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In 1992 macroinvertebrate sampling was initiated in Pools 4, 8, 13, 26 and the Open River reach of the Mississippi River, and La Grange Pool of the Illinois River, as part of the Long Term Resource Monitoring Program (LTRMP). Long term monitoring is needed to detect population trends and detect local changes in aquatic ecosystems. Mayflies (Ephemeroptera), fingernail clams (Sphaeriidae) and *Corbicula* species were selected for monitoring. These three members of the soft substrate community were chosen because they play an important ecological role in the Upper Mississippi River System (UMRS). Sampling was based on a stratified random design, and was conducted at 125 sites per study reach. Macroinvertebrate sampling produced a total of 1782 mayflies, 1119 fingernail clams and 25 *Corbicula* spp., with 43.6% of the sampling sites containing at least one of the target organisms. The number of mayflies and fingernail clams captured by Ponar sampling differed significantly between reaches ($P < 0.05$). Pool 13 had the highest mean number of mayflies (98.6/m^2) and fingernail clams (93.4/m^2). The lowest mean number of mayflies and fingernail clams (9.5/m^2 and 4.9/m^2, respectively) were from La Grange Pool. Significant differences were found also among habitat classes and substrate type ($P < 0.05$). Mean catch rates of mayflies were higher in contiguous floodplain shallow (CFS) and impounded (IMP) habitats. In Lake Pepin, IMP and CFS fingernail clam habitats were significantly better than backwater contiguous, side channel and channel border-unstructured habitats. Sand or gravel rock supported few mayflies or fingernail clams. The silt/clay substrate was significantly better mayfly habitat than all other substrates, while the muck/organic and silt/clay substrates were significantly better fingernail clam habitat.

WALLEYE AND SAUGER SPAWNING HABITAT SURVEY IN POOL 16 OF THE UPPER MISSISSIPPI RIVER.

Gary Siegwarth[1], John Pitlo[2], and Dave Willis[3]
[1]Iowa Department of Natural Resources, RR 2 Box 269, Manchester, IA 52057
[2]Iowa Department of Natural Resources, 24143 Hwy. 52, Bellevue, IA 52301
[3]Department of Wildlife and Fisheries, Box 2206, South Dakota State University, Brookings, SD 57001

Twenty-six adult walleyes (*Stizostedion vitreum*) and 22 adult saugers (*Stizostedion canadense*) were implanted with 90-day external radio transmitters to document pre-spawn and spawning habitat use in Pool 16 of the Mississippi RIver. During the pre-spawn period, walleyes used backwater lake habitats in the tailwater region and saugers utilized side channel border habitats in Sylvan Slough. Prior to spawning, both walleyes and saugers moved into various reaches of the Rock River below a lowhead dam. The remaining walleyes and saugers either occupied main channel border habitats or were not located. Drift nets were deployed in areas occupied by walleyes and saugers in the Rock River, main channel of the Mississippi, and in other likely spawning sites. The Rock River was identified as the primary spawning area in Pool 16 as over 2,700 walleye (81.2%) and sauger (18.8%) eggs were collected from drift net samples from 10 April to 5 May, after which eggs were no longer collected; only 10 eggs were collected from the Mississippi River despite a higher sampling effort. Peak spawning coincided with peak discharge rates in both the Mississippi and Rock Rivers at water temperatures ranging from 51 to 55 degrees F. Substrate of spawning sites within the Rock River consisted of shifting sand over solid bedrock, with current velocities ranging from 1.1 to 3.2 ft/sec. Areas used by both walleyes and saugers during the pre-spawn period appears limiting in Pool 16 due to extensive shoreline development in tailwater habitats. Primary used of a tributary for spawning has not been previously documented for Mississippi River walleye populations.

EFFECT OF WATER TEMPERATURE ON LOCOMOTION AND BURROWING IN UNIONID MUSSELS.

Diane L. Waller and Jeffrey J. Rach
National Fisheries Research Center, La Crosse, WI 52401-0818

Unionid mussels are collected from early spring to late fall for surveys, relocation projects, and commercial harvest. Mussel activity generally correlates with water temperature, but there are few data that establish guidelines for handling mussels at different water temperatures. Mussels that do not properly position and burrow may be more susceptible to predation, colonization by zebra mussels, and current movement. Our objective was to compare locomotion and burrowing at three water temperatures among four unionid mussel species. We collected threeridge (*Amblema plicata plicata*), pink heelsplitter (*Potamilus ohiensis*), pigtoe (*Fusconaia flava*), and pocketbook (*Lampsilis cardium*) mussels from Navigation Pool 8 of the upper Mississippi River. Mussels were transferred to three holding tanks that measured 2.92 x 0.69 x 0.61 m and contained 0.3 m sand and 0.3 m water. Fifteen mussels of each species were placed into each tank, total density=36 mussels/m^2. Mussels in each tank were acclimated to one of three test temperatures (7, 14, or 21°C) for at least 3 weeks. Following acclimation, mussels were removed from the tank, tagged, and placed back into the tank on their sides. We recorded observations of shell position, percent of shell buried, and mussel location in the tanks at 1, 2, 4, 6, 12, 24, 48, 72, and 96 h. We found that burrowing and locomotion increased significantly with temperature, and that activity varied significantly among species. At 7°C, only 20-60% of mussels were turned upright after 48 h compared to >90% at 21°C. Pink heelsplitter and pocketbook mussels moved further and more often than threeridge and pigtoe mussels. Moreover, they turned upright and burrowed more quickly than threerige and pigtoe mussels. Our results demonstrate the importance of planning surveys and relocation projects at water temperatures in which mussels are active and can reestablish quickly after displacement.

EFFECTS OF ZEBRA MUSSELS (*DREISSENA POLYMORPHA*) ON NATIVE UNIONID MUSSELS IN THE ILLINOIS RIVER.

Scott D. Whitney, Douglas Blodgett, and Richard Sparks
Illinois Natural History Survey, River Research Labs, 704 N. Schrader Avenue, Havana, IL 62644

In 1993, we quantitatively sampled zebra mussels (*Dreissena polymorpha*) and native unionid mussels at five mussel beds along the lower 180 miles of the Illinois River. We found an upriver-downriver gradient of native mussel densities, from 0.3/m^2 at river mile (RM) 181 to 12.2/m^2 at RM 5.5, attributable to a long-existing gradient in sediment and water quality, due to pollution from the Chicago area. The twenty-three species of native mussels remaining in the Illinois River clearly are threatened by recently introduced zebra mussels, which underwent exponential population growth in the Illinois River during 1993. Average densities of zebra mussels increased from less than 1/m^2 at RM 181 (our uppermost sample site) to 60,956/m^2 at RM 5.5, indicating a strong upriver-downriver gradient. This gradient may be due in part to the increased water velocities during the spring and summer of 1993, which transported zebra mussel veligers far downriver before they could settle out of the water column. The percentage of native unionids infested with zebra mussels likewise increased from only 3% at our upriver site to 99% downriver; numbers per unionid ranged from 0 to 1683. Recent mortality of some native mussels probably resulted from zebra mussel infestations which limited normal opening and closing of unionid valves. Apparently some unionids were forced open when zebra mussels that had attached to inside edges of valves increased in size and number. The valves of other unionids appeared to be held shut by an overwhelming number of zebra mussels tightly bound to both valves and to one another by byssal threads.

PRESETTLEMENT AND PRESENT FORESTS ON THE UPPER MISSISSIPPI RIVER FLOODPLAIN IN SOUTHERN ILLINOIS.

[1]**Yao Yin** and [2]John Nelson, [1]National Biological Survey, Environmental Management Technical Center, 575 Lester Avenue, Onalaska, Wisconsin 54650, and [2]Illinois Natural History Survey, Pool 26 Long Term Resource Monitoring Program Field Station, 1005 Edwardsville Road, Wood River, Illinois 62095.

We examined changes in floodplain forests that occurred between 1809 and 1993 for the Upper Mississippi River at southern Illinois. Presettlement forest conditions were reconstructed based upon General Land Office (GLO) survey records. Present forest conditions were determined with a sampling design similar to the GLO surveys. Results of our study reveal that the presettlement floodplain was nearly completely forested, except in large oxbow lakes. Whereas less than 20% of the present floodplain areas is forested. In addition to enormous acreage reduction, composition and structure of floodplain forests have changed significantly. Compared to presettlement conditions, present forests bordering the river are comprised of more *Salix nigra* and *Acer saccharinum*, fewer *Populus deltoides* and *Platanus occidentalis,* and lack mast-producing oak and hickory species; present forests further away from the river, behind Federal levees, are comprised of more *Quercus palustris* and *Q. pagdaefolia,* and less *Celtis occidentalis, Ulmus rubra*, and *Populus deltoides*. We believe these changes are directly affected by Federal levees, navigation improvement structures, and alteration of hydrology in the Upper Mississippi River.

FLUORESCENT ELASTOMER FOR SHORT-TERM MARKING OF FISH.

Steven J. Zigler and Michael R. Dewey
National Biological Survey, National Fisheries Research Center, La Crosse, WI 54602.

We tested a fluorescent elastomer (a multi-component, silicone polymer) for marking bluegills *Lepomis macrochirus* in laboratory and pond studies. Fish were anesthetized and then marked by injecting small amounts of elastomer under the skin with a small syringe. The time required to apply elastomer averaged less than 1 minute per fish. Retention of marks was determined by examining fish under ultraviolet light to enhance the visibility of marks. In the laboratory study, 60 adult bluegills and 10 juvenile bluegills were each marked at four bodily locations. For each size class, control fish were anesthetized but not marked. Fish were examined for retention of marks at 1, 2, and 6 months after marking. After 6 months, adult bluegills retained 99.6% of their marks. Juvenile bluegills, however, shed marks injected on the scalp after 1 month, but retained all marks on other areas of the body throughout the study. Only 2 marked fish and 1 control fish died. In the pond study, 203 juvenile bluegills (43-66 mm TL) were marked and placed in 12 enclosures. Within each enclosure, each fish had a unique combination of marks for identification. After 70 days, 99.5% of the marks were easily detectable with an ultraviolet light. We concluded that fluorescent elastomer is a reliable method for marking fish in laboratory and pond studies. However, this method is not practical for studies requiring unique marking of large numbers of fish (i.e., 100 or more) due to the limited number of injection sites on each fish.

1994 BUSINESS MEETING AGENDA

MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC.
26TH ANNUAL MEETING

FRIDAY APRIL 29, 1994
11:00 AM

HOLIDAY INN, LA CROSSE, WISCONSIN

1. Call to order

2. Announcements and acknowledgements
   a. presentation of 1993 best paper awards

3. Secretary's report
   a. approval of minutes of 1993 business meeting
   b. update on correspondence during 1993-94

4. Treasurer's report
   a. Final 1993 financial report
   b. Preliminary 1994 financial report

5. Old business
   a. MRRC support for 1994 Large Rivers Conference
   b. Other

6. New business
   a. Nomination and electionn of the 1994-95 Board of Directors (vice-president, secretary)
   b. Meeting notice for 27th (1995) annual meeting
      1. April 20-21 -- open
      2. April 27-28 -- tentative hold by another party
   c. The MRRC has initiated a photo album to maintain the pictoral history of annual meetings.
   d. brief presentation by Paul Hansen, Izaak Walton League,
   e. other

7. Raffle

8. Adjourn

MINUTES OF THE BUSINESS MEETING, 25th ANNUAL MEETING OF THE MISSISSIPPI RIVER RESEARCH CONSORTIUM, INC., APRIL 23, 1993

1. CALL TO ORDER

The meeting was called to order at 11:00 AM by Vice-President Teresa Naimo. Treasurer Joe Wlosinski and Secretary Charles Theiling, along with approximately 70 members, were in attendance.

2. ANNOUNCEMENTS AND ACKNOWLEDGEMENTS

The Vice-President acknowledged everyone who helped prepare and conduct the 25th Annual Meeting including moderators, judges, presenters and co-sponsors. She also encouraged others to become co-sponsors to help keep the costs of the meetings down. Awards were presented for the winners of the best poster (Steve Zigler), best paper (Susan Peitzmeier-Romano) and best student paper (Jim Fisher) at the 24th Annual Meeting of the MRRC.

3. SECRETARY'S REPORT

Rip Sparks moved, Tom Claflin seconded, and those present unanimously agreed to approve the minutes of the 1992 (24th) Annual Business Meeting, as presented in the 1993 Proceedings. Chuck Theiling also reported on letters sent to Congressional members supporting bills related to the Mississippi River including continued full funding of the LTRMP and the Interjurisdictional Rivers Bill.

4. TREASURER'S REPORT

Joe Wlosinski, as part of the registration package, distributed the Treasurer's report that presented a financial summary through March, 1993. Because all the bills and income from the 25th Annual Meeting have not been received, a final report for 1992-1993 was not yet available. As of March 1993, $5,180.86 was available in the Consortium account. Tom Claflin moved, Rip Sparks seconded and those present voted unanimously to accept the Treasurers report. Joe also called for an audit of the Consortium account with the election of a new treasurer. The issue will be settled by the Board of Directors.

5. OLD BUSINESS

The only item listed under old business was the MRRC Procedures Manual. Teresa Naimo gave a brief description of the Manual as a "living document" designed to guide the activities of the MRRC Executive Committee.

6. NEW BUSINESS

a.<u>Nomination and election of the 1993-1994 Board of Directors</u> - The nomination committee was made up of the 1992-1993 Board of Directors. The nominations were:

1. Mark Sandheinrich for Vice-President for a one year term followed by a one year term as President.

2. Neal Mundahl for Treasurer, for a two year term.

The Vice-President, Teresa Naimo, will become President for one year.

The Vice-President asked for nominations from the floor. John Pitlo presented a motion, seconded by Rip Sparks to accept the recommendations of the nominating committee. The motion was passed unanimously

b. Meeting notice for the 26th (1994) Annual Meeting
The Radisson Inn and the Holiday Inn, LaCrosse were both considered by the Board of Directors as possible locations for the 1994 annual Meeting. Joe Wlosinski explained differences in costs and facilities at both locations and opened discussion to the floor.

Doug Blodgett - was pleased with the Holiday Inn facilities but wondered if we needed more room.

Joe Wlosinski - he didn't expect attendance to increase by more than five people.

Tom Claflin - thanked the committee for their work on the 1993 meeting and commented that he liked the current poster arrangement.

Joe Wlosinski - added that we could add more posters if necessary. He also asked whether the members preferred tables at the meeting room.

Donna Wilson - commented that she liked having tables to write on.

John Pitlo - thought the arrangement without tables was acceptable.

Dave Day - asked if costs at the Holiday Inn might be higher next year.

Joe Wlosinski - explained that costs would be similar to those of 1993.

Teresa Naimo - asked for a voice vote concerning the location of the 1994 Annual Meeting. The members supported keeping the meetings at the Holiday Inn.

Bob Gaugush - asked if the meetings could be moved to March to avoid conflicts with field season.

Joe Wlosinski and Rip Sparks - commented that a March meeting would conflict with other UMRS related meetings.

c. Discussion on meeting format.
Teresa Naimo wanted to address specifically: length of meeting (2 or 3 days), length of presentations (15 or 20 min.), number of papers presented by a

single author, rejection of abstracts, poster vs. platform format and quality and date of submission of abstracts.

Mark Sandheinrich - he liked the two day format and suggested that excess talks be shunted to posters.

Joe Wlosinski - posters could be expanded.

Doug Blodgett - agreed with poster expansion and two day format but did not want talks cut back to 15 min. He also commended moderators for keeping speakers on time.

Teresa Naimo - was concerned about fitting in all talks submitted.

Terry Duckershein - speakers should be limited to 15 min.

Donna Wilson - agreed and suggested using a warning signal to indicate time is running out for the speaker.

John Sullivan - speakers presenting early in a session might use time devoted to later speakers.

Rip Sparks - some platform papers could be prepared as posters instead.

Rich Harris - posters should be posters and talks should be talks. He supported the 15 min. limit to fit in more talks.

Lara Hill - Agreed with the warning light idea.

Joe Wlosinski - asked for a voice vote about meeting days. The choice was Wed/Thurs vs. Thurs/Fri. Thurs/Fri won. The 1994 Annual Meeting will be April 28-29 at the Holiday Inn, LaCrosse.

Teresa Naimo - abstract quality and timeliness of submission. Many abstracts were late and many members did not follow instructions. Such carelessness creates trouble for the person compiling the abstracts and preparing the proceedings.

d. <u>1994 Large Rivers Conference.</u>

Joe Wlosinski gave a brief description of the Conference to be held in LaCrosse during July, 1994. He explained that the Board of Directors favored supporting the meetings with a $1,000 donation and opened the floor for discussion.

John Sullivan - the money could be better spent. He suggested scholarships for example.

Joe Wlosinski - the Consortium has not done scholarships in the past.

John Sullivan - we should do something better with Consortium money and let the Large Rivers Conference pay their own costs.

Pam Theil motioned, and John Pitlo seconded, that the Consortium support the Conference by making a $1,000 donation.

Teresa Naimo asked for further comments.

John Pitlo - supported the motion as a one time expense.

Dave Day agreed.

Chuck Theiling - scholarships should be funded through a more reliable source.

Donna Wilson - how many student don't attend because they can't afford to travel?

Joe Wlosinski - students are encouraged to contact the Board of Directors to make special arrangements if they can't afford the meetings.

Terry Duckershein - student attendance was low because of schedule conflicts, not money.

John Sullivan - concerned about increasing costs and use of the Consortium's balance.

Teresa Naimo - stressed that co-sponsor support helps keep meeting costs down.

Rip Sparks - inquired about student rates.

Joe Wlosinski - explained they were $15. He also added that recent increases in meeting costs were due to the need for a second room for posters.

Jerry Rassmussen - asked if the Lg. Rivers Conference would have student rates.

Pam Theil - they would but she didn't have the figures.

Teresa Naimo asked for a vote on Pam's motion.

The motion passed with a majority vote.

e. Results of Logo contest.

Members asked the Board of Directors earlier during the meetings why hadn't the old logo been considered in the contest. The Board responded that it was an oversight on their part.

Joe Wlosinski - the prize money should be awarded to Dorothia Rohmer regardless of the final outcome.

Rip Sparks - we should vote on the old one vs. the new one.

Dave Beckett - the lower part of the river was left out.

Pam Theil - gave a brief history of the current Proceedings cover. She stated that it was only a cover and that it was not intended to serve as a logo or letterhead.

Joe Wlosinski - had found three different letterheads while going through old documents.

Teresa Naimo presented motion and Pam Theil seconded. A majority vote accepted the new logo prepared by Dorothia Rohmer.

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

7. **Adjournment**

The meeting was adjourned at 12:00 PM.

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
24th	1992	Holiday Inn, La Crosse	Dr. Richard Anderson Mr. Mike Dewey Mr. Kent Johnson 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

ACKNOWLEDGEMENTS

The following persons or institutions have contributed substantially to the planning, execution, support, and ultimately, the success of the 26th Annual Meeting of the Mississippi River Research Consortium. The 1993-19934 Board of Directors gratefully acknowledges their involvement.

Local Meeting Arrangements, Meeting Announcements, and Mailings

Teresa Naimo, U.S. Fish and Wildlife Service, National Fisheries Research Center, La Crosse, Wisconsin

Mark Sandheinrich, River Studies Center, University of Wisconsin, La Crosse, Wisconsin

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

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

Program and Proceedings

Mark Sandheinrich, River Studies Center, University of Wisconsin, La Crosse, Wisconsin

Registration Table

Georginia Ardinger, U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin

Virginia Stefanez, U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin

Visual Aids

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

Raffle Prizes

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

Platform Session Moderators

Steve Gutreuter, National Biological Survey, Enviromental Management Technical Center, Onalaska, Wisconsin

William Richardson, National Biological Survey, National Fisheries Research Center, La Crosse, Wisconsin

Terry Dukerschein, Wisconsin Department of Natural Resources, LTRM Program, Onalaska, Wisconsin

Teresa Naimo, National Biological Survey, National Fisheries Research Center, La Crosse, Wisconsin

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

John Sullivan, Wisconsin Department of Natural Resources, La Crosse, Wisconsin

Bradley Frazier, Department of Biology & Microbiology, University of Wisconsin-La Crosse, Wisconsin

W. Gregory Cope, National Biological Survey, National Fisheries Research Center, La Crosse, Wisconsin

Judges for Best Platform Paper Awards and Best Poster Award

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

Logo Art

Dorothia Rohmer, Ames, Iowa

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

National Biological Survey
Environmental Management Technical Center
Onalaska, Wisconsin

National Biological Survey
National Fisheries Research Center
La Crosse, Wisconsin

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