River Almanac

An Information Sharing Bulletin of the
Long Term Resource Monitoring Program

National Biological Service
U.S. Department of the Interior

Scientists exchange information on Amazon and Mississippi Rivers

by Robert A. Hrabik and Robert J. Sheehan

On May 15, 1995, two Amazon River scientists, an English-Spanish interpreter, and Robert J. Sheehan of the University of Southern Illinois-Carbondale visited the Open River Field Station at Jackson, Missouri. Enrique Rios Tsern and Norma Arana Flores are Biological Sciences faculty members at the Universidad Nacional de la Amazonia Peruana (Peruvian National University, Amazonia Campus) in Iquitos, Peru. The Peruvian scientists visited the United States through a grant awarded to faculty at the Southern Illinois University Cooperative Fisheries Research Laboratory.

The grant project, sponsored by the United States Information Agency, will mutually benefit Southern Illinois University and the Peruvian National University by strengthening faculty knowledge, improving instructional programs, and providing cross-cultural understanding, particularly as these factors apply to the ecology, management, and economic uses of large river systems. Southern Illinois University received this award because of the long history of research activity the two universities have shared on their respective continents' largest rivers, the Amazon and the Mississippi.

(*Left to right*) Dr. Robert Sheehan, Norma Arana Flores, Robert Hrabik, and Enrique Rios Tsern enjoy a trip on the open river.

The first phase of the project is a faculty exchange program wherein faculty from each university visit their counterparts. Program participants then lecture in classes, conduct individual research, interact with host university faculty, and meet with students. One important objective of the program is to participate in field expeditions, where direct experience with river ecology and management can be gained. Another is for program participants to interact with the agencies involved in the management, preservation, and regulation of natural resources.

The May 1995 meeting included a trip on the river, staff discussions, and a presentation on the ecology of the Upper Mississippi River System and the purpose of the Long Term Resource Monitoring Program. The field trip began with an electrofishing demonstration in flooded areas along the river. This was the first time that Flores and

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Data Sharing Issue

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Clarification

The photograph caption on the front page of the January 1996 ***River Almanac*** incorrectly suggested that all 1994 aerial photographs covering 1,300 river miles of the Upper Mississippi River System are available through the EMTC Home Page. The caption should have indicated that these photographs are being made available via our home page. Currently, Pools 4–12 in River Reach 1, Pools 14–16 and Pool 26 in River Reach 2, and Peoria and La Grange Pools in River Reach 4 have aerial photo coverages available online. The EMTC is providing public access to these photographs as a service to natural resource managers, industry, and the general public. EMTC Home Page: ***http//www.emtc.nbs.gov***

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River Almanac is an authorized publication of the U.S. Department of the Interior, published periodically by the Environmental Management Technical Center to provide an ongoing exchange of information between the EMTC and other Long Term Resource Monitoring Program participants and the general public.

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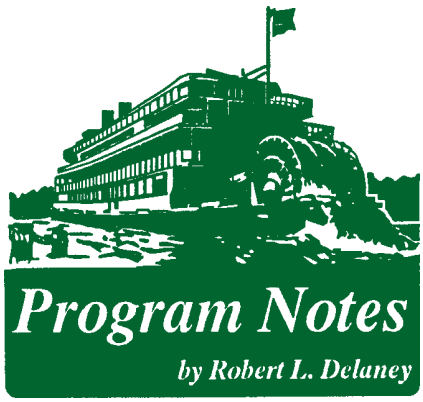
The Environmental Management Technical Center is a National Biological Service facility located in Onalaska, Wisconsin, USA. The Technical Center manages the Long Term Resource Monitoring Program, which is the largest river-related inventory, monitoring, research, spatial analysis, and information sharing program in the United States.

The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character.

The LTRMP is a cooperative effort by the National Biological Service, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.

Questions or comments may be directed to the EMTC, ***River Almanac*** Staff, 575 Lester Avenue, Onalaska, WI 54650-8552, Telephone: 608/783-7550, Fax: 608/783-8058.

River Almanac is also available on the World Wide Web (*http://www.emtc.nbs.gov/*).



A growing body of evidence indicates that physical (geomorphic) features control the biological structure and diversity of large floodplain rivers, particularly at large spatial scales. Scientists generally agree that large floodplain river ecological diversity and integrity is maintained by fluvial dynamics (flood pulses) and river-floodplain connectivity. Anything that tends to suppress the natural flood regime or constrains channel migration will disrupt these interactive pathways and lead to reduced ecological diversity and integrity of large floodplain rivers.

Applying the above assumptions about large floodplain rivers to the mainstem floodplain of the 2,339-mile Mississippi River should reveal something about the ecological diversity and integrity of the River. Figure 1 divides and names segments along the Mississippi River on the genteral basis of common geomorphic structure. Along roughly 80% of the river's length, including the upper, middle, lower and deltaic plain segments, the river channel is fixed in place as a commercial navigation channel using a variety of channel training structures (wing dams,

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Tsern had observed electrofishing, and they were able to see a good cross-section of Mississippi River fishes. Several buffaloes were captured and, as luck would have it, bighead carp. After observing the electrofishing catch, Flores and Tsern described some Amazon River fishes of a size that would dwarf our typical species. Although impressed with the efficiency of electrofishing, Flores and Tsern agreed that it may not be a practical sampling gear in the Amazon—not because of some physicochemical constraint, but because it would be too effective. On the basis of their observations, the Peruvian scientists thought that the density of fishes in the Amazon River was higher than in the Mississippi River. Electrofishing in the Amazon, they concluded, "would turn the water white with bellies; we couldn't count them all." They went on to explain that in their reach of the Amazon River at least 700 species of fish have been documented. By contrast, Open River biologists have captured 89 species to date.

Tsern had his picture taken with a large bighead carp, which led to a discussion about exotic species. Unlike the UMRS, which has several introduced exotics, the Amazon has relatively few. Only largemouth bass and common carp have been introduced into the Amazon Basin and they have not yet been captured in the mainstem river and tributaries.

Open River staff members were in awe as Flores and Tsern described the size and power of the Amazon River. At one point we were traversing across the river into a chute near Cape Girardeau, Missouri. As we slowed to observe habitat in the chute, we referenced a grain elevator about 1 km away. When asked to compare the size of the Mississippi River with the Amazon, Tsern said that "the distance from one bank to the first island would be from where we are to the grain elevator." *The first island*! Our impression after talking to Flores and Tsern was that the Amazon River in Peru is at least 2 km wide. Perhaps more incredible, *tributaries* to the Amazon River are larger than the Mississippi River at Cape Girardeau.

This discussion naturally led to several questions about sampling the Amazon River. How do biologists sample such a large river? The answer was that they do not—at least not in the main channel. The main channel was described as often deeper than 30 m, with velocities greater than what we experience in the Mississippi (probably approaching 1.5 m/s or twice as swift as the Mississippi River on average). Flores and Tsern assessed that it would be impossible to set and pull hoop nets. They added that they do sample the flooded riparian corridor with gill nets similar to ours.

After talking with the Peruvian scientists, we concluded that data collection, storage and retrieval, and computer technology for analyzing data in Peru seem to lag behind what is available in the United States. Amazonian scientists badly need such technology because the large floodplain rivers of the basin are relatively pristine environments that offer a rich area of study. Answers to many questions about large river ecology, such as the flood pulse hypothesis which originated from work done on the Amazon River, could be answered and applied to temperate North American rivers. An important objective of our exchange was to provide an opportunity for Peruvian scientists to observe our Program and data analysis tools, in the hope of laying the foundation for improved environmental programs in Peru.

Robert Hrabik is the Open River Field Station Team Leader, Missouri Department of Conservation, Jackson, Missouri (see "Personality Profile," this issue); Dr. Robert Sheehan is an Associate Professor of Fisheries in Zoology and the Assistant Director, Cooperative Fisheries Research Laboratory, Southern Illinois University, Carbondale, Illinois.❐

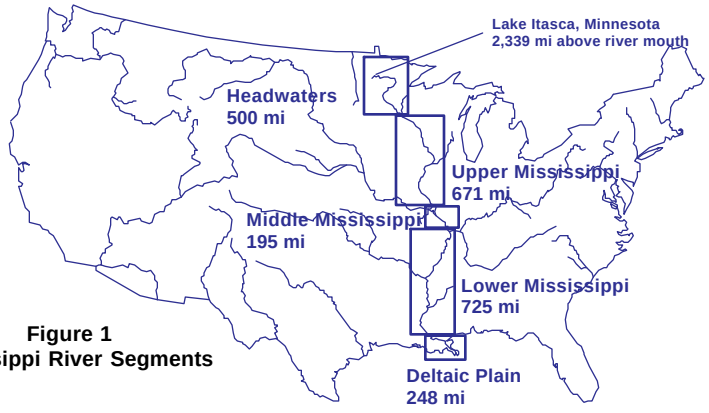


Figure 1
Mississippi River Segments

New invader of the Illinois River

by Jim Stoeckel

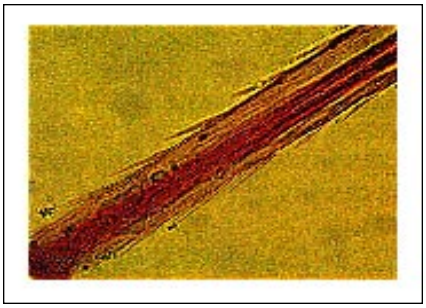
A new invader is spreading through Illinois waterways. Unlike the infamous zebra mussel, this invader does not shut down power plants or spread out in dense carpets over newly acquired territory. This is a quiet invasion. Currently, few people other than biologists are likely to be aware of it; to biologists, it is yet another species to add to the rapidly increasing list of exotic invaders (species native to other regions) becoming established in North American waterways.

Close-up of spines on *Daphnia lumholtzi* ventral carapace margin. Spines can grow much larger than those pictured.

Daphnia lumholtzi is a species of water flea (no relation to the fleas on your dog or cat) native to regions of Africa, Asia, and Australia. By daphnid standards, this species is like a giant pincushion. One long spine protrudes from the head and another from the tail end. Smaller spines cover the body. Large individuals can reach lengths of 1/4 inch (including the spines) and are easily visible to the naked eye. The spines make it difficult for fish to eat *D. lumholtzi*. Other *Daphnia* species have fewer, smaller spines and are an important food source for the larval stage of most fish species. During the larval stage, fish initially obtain nutrition from their yolk sac. When this yolk is used up, larvae must begin feeding on other organisms. The survival of larval fish is strongly dependent upon local abundance of food. If *D. lumholtzi* begin to replace native species of *Daphnia* and are too large and spiny to be ingested by larval fish, an important food source for larval fish will be greatly reduced. In a worst-case scenario, this replacement could result in a decrease in numbers of sport and food fish. Similar problems are expected in fish hatcheries if *D. lumholtzi* becomes established in hatchery ponds.

Daphnia lumholtzi was first reported in North America after being collected from Texas and Missouri reservoirs in 1990 and 1991. Since then it has been found as far east as the coastal states and has begun to spread in a northerly direction. In 1995, researchers at the Illinois Natural History Survey detected *D. lumholtzi* in plankton samples from the Illinois River. These samples were taken as part of a monitoring project for zebra mussel veliger larvae. Thus, while monitoring the presence of one invading species, the arrival of another was documented. In 1995, *D. lumholtzi* was found from Illinois River Mile (IRM) 0 (the confluence of the Illinois and Mississippi Rivers) to IRM 195.9 (between the cities of Hennepin and Henry, IL). *Daphnia lumholtzi* was not detected upriver of IRM 195.9. At IRM 121.1 (Havana, IL), *D. lumholtzi* abundance in the main channel of the Illinois River reached detectable levels in June, peaked at 22.5 individuals per liter (86.5 individuals per gallon) in early August, and fell below detectable levels by November. The peak abundance of 22.5 individuals per liter matched or exceeded peak abundances found in many lakes and reservoirs in Illinois and in the southeastern states. This level of abundance indicated that *D. lumholtzi* may be adapted to life in flowing water as well as in lakes and reservoirs.

***Daphnia lumholtzi* reared in the laboratory. When reared in the absence of predators, *D. lumholtzi* spines become greatly reduced. This female has produced an ephippium—a protective casing which encloses two resting eggs. This ephippium allows the eggs to survive drying, freezing, etc. Eggs can remain viable for many years before hatching.**



Close-up of *Daphnia lumholtzi* tail spine. Note the smaller spines growing off the main tail spine.

The relatively high abundance of *D. lumholtzi* in a river such as the Illinois is important for several reasons. Unlike isolated bodies of water such as lakes and some reservoirs, rivers may serve as "dispersal highways" for exotic species. Individuals can easily be transported downriver by currents and upriver by boats in bilge water, bait buckets, etc. Species that can survive in the main channel river habitat as well as in lakes and reservoirs can be dispersed much more easily than those that are adapted to only one type of environment. Also, because the Illinois River is connected to Lake Michigan via the Des Plaines River and the Chicago Sanitary and Ship Canal, water from Lake Michigan eventually flows into the Illinois River. Boats can travel from the Illinois River up into Lake Michigan

and vice versa without ever leaving the water. This connection of two major drainage basins (the Great Lakes-St. Lawrence and the Mississippi) means that an exotic species that becomes established in one basin can quickly invade the other.

The success of each invasion depends upon how well each species is adapted to local conditions. The best example of an exotic species that has invaded both basins is the zebra mussel. Zebra mussels became established in the Great Lakes Basin in the late 1980s. By 1993, they had spread into the Illinois and Mississippi Rivers. Although main channel populations of zebra mussels in the Illinois and Mississippi Rivers are less stable than those in the Great Lakes, they do occasionally carpet portions of the river bottom with abundances exceeding 50,000 per square yard. Other invading species such as *Bythotrephes cederstroemi* have become established in Lake Michigan but are not found in the Mississippi Basin. *Daphnia lumholtzi* now seems poised to invade the Great Lakes Basin via the Illinois River but whether or not it becomes well established in any of the Great Lakes remains to be seen.

Daphnia lumholtzi collected in the Illinois River. Note the long head and tail spines, which are thought to serve as anti-predator devices.

The list of exotic invaders now established in the Great Lakes and Mississippi Basins is already long and seems to be growing at an alarming rate. Many scientists are actively involved in developing new techniques to combat this problem. Because water from Lake Michigan and boaters from the riverine waterways must all pass through the same system of locks and dams to go from one basin to the other, it may be possible to develop dispersal barriers to prevent the transfer of organisms between those basins. Although the two basins were periodically connected in prehistoric times, they had been separated by land barriers for most of the past 6,000 years, minimizing the exchange of organisms. However, by the early 1900s, engineers had reversed the flow of the Chicago River and finished construction of the Chicago Sanitary and Ship Canal. This construction allowed water from Lake Michigan to flow directly into the Mississippi Basin, and boaters to travel back and forth between Lake Michigan and the Mississippi Basin rivers. It also made it much easier for aquatic organisms in one basin to once again invade the other. Dispersal barriers may need to be reconstructed in places where they formerly existed to slow the spread of exotic species throughout our waterways.

Jim Stoeckel is an Associate Supportive Scientist for the Illinois Natural History Survey.

This article was adapted from a news release available on the Illinois Natural History Survey **Home Page:** http://www.inhs.uiuc.edu/inhshome.html. For additional information on *Daphnia lumholtzi* in the Illinois River, contact Jim Stoeckel at **Phone:** 309/543-3950 **E-mail:** stoeckel@uxl .cso.uiuc.edu. For additional information on potential effects of *Daphnia lumholtzi* on fish populations, contact Cindy Kolar at **Phone:** 618/245-6348 **E-mail:** kolar@uxl.cso.uiuc.edu ❐

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dikes, riverments, dredging). The fluvial dynamics once responsible for channel migration across the floodplain, for alternating terrestrial and aquatic phases on the floodplain surface, and for sustaining a diverse array of aquatic habitat types and alluvial forest successional stages have been largely arrested along 80% of the river's length. Figure 2 compares each river segment's total floodplain acreage with the percentage of floodplain that has been isolated from the main river channel. Note that there is a progressive downstream isolation of the floodplain, with 90% of the total Mississippi River floodplain largely isolated from the main channel by levees.

River Segment	*Approximate Floodplain Acres in 1,000s*	*Percent of Floodplain Behind Levees*
Headwaters	328	<0.01%
Upper Mississippi	1,502	37%
Middle Mississippi	663	82%
Lower Mississippi	25,000	93%
Deltaic Plain	3,000	96%
TOTALS	30,493	90%

Figure 2. Mississippi River Floodplain

If the above assumptions are correct—that geomorphic structure, fluvial dynamics, and river-floodplain connectivity largely control ecological diversity and integrity of large floodplain rivers—then, given the current influences along the mainstem floodplain of the Mississippi River, some level of physical remedial action would seem appropriate.

The level and kinds of remedial actions needed should be set by clear, measurable management goals and objectives for the river. Currently, management goals and objectives do not exist in any systemic fashion for the Mississippi River. This makes it difficult to effectively and efficiently direct resources toward needed remedial actions. It would appear the States, individually and collectively, have an important role and task here—to reach agreement and establish management goals and objectives for the Mississippi River that balance the competing River uses—or should the States leave this to the Federal Government? Perhaps they already have.❐

Mapping of land cover from aerial photography continues

by Kevin Hop and Frank D'Erchia

The Operating Plan for the Long Term Resource Monitoring Program specifies collection of aerial photographs of the entire Upper Mississippi River System at 5-year intervals. Because the initial systemic collection was completed in 1989, the target date to repeat the collection was 1994.

In addition to the original premise for collecting photography, the complete 1994 systemic collection will document an important historic event, the Flood of 1993. These photos are a valuable asset to the LTRMP and our partners and can also be used to create spatial databases for analysis using geographic information systems (GIS) technologies.

Upon receiving the 1989 photographs, the EMTC began creating high-resolution land cover/use spatial databases for selected key pools along the UMRS. In 1994, the LTRMP set the goal of using the remainder of the 1989 color-infrared aerial photographs to provide a complete GIS database coverage of the UMRS. These database coverages provide river managers and planners with baseline information for monitoring and managing the UMRS. This project has been funded solely by non-LTRMP projects, such as Rock Island District U.S. Army Corps of Engineers Habitat Rehabilitation and Enhancement Projects and navigation studies, and the National Biological Service Management Strategy for Migratory Birds.

Specific techniques are used to promote correct interpretation of photographs. First, aerial photograph prints are taken to the field, where an interpreter checks the vegetation photo "signature," or characteristic appearance of an object on the photograph. The vegetation present has changed considerably since 1989 in many areas, especially after the extensive flooding in 1993, so the field interpreter must look for clues such as residual vegetation and whether the area is wet or dry. Photo signatures are also compared with adjacent pools where field work was performed shortly after the date of photography. Ultimately, the experience of the photointerpreter gives the final assurance of accuracy in identifying these areas of change.

After the field work is complete, the photographs are interpreted using stereoscopes. LTRMP Standard Operating Procedures are followed closely to promote consistency in mapping. Currently, photointerpreters are working on the 1989 land cover/use mapping effort. Anjela Fisher, formerly at the LTRMP Pool 26 Field Station, had devoted half her time to the interpretation of some of the southern pools. Kevin Hop at the EMTC is devoting time to the mapping effort as well as providing support to other LTRMP mapping projects. Janis Ruhser, an EMTC cartographer, assists in photointerpretation and quality control.

To date, we have used the 1989 aerial photography to complete the land cover mapping of Pools 4–9, 11, 13, 17–19, 21, 22, 25, and 26, as well as 50 miles of the open river on the Mississippi River and La Grange Pool on the Illinois River. Remaining Pools include 1–3, 10, 12, 14–16, 20, 24, as well as the St. Croix, the rest of the open river on the Mississippi River, and the rest of the Illinois River. Pools 10, 12, 14–16, 20, and 24 are scheduled to be added to the 1989 database by the end of the year. Completion of this effort will result in a detailed spatial database for Pools 4–26 which can be used for systemic analysis and modeling and as a basis for comparison to determine trends and changes in selected reaches.

While we are still working on a systemic spatial database from the 1989 photographs, our partners have expressed the need for a more current spatial database of LTRMP study pools. Because the LTRMP lacks the funds to complete this automation project, we have recruited alternative funding sources for Pools 8 and 26. A spatial database for Pool 8 from the 1994 photographs was developed through a cooperative effort with the Onalaska Field Station. The Geospatial Applications Division of the EMTC trained staff from the Wisconsin Department of Natural Resources to interpret the aerial photography and to cartographically transfer the information for automation. Student support staff in the Geospatial Applications Division then digitized the information to create the final coverage.

In another example of a cooperative effort, the White House-sponsored Scientific Assessment and Strategy Team (SAST) used geospatial technology and spatial data developed for Pool 26 to study the effects of the 1993 flood. The SAST developed databases and reports in the year following the flood and provided the funding to complete the land cover database for Pool 26 from the 1994 aerial photography. As part of the LTRMP flood analysis effort, Geospatial Applications Division staff will compare the 1989 and 1994 spatial databases to help determine land cover changes.

The databases for these two pools are available to LTRMP partners through the EMTC Home Page on the Internet (www.emtc.nbs.gov) in both UNIX- and PC-based ARC/INFO formats. If you do not have Internet access or have questions regarding these databases, please contact GIS Project Coordinator Lynne Arndt at 608/783-7550, extension 30.

The Geospatial Applications Division is continually seeking opportunities to develop mutually beneficial partnerships with non-LTRMP entities. With the help of such partnerships, we will be able to complete the land cover database from the 1994 photography for the remaining study pools.

Frank D'Erchia is Director of the EMTC's Geospatial Applications Division. Kevin Hop is a Saint Mary's University photointerpreter. ❐

The 28th annual meeting of the Mississippi River Research Consortium

by Mi Ae Lipe-Butterbrodt

On April 25–26, 1996, nearly 175 scientists, researchers, and students gathered at the La Crosse Holiday Inn for the 28th Annual Mississippi River Research Consortium Meeting. The meeting included 34 platform presentations, 29 poster presentations, and several in-person demonstrations. Platform presentations covered diverse topics including fish, invertebrates, birds, vegetation, and habitat of the Mississippi River and its tributaries, as well as impacts of the 1993 Flood.

Participants and presenters included staff members from the Environmental Management Technical Center, LTRMP Field Stations, the U.S. Army Corps of Engineers, universities, and other State and Federal agencies. ❒

Poster presentations: an exchange of ideas, information, and interests

(Above) **Steve Hagedorn accesses the EMTC Home Page as part of a poster presentation highlighting distribution of spatial data via the Internet.**

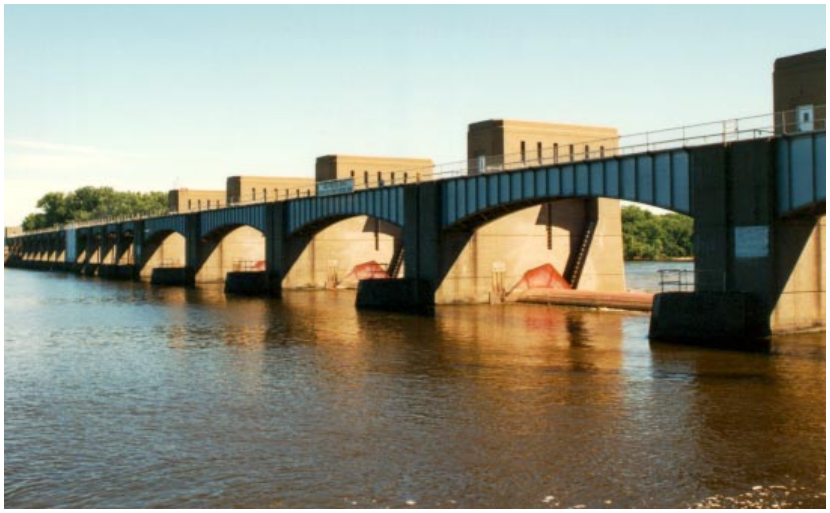
(Above, left) **Debbie L. Vaughn of the Large Rivers Program at the Univer-sity of Louisville, Kentucky, shows her poster, "Effects of Zebra Mussels (Dreissena polymorpha) on Amphipods in Artificial Streams." Vaughn was one of seven student poster presenters at the MRRC Meeting.**

(Left) **Daniel Fitzpatrick of the EMTC discusses his poster presentation, "Developing a Current Vegetation Map of the Upper Mississippi Basin from Landsat Thematic Mapper Satellite Imagery and GIS Data."**

(Photos by Mi Ae Lipe-Butterbrodt.)

Should we investigate locking to improve fish passage opportunity?

by Joe Wlosinski

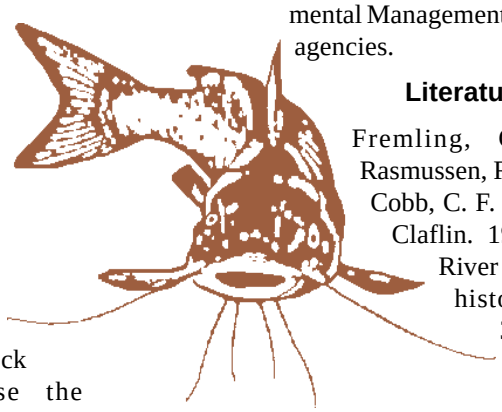


Upper Mississippi River Lock and Dam 7, Dresbach, Minnesota *(photo by Mi Ae Lipe-Butterbrodt).*

According to Fremling et al. (1989), the lock and dam system on the Upper Mississippi River is at least somewhat of a barrier to fish passage. Environmental Management Technical Center staff members have compiled fish movement information from over 80 tagging and radiotelemetry studies on the Upper Mississippi River. More than 62,000 fishes of 15 species were tagged and 4,594 were recaptured. Eighty percent of the recaptured fishes were found to be from the pool in which they were originally marked. Only 12% of the recaptures were found in pools upriver of the tagging location, and only 8% were found downriver. Scientists think most fishes that move through dams do so when dam gates are out of the water. At most dams, the gates are out of the water less than 20% of the time, and two dams are never at open river conditions. However, fishes may also be able to pass dam structures by locking through. Lock chambers are used routinely on the Ohio River to sample fish. At the Willow Island Lock on the Ohio River, 69,000 fishes weighing nearly 10,000 pounds were collected in the lock chamber as part of a sampling study (Keyes and Klein 1984).

Scientists think most fishes that move through dams do so when dam gates are out of the water.

Given the above information, should we investigate the use of locking to improve fish passage opportunity? The following presents the procedure for a hypothetical study: During periods when barges are not being locked through, close the upriver lock gates and open the downriver lock gates. Open the upriver valves and close the downriver valves so that water flows through the lock chamber in order to attract fishes heading upriver and to orient fishes heading downriver. After some prescribed period of time, close the downriver lock gates, which will allow the chamber to fill. When the water level reaches the pool elevation, open the upriver lock gates, close the upriver valves and open the downriver valves, and again allow the water to flow through the lock chamber. After some prescribed period of time, close the upriver gates, allowing the chamber to empty. Continuing this mode of operation would presumably allow fish to pass in both an upriver and a downriver direction.



We could investigate the efficacy of this mode of operation with fish radiotelemetry studies, side-scan hydroacoustics, and/or lock sampling. Allowable dam gate manipulations could also be attempted to study their effect on fishes. Staff members at the EMTC believe the study would best be performed as a cooperative effort among all Environmental Management Program partner agencies.

Literature Cited

Fremling, C. R., J. L. Rasmussen, R. E. Sparks, S. P. Cobb, C. F. Bryan, and T. O. Claflin. 1989. Mississippi River Fisheries: A case history. Pages 309-351 *in* D. P. Dodge, editor. Proceedings of the International Large Rivers Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Keyes, J. L. and W. L. Klein. 1984. Lock rotenoning - A technique used to sample fish population trends on the Ohio River. *In* the Proceedings of the Fortieth Annual Meeting Upper Mississippi River Conservation Committee. Rochester, Minnesota, March 13-15, 1984. 279 pp.

Dr. Joe Wlosinski is an EMTC staff ecologist who is investigating alternative water level management strategies for the Upper Mississippi River. ❐

Selected abstracts of ongoing LTRMP efforts

Potential for zebra mussel transport via divers' wetsuits

Blodgett, K. D., L. A. Camlin, R. E. Sparks, and C. E. Kraft. 1995. Paper presented at the Twenty-Seventh Annual Meeting of the Mississippi River Research Consortium, La Crosse, Wisconsin, April 27-28, 1995.

After their successful introduction into North America about 1986, zebra mussels *(Dreissena polymorpha)* spread rapidly through the Great Lakes and into inland waterways. In addition to effective natural dispersal, especially downstream drift of larval veligers, their spread has been facilitated by human-mediated transport mechanisms which also can move them upstream and overland. Of the first 18 inland bodies of water requiring overland transport for colonization, 3 were quarries frequented by scuba divers but offering limited opportunities for angling, boating, or other recreational activities. This led us to investigate the potential for passive transport of zebra mussels, especially veligers, by divers. We exposed divers in wetsuits ("farmer john" pants, jackets, boots, and gloves) to naturally occurring concentrations of zebra mussel veligers and adults in the Illinois River on four separate occasions. After dives of 30 to 195 minutes, divers surfaced and wetsuits were removed and stowed separately in plastic bags. Suits were returned to the laboratory in 2 to 5 hours, where we hand-washed them in water for 5 minutes, and the wash water was filtered through 60-micron netting. Material retained in the netting was subsampled and inspected under 30- to 110-× magnification using cross-polarized light.

Calculated veliger concentrations in the water column on the four occasions ranged from 7 to 68 veligers per liter. From a total of eight dives, calculated numbers of veligers collected from suits ranged from 0 to 514 per suit. The number of veligers on a suit did not correlate with the density of veligers in the water column or dive duration. In some subsamples, up to 40% of the veligers were obviously alive (i.e., swimming) over 3.5 hours after the divers came out of the water.

During over 300 hours of diving in zebra mussel-infested waters (concentrations up to 61K per square meter) of the Illinois River, we never observed an adult zebra mussel attached to our divers or their associated diving equipment. However, zebra mussels less than 15 mm have attached to our steel sampling frames on the river bottom in less than 24 hours. The number of zebra mussels, either veligers or adults, needed to establish a reproducing population is unknown, but results of this work indicate viable veligers can be transported by divers. While zebra mussels may increase water transparency and visibility, their negative impacts, both economic and environmental, should prompt precautions to reduce their spread. The potential for accidental transport by divers can be reduced significantly if they subscribe to any of a number of simple precautionary measures (e.g., rinsing in hot and/or chlorinated water or thorough drying of equipment) after diving in infested waters. Therefore, divers and other wetsuit users, such as jet-ski riders, need to be educated to reduce their potential for contributing to the spread of zebra mussels.

Hydraulic and spatial models for studying the effects of management options on habitat

Rogala, J. T., and J. H. Wlosinski. 1995. Poster presented at the Twenty-Seventh Annual Meeting of the Mississippi River Research Consortium, La Crosse, Wisconsin, April 27-28, 1995.

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

Meetings of Interest

Minnesota GIS/LIS Consortium Annual Conference - Sheraton Park Place Hotel, St. Louis Park, Minnesota, *September 25-27, 1996* - For more information contact GIS/LIS Consortium c/o LMIC, 330 Centennial Bldg., St. Paul, MN 55155.

Eco-Informa '96 - Lake Buena Vista, Florida. *November 4-7, 1996.* This major international conference, organized by leaders in the environmental science and policy communities, focuses on worldwide communications for environmental applications and addresses the critical need to share information that promotes responsible decision making in environmental problem solving. For more information contact ERIM/Eco-Informa, P.O. Box 134001, Ann Arbor, MI 48113-4001. Phone: 313/994-1200, ext. 3234. Fax: 313/994-5123.

The Delta: Connecting Points of View for Sustainable Natural Resources - Cook Convention Center, Memphis, Tennessee, *August 13-16, 1996.* For information on exhibit opportunities and conference registration forms, contact Missy Kilgore, c/o Tennessee Association of Conservation Districts, 1320 W. Main, #320, Franklin, TN 37064. Phone: 615/ 790-5792. Fax: 615/ 790-5463.

Upper Mississippi River Geospatial Workshop - La Crosse, Wisconsin, *November 18-20, 1996.* This informal workshop is for users of geospatial technologies such as geographic information systems (GIS), remote sensing technologies, and the Global Positioning System. For more information contact Frank D'Erchia, EMTC, 575 Lester Avenue, Onalaska, WI 54650. Phone: 608/783-7550, ext. 11. Fax: 608/783-8058.

Tracking the zebra mussel

The Rivers Curriculum Project, funded by the National Science Foundation, has undertaken a cooperative effort with the Illinois Natural History Survey (INHS) and the Water Resources Center at the University of Illinois to help track the zebra mussel as it enters the Midwest. Sightings of the mollusc have been reported in the Illinois, Ohio, and Mississippi Rivers. Through a grant from the Illinois- Indiana Sea Grant Program, the teachers of the Rivers Project were given monitoring devices to be placed at their schools' river observation sites. The schools will use the project's telecommunications system (SOLED NET) to send their mussel sightings to INHS, which coordinates the effort. If anyone wishes information on the zebra mussel incursion into the Midwest or wishes to place detection devices in their own water monitoring site, the Illinois Rivers Project has both information and devices. The devices cost $12.00 and include complete instructions.

The Rivers Curriculum Project
Zebra Mussel Watch
Southern Illinois University
Box 2222
Edwardsville, IL 62026
Phone: 618/692-3788 or
Fax: 618/692-3359

U.S. Fish and Wildlife Service fisheries biologist Ann Runstrom holding a paddlefish.

Federal agencies share information on fish

by Mark Steingraeber

Cooperating with other government agencies in the management of nationally significant interjurisdictional species of fish and the ecosystems they inhabit is one of the goals of the U.S. Fish and Wildlife Service La Crosse Fishery Resources Office (FRO). Staff members from the La Crosse FRO and the Environmental Management Technical Center frequently exchange information needed to evaluate management strategies for the Upper Mississippi River (UMR) ecosystem.

The success of this interagency cooperation is evident in recent FRO and EMTC products. For example, the La Crosse FRO is participating in several ongoing paddlefish studies in the Upper Mississippi River Basin. Since 1994, nearly 400 feral paddlefish in Minnesota and Wisconsin have been tagged in support of these projects. Lake sturgeon, another interjurisdictional species of concern in the UMR system, are frequently captured with paddlefish and tagged as well. Mark and recapture data for these fish were recently made available to EMTC staff and incorporated into a database used to evaluate alternatives for the operation of UMR locks and dams to improve fish passage.

The Fishery Resources Office likewise can easily access the EMTC's hydraulic data about the UMR to evaluate relationships between river discharge and habitat selection by paddlefish. Moreover, FRO radiotelemetry data of paddlefish movements and habitat utilization in Pool 5A were recently plotted on geographic information systems (GIS) base map coverages available from the EMTC.

The continued cooperation of the La Crosse FRO and the EMTC on this project will expand GIS paddlefish coverage layers to several other UMR pools in the near future. Information of this type should improve State and Federal management of UMR paddlefish populations by permitting a more accurate assessment of both the risks and benefits of proposed Habitat Rehabilitation and Enhancement Projects to this interjurisdictional species of concern.

Mark Steingraeber is a fisheries biologist with the U.S. Fish and Wildlife Service in Onalaska, Wisconsin, who works on species at risk and aquatic contaminant issues in river systems of the Upper Midwest. ❐

Monitoring zooplankton in Lake Pepin

by Robert Burdis

Zooplankton are the microscopic animals of the plankton community. Although small, these animals play an important role in aquatic ecosystems. Zooplankton consume all sorts of organic material, including phytoplankton (algae); in turn, they can be important diet items of young fish as well as of adult planktivores such as paddlefish. Two dominant groups of freshwater zooplankton are the Cladocera (water fleas) and Copepoda (copepods), which typically range in size from 0.2 to 3.0 mm.

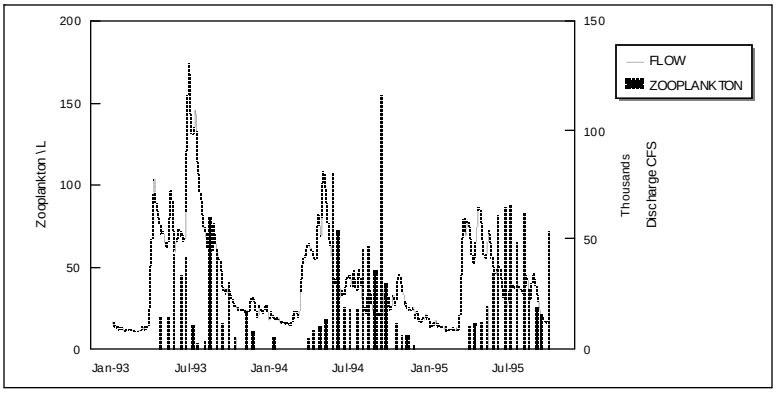


Figure 1. **Total number of zooplankton per liter at site M766.0 (located at the lower end of Lake Pepin) and mean daily discharge of the Mississippi River at Prescott, Wisconsin.**

The Minnesota Department of Natural Resources' Long Term Resource Monitoring Program Field Station began collecting zooplankton on Lake Pepin in April 1993. Lake Pepin is a 22-mile-long riverine lake with a unique hydrology. Under high flow conditions, Lake Pepin acts more like a riverine environment, but under low flow conditions it behaves more like a lake environment. During the high flow summer of 1991, water took an average of 7 days to flow through Lake Pepin, but during the low flow summer of 1988, water in Lake Pepin had an average residence time of 45 days.

Zooplankton samples are collected in conjunction with both fixed and random site water quality monitoring efforts. Zooplankton are sampled biweekly April through October at four fixed water quality sites on Lake Pepin. In addition, 30 randomly selected sites on Lake Pepin are sampled four times a year—in late April, early June, late July, and mid-October. Zooplankton are collected by pulling a Wisconsin tow net 1 m above the bottom vertically through the water. Samples are preserved in the field and brought back to the lab for identification and enumeration. Cladocerans are identified to at least the genus level and adult copepods are identified to suborder.

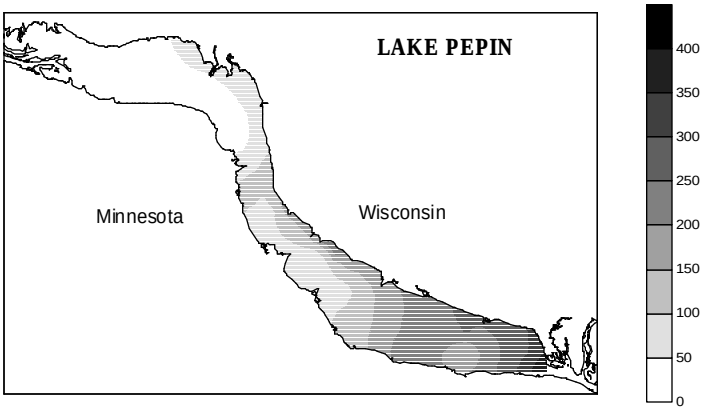


Figure 2. **Total number of zooplankton per liter on June 3, 1994. Map based on data collected from 30 randomly selected sites.**

The zooplankton found in Lake Pepin consists of mainly cyclopoid copepods and their larvae (nauplii) and the cladoceran genera *Daphnia*, *Diaphnanosoma*, and *Bosmina*. Other cladocerans such as *Leptodora kindti* and chydorids have also been numerous at times. Early analysis of the data shows differing seasonal trends among the different groups of zooplankton. Typically, peak densities occur in early June and are dominated by *Daphnia*, although in June 1993 the flood appears to have decimated zooplankton populations (Fig. 1).

Zooplankton densities typically increase downstream in Lake Pepin (Fig. 2); zooplankton tend to thrive in lakelike environments and so reproduce more rapidly as they move through Lake Pepin. Greater zooplankton densities are usually found along the Wisconsin (east) side of the lake, probably because of lower water velocities on that side.

Beginning in July 1996, the Minnesota Department of Natural Resources' Biology Lab in St. Paul has agreed to process our 1995 and 1996 samples. The Biology Lab has new computer imaging equipment that allows on-screen identification, enumeration, and length measurements, as well as biomass estimates. The data from this zooplankton study may help us learn the role that these tiny creatures play in the Lake Pepin ecosystem.

Robert Burdis is the Water Quality Specialist for the Lake City, Minnesota, Field Station. ❐

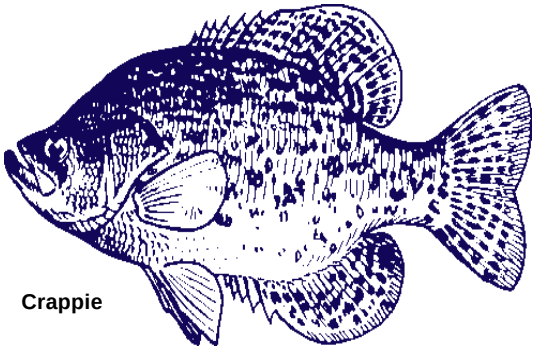
The pulse of the river

by Andy Bartels

Floods can cause big problems for people and terrestrial animals, but fish and other aquatic animals often benefit from high waters. According to a theory called the "flood pulse concept," rivers with large floodplains, such as the Mississippi, depend on annual flood cycles to sustain biological productivity. The flood pulse concept was developed from work on tropical rivers, including the Amazon; to date, it has not been tested in temperate rivers such as the Mississippi.

During floods, the river and its floodplain become connected. This connection allows nutrients to be exchanged, channels to be scoured deeper, and new topsoil to be deposited on the floodplain. Plants and animals take advantage of flood conditions to make use of newly available resources. For example, water smartweed, a valuable food plant for waterfowl, quickly establishes itself in moist areas during and just after a flood. Aquatic and terrestrial insects are concentrated in the shallows during a flood and fish that frequent these shallow habitats often find a bonanza of food awaiting them. The border between land and water, called the flood margin, is where biological activity is concentrated.

A recent study funded by the Upper Mississippi River System Long Term Resource Monitoring Program found evidence that this theory is holding true locally on the River. Researchers from the Wisconsin Department of Natural Resources, the National Biological Service, and the River Studies Center at the University of Wisconsin-La Crosse studied growth of bluegills, crappies, and freshwater drum in Pool 8 of the River from 1989 to 1993. The cooperative research found that bluegills, which frequent shallow, vegetated backwaters, grew faster during the 1993 flood year than in previous years, but that crappies and drum, which spend more time in deep areas, did not show a growth increase.



Crappie

Bluegills from 2–4 inches long grew fastest and grew up to 40% more during the flood year than in previous years. These medium-size bluegills spend more time in the shallows and rely more heavily on insects in their diet than do very small or larger size bluegills. Medium-size bluegills showed increased growth, indicating that the flood margins were providing good conditions for fish growth during the flood.

The study also indicated that growth rates for both bluegills and crappies decreased during the 1989 drought, strengthening the ties between fish growth and the flood pulse. Poor early growth can have a negative impact on fish populations because natural mortality will remove many of these small fish before they ever reach spawning maturity or desirable size for anglers.

From all indications, the River is recovering from the drought years of 1988 and 1989. Aquatic vegetation is reestablishing itself, waterfowl populations are increasing, and many species of fish have had successful spawns in the last few years. According to the flood pulse concept, we can thank the Flood of 1993 for at least part of that recovery.

Andy Bartels is the Fisheries Specialist for the Onalaska, Wisconsin, Field Station. ❐

Rivers Project summer training

The Rivers Curriculum Project is conducting its fifth annual summer training on the campus of Southern Illinois University, across the Mississippi River from St. Louis. Teachers will concentrate on one of six curriculum areas while receiving interdisciplinary training in the study of rivers. The six units being prepared for publication are biology, chemistry, earth science, geography, language arts, and mathematics. The units were developed under a grant from the National Science Foundation. Trainers for the week-long session are teachers who have used and developed the units.

Participating teachers will attend a training session scheduled for August 4–9, 1996, in Edwardsville, Illinois. Tuition for three semester hours of credit (Fall 1996) and curriculum materials will be provided. A noncredit option is available. Lodging and food will be available at low cost. Interdisciplinary teams from the same school are encouraged.

For more information:

Phone: 618/692-3788
Fax: 618/692-3359
World Wide Web:
http://www. siue. edu/OSME/river

The Rivers Project also has curriculum materials available for middle school. ❐

The Upper Midwest Gap Analysis Program

by Daniel Fitzpatrick

If ecologically meaningful information is to be useful at watershed or ecoregional scales, the spatial data about the biological resources within those landscapes must be uniform and consistent throughout their extents. To generate geographic information system (GIS) data that meet these criteria, the Upper Midwest Gap Analysis Program (UMGAP) is developing and implementing rigorous regional protocols. An equally important objective is to build partnerships around the development and application of this information.

UMGAP is part of the national Gap Analysis Program (GAP), a National Biological Service project being implemented nationwide with the help of over 400 cooperators, including the private sector, nonprofit organizations, and many government agencies. The program is an effort to map and analyze the distribution of natural land cover, terrestrial vertebrate species, and lands managed for conservation. UMGAP is being coordinated by the Environmental Management Technical Center, and currently is in full progress in the states of Illinois, Michigan, Minnesota, and Wisconsin, while the states of Iowa, Indiana, and Ohio are in various stages of planning or startup.

Natural Vegetation

Maps of natural vegetation are being developed from satellite imagery and other available data. The EMTC acquires pertinent Landsat Thematic Mapper (TM) satellite imagery from the EROS (Earth Resources Observation System) Data Center of the U.S. Geological Survey. This imagery is reviewed, copied, and archived by the EMTC before being forwarded to each State partner for processing. In cooperation with the State partners, Dr. Thomas Lillesand, Director of the Environmental Remote Sensing Center, University of Wisconsin-Madison, has developed a regional image processing protocol that is designed to take maximum advantage of existing ancillary GIS data. The protocol calls for multidate TM imagery to be stratified first by ecoregion and then by urban/rural and upland/lowland strata prior to computer-assisted classification. The objective is to produce a regionally consistent classification to the *alliance* level of detail following the UNESCO/TNC (United Nations Educational, Scientific and Cultural Organization/The Nature Conservancy) vegetation classification system, with an effective minimum mapping unit of 1–5 acres.

Predicted Terrestrial Vertebrate Distribution

Predicted species distributions are modeled based on existing range maps and other occurrence data, combined with the natural vegetation maps and information on the habitat affinities of each species. A proposed regional GIS protocol to predict the distribution of native terrestrial vertebrates is being developed by Dr. Nancy Mathews of the Department of Wildlife Ecology, University of Wisconsin-Madison. Cooperating in the development of the protocol are the State partners, the U.S. Forest Service, the Environmental Protection Agency, the Natural Resource Conservation Service, the Great Lakes Indian Fish and Wildlife Commission, The Nature Conservancy, and others. Following the developed protocol and working closely with the State partners, the EMTC will produce maps of the predicted distribution of all breeding native terrestrial vertebrates in the UMGAP region.

Stewardship Lands

To assess the conservation status of species and their habitats, maps of conservation lands (stewardship maps) are compared with maps of the distribution of species and habitats. The UMGAP State partners are responsible for the development of stewardship maps for their respective States. These GIS maps are developed by mapping land ownership categories into (1) all public lands by their managing agency, (2) voluntarily identified private lands specifically managed for conservation, and (3) all other private lands. Individual parcel boundaries are not delineated on private lands not voluntarily identified as being specifically managed for conservation.

Data Distribution

As they are completed, digital thematic maps of natural land cover, vertebrate species distribution, and stewardship lands, all of uniform scale and format and meeting Federal Geographic Data Standards, will be made publicly available via the Internet and on CD-ROM. To the extent feasible, data will be distributed as they become available, rather than waiting for the entire UMGAP project to be completed. For those UMGAP States currently in full progress, vegetation and stewardship data are expected to become available beginning in 1997. The EMTC expects to begin making data available on predicted species distribution in 1998. Currently, UMGAP is serving a georeferenced, full resolution, single-band color composite of the satellite imagery covering one ecoregion in Minnesota. This satellite data sample and other information about UMGAP can be found on the Internet at the UMGAP World Wide Web Home Page site: www.emtc.nbs.gov/umgaphome.html.

Daniel Fitzpatrick is the UMGAP coordinator at the EMTC. ❐

Personality Profile

A closer look at the people who make the LTRMP a success

by Madelon Wise

Open River Field Station Team Leader Robert (Bob) Hrabik has an "upbeat outlook" for the Middle Mississippi River, that portion of the open Mississippi River between St. Louis, Missouri, and Cairo, Illinois. Hrabik, who founded the Jackson, Missouri, field station and still works with his original staff of 6 years, is proud of the Open River Field Station and its accomplishments.

Robert A. (Bob) Hrabik, Team Leader of the Open River Field Station at Jackson, Missouri.

In addition to his Team Leader duties, serving as an expert fish taxonomist for the six Long Term Resource Monitoring Program (LTRMP) field stations, hosting scientists from here and abroad, and publishing in journals and in the LTRMP report series, Hrabik is completing a master's degree in biology with a focus on fish taxonomy and systematics.

Fisheries biology has been a lifelong interest for Hrabik, who was influenced by his "naturally curious and very observant" father. While still an undergraduate at the University of Nebraska, Hrabik received an offer from a professor to apply for a position cataloging the fishes of Nebraska through an Institute of Museum Services grant. "This professor knew that my father and I did a lot of seining to collect bait fish," says Hrabik. "We had purchased books on our own to identify fish." Through the 2-year grant project, Hrabik's avocation developed into his first professional love as he "cataloged many thousands of fish" at the University of Nebraska State Museum in Lincoln.

"I feel I have the ability to recognize important characteristics that differentiate organisms." Hrabik describes his approach to taxonomy as "holistic," a term that also describes his overall way of working within the LTRMP.

When he and his team were establishing the Open River Field Station in 1991, they recognized several important physical and biological differences between the pooled and unpooled portions of the Mississippi River. "Because of the nature of the open river, several factors that were not understood by the LTRMP at the time went into developing our program. Foremost, the Mississippi River in this part of the world has been modified to be narrow, swift, and deep. It is naturally turbid and is actually becoming less turbid, contrary to what many may think."

"Also, our seasons come much earlier compared to other field stations in the Program. We receive warmer water earlier because of our physical habitat and geographic position. Because we are so far south, we get an influence from the Illinois and Missouri Rivers. These factors make sampling more challenging than in the pooled regions. As a consequence, our logistics and time frames are different. We had to make adjustments in 1991 to ensure comparable data with other field stations."

The Mississippi River in Hrabik's area is not impounded with the locks and dams common farther north. Hrabik describes more differences: "On the Upper Mississippi River above St. Louis, an ample amount of Federally owned public ground provides a little bit of an environmental cushion. In the south, most of the land near the river is privately owned, so the river has been narrowed by levees for agriculture. Anything flat is rich ground and is intensively farmed, especially the floodplain."

Very little information has been published on the environment of the Middle Mississippi River, according to Hrabik. "This, in part, is why the Open River Field Station has become so valuable, not only to the Environmental Management Program, but also to the States of Missouri and Illinois."

Hrabik is currently heading up the Middle Mississippi River Ecosystem Management Work Group of the Upper Mississippi River Conservation Committee (UMRCC). The work group has discovered that lack of historical data is their biggest problem. Hrabik explains, "If we don't know what we've lost, we don't have a basis for

Web Sites of Interest

- *Free Mini-Guide to the Upper Mississippi* offers a simple overview of a trip on the upper river:
  www.greatriver.com
- *About the Mississippi River*:
  http://www.bcl.net/~whig/lonews.html#local
- *Writing Tips for Environmental Professionals* provides quick tips for environmental professionals who want to improve the quality of their writing; a new tip is listed and explained each month:
  http://members. aol.com/blryan/qtip.htm
- *An Internet Notebook for Biologists*:
  http://www.p-pub.com

restoration. Without the historical data, we don't know how to go about making changes to maintain diversity or improve habitat."

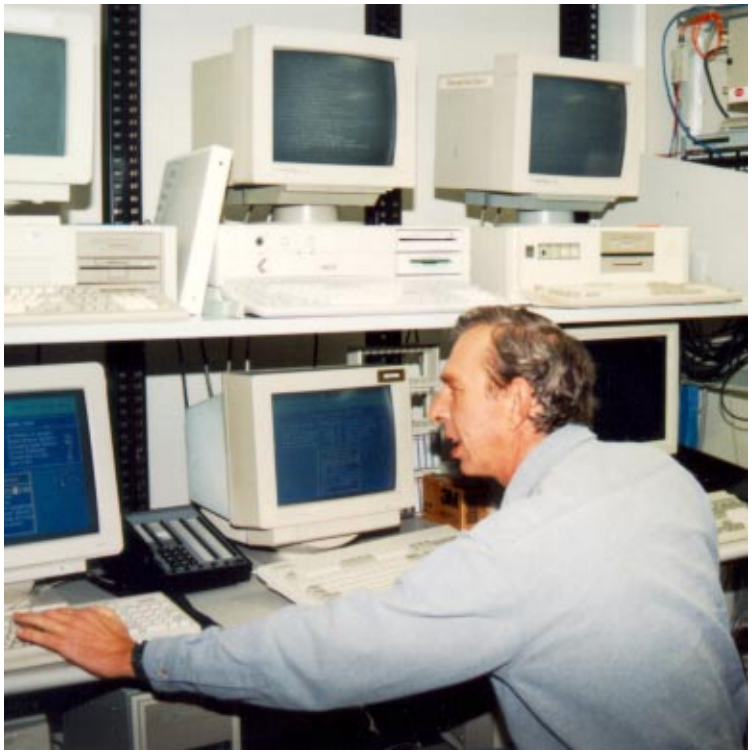
The Ecosystem Management Work Group consists of partners from the U.S. Army Corps of Engineers, the Illinois Department of Natural Resources, the Missouri Department of Conservation, the National Biological Service, universities, and the U.S. Fish and Wildlife Service. Hrabik explains, "Each entity has collected data over time, but these data are not published; rather, they are archived away. It will be a time-consuming, painstaking process—going through old files, desks, and libraries, and dusting off old books and papers. This job will take a long time, but it must be done."

"We all know that the Middle Mississippi River has changed but we are not sure by how much nor can we agree upon the implications of these changes. The historical data are being collected to document physical, chemical, and biological changes over time. Then, armed with such information, we can better define goals, objectives, and strategies in the context of multipurpose needs to restore the river so it may provide maximum benefits to all users." As they draw up their plan, the Ecosystem Management Work Group has invited the navigation industry and other industries with a vested interest in the Mississippi to participate, notes Hrabik.

In addition to his involvement with the UMRCC, Hrabik is excited about networking with partners from the Lower Mississippi Conservation Committee. "The Upper Mississippi River ends at the confluence of the Ohio River. Because we lie at the dividing line of the Upper and Lower Mississippi, we have received interest from the Lower Mississippi people. They view the open river data with interest because this stretch of the river is considered the headwaters to the Lower Mississippi. This partnership will be very important for our respective programs in sharing information and expertise and in bridging the gap between the Upper and Lower Mississippi."

Hrabik maintains an optimistic view of the future. "Throughout the time I've been here, everyone has been trying to put on their environmental hats. Since 1991, we have forged good relationships with the U.S. Fish and Wildlife Service, the National Biological Service, and the U.S. Army Corps of Engineers by working together closely." The parties have begun a series of discussions about developing new engineering technologies to help restore side channels and enhance habitat. Hrabik sees great potential in this positive cooperation. "I want to make some difference in the world. I want to make this world a better place for my children, and I want to leave behind a legacy for those who will carry on after I've put in my time so that they may continue on the same path."

With his hard work and optimism, Bob Hrabik's time *is* making a difference.❐



Ron Rogers checks the status of the Novell network server at the EMTC to ensure smooth operation. A second Novell server was recently added to distribute working applications and thus increase computer performance (*photo by Mi Ae Lipe-Butterbrodt).*

On February 20–22, 1996, Douglas A. Olsen conducted an "Introduction to ARC/INFO" workshop at the EMTC. Participants included staff members from LTRMP field stations, the Missouri Department of Conservation, the National Biological Service, the U.S. Army Corps of Engineers, and the U.S. Forest Service (*photo by Mi Ae Lipe-Butterbrodt).*

New Reports

The following reports were recently completed and have been distributed to Program partners. LTRMP reports are available through the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (800/553-6847 or 703/487-4650).

D'Erchia, F. 1995. *Geographic information systems and remote sensing applications for ecosystem management.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, revised December 1995. LTRMP 95-P001R. 22 pp.

Gutreuter, S., R. Burkhardt, and K. Lubinski. 1995. *Long Term Resource Monitoring Program Procedures: Fish Monitoring.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P002-1. 42 pp. + Appendixes A-J.

Holland-Bartels, L. E., M. R. Dewey, and S. J. Zigler. 1996. *Ichthyoplankton abundance and variance in a large river system concerns for long-term monitoring.* Regulated Rivers: Research & Management 10:10-13. Reprinted by the National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, February 1996. LTRMP 96-R001. 13 pp.

Laustrup, M. 1995. *Geospatial Application: Evaluation of multidate Landsat Multispectral Scanner data for determining changes between aquatic and terrestrial habitats on the Upper Mississippi River System.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, September 1995. LTRMP 95-P009. 19 pp. + Appendixes A and B.

National Biological Service. 1995. *Annual Work Plan, Fiscal Year 1996, for the Upper Mississippi River System Long Term Resource Monitoring Program.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, September 1995. LTRMP 95-P007. 144 pp. + Appendixes A-D.

National Biological Service. 1995. *Long Term Resource Monitoring Program Procedures.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P002.

National Biological Service. 1996. *Proceedings, Upper Midwest Gap Analysis Meeting, January 18-19, 1995.* F. D'Erchia and D. Fitzpatrick, editors. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, April 1996. EMTC 96-G001. 66 pp. + Appendixes A-B.

National Biological Service (NBS) and U.S. Fish and Wildlife Service (USFWS). 1996. *The Great River Flyway: The Management Strategy for Migratory Birds on the Upper Mississippi River.* Published by the Upper Mississippi Science Center, La Crosse, Wisconsin; Environmental Management Technical Center, Onalaska, Wisconsin; and USFWS Region 3, Fort Snelling, Minnesota. March 1996. 20 pp.

National Biological Service. 1995. *Standard operating procedures for spatial data processing.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P008.

Owens, T., and J. J. Ruhser. 1996. *Long Term Resource Monitoring Program standard operating procedures: Aquatic areas database production.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, March 1996. LTRMP 95-P008-6. 4 pp. + Appendix. (NTIS #PB96-172267)

Raibley, P. T., K. D. Blodgett, and R. E. Sparks. 1995. *Evidence of grass carp (Ctenopharyngodon idella) reproduction in the Illinois and Upper Mississippi Rivers.* Journal of Freshwater Ecology 10(1):65-74. Reprinted by the National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, November 1995. LTRMP 95-R008. 10 pp.

Sauer, J. 1996. *Annual Status Report: 1992 macroinvertebrate sampling.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, February 1996. LTRMP 96-P001. 18 pp. + Appendix A.

Thiel, P. A., and J. S. Sauer. 1995. *Long Term Resource Monitoring Program Procedures: Macroinvertebrate monitoring.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, August 1995. LTRMP 95-P002-2. 9 pp. + Appendixes A-G.

Tucker, J. K., and E. R. Atwood. 1995. *Contiguous backwater lakes as possible refugia for unionid mussels in areas of heavy zebra mussel (Dreissena polymorpha) colonization. Journal of Freshwater Ecology* 10(1):43-47. Reprinted by the National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, April 1996. LTRMP 96-R003. 5 pp.

Tucker, J. K., and J. B. Camerer. 1995. *Colonization of the dragonfly, Gomphus vastus Walsh, by the zebra mussel, Dreissena polymorpha (Pallas) (Anisoptera: Gomphidae; - Bivalvia, Eulamellibranchia: Dreissenidae).* Odonatologica 23(2):179-181. Reprinted by the National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, December 1995. LTRMP 95-R009. 3 pp.

U.S. Army Corps of Engineers Louisville District. 1995. *Navigation Predictive Analysis Technique (NAVPAT) pilot application for Pool 13, Upper Mississippi River.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, September 1995. LTRMP 95-S001. 54 pp. + Appendixes A-D.

Wlosinski, J. H. 1996. *Pool 25: Analysis of water levels and discharge.* National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, March 1996. LTRMP 96-T001. 88 pp.

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National Biological Service
Environmental Management Technical Center
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