Proceedings

1991
Governor's Conference
On the Management
Of the Illinois River System

Third Biennial Conference
October 22-23, 1991
Hotel Père Marquette
Peoria, Illinois

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Contents

Acknowledgments

Planning Committee

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Roberta M. Parks, Co-Chair, Peoria Area Chamber of Commerce

Nani Bhowmik and Richard G. Semonin, Illinois State Water Survey

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Steve Havera and Richard E. Sparks, Illinois State Natural History Survey

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Pleasure Driveway and Park District of Peoria

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Woodford County Farm Bureau

Proceedings

OPENING ADDRESS

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The Heartland Water Resources Council of Central Illinois, which represents the Peoria Area, is especially pleased to serve as the local host for this Illinois River conference because of its historical significance. It was just 300 years ago that a party of Frenchmen, fur traders, and missionaries, led by French military men Henry de Tonti and Francois de LaForest, traveled from Starved Rock to construct Fort St. Louis II on the shores of Peoria Lake. They were accompanied by thousands of native Americans who had named this area "Pimiteoui," or "Land of Great Abundance." This year the Peoria Area is celebrating the 300th anniversary marking the establishment of the first European settlement in Illinois at what is now the city of Peoria.

Journals from these early explorers indicate that they marveled at the sight of the deep clear waters of the Illinois River and were in awe at how the area abounded with fish and wildlife. Such awe-inspiring sites are now rare because the Illinois River System has fallen victim to a variety of destructive and wasteful environmental management practices that threaten its very existence.

The Illinois River system is our state's most important inland water resource. It is part of the seventh largest river system in the world, draining nearly 18.5 million acres in three states. As each of us in this room must acknowledge, the Illinois River system is in jeopardy, and only through efforts like this conference will solutions to the river's problems be found.

The governor of Illinois, Mr. Jim Edgar, has recognized the tremendous importance of the Illinois River system to our state and also realizes it provides a key environmental challenge. Consequently, the 1991 Conference on the Management of the Illinois River system has been designated a Governor's Conference, and a special Governor's proclamation has been issued to emphasize our state's commitment to

conscientiously manage this important natural resource for the benefit of future generations.

PROCLAMATION

WHEREAS, the Illinois River System is an integral part of our state's geography, history, economy, and ecology; and

WHEREAS, the Illinois State Water Plan Task Force has identified sedimentation and erosion as the top problems our water resources are facing; and

WHEREAS, the Illinois River, its backwater lakes and wetlands, and the natural habitats they once provided are particularly affected by sedimentation; and

WHEREAS, the continuing degradation of the Illinois River System will severely impact our state's future economical, recreational, and environmental development; and

WHEREAS, our state should embrace an integrated approach to large-river management (viewing rivers as systems) and think and work according to a well-coordinated, efficient, and continuous management program for our river;

THEREFORE, I, Jim Edgar, Governor of the State of Illinois, call for a continuing commitment and expanded cooperation among all state, federal, and local agencies; agricultural, business, and industrial communities; and citizens and private organizations to meet these challenges and ensure the well-being of the ILLINOIS RIVER, preserving and expanding the role of the river as a vital economic, recreational, and environmental resource in our state.

/s/ Jim Edgar
Governor of the State of Illinois
October 16, 1991

Although Governor Jim Edgar is unable to be here because he is representing Illinois at the Midwest Governor's Conference in Iowa, we are very pleased to announce that Mr. Bob Kustra, our lieutenant governor, will be attending and will serve as our featured speaker for our closing luncheon tomorrow.

Two years ago, following the 1989 Illinois River Conference, a statewide planning committee was formed to begin making plans for the conference convening here today. I feel these committee members have done an outstanding job of developing the program and making the necessary arrangements. This committee will be introduced at the luncheon today, but at this time, I would like to especially recognize the efforts of two individuals. First is the co-chair for this conference, Roberta Parks, vice president of government relations for the Peoria Area Chamber

of Commerce. Roberta will be chairing the conference sessions tomorrow. Roberta, thank you for the excellent leadership you have provided this conference.

I would also like to recognize Bonnie Noble, the executive director of the Heartland Water Resources Council of Central Illinois. Bonnie and the Heartland Water Resources Council have been handling the many local arrangements necessary to make this conference successful.

On behalf of the planning committee, I hope you will this conference informative, stimulating, and enjoyable. Our dinner and cruise this evening aboard the *Spirit of Peoria* promises to provide an excellent social opportunity for our conference participants.

We are especially pleased to have United Artists Cablevision televising the presentations at this conference. These will be shown, on a taped-delay basis, to central Illinois viewers on cable Channel 22 over the next several months.

Today, the 1991 Governor's Conference on the Management of the Illinois River System will feature sessions on management perspectives for the Illinois River, river-based resources, environmental concerns, management strategies, and river issues and initiatives. At this time, I would like to ask for the lights to be dimmed and for us to view a 3-minute video that will set the stage for our discussions over the next two days.

(Video Presentation)

I would like to thank Jon Rodsater, with the Illinois State Water Survey, for developing this excellent conference video.

I am very pleased to see the interest and enthusiasm for the Illinois River that is being generated by your attendance and participation here today. As of this morning, over 250 participants have registered. At this time, before proceeding with our morning program, we will be formally welcomed by Mayor Jim Maloof of Peoria and Mr. Tim Howard, Vice Chairman of the Peoria County Board.

PERSPECTIVES ON THE FUTURE MANAGEMENT OF THE ILLINOIS RIVER SYSTEM

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ABSTRACT

Over the last decade, a number of activities undertaken by federal, state and local governments have refocused the attention of all Natural Resource agencies to the issues, problems and needs of the Illinois River System. A number of these activities have also supplied needed direction and insight for addressing appropriate solutions to these problems and needs.

The State of Illinois must continue to support the activities of the federal, state and local agencies responsible for the management of the Illinois River System. Future activities will fall into the general categories of modernization of the transportation system, restoration of quality impaired habitats such as backwater lakes, and preservation of the remaining natural resources such as wetlands and riparian vegetation. The insight and lessons learned through the implementation of the Upper Mississippi River Environmental Management Program should have a profound effect on the future direction and activities undertaken by both state and federal agencies for habitat restoration and management in the Illinois River Basin.

Needs remain for the future development of a comprehensive management program for Peoria Lake followed by a series of comprehensive management and restoration plans for the high valued backwater areas and bottomland lakes. These activities need to be accompanied by improved plans and programs for tributary watershed management such as stream bed and bank stabilization, riparian habitat restoration, and the continued implementation of programs for sediment and erosion control for both agricultural and urban areas.

INTRODUCTION

A number of significant Federal, State and local activities have been initiated during the last ten years which will have a profound effect on the future management of the resources of the Illinois River System. These activities have set the course for the direction of the modernization of the waterway transportation system, restoration of quality impaired habitats, and preservation of the remaining natural resources such as wetlands and riparian habitat.

MODERNIZATION OF THE TRANSPORTATION SYSTEM

The Illinois waterway system is a is valuable transportation resource of the State of Illinois. Illinois ranks second in the nation in the number of miles of inland waterways. Of the 2000 miles of waterways that serve Illinois, the 368 miles of the Illinois Waterway carries 49% of the total tons of traffic that have an origin and/or destination within the state. Commercial tonnage on the Illinois Waterway has grown from 1.7 million tons in 1935 to approximately 46 million tons in 1990. Traffic is expected to continue growing, and three of the Illinois Waterway's eight locks were identified by the "1988 Inland Waterway Review" as among the 20 locks with the highest average delays, total delays, total processing times, lockage times, and lock utilization in the country's entire inland waterway system.

A Corps of Engineers study entitled the "Illinois Waterway Reconnaissance Report" was completed in the Spring of 1991. This study concluded that improved navigation facilities are needed on the Illinois Waterway Navigation System and recommended that the next level of feasibility studies be completed. Although this study was not designed to provide a final assessment of navigation needs and their environmental impacts, significant conclusions were reached concerning the nature of the issues involved in system modernization, potential solutions demanding further consideration, and the range of benefits and costs that could be expected from modernization. Based on projected traffic demand and the need for capacity expansion, the reconnaissance report concludes that the top priorities for lock improvement, in order, are:

- LaGrange - construct 1,200 x 110 foot lock @ $380 million
- Peoria - construct 1,200 x 110 foot lock @ $390 million
- Marseilles - widen Marseilles Canal @ $8.1 million

As a potential alternative to building new locks at LaGrange and Peoria, the report recommends examining the possibility of replacing the LaGrange and Peoria facilities with a new lock and dam near LaGrange. The report also concludes, based on traffic projections, that nonstructural and minor structural measures could be used to extend the economic life of existing structures for a period of 50 years. The report further recognized that additional studies will be required to identify navigation impacts and identify environmental enhancement opportunities.

As approved by Corps Headquarters, the reconnaissance report recommends that a feasibility study be undertaken to:

- prioritize capital investment recommendations for the Illinois Waterway navigation system for the 50-year planning horizon;
- address system-wide environmental impacts of proposed plans;
- provide appropriate National Environmental Policy Act documentation; and
- complete detailed engineering, economic, and environmental studies at the first priority site (LaGrange Lock).

The cost of the feasibility study is estimated at $10.3 million. The future funding of this study is not certain at this time but, once this study is initiated, it should become a major factor in determining the future of the Illinois River System. The need for transportation improvements has already been defined. The future of the Illinois Waterway will depend on the completion of this feasibility study.

RESTORATION OF QUALITY IMPAIRED HABITATS

When congress authorized the replacement of Lock and Dam 26, the Upper Mississippi River Basin Association was also directed to prepare a Comprehensive Master Plan for the Management of the Upper Mississippi River System including the Illinois Waterway System. The Master Plan recommended that Congress authorize and fund a ten-year Environmental Management Program totalling some $191 million. This program was designed to deal with past, present and future deterioration of the fish and wildlife habitat of the river system.

A General Plan for the implementation of the Upper Mississippi River System--Environmental Management Program was completed by the North Central Division, U.S. Army Corps of Engineers in January, 1986. The U.S. Fish and Wildlife Service, Region 3, and the five affected states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) participated through the Upper Mississippi River Basin Association, in developing the General Plan. Habitat Rehabilitation and Enhancement Projects (HREP), Long-term Resource Monitoring (LTRM), Recreation Projects, a study on the Economic Impacts of Recreation and Navigation Traffic Monitoring are the five elements of the General (EMP) Plan. Approximately 95% of the currently authorized $191 million for EMP is for the HREP and LTRM elements of the plan.

Initial funding levels had fallen short of the authorized amount but a concerted effort by the states through the upper Mississippi River Basin Association convinced Congress to fully fund the program for FY 1992, as well as extend the program to the year 2002. There are presently eight major EMP projects underway along the Illinois River, most of which are designed to counteract side channel and backwater sedimentation. These projects are located at Peoria Lake, Banner Marsh, Rice Lake, Chautauqua Refuge, Sanganois Wildlife Area, Stump Lake Complex, Swan Lake Refuge, and Calhoun Point. Estimates for the completion of construction for these

projects is as follows: Peoria Lake - 12/93, Banner Marsh - 9/96, Rice Lake - 9/97, Chautauqua Refuge - 9/93, Sanganois Wildlife Area - unscheduled, Stump Lake Complex - 6/94, Swan Lake Refuge - 3/96, and Calhoun Point - 9/2000.

The knowledge, insights and experiences gained by the States and Federal agencies through the EMP will be of extreme value in directing future management activities in the Illinois River System and the Upper Mississippi River Basin. The EMP program is due to conclude in 2002. What the States and Federal agencies must now consider, is how to continue this program, or some modification of it, well into the next century.

While the EMP is a significant effort that is now underway along the mainstem of the Illinois River, other activities are also taking place within the tributary watershed areas that will provide long term benefits and direction to the management of the Illinois River System. A number of these activities are described elsewhere in the proceedings of this conference. These activities involve efforts to control sediment and erosion on farmland, preservation of riparian habitats, streambed and streambank stabilization projects, restoration of flood prone properties to non-damageable land uses and continued efforts to improve water quality. These programs should have a significant impact on reversing the trends of the deteriorating quality of habitats within the Illinois River System. These programs must continue and be expanded over the next ten years.

PRESERVATION OF REMAINING NATURAL RESOURCES

Efforts are now underway to improve State and Federal roles in preserving the remaining wetlands and riparian habitats of the nation. Federal and State agencies are now working on refining the appropriate level of protection for wetland areas. The resulting regulatory program should have a significant impact on the protection of wetland areas adjacent the Illinois River and its tributaries. State agencies are also currently working with interest groups to define and implement a protection and management program for the State's remaining natural streams. Natural streams are those streams that still exist in a mostly undisturbed state and with a substantial amount of unique natural features and habitat along their riparian corridors. These unique and natural features will benefit from improved protection and management.

The position of an "Environmental Advocate" was recently established in the Governor's office. The Governor's Environmental Advocate will be assigned the responsibility of developing for the State a "Critical Trends Assessment" and "State of the Environment Report." The objective of this two efforts, which will take two years to accomplish, is to produce a comprehensive assessment of Illinois' enviromnment which will be useful and understandable to the general public. A critical element of Trends Assessment will be to document environmental trends and conditions by integrating available scientific data into a geographic information system (GIS). This GIS database will be used to forecast environmental conditions into the future. These two efforts should become valuable tools for assisting this administration in making policy decisions on critical environmental problems.

In total these natural resource preservation efforts will most likely involve further regulation and acquisition of the remaining high value habitats within the Illinois River system. State, local and Federal agencies must continue to work together to identify the high value habitat areas within the Illinois River basin and pursue programs for their preservation.

CONCLUSION

Modernization of the waterway transportation system, continued programs for the restoration of quality impaired habitats and the continued pursuit of means to preserve the remaining high value habitats are the activities within the Illinois River Basin that will command our attention well into the next century. The opportunities are before us and must now be pursued.

REFERENCES

Donels, Bill. 1989. Environmental Management Program Proposals: The Illinois Basin. In *Proceedings of the Second Conference on the Management of the Illinois River System: The 1990's and Beyond*. pp.77-80. Portions of the section on Restoration of Quality Impaired Habitats were extracted in part from this reference.

Upper Mississippi River Basin Association. Navigation Studies--Illinois Waterway. In *The River Register*, Vol. 4 No. 3, June 1991. Portions of the section on Modernization of the Transportation System were extracted in part from this article.

MANAGEMENT OF THE ILLINOIS RIVER

Colonel James D. Craig
Commander, St. Louis District
U.S. Army Corps of Engineers

Good Morning Ladies and Gentlemen. I'm Colonel James Craig, the new district commander for the St. Louis District. This is my first occasion to address our management activities and long range goals for that portion of the Illinois River that lies in the St. Louis District. I am pleased to have this opportunity, and I look forward to meeting many of you throughout the day.

Although the St. Louis district boundaries encompass only the lower 82 miles, or roughly 25 percent of the Illinois River System, this area presents a diversity of resource management opportunities and challenges which are equal to, or greater than, those found anywhere else in the system.

This lower stretch of the Illinois River contains no navigation locks and dams. However, it is part of pool 26, which is formed by the Melvin Price Locks and Dam on the Mississippi River at Alton, Illinois.

The Illinois waterway moved approximately 46.6 million tons of traffic in calendar year 1990, according to preliminary waterborne commerce statistical center data. Primarily farm products--35 percent, petroleum and chemical products--26 percent, and coal--12 percent. The vast majority of this traffic (over 36 million tons) passes through the Melvin Price Locks and Dam in transit to their ultimate destination. The Illinois waterway has year round navigation.

For comparison, the upper Mississippi River moved approximately 42 million tons through Melvin Price Locks and Dam. This tonnage was composed primarily of the same commodity groups but with a larger relative percentage of farm products. The navigation season on the upper Mississippi River is approximately nine months.

In addition to being a valuable component of this country's commercial navigation system, the lower Illinois River is recognized for its recreational and environmental virtues. This stretch of river contains a complex system of lakes, wetlands, and forest. Our commitment to the management of this diversity is to sustain these values for future generations. This means we must use them with care today. To this end, we are applying an integrated river engineering philosophy to our management of this valuable river system. We are committed to going beyond compliance when it involves environmental considerations; we are striving to develop environmentally beneficial designs in all of our river engineering work; we are evaluating our methods of operation to determine if we can make changes that will help us realize our commitment to overall sustainability; and we are actively seeking to develop new partnerships with others to help us do business in a more environmentally sensitive manner.

The greatest challenge facing us on this portion of the Illinois River is sedimentation. Sedimentation clogs the navigation channel, increases turbidity of the river, and accelerates the silting of backwater lakes along the river. In the last 35 years, we have had to dredge over 14 million cubic yards of sediment from the river. Most of this sediment was located in a 30 mile reach below the La Grange Lock and Dam. Sediment passing through the La Grange Lock and Dam from upstream is a significant contributor to the problem downstream.

Another source of sedimentation is shoreline erosion, due to wave action and waterway traffic. Bank erosion, if left unchecked, also endangers adjacent flood control structures, power lines, bridges and pipeline crossings.

The St. Louis district has recently established a riverland area office which puts our natural resource managers to work on the river just like you see them at work on our lakes. We believe that their presence on the river will enable us to manage our lands in a more beneficial manner. They are already working to clean up unauthorized dump sites, create wetland areas and improve other habitat, as well as to control trespass and other forms of unauthorized use of our public lands. Their enforcement authority and presence along the river will support other agencies and local law enforcement efforts.

We are also in the process of updating our "Master Plan" for the Mississippi and Illinois River. This effort will include considerable coordination with the public, as well as with other federal and state agencies. The ultimate result of this work will be the development of long range plans for our management of the river. Environmentally sustainable development and management of our project lands will be addressed in detail.

Just like the Rock Island district, we are actively participating in the upper Mississippi River environmental management program and we have not ignored the opportunities present in the lower Illinois River. Working with the U.S. Fish and Wildlife service and the Illinois Department of Conservation, we have designed two very significant habitat improvement projects in this river reach.

The first of these projects, Stump Lake, is designed to reduce existing problems with sedimentation by 80 percent, by providing a 3 to 4 year level of flood frequency protection. This project will also provide increased capability for managing water levels in valuable wetland units and restore fisheries habitat. This project is designed to provide habitat for approximately 50 years.

The second of these projects is the Swan Lake habitat rehabilitation project. This project is a real demonstration of the value of new partnerships. We have joined efforts with the U.S. Fish and Wildlife Service, the U.S. Soil Conservation Service, and Local Landowners in the uplands to attack soil erosion at its source, before it becomes a problem in the Illinois River Floodplain. Sediment detention reservoirs in the uplands will eliminate approximately 60 percent of future sediment deposition in Swan Lake. A dike and levee system, gated structures, and pumps will provide a significant degree of water control, which will permit greater cultivation of food plants. Islands will be created to deepen the lake and reduce wave action. Enhance habitat and food production will result for both fisheries and waterfowl.

The St. Louis district is actively working to assist all of you here in Illinois to protect and develop your river resources for you to use and enjoy, but also for you to pass along to future generations.

Thank you for having me here today.

ROCK ISLAND DISTRICT PERSPECTIVE OF THE MANAGEMENT OF THE ILLINOIS RIVER

Colonel John R. Brown, District Engineer
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ABSTRACT

By virtue of its civil works mission involving 268 miles of the Illinois Waterway from Chicago, downstream to the LaGrange Lock and Dam near Beardstown, the Rock Island District shares an interdependent future with the Illinois River.

INTRODUCTION

The Illinois River and its tributaries, or, as we know it--the Illinois Waterway, is a nationally recognized commercial navigation and recreational boating system. The Waterway is also recognized as a rich habitat for a variety of plant and animal species, supporting over 60,000 acres of state and federal wildlife refuges. Realizing the social and economic importance of these habitats, the Corps is accomplishing its navigation mission on the Illinois Waterway in harmony with its "environmentally sustainable development" mission.

NAVIGATION

Since 1980, Rock Island District has maintained the navigation channel and operated and maintained eight locks and seven dams on the Illinois Waterway. These locks and dams were constructed mainly during the 1920's and 1930's. Time, weather, and increasing use have taken their toll. As the structures and equipment approach the end of their projected lives, breakdowns plus the failure of mechanical and electrical equipment become more frequent. These breakdowns are expensive to

the taxpayer and result in delays and increased costs to commercial shippers and their customers.

MAJOR REHABILITATION/MAJOR MAINTENANCE

The major rehabilitation/major maintenance program on the Illinois Waterway was designed to systematically repair and update lock and dam structures. The program will restore lock and dam structures to a condition that will not require major capital expenditures for the next 50 years.

The rehabilitation effort has been essentially completed at Lockport Lock, and Brandon Road, Dresden Island, Marseilles, Starved Rock, Peoria and LaGrange Locks and Dams.

We have completed a rehabilitation evaluation report which proposes additional work to include resurfacing lock walls at Lockport Lock and replacing the lower miter gates at Brandon Road, Dresden Island, and Marseilles Locks. Continued funding is essential in maintaining the navigational infrastructure within the Rock Island District's boundaries. However, major rehabilitation and major maintenance alone will not address the future needs of the Illinois Waterway navigation system.

Mr. Paul Soyke, from Rock Island District's Planning Division, a member of the next panel, will discuss the details of navigation trends and economics of the Illinois Waterway, and summarize the conclusions of the Illinois Waterway Reconnaissance Study, so I won't cover that aspect here.

It will take the energies and efforts of all of us concerned with efficient management of the Illinois River resources to bring about the construction of any capital improvements recommended by the study.

HYDROPOWER

The Rock Island District is also working closely with three Illinois River municipalities to assist them in the proposed development of hydroelectric power at Dresden Island, Brandon Road, and Starved Rock Dams. The Federal Energy Regulatory Commission issued a license to the city of Peru for Starved Rock Dam in 1988 and they must begin construction by June 1992. Licenses have also been issued to Rockdale for Brandon Road Dam and Channahon for Dresden Island Dam.

UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM

The Rock Island District recognizes the importance of keeping the navigation channel operable, while protecting the Illinois Waterway ecosystem. Thus, the Waterway is a part of the Upper Mississippi River Environmental Management Program--UMR-EMP.

The UMR-EMP is a unique program implemented by the Corps in cooperation with interagency groups, including the Fish and Wildlife Interagency Committee, the River Resources Coordinating Team, the On-Site Inspection Team, the River Industry Action Committee, and others. The program has no definitive cost-benefit ratio requirement; that, in itself, is unique.

The $289 million dollar program was initially authorized by the Supplemental Budget Act (PL 99-88) of 1985, and the Water Resources Development Act of 1986 (PL 99-662) further elaborated on the program.

Through the EMP, the Corps is rehabilitating and enhancing side channel, backwater, and wetland habitat by dredging channels, constructing dikes, levees, and other structures to control flows and water levels, and building islands for habitat diversity and to reduce turbidity in the areas they shelter.

The U.S. Fish and Wildlife Service conducts the long-term resource monitoring portion of the EMP.

Currently, 95 percent of EMP funds are used for habitat rehabilitation and long-term resource monitoring, with 60 percent of that going to habitat rehabilitation.

CURRENT EMP PROJECTS

The Rock Island District's habitat rehabilitation projects are undertaken on a cost-shared basis with other federal, state and local agencies. Four habitat projects proposed for the future on the Illinois River are in varying stages of planning.

Peoria Lake Project

The Peoria Lake Project is ready to go out for competitive bid and contract award as soon as all aspects of the federal and non-federal cost sharing requirements are resolved.

Plans for the project include the creation of a barrier island, removal of the East River channel silt plug, addition of rock substrate near the upper end of the East River channel, construction of a forested wetland management unit at the Woodford County Conservation Area, and extensive site revegetation.

The Illinois Department of Conservation is the cost- sharing sponsor in the state of Illinois for EMP projects. The non-federal share of construction and operation and maintenance is 25 percent.

The current estimated cost for the Peoria Lake Project is $4.3 million dollars (includes non-federal cost share).

Chautauqua Lake Project

Construction of the $4.7 million dollar Lake Chautauqua National Wildlife Refuge Project, located upstream of Havana, is scheduled to begin in the summer of 1992. This project includes construction of a pump station to service both the upper and lower lake, rehabilitation of an existing cross dike and the upper lake perimeter levee, installation of two water control structures, channel dredging, and excavation of a selected reach of the Liverpool Ditch.

Banner Marsh Project

At the Banner Marsh Fish and Wildlife Area, adjacent to the upper end of the LaGrange pool, general design of a project involving the following features is well underway: development of approximately 40 2-20 acre wetland sites with independent water level capability, construction of additional fish rearing ponds, nesting islands and a primary pumping station, renovation and gradation of nearly 400 acres of grassland habitat, and the clearing and stabilization of the existing river levee.

This is a relatively large project with a current cost estimate of $4.6 million dollars, cost-shared at 25 percent by the Illinois Department of Conservation.

Rice Lake Conservation Area

The Rice Lake Conservation Area Project, located south of Banner Marsh, is in the planning stage. General design work was initiated by the district this fall.

The proposed project would include upgrading the existing levee works and constructing additional levees, constructing a pump station, excavating interior channels, and creating islands and mud flats in the lakes.

The Illinois Department of Conservation's cost share would be 25 percent of the estimated total project cost of $975 thousand dollars.

I must emphasize that implementation of these projects is dependent upon continued program funding and satisfaction of cost sharing requirements.

OTHER ENVIRONMENTAL PROTECTION PROGRAMS

The Rock Island District has other avenues for the continued protection of the Illinois Waterway environment; for example, local flood control projects and the Corps ongoing regulatory review process.

Liverpool

The village of Liverpool is located approximately 30 miles downstream of Peoria, on the river side of an agricultural levee. In past years, flood damage in Liverpool has been substantial. We plan to construct a village levee that will tie into the existing agricultural levee, provide interior drainage now being blocked by the

levee, and construct a 2-acre ponding area and a pumping station. A flood warning system will be implemented by the village.

Construction is scheduled to begin during the summer of 1993. The Assistant Secretary of the Army for Civil Works has authorized allocation of funds for the project. Efforts are now underway to get the record of decision and the local cost-sharing agreements signed this year.

The Illinois Department of Transportation, Division of Water Resources, supports the levee plan and will financially support the village in constructing the project. The 75 percent federal, 25 percent non-federal cost share ratio applies to this project. Following approval of the project, 18 months are allowed for the project sponsor to obtain rights-of-way.

S.E. Ottawa

In Ottawa, a Section 205 flood control project has been approved for construction which will provide protection for residents and the high school from flooding along the Fox and Illinois rivers.

The project provides for construction of an earthen levee 4,800 feet in length and 14 feet high. The total project cost is estimated at $2.3 million dollars. The local sponsor for this project is the Ottawa Township High School Board.

E. Peoria

A cost-shared feasibility study is ongoing for a Section 205 flood control project at East Peoria. The East Peoria Drainage and Levee District, as the non-federal partner, is evaluating the level of protection they wish to request. Construction of this project could begin in approximately two years, following preparation of plans and specifications and acquisition of the necessary rights-of-way.

REGULATORY REVIEW PROCESS

The Rivers and Harbors Act of 1899 gave the Corps the responsibility and authority to regulate activities on public waterways. The National Environmental Protection Agency of 1968 and the Clean Water Act of 1977 expanded these responsibilities.

This means the Corps regulates any work or structure that occurs on or over the Illinois Waterway, and any discharge of dredged or fill material that would occur in the Waterway and adjacent wetlands.

On the Illinois River, the Rock Island District processes between 25-50 individual permit applications annually which require public notice; several more, if you consider all permits on the tributaries in the Illinois Waterway Drainage Basin. Non-controversial individual permits normally take around 60 days to issue.

A permit for riverboat gambling facilities at Peoria was issued to Greater Peoria Riverboat Corporation last month. The city of Joliet has applied for a permit through Chicago District, and we are reviewing their proposal to modify the seawall.

My final decision to issue or deny a Corps permit is based upon the overall public interests and usually includes review and comment by some or all of the following: U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, National Park Service, State Department of Conservation, State Department of Transportation, State Historic Preservation Office, Illinois River Carriers Association, American Waterways Operators, and numerous other environmental and navigation industry groups. Numerous factors are considered when issuing a permit, including pollution, fish and wildlife, historical and archaeological significance, cultural considerations and many others.

RECREATION

As I stated earlier, navigation on the Illinois Waterway includes recreational boating. However, limited federal funding for recreation facilities and lack of federally owned land on the Illinois Waterway allows for minimal recreation planning by the Corps.

Farmdale and Fondulac Recreation Areas are open for non-motorized recreation, such as hiking and day use. These recreation areas are funded for operations and maintenance only.

Each lock and dam on the Illinois River has observation and day use areas. The Corps operates the Illinois Waterway Visitors Center at Starved Rock Lock and Dam. It is a fully staffed Corps facility, receiving approximately 50,000 visitors per year. The Center's slide presentation includes a panoramic history of the Illinois River.

There are no Corps camping areas on the Illinois River at the present time.

CONCLUSION

All of us at the Rock Island District Corps of Engineers plan to do our best to meet the needs of the people we serve on the Illinois Waterway in the 1990's and beyond.

FRESHWATER MUSSELS OF THE ILLINOIS RIVER: PAST, PRESENT, AND FUTURE

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ABSTRACT

Recent stream surveys throughout the United States have documented drastic declines in populations of freshwater mussels, which may be the most endangered group of animals in North America. A survey of the mussels of the Illinois River conducted in 1966 documented less than half of the species previously reported from the river. A variety of factors - including loss of habitat, siltation, herbicides and insecticides, pollution, loss of suitable host species, competition from introduced exotics species and overharvest - have been implicated in the loss of mussel diversity.

In the early part of the 20th century, enormous quantities of mussel shells were harvested and finished into buttons for clothing. The pearl button industry and mussel fishery were all but eliminated by the advent of plastics in the 1950s. Today, freshwater mussel shells are harvested and exported to Japan, where they are converted into beads and inserted into oysters to serve as nuclei for cultured pearls. The continued decline of freshwater mussel populations in the Illinois River and other streams underscores the need for more research on the basic biology of these animals in order to better manage and protect them from extirpation or extinction.

INTRODUCTION

North America has the most diverse freshwater mussel fauna in the world. Close to 300 species of mussels are known from the United States, and the vast majority of these are found east of the Rocky Mountains. Because of Illinois' location along the Mississippi, Ohio and Wabash rivers, it has historically supported a diverse freshwater mussel fauna. Seventy-eight of the 285 species of mussels known from North America have been reported from Illinois.

Recent stream surveys throughout the United States have documented drastic declines in mussel populations, and mussels may be the most endangered group of animals in North America. Thirteen species are considered globally extinct (Turgeon et al. 1988), 39 are on the federal endangered species list, and over 50 more have either been proposed or are candidates for listing in the near future. The Illinois Threatened and Endangered Species List currently contains 33 mussels (29 endangered, 4 threatened) (Illinois Endangered Species Protection Board 1990). Another 11 species are candidates for listing in Illinois, which brings the total of rare or listed species to 44, or 56% of the mussel species reported from the state (Cummings 1991).

FRESHWATER MUSSELS OF THE ILLINOIS RIVER

The Past

Historical information on the mussel fauna of the Illinois River and its tributaries is available in a number of publications (Calkins 1874; Strode 1891, 1892; Kelly 1899; Baker 1906; Wilson & Clark 1912; Danglade 1914; Eldridge 1914; Starrett 1971; Lewis & Brice 1980; Suloway 1981; Schanzle & Cummings 1991). The first comprehensive study of the mussels of the Illinois River was conducted from 1907 to 1912 by E. Danglade of the U.S. Bureau of Fisheries and was published in 1914.

The commercial harvest of freshwater mussels has long been an integral part of the cultural history of the people inhabiting the towns along the Illinois River. In the early part of the 20th century enormous quantities of mussel shells were harvested, cooked out, and shipped to factories where they were cut and finished into buttons for clothing. It has been suggested that the first shells collected for the purpose of button manufacture came from the Illinois River at Peoria in 1872 (Danglade 1914; Coker 1919). The first shelling of any consequence in the Illinois River was not done until the spring of 1892 at Meredosia. This effort proved a failure however, and harvest in the Illinois was discontinued until 1907, when shellers, who had exhausted the supply of shells from the Wabash went looking for new rivers to exploit. Commercial harvest in the Illinois River reached its peak in 1909, when there were about 2,600 boats engaged in mussel fishing between Peru and Grafton (Coker 1919). The harvest pressure was so intense that over 100 boats were observed working the same bed at one time. By 1912, 15 button factories were located on the river in Peoria, Beardstown, Meredosia, Naples, Pearl, and Grafton.

The intense fishing pressure resulted in a severe decline in the mussel fishery. By 1912 only about 400 boats were working the Illinois. The price paid for shells in 1912 was about $12 a ton. In 1913, 11,780,000 lb of shells were harvested from the Illinois River, at an estimated value of $88,350, or about $15 a ton. The harvest of mussels continued for the next 35 years, and increased demand for shells drove the price up to around $30 a ton by the 1940s. The fishery continued in this fashion until about 1950, when the the advent of plastics all but eliminated the pearl button industry and the harvest of mussels.

About 1962, renewed interest in the commercial harvest of Illinois shells was stimulated by the market demand created by the Japanese cultured pearl industry. In this industry freshwater mussels are harvested and exported to Japan, where they are converted into beads and inserted into oysters to serve as nuclei for cultured pearls. Soon after the renewal of interest in commercial harvest, it was decided that new data were needed on the distribution of mussels in the Illinois River.

In 1966, William C. Starrett of the Illinois Natural History Survey conducted a comprehensive survey of the Illinois River using a variety of collecting techniques, including crowfoot bar or brail, dredge (dip net) and wading (Starrett 1971). A total of 4,249 mussels were collected alive from 429 sites along the entire Illinois River from Dresden to Grafton. In this survey Starrett collected less than half of the species (23 of 47: 49%) previously reported from the Illinois, and five of the 23 species of living mussels he collected were represented by single specimens (Table 1). Starrett divided the Illinois into four main areas: Upper River, Peoria Pool, La Grange Pool and Alton Pool (Figure 1). A comparison of mussels found in each of the four areas to those found in earlier studies revealed a drastic reduction in the number of species (Table 2).

Table 1. Freshwater Mussels (Unionacea) of the Illinois River. FE = Federally Endangered, FC = Federal Candidate Species, SE = Illinois State Endangered, ST = Illinois State Threatened, SC = State Candidate or Watch List Species. P = Peoria Pool, L = La Grange Pool, A = Alton Pool. Data from Starrett 1971.

	Museum Records pre - 1913	Individuals 1966-69	Pool 1966-69
FAMILY MARGARITIFERIDAE			
Cumberlandia monodonta (Say, 1829) FC, SE	X		
FAMILY UNIONIDAE			
Subfamily Ambleminae			
Amblema plicata (Say, 1817)	X	2650	P L A
Cyclonaias tuberculata (Rafinesque, 1820)	X		
Elliptio crassidens (Lamarck, 1819) ST	X		
Elliptio dilatata (Rafinesque, 1820) SC	X		
Fusconaia ebena (Lea, 1831) SC	X	1	A
Fusconaia flava (Rafinesque, 1820)	X	46	P L A
Megalonaias nervosa (Rafinesque, 1820)	X	207	P L A
Plethobasus cyphyus (Rafinesque, 1820) ST	X		
Pleurobema sintoxia (Rafinesque, 1820)	X		
Quadrula metanevra (Rafinesque, 1820)	X		
Quadrula nodulata (Rafinesque, 1820)	X	66	L A
Quadrula pustulosa (Lea, 1831)	X	425	L A
Quadrula quadrula (Rafinesque, 1820)	X	390	P L A
Tritogonia verrucosa (Rafinesque, 1820)	X	2	P
Uniomerus tetralasmus (Say, 1831) ST	X		
Subfamily Anodontinae			
Alasmidonta marginata Say, 1818	X		
Alasmidonta viridis (Rafinesque, 1820) SE	X		
Anodonta grandis Say, 1829	X	120	P L A
Anodonta imbecillis Say, 1829	X	5	P L A
Anodonta suborbiculata Say, 1831	X	1	L
Anodontoides ferussacianus (Lea, 1834)	X		
Arcidens confragosus (Say, 1829)	X	78	L A
Lasmigona complanata (Barnes, 1823)	X	13	P L A
Lasmigona compressa (Lea, 1829) ST	X		
Lasmigona costata (Rafinesque, 1820)	X		
Simpsonaias ambigua (Say, 1825) FC, SE	X		
Strophitus undulatus (Say, 1817)	X		
Subfamily Lampsilinae			
Actinonaias ligamentina (Lamarck, 1819)	X		
Ellipsaria lineolata (Rafinesque, 1820) SC	X		
Epioblasma triquetra (Rafinesque, 1820) SE	X		
Lampsilis cardium Rafinesque, 1820	X		
Lampsilis higginsi (Lea, 1857) FE, SE	X		
Lampsilis siliquoidea (Barnes, 1823)	X	8	P L
Lampsilis teres (Rafinesque, 1820)	X	53	P L A
Leptodea fragilis (Rafinesque, 1820)	X	64	P L A
Leptodea leptodon (Rafinesque, 1820) FC, SE	X		
Ligumia recta (Lamarck, 1819)	X		
Obliquaria reflexa Rafinesque, 1820	X	49	L A
Obovaria olivaria (Rafinesque, 1820)	X	1	A
Potamilus alatus (Say, 1817)	X		
Potamilus capax (Green, 1832) FE, SE	X	16	P L A
Potamilus ohiensis (Rafinesque, 1820)	X	42	P L A
Toxolasma parvus (Barnes, 1823)	X	1	A
Truncilla donaciformis (Lea, 1828)	X	1	A
Truncilla truncata Rafinesque, 1820	X	10	L A
Villosa iris (Lea, 1829) SE	X		

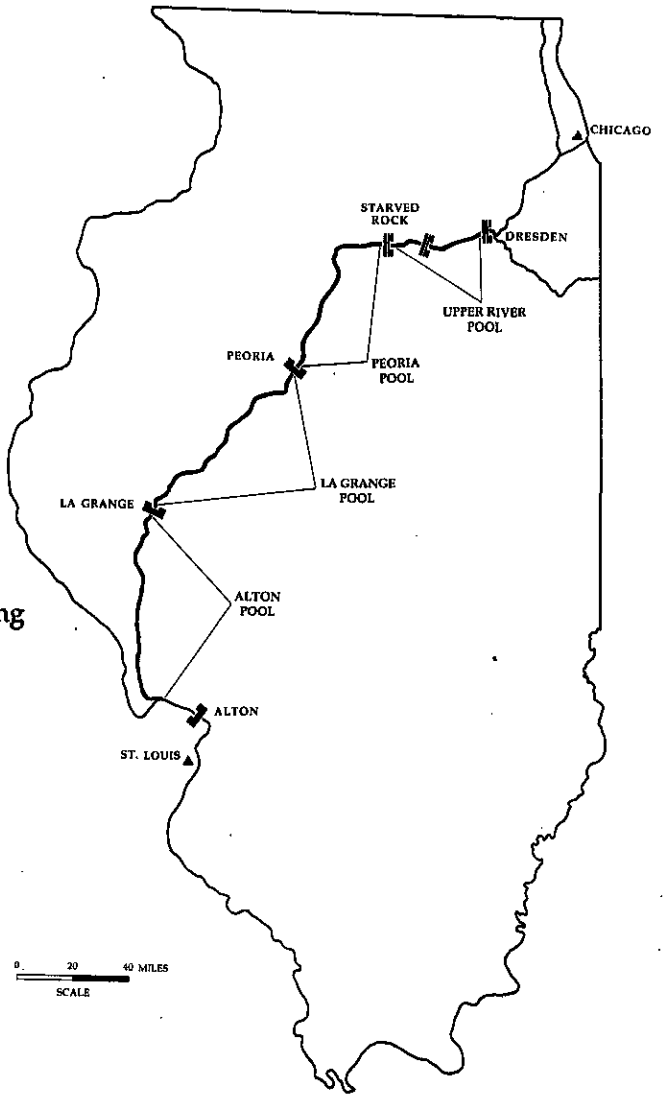

Figure 1. Map of the Illinois River showing the location of the major pools and dams.

Table 2. Number of species and individuals (1966-1969) of freshwater mussels found in the Illinois River, 1870-1969. (Data modified from Starrett 1971).

	Upper River	Peoria Pool	La Grange Pool	Alton Pool	Illinois River
Species 1870-1966	34	37	39	38	47
Species 1966-1969	0	13	18	20	23
Individuals 1966-1969	0	851	591	2807	4249

Upper River

The Upper River, as designated by Starrett, extended from the confluence of the Des Plaines and Kankakee rivers downstream to the Starved Rock Lock and Dam, a distance of 42 river miles (Figure 1). The pollution carried down from Chicago via the Sanitary and Ship Canal had an enormous impact on the mussel fauna of the Upper River in the early part of the century. The number of mussel species reported from Starved Rock had been drastically reduced from 34 in 1874 to only two by 1912 (Calkins 1874; Forbes & Richardson 1913). Although sewage treatment plants had improved water quality in the Upper River by 1966, not a single living mussel was collected in this stretch of the Illinois, and it was considered to be a poor environment for fishes as well (Starrett 1971; Mills et al. 1966; Table 2).

Peoria Pool

Peoria Pool runs from the Starved Rock Lock and Dam downstream to Peoria Dam (73 river miles). As with the Upper River, Peoria Pool suffered a significant decline in the number of species from 1874 to 1966 (Table 2). Whereas many of the species in the Upper River were thought to have been extirpated by the turn of the century, the loss of diversity in Peoria Pool occurred from 1912 to 1925. Danglade (1914) reported 32 species in Peoria Pool, 24 of which occurred above Peoria Lake. A 1925 survey of Peoria Pool found no live mussels above Peoria Lake (Richardson 1928). Although 15 species were found in Peoria Pool in 1966-1969, only 38 individuals of nine species were in the upper 56 miles of the pool. Although mussels are nowhere near as diverse as in the past, the finding of at least a few species in the upper part of Peoria Pool in 1966 indicated that conditions in this part of the river had shown some improvement (Starrett 1971).

La Grange Pool

La Grange Pool runs from the Peoria Dam to the La Grange Dam (78 river miles). Between 1870 and 1912 at least 39 species of mussels were known from the La Grange Pool (Starrett 1971). Richardson (1928) did not collect data on the mussel fauna of the La Grange Pool but did document the drastic reduction in the number of other organisms attributed to domestic and industrial pollution from Chicago and the Peoria-Pekin area. Thirty species of mussels were collected in the mainstream of the river between Peoria Dam and Havana in 1912, whereas only 11 species were reported from this section of the river in 1966 (Danglade 1914; Starrett 1971). A total of 18 species were collected in the La Grange Pool in 1966; this represents a reduction of 46% from 1870 (Table 2).

Alton Pool

Alton Pool runs from the La Grange Dam to the Mississippi River (80 river miles). At least 38 species of mussels have been found in the Alton pool since 1870 (Table 2). Thirty species were collected in Alton Pool in 1912 (Danglade 1914), whereas only 20 were found in 1966 (Starrett 1971). Conditions in Alton Pool in 1966 were favorable to mussels, and the largest populations in the entire Illinois River were found in this pool. Although water quality had improved somewhat, it clearly had not recovered enough to support the number of species and individuals known to have existed there in 1912. The number of species taken at Meredosia declined from 30 in 1912, to 18 in 1930, 16 in 1955, and 14 in 1966.

The results of the survey by Starrett indicated that from 1870 to 1966 the Illinois River changed from an excellent mussel stream to a relatively poor one. Twenty-four, or over half of the species that formerly inhabited the Illinois River, were no longer present by 1966. Of those 24 species, 12 are in trouble statewide and are listed as either endangered or threatened or are candidates for listing (Table 1). Starrett blamed the reduction on a combination of domestic,

industrial, and agricultural pollution and stressed the need for a strong soil conservation plan to control rapid run-off and reduce siltation in the basin.

The Present

It has been 25 years since the last mussel survey of the Illinois River, and the number of species and status of those still present are unknown. However, surveys of a few of the tributaries of the Illinois have been recently studied, including the Kankakee (Lewis and Brice 1980; Suloway 1981), Mackinaw (Cummings et al. 1988), Sangamon (Schanzle and Cummings 1991), and Vermilion (Cummings, unpubl. data) rivers. From those surveys it is evident that the rivers of Illinois have undergone a radical change, including the loss of many species that were historically widespread and common in the state.

Although no surveys have been conducted in recent years, some data on the mussel fauna of the Illinois River are available through the commercial harvest reports prepared by the Illinois Department of Conservation (Fritz 1990). Because of continued demand for shells to supply the cultured-pearl industry, commercial harvest on the Illinois River steadily increased from 24, 800 lb in 1979 to 1,462,200 lb in 1985. Although the number of shells harvested declined from 1986 to 1989, the catch still averaged 431,350 lb per year (Fritz 1990). In 1989, 585,081 lb of mussel shells were harvested from the Illinois River with an estimated wholesale value of $321,074. The 1990 statistics show some startling increases in the numbers being harvested and the price being paid for shells (Figure 2). In 1989, 523 lb of shells were taken from Peoria Pool of the Illinois River. In 1990 the number harvested from Peoria Pool grew to 372,21, a staggering increase of over 70,000% (Table 3). The location of the harvest is highly variable and will often change from pool to pool depending on the year. For example, in 1989, 97% of the total harvest for the Illinois River was from the Alton Pool, whereas in 1990 only 50% of the mussels collected from the river came from that pool.

Table 3. Freshwater mussel shells harvested (in pounds) from three pools in the Illinois River in 1989 and 1990 (in parentheses). (Data from Fritz 1990 and pers. comm. 1991).

Species	Peoria Pool	La Grange Pool	Alton Pool	TOTAL
Washboard	14 (17,025)	8,221 (54,662)	346,614 (225,137)	354,849 (296,824)
Threeridge	468 (328,290)	7,000 (87,854)	221,356 (309,227)	228,824 (725,371)
Mapleleaf	17 (11,895)	0 (15,104)	1367 (188)	1,384 (27,187)
Other	24 (15,000)	0 (15,600)	0 (0)	24 (30,600)
TOTAL	523 (372,210)	15,221 (173,220)	569,337 (534,552)	**585,081 (1,079,982)**

The number of mussels harvested appear to be driven by the price being offered for the shells. As the price increases, more and more people are attracted to harvesting. The number of licenses for harvesting increased from 1075 in 1990 to 1500 in 1991 (B. Fritz, pers. comm.) How long the resource can survive with the increase in pressure is unknown. Although season and length limits have been established to control the commercial harvest of mussels,

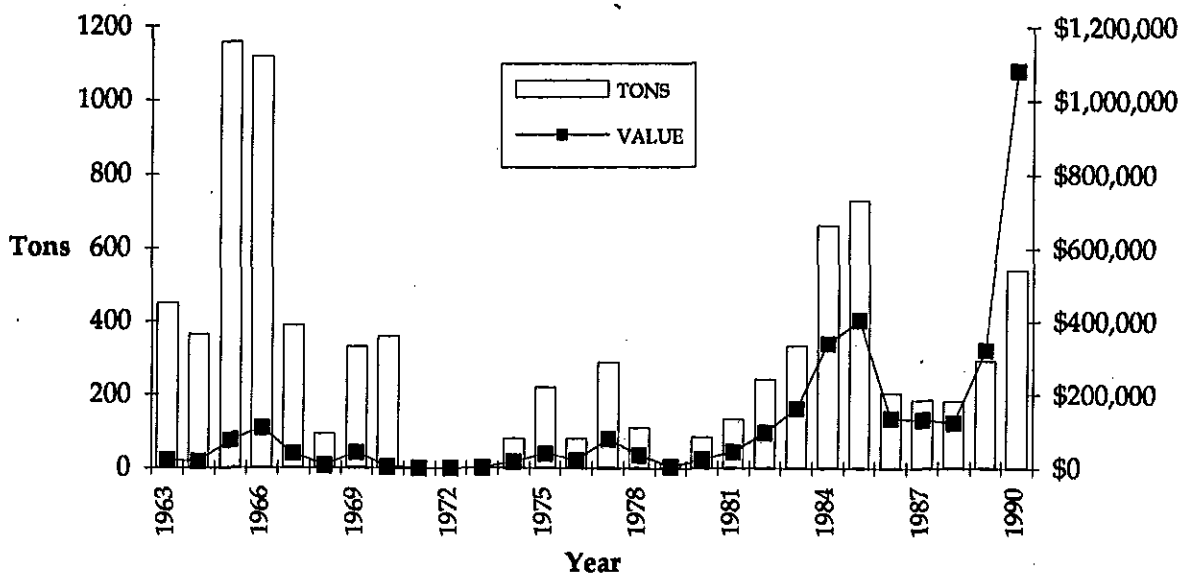

Figure 2. Number of tons and value in dollars of freshwater mussels harvested in the Illinois River, 1963-1990. (Data from Fritz 1990 and pers. comm. 1991).

little or no data are being collected on sustainable yield or standing crop estimates for particular pools. From a management standpoint it is obvious that more attention should be given to monitoring this biologically important resource.

The Future

A variety of factors are responsible for the decline in mussel diversity. Foremost among them is loss of habitat through direct alteration of the waterway (i.e., dams, channelization). Other factors include the smothering effects of siltation caused by poor land management, herbicide and insecticide run-off, pollution, loss of suitable host species, competition from introduced exotics and overharvest.

The continued survival of freshwater mussel populations in the Illinois and other rivers of our state is uncertain. Although a considerable fishery and commercial market exists for freshwater mussels, very few research dollars are spent studying the basic biology and life history requirements of these animals. Because many mussels are considered endangered by the state or federal government, some money has been allocated to research individual species. However, this is a reactive approach, and more resources are needed to begin to study and protect essential habitat for these unique and commercially important animals. The decline and elimination of freshwater mussels portend the loss of other less visible plants and animals from our streams. Even in times of fiscal restraint we cannot afford to cut back on efforts to document and monitor changes in our environment. Instead of reducing the budget of our natural resource agencies, we should be employing more systematists and sytematics-trained field biologists in order to provide information on how to protect our state's valuable natural heritage.

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ILLINOIS RIVER FISHERIES AND WILDLIFE RESOURCES

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As I reviewed the program for this conference, I was impressed with the broad range of topics that are being addressed. They underscore the scope of issues impacting upon the management of the Illinois River system. That the river is one of the State's most important natural resources cannot be overstated. The uses we ask the river to provide touch many areas of our society and we will give attention to some of the more important ones during the next two days.

The fisheries and wildlife resources along the river have long played an important role to those who enjoy a wide array of water oriented recreational pursuits. In an earlier era, the bottomland lakes along the river were considered among the best sport and commercial fishing waters in this country (Starrett and McNeil, 1952). At Havana, some of the earlier citizens recalled the special trains that brought Springfield anglers to Havana for a day's fishing and the carloads of live fish shipped to the New York City market (Starrett and Bellrose, 1966). Largemouth bass were abundant enough in the bottomland lakes so that one could make wages by catching them with a cane pole for the local market. In 1897, 13,061 pounds of bass were handled commercially at Havana fish markets (Cohen, Bartlett, & Lenke, 1899). Between 1899 and 1908, the commercial yield of largemouth bass increased 322 percent (Forbs & Richardson, 1919). Waterfowl populations provided tremendous hunting opportunities, not only for sport but also for the market. The bottomland lakes of the Illinois Valley were a paradise, especially for mallards. The first Federal regulations for hunting migratory waterfowl provided for a season that averaged 100 days and bag limits of 25 ducks and 8 geese. That was in 1918 (U.S. Fish & Wildlife Service, 1964).

But as time tread on, the river began to change. Its topographic features were among the factors involved. Barrows (1910) stated, "The nearly level channel and

the small volume result in a very sluggish river,... It is wholly unequal to the task of washing forward the sediment delivered by its headwaters and its numerous tributaries..." Lakes were levied off and pumped dry for agricultural production. Locks and dams were built to support river navigation. These structures have tended to slow the river even more. The streams that flow into the river in its central and lower reaches have a steeper gradient. Since the river is impounded and the gradient is low, it has difficulty carrying silt, resulting in a tremendous amount of this turbid burden being deposited in the remaining floodplain lakes when spring floodwaters top the low natural banks (Starrett & Bellrose, 1966).

The conversion of timber land to agriculture and other uses has had an impact on the silt load of the river. The Division of Forest Resources has estimated there were almost 6 million acres of forest in the Illinois River watershed in 1820. Now, there are about 1.6 million acres; a loss of some 73 percent (Roberts, 1987).

Increasing human populations in the villages, towns and cities along the river and in its headwaters placed additional impacts upon the river's capacity to maintain good water quality. By the 1920s, pollution in a variety of forms had taken a heavy toll. Dissolved oxygen levels were considerably depressed at several stations along the middle and upper reaches of the River during that time. The river was no longer able to sustain formerly large catches of commercial fishes. Commercial harvest of fish had reached a high of about 24 million pounds in 1908, declined to about 5 million pounds by 1931, and to less than 2 million pounds by 1964 (Starrett and Bellrose, 1966). In 1989, the reported catch was less than 600,000 pounds (Fritz, 1990). Bottom feeding waterfowl found their supply of food organisms being depleted. Silt began to cover the remaining bottomland lakes and backwaters and aquatic vegetation, so important to both fish and waterfowl populations, was drastically reduced.

The number of ducks decreased dramatically from 1950 to 1980, and dropped even further by 1990 (see table below).

Illinois Natural History Survey
Waterfowl Fall Peak Numbers
Illinois Valley

DABBLERS		DIVERS		TOTAL DUCKS	
11/13/50	1,411,697	11/13/50	332,955	11/13/50	1,744,652
10/28/80	517,035	10/28/80	26,365	10/28/80	543,400
11/19/90	278,165	11/07/90	17,035	11/07/90	295,200

The diving ducks left the river in the 1950s when most of the benthic organisms and aquatic vegetation were lost to sedimentation, increasing use of herbicides and possibly other factors. Dabbler numbers have been steadily decreasing as natural foods have disappeared from the valley as a result of sedimentation, increases in the frequency of fluctuating water levels due to

channelization and sedimentation, and less waste grain in the fields because of an increase in fall plowing (Havera, 1991).

Many feeder streams were channelized, affecting the ability of their waters to provided critical nursery areas for fish and riparian wildlife. During the 1940s, pesticides came into widespread use to increase agricultural production and protect human health. Some aquatic floral and faunal species became extinct or endangered. These negative impacts were often thought to be a necessary price to pay for so called "progress". Yet there were increasing numbers of private citizens, legislators, resource oriented organizations and, of course, conservation agencies that realized actions should and must be taken to alter the course of events. This concern is borne evident by the passage of the Federal Aid in Wildlife Restoration Act of 1937 and the Federal Aid in Sport Fish Restoration Act, which followed in 1950. The monies for these programs were generated by excise taxes on arms, ammunition, and fishing equipment. While these acts did not concentrate exclusively on the needs of riverine aquatic resources, they nevertheless point out the early interest in and commitment to the overall restoration of fish and wildlife resources.

Over time, and by the 1950s, enough attention was brought to bear on the condition of this river and others across the nation to start the "healing" process. Water quality laws were passed. We began to assess damages caused in fish kills and, working in concert with the Illinois Pollution Control Board, those responsible were required to pay for the damages. Uses of certain pesticides such as DDT, chlordane, and PCBs were prohibited. Environmental impact statements were required of proposals that could impact a rivers' resources. Permits became a requirement for some actions that would alter a stream course or place fill in streams or wetlands. Agricultural programs were enacted to reduce erosion. Millions of dollars were spent upgrading municipal sanitary and industrial facilities to improve the water quality flowing into the receiving streams and rivers. Passage of the Clean Water Act of 1972 was a hallmark piece of federal legislation that began a significant process of "cleaning up" our flowing waters.

Fish and wildlife species have long been barometers of the "well-being" of our environment. It is important to note that water quality standards were established to protect not only human health but to provide waters capable of sustaining fisheries. Over 97 percent of Illinois rivers and streams are in fair to good condition according to the Illinois EPA's "Illinois Water Quality Report" for 1988-1989. The report shows water quality conditions of rivers and streams as being good in 43.5 percent, fair in 55.3 percent, and poor in only 1.2 percent. This is a significant improvement over the 1972 conditions which showed 34.7 percent of the rivers and streams in good condition, 54 percent in fair condition and 11.3 percent in poor condition. Agricultural activities causing soil erosion and nutrient migration were the primary sources impacting streams in Illinois (Illinois Environmental Protection Agency, 1990). But just sustaining fisheries is not enough. Anglers and others want to be able to eat fish. Unfortunately, there are some sites in Illinois for which there are fish consumption advisories. Here on the Illinois River in the stretch from its origin at the Kankakee and Des Plaines Rivers downstream to the Peoria Lock and

Dam, carp over 15 inches and channel catfish should not be consumed. PCBs, which have been banned but still persist in the environment, are responsible. The problem is less an increase in PCBs than a redistribution of them. Apparently, decreasing water levels of the Illinois River caused by both siltation and the drought of 1988 exposed buried sedimentation to barge traffic. The barges stirred up this old, undisturbed silt, and fish that spend time on the bottom were affected (Hornshaw, 1991).

Soil erosion is, of course, not a relatively recent event, having been occurring since the beginning of time through changes in topography and the effects of glaciers, wind and flowing water that created valleys and cut down stream courses to accommodate flow. But it became exacerbated as agriculture progressed through the centuries with the turning of the soil. What has happened in the Illinois River Valley is only a microcosm of what is taking place in much of the world. The United States Government recognized the need for a concerted effort to stem the tide of soil erosion with the creation of the Soil Conservation Service in the 1930s. Unfortunately, erosion continues at an alarming rate. According to Dwayne Andreas, Chairman, Archer, Daniels Midland Company, "The loss of the world's topsoil is the biggest threat facing mankind today. Over the past decade, a quarter-billion tons of topsoil has been lost in the world, equal to over half of all of the topsoil cover in the United States. It took a billion years or more to build up the topsoil cover that feeds the world, but it's taken only 50 years to destroy a fifth of the world's agricultural topsoil." He estimates that Illinois is losing 1.5 bushels of topsoil for every bushel of corn produced (Andreas, 1991). In the Illinois River watershed, a great deal of that eroded soil finds its way to the Illinois River, since it drains approximately 43 percent of the entire state.

Row crops are planted over vast acreage to the virtual exclusion of small grains. Row crops are not high quality wildlife habitat. While offering food for some species, they provide little nesting or winter cover. Some of the acres planted to row crops erode easily, increasing sedimentation. Economic incentives provided by row cropping have resulted in reduced acreage of hay and livestock pasture, once the "substitute prairie" supporting much of the state's wildlife. The trend became critical after World War II, as the cash grain system became in vogue. Previously, farms had livestock, hayfields and pastures from which to feed the animals and fences to contain them. But as livestock were eliminated, hayfields, pastures and fencerows were plowed. Most livestock today is closely confined (Illinois Wildlife Habitat Commission Report, 1984-1985). Our Nation's government again reacted to the soil erosion crisis by passing the Farm Bills of 1985 and 1990, through which land owners are provided cash incentives to retire marginal lands from row cropping.

In spite of the problems outlined above, we've witnessed fantastic improvements in the Illinois River fishery. In 1975, the Division of Fisheries established stations on the River to monitor changes in the fish population. With the collection of the 1989 samples, we now have 15 years of data to examine and are seeing some trends that only become apparent when a long-term data set is available. One trend is the change in sport fish. With the improvement in water quality and the rebuilding of the sport fishery in the early 1970s, we saw

improvements to the point that 70 percent of the quality size fish--fish that most fishermen consider worthy of harvest--were the more desirable species such as bass and crappie, and only about 30 percent were carp. Since 1975, we see about the same ratio of carp, but the proportion of some of the other species has changed in apparent response to changes in habitat. In 1975, typical backwater lake species such as largemouth bass, crappie and sunfish were 55 percent of the sport fish, and more riverine species such as white bass, smallmouth bass, catfish, sauger, walleye, and drum were only 16 percent of the sport fish. By 1989, the backwater species were only 22 percent of the sport fish and the more riverine species made up 48 percent (Bertrand, 1991).

Another trend seems to be related to low flows in winter. Low average flows from December through February usually results in reduced numbers of sport fish in our samples the following summer. We tend to collect greater numbers of sport fish following above average flows in winter. The drop in fish numbers is not necessarily proportional to the severity of the low flow, so we believe there are other factors such as water quality at the time of the flow, daily flow variability within that low flow period, and cold water temperatures during the period are also influencing survival. During cold weather, some backwaters have temperatures a few degrees higher than that found in the main channel. With an increase in flow, fishes can be forced out of these backwaters and into flowing water where they must expend energy to seek another quite water area. During these instances, energy reserves may be depleted to the point where mortality occurs (Bertrand, 1991).

To address the need of improving fish habitat in Peoria Lake, the Department of Conservation is cooperating with the Department of Energy and Natural Resources in a project to enhance revegetation techniques. Reimbursement is provided through the Federal Aid in Sport Fish Restoration Act. Vegetation established behind wind breaks has demonstrated an increase in sportfish populations. Two floating islands have been constructed and vegetated at the Woodford County Conservation Area to determine usefulness of these islands for the rapid growth of aquatic vegetation. The U.S. Army Corps of Engineers is planning construction of a $2 million barrier island to dampen wave action. Funding for this project has been obtained through a separate authorization passed under the Federal Water Resources Development Act of 1986. The successful development of durable plant beds will allow full revegetation to occur.

To get a picture of the sport fishery that the River can provide, the average weights of various sport fish are: crappie - 2/3 lb.; sunfish - 1/3 lb.; largemouth bass - 1.5 lb.; smallmouth bass - 1.0 lb.; channel catfish - 2.0 lb.; white bass - 2/3 lb.; bullheads - 1/2 lb.; and walleye-sauger - 1-1/4 lb. (Bertrand, 1991). Fishing pressure is high on the 12.7 mile section between Starved Rock Lock and Dam and Route 89 downstream of Peru. During the seven months from June-November, 1989 and March, 1990, fishing pressure was 128,363 angler hours, or an equivalent of 119 hours per acre. Anglers caught 106,931 fish. The majority were white bass (57,095), followed by freshwater drum (29,436), channel catfish (4,491), sauger (3,625), gizzard shad (3,374), common carp (2,521), and walleye (1,754) (Heidinger, Tetzlaff, Hansen and Brooks, 1990).

The walleye and sauger fishery has shown such improvement that a Masters Walleye Circuit tournament has been held annually at Spring Valley since 1987. This year it was held on April 13th and 14th. There were 355 contestants from eleven states participating. During the two days, 469 fish averaging 1.77 pounds were entered. The winning team caught 37 pounds (Spring Valley Walleye Club, Inc., 1991).

At the American Team Championship Bass Fishing Classic held at Peoria on June 7 and 8, 1991, 86 competitors caught 393 fish weighing 566 pounds, with 209 of the bass weighing 314.8 pounds on the last day. On September 18-20, 1991, the Bass Angler Sportsmens Society (B.A.S.S.) Illinois Invitational was held at Alton, Illinois. Approximately 324 anglers from 34 states and Mexico competed in the tournament and caught 735 bass weighing 1,044 pounds. These tournaments demonstrate that the Illinois River has become known for its good bass fishing.

The potential for future economic benefit to this local area from fishing are encouraging. We were contacted earlier this year by the Peoria Convention and Visitors Bureau about the BassMaster Classic tournament being considered for Peoria in 1993. Based on the improvement in the largemouth bass fishery, we encouraged the Bureau to pursue this event. B.A.S.S. tournaments are held throughout the United States each year. Fishermen earn qualifying points at these tournaments and only the top qualifiers may compete in the Classic. If the tournament is held in Peoria, there will be significant economic impacts resulting from expenditures not only from the competing anglers, but these tournaments attract spectators and media coverage as well. According to marketing studies, the Classic is said to have a $17-$22 million economic impact for a host city. As a rookie biologist making fish population surveys in the Illinois River in the early '70s, if someone had told me the river would be the location of the BassMaster Classic in twenty years, I would have thought the person was joking. We hope it happens because it will create a positive focus on the Illinois River and its fishery.

Aside from the direct recreational benefits of fish and wildlife along the Illinois River, there are noteworthy returns to the economy as well. The River and its backwaters provide about 2.0 million angling days, or about 5.0 percent of the total stateside angling days (Baur, 1989). Based on an average of $20.00 spent by fishermen per angling day, this amounts to $40.0 million annually (U.S. Fish & Wildlife Service, 1989). Even though the commercial take of fish has declined (about 1.4 million pounds in 1964), 558,000 pounds of buffalo, carp, catfish, drum and other species with a wholesale value of $164,000 were harvested in 1989. In addition, 290 tons of mussels worth $321,000 were taken. Harvest of mussels has varied widely in recent years, but is down considerably from the 1,159 tons taken in 1965 (Fritz, 1990).

Hunting and trapping also contribute to the economy. In 1989, over 9,000 waterfowl stamps were sold in counties along the river. Results from the 1990 Illinois Waterfowl Hunter Survey indicate that each of the waterfowl hunters spent an average of $814 that year. Thus, the hunters spent a total of about $7.3 million (Anderson, 1991).

About 450,000 hunters pursued upland wildlife (rabbit, quail, pheasant, dove, gray partridge, woodcock, common snipe, crow and groundhog) and spent 2.6 million days afield in Illinois in 1989. In the same year, some 407,000 hunters sought forest game (squirrels, deer and turkey) and hunted 2.8 million days. Fur bearers (raccoon, fox, coyote and opossum) were hunted by 73,000 individuals who totaled 680,000 trips afield (Anderson, Campbell, and Zielske, 1990). Sixteen percent of hunting licenses are sold in Illinois River counties. Using those figures and an average daily expenditure of $30 by upland wildlife hunters, $52 for those who hunted forest game, and $4 for hunting fur bearers (Illinois Division of Wildlife Resources, 1990), the expenditures totaled $36.4 million. The value of furs taken by hunters and trappers in the 1989-1990 season in the Illinois River counties was about $70,000 (Bluett, 1991).

Fishing, hunting and nonconsumptive recreation are big business in Illinois. The total annual economic impact from fishing is estimated to be $1.6 billion; for hunting, $366 million (Griffith & Associates, Ltd., 1990). Annual nonconsumptive expenditures is estimated to be $893 million (U.S. Fish & Wildlife Service, 1989). Grand total annual expenditures are $2.86 billion. Even though the dollar values of outdoor recreation are impressive, it is very difficult to place an economic value on just how much it means to an individual to spend a day afield or afloat. Numerous surveys have pointed out that people enjoy fishing and hunting for a variety of reasons. Our sport fishing survey revealed that not only do fishermen fish for food and the sport of catching fish, but they also tell us they go to enjoy the outdoors and for peace and solitude (Baur, 1989). Perhaps those intangibles are the greatest benefit of all.

Not only are our fish and wildlife resources important economically, they are even more important from an ecological perspective. If we protect the health of our environment and the natural resources therein, we also protect human health. By considering the needs of the eagle, the smallmouth bass, and the muskrat, we consider the needs of ourselves. We must make every effort to sustain the well being of the Illinois River, because it is so fragile. We could lose its beauty and its ability to sustain its fish and wildlife. We must continue to address the problems of ammonia loading in the upper river, the loss of vegetation in the backwaters due to siltation, the potential adverse effects of future increases in barge transportation, the filling in of wetlands, the destruction of riparian vegetation, and the channelization of tributary streams.

Certainly much needs to be done to bring about improvements to aquatic and riparian habitat along the River. I believe this conference will help keep focus on those needs, and I am confident that progress in protecting and enhancing the River's fish and wildlife resources will continue.

Thank you.

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ECONOMIC IMPACT OF BARGE TRANSPORTATION

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BACKGROUND

The use of the Illinois River for transportation is not a modern development. It was used by native Americans to travel and transport goods as well as for hunting and fishing. French traders used the waterway to bring goods to trade and, later in history, it was used by explorers to investigate the interior of this country.

As the interior of the United States became settled, the river was used to transport people and their possessions to settlements in Illinois. As the development of the state continued, the river became an important avenue of commerce for the population to ship and receive goods.

HISTORY

The development of the Illinois Waterway began in 1848 when the state of Illinois opened a canal between Chicago and LaSalle. By 1916, 240,000 tons of freight were moved on the waterway. This included over 28,000 head of livestock and 1.7 million bushels of grain. It was not until 1933 that the first tow from New Orleans arrived at Chicago; however, by 1935, 620,000 tons of commerce used the Illinois Waterway. This increased to 3.5 million tons by 1943 (the first year for which we have annual records) and, in 1990, there were 45 million tons shipped and received on the waterway.

EXISTING CONDITIONS

The traffic on the Illinois Waterway is quite variable. It follows the economic cycles of the state fairly closely. The types of commodities have changed since 1916 (we don't see livestock shipped anymore). Industrial commodities now make up a significant portion of the tonnage. Traffic levels will continue to follow the cycles and the commodities will no doubt continue to change, but the Illinois Waterway is so important to the economy of this area that we do not doubt that it will continue to increase in the future similar to the way it increased in the past. Based on national projections, we expect traffic to exceed 55 million tons by 1999. That will continue to make it fourth in tonnage, exceeded only by the Mississippi, Ohio and the Gulf Intracoastal Waterway. It now carries 8 percent of the total tons carried on the inland waterways. That's as much as the Missouri, Arkansas, Columbia, and Cumberland Rivers combined. The Illinois Waterway is indeed a major transportation resource for this state.

There is a significant difference between the commodities carried on the upper and lower portions of the waterway. The upper portion from Lake Michigan to Marseilles reflects the industrial nature of the Chicago area. Petroleum products, chemicals, and steel products make up half of the commodities in that reach. From Marseilles downstream, agricultural commodities become increasingly more dominant. At the LaGrange Lock, grain is nearly half of the total. There have been some changes in this mix over the past 15 years. The decline in manufacturing has caused a related decline in the amount of coal, iron, and steel transported on the waterway. However, the biggest single decline in traffic has been in waste products. The waterway at one time carried nearly 4 million tons of sewer sludge each year. This commodity was transported from Chicago to Fulton County during the early 1970's. By 1977 it had disappeared, due to a number of reasons.

While iron and steel products and coal have declined about 15 percent over the past 15 years and sewer sludge has disappeared, grain has shown a 33 percent increase and chemicals have increased by 21 percent. The result is that total traffic is about the same. The distribution of this traffic has changed significantly, however.

The tonnage at Lockport peaked in 1974 at 27 million tons and declined until 1987. Traffic has increased over the past 3 years and was over 17 million tons last year, the highest since 1983. The transportation of coal, petroleum, chemicals, and sand and gravel should result in an increasing trend on this part of the waterway.

LaGrange, at the other end of the waterway, is quite a different story. In 1990 a new record was set with over 36 million tons going through the lock. Grain makes up 47 percent of the tons at LaGrange compared to 10 percent at Lockport. The upward trend in grain is expected to continue though not at the accelerated rate it has in the past. As those increases continue, LaGrange and Peoria are expected to reach capacity in the next ten years.

IMPORTANCE OF BARGE TRANSPORTATION

Why is this resource so important? Because the transportation savings are significant and the benefits affect so many people. The annual savings in transportation costs are presently $326 million annually. That means that those who ship and receive goods would have to pay at least that much more if the Illinois Waterway was not available. That is a very conservative estimate because it does not consider the effects of competition. We all know that competition usually results in lower prices. Without alternate modes of transportation, existing prices would increase substantially.

Let me give you some examples of the existing differences in transportation costs. It costs about $14,000 to transport a barge load of grain from Peoria to New Orleans. To transport this same tonnage by rail would cost $26,000.

Other commodities have substantial cost savings as well. Its cost almost $14 less to ship one ton of industrial chemicals from Texas to Joliet, $22 less to ship a ton of petroleum from Louisiana to Morris, Illinois, and over $13 less to ship a ton of fertilizer from Baton Rouge to Peoria. The savings in transportation costs range from 40 percent to 74 percent for most commodities.

Grain is the biggest commodity shipped on the waterway. Most of this grain goes to New Orleans for export. The savings on one bushel of corn from Peoria to New Orleans is 23 cents. That doesn't sound like much until you realize that a barge holds 52,500 bushels and there were about 7,600 barge loads shipped down the Illinois Waterway last year. This is over $90 million in cost savings that goes to Illinois corn producers and has positive impacts for the economy of Illinois and also for the U.S. balance of payments. Since Illinois is the nation's largest corn producer and nearly 70 percent of the corn exported is shipped from the Mississippi Gulf, the impacts of barge transportation become fairly obvious.

Not so obvious perhaps is the ability of other transportation modes to handle these commodities if navigation were not available. To carry the 36 million tons which went through the LaGrange Lock would require 360,000 rail cars; this during a time when these cars are in short supply. This certainly is not intended to ignore the value and the benefits of other forms of transportation. Each have their part to play in our transportation system and in providing benefits to the people of this state.

OTHER BENEFITS

The direct benefits of navigation are relatively easy to measure. However, there are far more benefits than just rate savings. Jobs are created not only by the navigation industry, but also by industries that locate here because of the availability of navigation and the lower cost of transportation. Jobs are also created as a result of the additional money available from the reduced transportation costs. The multiplier effect in the economy further benefits the state. Although we have not yet calculated all of these benefits, it is safe to say that they exceed one billion dollars a year.

In spite of some of the environmental controversy, the pools created by the dams provide a relatively constant water level and opportunities for recreation. Without the dams, the river would look quite empty during dry summer months. It would certainly be much narrower in many places. The recreation benefits of the waterway are tremendous. There is far more water surface with the dams then there would be otherwise. The visual and social benefits add value to the communities along the waterway. The river increases tourism and the river boats that keep increasing in number could not exist without the navigation system.

IMPROVEMENTS

As I mentioned earlier, the transportation cost savings from the Illinois Waterway are $326 million annually. Over the next 50 years these benefits will grow to only $383 million without any improvements on the waterway. If improvements are made as they are required, the benefits would exceed $1 billion annually in the next 50 years

Delay cost is an important component of transportation costs. The average cost of a tow that goes through the lock at Peoria is $220 an hour. As congestion increases, the tows are delayed more hours and the cost of transportation rises. It is not just lost profits to a single industry, it has an impact on all of us. In 1990, the total delays at all of the locks on the waterway exceeded 24,000 hours. These costs are eventually paid for by the consumer. These delays will rise to 12 hours per tow by 2010 without improvements. It is important that we all understand the importance of the waterway and the economic value it has for the state. Preliminary studies indicate that new locks are needed and are economically justified at Peoria and LaGrange by 2000. Improvements to the Marseilles Lock are also needed and justified by 2000. These and other improvements need to be made as the become justified in order to maintain the viability of the waterway and assure that the state continues to receive the benefits that the waterway provides.

The improvements that I refer to at Peoria and LaGrange are the addition of 1200-foot locks to the existing structures. These locks have tremendous capability to reduce delays. The existing 600-foot locks are inadequate to pass the 15 barge tows that are prevalent on the system today. While it takes about two hours to lock a tow with more than 6 barges through the existing lock, it only takes 30 minutes to lock a 15 barge tow through a 1200-foot lock.

At the Marseilles Lock, there is a 2-1/2 mile canal above the lock that is too narrow and too shallow for the traffic that is on the waterway today. As a result, tows cannot pass each other for most of its length. This causes delays to traffic using this lock.

There are also smaller scale improvements that can be made at other locks on the waterway. These improvements will delay the need for new locks or will result in efficiencies that would justify implementation. Extended guidewalls with powered kevels, guide cells, and improved approaches are the primary examples of these types of improvements.

In addition to the reductions in delay times, the improvements will provide additional benefits. They will provide jobs in the engineering, construction, manufacturing, and service sectors. They will give a boost to the cities near the construction sites. Most importantly, however, they will provide long-term benefits to the entire region.

The Illinois Waterway is a vital link in this country's navigation system. It is also a vital part of the economy of this state. The waterway provides jobs, it provides low cost transportation, it provides recreation, it improves our economy, and it improves our lives. We need to assure that it continues to do all of those things. We need to take an active interest in its future. We need to assure that the Illinois Waterway serves us even better in the future than it has in the past. I hope that you will take an active interest in the waterway's future and in the studies that will be taking place. The Illinois River is an important resource for all of us and barge transportation is an important part of that resource. With understanding and concern, we can assure that the Illinois River will continue to be a vital economic and environmental resource for this state.

TOURISM RESOURCES ALONG THE ILLINOIS RIVER

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ABSTRACT

Rural Illinois River counties lag behind the rest of rural Illinois in travel and tourism expenditures. Urban based riverboat gambling offers an opportunity to capture additional tourism revenue by expanding rural tourism efforts and adopting new marketing techniques.

INTRODUCTION

Travel and tourism have become important contributors to rural economies. Recent research indicated that historical and cultural types of tourism attractions were better economic performers in rural Illinois than were natural resource based attractions (Botkin and McGowan 1990). Various researchers are studying the effects of tourism on rural residents' perceptions of community satisfaction and quality of life (ibid., Botkin 1991, Long, Perdue and Allen 1988). Long, Perdue and Allen (1988) reported an increase in both negative and positive perceptions of tourism impacts upon community with the most statistically significant changes being an improved local perception of quality of life. The researchers hypothesized that residents' favorable attitudes toward tourism development initially would rise with increasing development but would reach a threshold that would provoke a decline. The range of between 3.6 and 10.5 percent of local retail sales derived from tourism was determined as the threshold of development where resident attitudes toward tourism development began to decline. Botkin and McGowan (1990) found the perception that tourism contributes to rural residents' quality of life to peak when tourism accounts for approximately nine percent of county retail sales. Botkin (1991) stated that the relationships among the perception that tourism contributes to quality of life, independent subjective measures of quality of life and community satisfaction

and measures of the economic impact of county travel and tourism expenditures were significantly correlated.

PURPOSES

The purposes of the study were to examine the economic contribution of travel and tourism to the economies of the 14 rural counties contiguous to the Illinois River, estimate residents' attitudes on the newest Illinois river-based tourism attraction (i.e., riverboat gambling), and measure their perceptions of quality of life, community satisfaction, and the contribution tourism makes to their quality of life.

METHODOLOGY

In the fall of 1989, a list of 12 travel and tourism modified Likert scale questions (Strongly disagree, Disagree, Neutral, Agree, Strongly agree) were included in a mailed questionnaire sent to ten thousand rural families in 76 Illinois counties (Botkin and McGowan 1990). Of significance to this study was the following question: "Tourism has increased the quality of life in this area." A total of 2,827 rural households responded and agreed to serve on the Illinois Rural Life Panel. In the spring 1990, panel members were mailed a second questionnaire. Among the questions were three modified Likert scale questions measuring community satisfaction and four questions measuring quality of life (Botkin and DiGrino 1991). In addition were 35 questions to measure the importance of and satisfaction with six dimensions of community satisfaction (i.e., health and safety, recreation and leisure composed of community social interaction factors and recreation opportunity resources, environment composed of community appearance factors and environmental conditions, formal education, economic conditions and public administration). To measure satisfaction with community economic conditions, respondents were asked to indicate their satisfaction with five elements associated with their community or the community closest to their residence. A total of 2,199 rural panel members responded. In the spring of 1991, panel members were sent a third questionnaire. Included were 11 questions on residents opinions about the anticipated effects of Illinois riverboat gambling on rural crime, traffic, tourism, jobs and economies. Panel members were also asked if they believed riverboat gambling was an appropriate business for rural communities. In all three surveys, data describing the respondents socioeconomic characteristics were also collected (e.g., age, education, income, home ownership, gender, marital status, occupational type). The responses to all questionnaires were examined for data entry errors and data abnormalities. Responses were normally distributed. Mean scores representing residents' attitudes were computed for each rural Illinois River county, for those rural counties contiguous to the Mississippi, Rock, Wabash and Ohio rivers, for rural counties which are not contiguous to a major Illinois river and statewide. To estimate the countywide economic impact of travel and tourism, a Economic Impact Indices (EIC) for rural Illinois counties was constructed using the percentage of total county retail sales accounted for by the mean travel and tourism expenditures for 1987 and 1988. Travel and tourism expenditure data for 1987 and 1988 were furnished by the Division of Research and Analysis, Illinois Department of Commerce and Community Affairs.

LIMITATIONS

Any time secondary data is utilized, caution is in order. Such is the case with the economic data used in this study. Besides the error incurred because of the difference in time between the collection of the travel and tourism and retail sales expenditure data (i.e., 1987 and 1988) and the assessment of the respondent perception data (i.e., 1990 and 1991), potential error exists because the primary unit of analysis for this study is the rural county rather than the entire state. While the statewide samples of rural Illinois residents have a level of precision of slightly better than +/- 2.5 percent, this level of precision decreases dramatically as the sample is partitioned into county groups. The range of the estimates of specific county-wide perceptions among counties is between +/- 10 percent and +/- 20 percent. Unfortunately, achieving more precise estimates for a statewide county by county comparison are currently cost prohibitive. Therefore, there is every reason to believe that there are specific rural Illinois counties whose residents' perceptions of quality of life, community satisfaction, the contribution that travel and tourism makes to quality of life and satisfaction with economic conditions are significantly different from the estimates used in this study.

RESULTS

Rural Illinois counties contiguous to the Illinois River averaged about $8.5 million in travel and tourism expenditures during the period between 1987 and 1988 (Table 1). Unlike its statewide counterparts, LaSalle county with its natural resource (NR) based tourism attractions out performed the three rural counties along the Illinois River with historic and cultural (HC) based tourism attractions by 323 percent. On a per capita (PC) basis, travel and tourism expenditures were 46 percent greater in LaSalle county than in Bureau, Fulton or Morgan counties. As was the case statewide, Illinois River counties with little or no travel and tourism industry lagged far behind both NR and HC counties.

However, rural residents in HC counties believe more strongly than residents in either NR or mixed counties that travel and tourism contributes to their quality of life (Table 1). In addition, rural residents in these three counties have a more positive perception of the quality of their lives and are more satisfied with the rural communities in which they reside than their peers living in LaSalle county or in counties with little or no existing travel and tourism industry.

When compared to rural counties contiguous to other major Illinois rivers or to landlocked rural counties, rural counties bordering the Illinois River rank no higher than third in a field of six (Table 2). Only rural counties along the Wabash and Ohio rivers are poorer travel and tourism economic performers than those along the Illinois river. In addition, rural residents on the Illinois river are less likely to believe that travel and tourism contributes to their quality of life than residents along the Rock and Mississippi rivers; have a less positive perception of the quality of their lives than all residents but those adjacent to the Ohio river; and are less satisfied with their rural communities than county residents along the Rock and Wabash rivers (Table 2).

TABLE 1. Description of counties in the Illinois river system by type of travel and tourism attraction.

ATTRACTION	COUNTY	MEAN 87/88 T&T**	MEAN 87/88 PC
NR	LASALLE	$55,739,215	$517
HC	BUREAU	$10,841,382	$296
HC	FULTON	$10,026,390	$266
HC	MORGAN	$18,663,555	$503
MIXED	BROWN	$757,016	$148
MIXED	CALHOUN	$1,556,882	$278
MIXED	CASS	$3,179,016	$230
MIXED	GREENE	$2,915,728	$186
MIXED	MARSHALL	$3,008,256	$231
MIXED	MASON	$3,469,582	$203
MIXED	PIKE	$4,279,680	$243
MIXED	PUTNAM	$1,473,863	$254
MIXED	SCHUYLER	$2,008,518	$261
MIXED	SCOTT	$1,062,689	$177
ALL	MEAN	$8,498,698	$271
NR		$55,739,218	$517
HC	MEAN	$13,177,109	$355
MIXED	MEAN	$2,371,123	$221

ATTRACTION	COUNTY	T&T & QoL*	MEAN EIC 87/88
NR	LASALLE	3.04	8.26%
HC	BUREAU	2.90	8.03%
HC	FULTON	3.02	6.15%
HC	MORGAN	2.81	8.37%
MIXED	BROWN	3.43	7.40%
MIXED	CALHOUN	2.71	9.70%
MIXED	CASS	3.07	7.38%
MIXED	GREENE	3.23	7.46%
MIXED	MARSHALL	2.93	7.81%
MIXED	MASON	3.13	7.25%
MIXED	PIKE	3.28	7.50%
MIXED	PUTNAM	3.33	9.79%
MIXED	SCHUYLER	3.44	6.82%
MIXED	SCOTT	3.15	8.11%
ALL	MEAN	3.11	7.86%
NR		3.04	8.26%
HC	MEAN	2.91	7.52%
MIXED	MEAN	3.17	7.92%

TABLE 1. Description of counties in the Illinois river system by type of travel and tourism attraction (continued).

ATTRACTION	COUNTY	QoL*	COMMUNITY SAT.*
NR	LASALLE	2.54	2.39
HC	BUREAU	2.58	2.04
HC	FULTON	2.41	2.46
HC	MORGAN	2.60	2.21
MIXED	BROWN	2.93	2.48
MIXED	CALHOUN	2.17	1.83
MIXED	CASS	2.90	2.83
MIXED	GREENE	2.58	2.28
MIXED	MARSHALL	2.50	2.00
MIXED	MASON	2.69	2.61
MIXED	PIKE	2.81	2.58
MIXED	PUTNAM	3.33	2.75
MIXED	SCHUYLER	2.43	1.71
MIXED	SCOTT	2.57	2.27
ALL	MEAN	2.65	2.32
NR		2.54	2.39
HC	MEAN	2.53	2.24
MIXED	MEAN	2.69	2.33

Likert Scale: Responses 5 (Strongly Disagree), 4 (Disagree), 3 (Neutral), 2 (Agree) & 1 (Strongly Agree).

Sources: *Illinois Rural Life Panel Surveys, November 1989 (N = 2,827) and April 1990 (N = 2,074). Funding provided by the Lt. Governor's Office, in cooperation with the Illinois Institute for Rural Affairs. **Travel and Tourism expenditure data furnished by the Division of Research and Analysis, Illinois Department of Commerce and Community Affairs.

With one exception, the attitudes of rural Illinois River residents do not significantly differ from those of other rural Illinois residents on issues concerning Riverboat Gambling (Table 3). Fewer rural Illinois River residents believe that riverboat gambling will increase traffic in either their communities or statewide in rural counties. In general, fewer than a third of rural Illinois residents believe that the fledgling Illinois riverboat gambling industry will improve rural economies. A third of rural Illinois residents believe that an increase in rural jobs will occur as the result of riverboat gambling. About 45 out of every 100 rural residents think that riverboat gambling will either improve rural tourism or increase rural crime. Out of every 100 rural residents, between ten and twenty anticipate any effect on their communities from riverboat gambling.

TABLE 2. Description using average 1987/1988 county data by Illinois River of travel and tourism economic performance and rural residents' quality of life.

RIVER	TRAVEL & TOURISM **	PER CAPITA
ROCK	$19,641,768	$407
NO RIVER	$12,623,975	$399
MISSISSIPPI	$11,804,318	$361
ILLINOIS	$8,498,698	$271
WABASH	$4,065,066	$253
OHIO	$1,592,767	$165

RIVER	T&T & QoL*	EIC
ROCK	3.00	9.76%
NO RIVER	3.01	9.05%
MISSISSIPPI	3.11	9.87%
ILLINOIS	3.11	7.86%
WABASH	3.15	6.75%
OHIO	3.36	9.33%

RIVER	QoL*	COMMUNITY SAT.*
ROCK	2.37	2.22
MISSISSIPPI	2.45	2.37
NO RIVER	2.56	2.38
WABASH	2.59	2.31
ILLINOIS	2.65	2.32
OHIO	2.74	2.40

Likert Scale: Responses 5 (Strongly Disagree), 4 (Disagree), 3 (Neutral), 2 (Agree) & 1 (Strongly Agree).

Sources: *Illinois Rural Life Panel Surveys, November 1989 (N = 2,827) and April 1990 (N = 2,074). Funding provided by the Lt. Governor's Office, in cooperation with the Illinois Institute for Rural Affairs. **Travel and Tourism expenditure data furnished by the Division of Research and Analysis, Illinois Department of Commerce and Community Affairs.

DISCUSSION

Rural counties contiguous to the Illinois River lag behind the rest of rural Illinois in travel and tourism expenditures. Problems of accessibility due to few interstate highways in the region may account for some of this. However, fledgling or nonexistent community tourism organizations in ten of the fourteen counties in the region and consequently under-developed tourism attractions account for the bulk of the poor performance.

TABLE 3. Comparison of Illinois River rural residents' attitudes concerning riverboat gambling (N= 1901).

IN RURAL ILLINOIS, RIVERBOAT GAMBLING:

	DISAGREE		NEUTRAL		AGREE	
	I.R.	ALL	I.R.	ALL	I.R.	ALL
will increase traffic	26%	25%	26%	22%	48%	53%
will improve tourism	35	36	20	19	45	45
will increase crime	28	26	31	29	41	45
will increase the number of rural jobs	44	44	22	23	34	33
will improve rural economies	43	45	27	26	30	29

IN MY RURAL COMMUNITY, RIVERBOAT GAMBLING:

	DISAGREE		NEUTRAL		AGREE	
	I.R.	ALL	I.R.	ALL	I.R.	ALL
will increase traffic	57%	49%	24%	21%	19%	20%
will improve tourism	71	70	14	16	15	14
will increase crime	50	50	28	29	22	21
will increase the number of rural jobs	73	74	17	16	10	10
will improve its rural economy	68	68	20	20	12	12

RIVERBOAT GAMBLING IS AN APPROPRIATE BUSINESS FOR RURAL COMMUNITIES

DISAGREE		NEUTRAL		AGREE	
I.R.	ALL	I.R.	ALL	I.R.	ALL
50%	51%	30%	27%	20%	22%

I.R.: residents in rural Illinois River counties
ALL: rural residents statewide
Collapsed five part Likert Scale: Disagree = responses 1(Strongly Disagree) & 2 (Disagree), Neutral = response 3, and Agree = responses 4 (Agree) & 5 (Strongly Agree).

Source: Illinois Rural Life Panel Survey, April 1991. Funding provided by the Lt. Governor's Office, in cooperation with the Illinois Institute for Rural Affairs.

While urban based, Riverboat Gambling provides a catalysis that rural communities along the Illinois River can use to enhance their rural tourism potential. The increase in visitation to East Peoria and Joliet offers an excellent opportunity for rural communities to market new historical and cultural tourism attractions which would appeal to urban residents already primed for an unique leisure activity (i.e., riverboat gambling) associated with the river resource. One of the reasons that tourism in LaSalle county has been successful is the optimization of the tourism resources and opportunities it contains. A strong positive relationship exists between the holistic marketing of its community festivals, special events associated with its State Parks and Lodges, outdoor recreation opportunities, federal and state visitor centers and riverboat excursions and the significant travel and tourism expenditures supplementing its economy. Integrating the newest regional attraction into the development and marketing of tourism attractions in the rest of the thirteen rural Illinois river counties can not but help their efforts.

To facilitate this effort, private entrepreneurs and the public sector should initiate the following: (1) establish a regional taskforce unconstrained by artificial governmental units and boundaries to develop marketing initiatives designed to capitalize on the upcoming onslaught of new tourism visitors inroute to urban riverboat ports; (2) develop and schedule new river-based tourism events which will appeal to primarily urban visitors, complement their riverboat gambling experience and entice them to visit overnight rural communities along the Illinois River; (3) develop a working partnership with the Riverboat Gambling industry to facilitate the development of package tours preferably by motorcoach or rail which take advantage of these new tourism initiatives; and (4) initiate a strategy of monitoring and evaluating the success of all new initiatives to ensure efficient market corrections, minimize wasted financial resources and strengthen the public's perceptions of the positive economic benefits accruing to rural communities from public and private investment partnerships.

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INTERJURISDICTIONAL RIVERS AND RESOURCES
A U.S. FISH AND WILDLIFE SERVICE PERSPECTIVE

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I would like to begin my presentation by telling you about a meeting that recently occurred in Illinois that holds great promise for the State. Mr. Brent Manning, Director of the Illinois Department of Conservation invited the U.S. Fish and Wildlife Service (Service) and the U.S. Army Corps of Engineers to participate in a meeting to discuss ways to develop partnerships to protect riverine habitats. A number of projects were discussed during the meeting including:

Kaskaskia River Basin--Is the largest river basin wholly contained in Illinois. The river This river basin stretches 325 miles from central to southern Illinois and covers an area of 5840 square miles. Two multi-purpose reservoirs are contained in the basin Carlyle Lake and Lake Shelbyville. This river basin holds tremendous environmental and economic opportunities.

Mississippi River Fish and Wildlife Areas--The Illinois Department of Conservation manages extensive lands along the Mississippi River for fish and wildlife recreation and resource programs, through a cooperative agreement with the Service. The potential for increased natural resource management and habitat improvement is significant.

Calhoun Point--Is a major environmental restoration project located at the confluence of the Illinois and Mississippi rivers. Plans include wetland enhancement, dike construction, permanent pumping stations and various water control structures.

Yellowbanks--Is in a "Preliminary Project Proposal" stage for consideration as a National Fish and Wildlife Refuge to preserve bottomland hardwood and wetland communities. Yellowbanks is located along the juncture of the Wabash and Ohio rivers. A local group is developing an Agriculture Conservation and Environmental

Center to demonstrate conservation tillage for sustainable, environmentally sound, and economically feasible agricultural practices.

The agencies agreed to form a Task Force to further develop these ideas into a number of specific initiatives. The criteria for projects will include:

- Marketability
- Ecological benefits
- Holistic approaches, and
- Ability to serve as models for other partnerships.

Jim Gritman, our Region 3 director, commented that two constraints limit the ability of partnership activities to restore the Illinois River ecosystems: lack of initiative, and lack of creativity. Knowing Jim and his staff, I can assure you that these constraints will not be a factor and the Service will work cooperatively to meet Director Mannings challenge.

Nonindigenous Species

An increasing management concern in the Illinois and other major river systems are the occurrence of nonindigenous species, especially now that zebra mussels are spreading beyond the Great Lakes. To address the problem of unintentional introductions of nonindigenous aquatic species and to lay a foundation for dealing more effectively with intentional introductions, Congress passed the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 late last year. This important new statutory authority--Public Law 101-646--created an intergovernmental Aquatic Nuisance Species Task Force to develop and implement a comprehensive, nationwide program to reduce the risk of the unintentional introduction and spread of nonindigenous aquatic species, and to control any aquatic nuisance species that become established. The Task Force is co-chaired by the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration and involves five other Federal agencies and eight representatives of other governmental entities. Good progress is being made in developing the Aquatic Nuisance Species Program required by the Act and in implementing its other requirements.

The zebra mussel infestation originated in the Great Lakes in 1986 as a result of ballast water discharges and has now spread to adjacent river basins, including the Illinois system. It has had massive, immediate impacts on water users in the Great Lakes and there is substantial concern regarding impacts to fisheries, other natural resources, and on basic ecological processes. One estimate suggests the economic impact of zebra mussels in the Great Lakes alone could reach $5 billion by the turn of the century.

The Federal government, as well as State and local governments, the private sector and Canadian interests, have initiated many programs and efforts to minimize the effects of the infestation on water users and to better understand this organism and its environmental effects. The Fish and Wildlife Service along with the Illinois Natural History Survey and others are establishing coordinated programs to monitor the spread of the infestation to new areas. Such monitoring is intended to provide

early warning of the presence of zebra mussels to those likely to be affected allowing them to promptly initiate protective actions.

Zebra mussels are likely to create major new problems for the management of the Illinois and other river systems. We will continue to cooperate with all concerned to find effective, environmentally-sound means to respond to this problem.

Throughout history our Nation's river systems have been utilized for transportation, waste disposal, domestic, industrial and agricultural water supply, hydropower production and electrical generation, commercial subsistence, and recreational fishing and hunting, and non-consumptive recreation. These rivers comprise 3.5 million miles of inland waterways and our dependance on these rivers has increased with time. Along with increased dependence came the need to physically alter rivers to provide stable flows and channels for navigation, provide a water supply, and to reduce flooding of communities and agricultural lands. We recently have become aware of the impacts our activities have had upon fish and wildlife resources, yet, we continue to modify stream channels, control flow, and dispose of our wastes in the aquatic environment. Consequently instream habitats, as well as adjacent wetland and riparian habitats, are no longer capable of supporting historic fish and wildlife populations. Habitats associated with river corridors provide refuge for many fish and wildlife resources. Roughly one-third of all Federally listed threatened and endangered species rely on water and/or riparian lands. The Service is greatly concerned and involved with the protection of river habitat for fish and wildlife resources. Barriers and destruction of riparian habitat pose a significant threat to natural resources associated with river ecosystems. A high quality aquatic environment is essential for fish and other aquatic organisms, and for the quality of associated wetland and riparian habitats.

The Service has significantly expanded our fisheries management capabilities by establishing Fishery Management field stations throughout the country. Today, 49 of these stations work closely with numerous public and private cooperators for the benefit of fishery resources. Sixteen of these stations have River Coordinators who focus their work almost exclusively on the restoration of major river systems. These biologists are well versed in fishery biology, hydrology, biopolitics, and environmental economics; all of which are required for this specialized work. Many of the beneficial riverine fisheries programs in which our River Coordinators are involved have directly benefitted other aspects of river ecosystems. The most notable is the maintenance of flow regimes.

The Service's National Fish Hatchery System consists of 78 fish hatcheries, 6 of which serve as fish technology centers, and 9 fish health centers. These facilities are managed to produce and distribute about 60 species of fish for six major fish cultural programs the Service has identified as warranting Federal responsibility and stewardship. These programs include; Pacific salmonids, Atlantic salmon, Anadromous striped bass, Great Lakes Lake trout, Inland species, and Endangered and threatened species. While the Service continues to place significant emphasis on the hatchery aspects of our fish management activities, emphasis is now on quality versus quantity of hatchery fish. We are producing the healthiest fish possible,

maintaining genetic variation and suitability, and assisting State and other cooperators with transfer of new technology.

The Service continues to have an active role in the restoration and conservation of anadromous species inhabiting interjurisdictional rivers. Service involvement has ranged from rearing and stocking of juvenile salmon, to habitat and stock assessment, coordination and comprehensive planning, and research and technology development.

Trinity River

The Trinity River in Northern California is one example where the Service is taking an active role in the restoration and conservation of anadromous species. The Trinity River Fish and Wildlife Restoration Program, is an ecosystem-wide effort to restore extremely important runs of Pacific salmon and steelhead and to concurrently enhance wildlife resources. The Service and the numerous cooperators recognize that the conditions from mountain top to sea dictate the productivity of streams that connect the two. Restoration efforts include establishing formal agreements by land managers to be better stewards of existing high quality habitat through tighter controls on logging, grazing, road-building, and recreation. These efforts include addressing "loaded-guns" such as road cuts and undersized culverts on fragile, erodible slopes, that can result in massive slumping and revegetating and reshaping chronic soil erosion sites. Most of these watershed restoration efforts have direct benefits to wildlife and secondary benefits to dish. Within the stream, this restoration program is implementing such measures as dredging filled-in pools, importing spawning gravel, constructing side channels to provide natural rearing areas for juvenile fish, and feathering back banks that have become chiseled, vertical banks.

In May 1991, the Secretary of the Interior signed a decision document that dramatically improved streamflows in the Trinity River, during a designated critically dry year! This flow change is the result of 2 years of broad based, multi-agency cooperation that was initiated by Native Americans. These negotiations were based upon sound biological and hydrological data that is being collected and analyzed by the Service and the California Department of Fish and Game, and was resolved by an interagency negotiation team representing the Bureau of Indian Affairs, Bureau of Reclamation, and the Service.

The key to the success of the Trinity River program is that it is fixing the root problems that have caused fish and wildlife impacts (land use practices and flow reductions) and it is proactively manipulating habitat to hasten recovery. The Service recognizes that manipulating disturbed habitat without concurrently eliminating the source of the perturbation is a waste of time and money.

Russian River Restoration

The Russian River is a coastal watershed in California that has been dramatically impacted by water diversions, dams, water pollution, and floodplain/riparian encroachment by increased population. The first step in restoring this river has been to convince Congress that there is a problem, that a partnership

of federal, state, and local governments as well as private interest groups is the best vehicle for implementing solutions, and that a detailed evaluation of resource status, restoration options, and costs and benefits is needed. Congress passed the Russian River Study Act that authorizes federal funds to establish partnerships, gather available information, conduct needed investigations and develop recommendations for restoring fishery resources. The challenge now is to seek and obtain funding to implement provisions of the Russian River Study Act.

Chehalis River Basin Restoration

The Service is implementing the provisions of the Washington State Chehalis River Basin Fishery Resources Study and Restoration Act. This act was spearheaded by local members of Congress at the request of their concerned constituents. This grass roots support for the program has created tremendous public interest and involvement in implementing the Act. The process for the Chehalis is similar to that of the Russian River; i.e. determine causes of problems, develop action alternatives for addressing the problems, and estimating costs and benefits of the potential actions. The Service obtained the necessary funds to initiate these activities through a coalition of Administration and Congressional interests. In implementing provisions of the Act, the Service is again focusing heavily on developing partnerships with various government agencies, Native Americans and the private sector. Only with this broad involvement can such programs establish and maintain momentum and eventually achieve success.

Connecticut River

The Connecticut River is currently undergoing an active fish restoration program with emphasis placed on Atlantic salmon and American shad. This cooperative effort involves the States of Connecticut, Massachusetts, New Hampshire, and Vermont, the National Marine Fisheries Service and the Service and dates back to 1965 and the passage of the Anadromous Fish Conservation Act. The program has been successful in providing fish passage facilities at major barriers, increasing needed hatchery stockings of salmon, and establishing and increasing runs of anadromous species.

Dam construction on the mainstream Connecticut River at Turners Falls, Massachusetts, in 1798 blocked the upstream passage of Atlantic salmon to spawning grounds as far North as Beecher Falls, near the Canadian border. Passage to American shad, blueback herring, and shortnosed sturgeon, now an endangered species, was also blocked by construction of this dam. Subsequent dams on the river has further reduced the anadromous fish productivity of the Connecticut River. Attempts made during the 1940's to provide upstream fish passage were unsuccessful due to poor entrance location, insufficient attraction water and excessive pool turbulence. The first successful passage of fish along the Connecticut River occurred during the 1950's. Committees for Fisheries Management of the Connecticut River Basin were formed after passage of the Anadromous Fish Conservation Act of 1965. These committees were composed of representatives from States along the River and the Federal Government, and are still functioning today. Presently, upstream fish passage facilities are functioning on all hydroelectric facilities on the mainstem Connecticut River.

The need for downstream fish passage was first documented in the written record in 1968. A Memorandum of Agreement for downstream fish passage in the Connecticut River was signed in 1990 by the Power Utilities, the Connecticut River Salmon Commission, the National Marine Fisheries Service, the Service, and States (CT, MA, NH, VT) along the River. In these agreements the Power Utilities committed to the study and installation of downstream fish passage facilities at 5 hydroelectric projects. The first direct benefits for downstream fish passage is expected in 1992.

The patient and persistent commitment of Federal, State, Local, and Private organizations has resulted in the current on-going success in restoring Atlantic salmon and American Shad to the Connecticut River. Improvements in water quality to the River following enactment of the Clean Water Act has also been instrumental in allowing returns of these anadromous fish to the Connecticut River.

Federal Energy Regulatory Commission

Today, hydroelectric facilities are regulated by the Federal Energy Regulatory Commission (FERC). FERC has 1,063 hydroelectric licenses in effect across the Nation. Over 260 hydropower licenses have or will expire during the next ten years. Most of the relicensing activity will occur in the Northeast and Midwest. Relicensing will affect over 135 major river systems throughout the country, including the Connecticut River, Shenandoah River, Mississippi River, and the Snake River. The impact of relicensing or licensing old existing projects for the first time will significantly affect a wide array of fish and wildlife resources and river systems. For example, in Michigan these projects affect 24 States, and 49 river systems. They block over 1,500 miles of river to anadromous fish passage while 756 miles of river are directly affected either by impoundment or controlled by operations.

This reauthorization processed will involve extensive and complex evaluations and negotiations over the continued protection of affected fish and wildlife and their habitats. Water quality, instream flows, reservoir water fluctuations, entrainment and impingement, fish passage, endangered species, and recreation are concerns which must be addressed. The Service believes that downstream passage for anadromous fish must be provided at hydroelectric facilities in addition to upstream passage. Presently, FERC is questioning the Service's authority to require downstream fish passage at these facilities.

Until recently, the Service has not consistently focused its attention on the broad based conservation of aquatic resources associated with interjurisdictional rivers. This in part is due to the Service's role in responding to habitats that have become degraded or destroyed and fish populations in need of rehabilitation or restoration. Effective conservation efforts require a shift from reactive to proactive management with the realization that ecosystem management must occur rather than single resource management. The Service recognizes this need for management of ecosystems and biological communities. Conservation strategies for the preservation of America's natural resources must be developed. Partnerships must be developed between Federal, State, Native American, local governments, and an interested public. Cooperative management on river systems has and will result in the restoration and enhancement of fish, wildlife, and their habitats.

MICRA

The Service is currently a partner in several programs that employ this concept of ecosystem management. One example is the Mississippi Interstate Cooperative Agreement (MICRA). The Service is assisting 29 States, in assessing the Mississippi River drainage fishery resources and habitat requirements to protect, maintain, and enhance interstate fish species in the basin.

The MICRA Mission Statement is "Improve the conservation, development, management and utilization of interjurisdictional fishery resources in the Mississippi River Basin through improved coordination and communication among the responsible management entities."

MICRA will improve information bases and data management, communication and coordination, while eliminating duplication of effort and achieving overall cost savings to taxpayers and user groups.

A draft Comprehensive Strategy Plan has been produced establishing basin-wide goals, objectives, and tasks. The strategic plan identifies 10 goals, 29 objectives, and 129 tasks. The Comprehensive Strategic Plan will be supplemented by Species Sub-Plans and Watershed Sub-Plans, which will address specific fishery and aquatic habitat management problems throughout the Basin.

To date, 28 of the 29 State conservation departments have signed on as participants to MICRA, A total of 139 entities have recently been contacted for their participation in MICRA, including: 9 Federal agencies, 2 U.S. independent agencies; 4 interstate commissions; 86 Indian tribes; and 38 utility companies.

Upper Mississippi River System EMP

The Long Term Resource Monitoring Program for the Upper Mississippi River System is being implemented by the Service in cooperation with the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin with guidance and overall Program responsibility provided by the U.S. Army Corps of Engineers. The Program was authorized under the Water Resources Development Act of 1986 as an element of The U.S. Army Corps of Engineers Environmental Management Program.

The mission of the Program is to provide decision-makers with the necessary information to maintain the Upper Mississippi River System as a viable large river ecosystem given its multiple use character. Congress has declared the system as both a nationally significant ecosystem and a commercial navigation system. Long term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.

Resource data is being collected on five separate 25-30 mile reaches of the Mississippi and one reach of the Illinois River to document system wide trends. Key resources being monitored include water, sediment, invertebrates, fish, vegetation, land cover, and land use.

Resource problems being investigated include impacts of navigation, sedimentation, water level fluctuations, and the lack of aquatic vegetation and reduced fish populations in the Mississippi River for their impact to the System.

Missouri River

Presently, the Service has undertaken a new program initiative on the Missouri River entitled Missouri River-Conserving a River ecosystem (MOR-CARE), "A Missouri River Partnership." The goal is to facilitate, in cooperation with interested governmental, Tribal and private parties, the optimal recovery of the natural values and environmental health of the Missouri River ecosystem, for the benefit of basin residents, consistent with existing resource uses.

Over the last 50 years, the Missouri River has lost 95 percent of it's original wetlands, 90 percent of it's sand bars, 75 percent of it's stream surface area, 66 percent of wooded riparian habitat, and nearly all of the riparian wet prairie habitat. As a result, 21 percent of the native fish species and numerous other plant and animal species have been eliminated or depleted to critically low levels. Over 900 miles of the upper river have been converted into multi-purpose reservoir pools. The lower 733 miles consist of a constricted navigation channel, with regulated flows released from upstream reservoirs.

The objectives of the Service's Missouri River Program are to:

- To facilitate establishment of, and to coordinate, an operational Missouri River environmental resources management, restoration and enhancement program involving Federal, State, Tribal and local governments, and an interested public.

- To coordinate preparation of a comprehensive action plan for the management, restoration, and enhancement of fish, wildlife and related habitats within the Missouri River Ecosystem, and facilitate its implementation.

- To develop and implement plans for providing optimal fish and wildlife resource-based recreational opportunities for people within the Missouri River Ecosystem.

- To establish a functional outreach program to involve and exchange information with the public concerning problems, opportunities and resource restoration needs in the Missouri River Ecosystem.

The Missouri River Partnership will be a basinwide effort that will include coordination among the States of Wyoming, Montana, North Dakota, South Dakota, Nebraska, Iowa, Kansas, and Missouri, other Federal agencies, Indian tribes, local governments, private organizations, and the public.

The Missouri River Basin Fish and Wildlife Restoration Act represents legislation that is being developed for Congressional consideration to support the Service's Missouri River Initiative. Support among constituencies for the draft

legislation has been expressed. Introduction of the legislation to Congress will likely occur in early 1992. Legislation is not needed to provide authority to the Service to conduct the Missouri River initiative, however, it will provide a higher profile, promote the establishment of partnerships, and provide the appropriations needed to adequately implement the initiative.

The Service has started conducting presentations to the States and other entities to discuss the basics of the initiative and determine what the needs and concerns of the States are so they can be incorporated into a Conceptual Plan. Conservation of America's River Ecosystems (CARE).

In 1993, the Service proposes to consolidate and expand its large river work initiated in 1991 and 1992 into a National program of Conservation of America's River Ecosystems (CARE). The CARE program will:

- Develop a comprehensive National Interjurisdictional Rivers Action Plan to ensure ongoing and proposed programs are coordinated and focused on environmental issues, cooperative management, restoration, and enhancement programs for fish, wildlife, and related habitats;

- Coordinate preparation of comprehensive action plans on specific rivers for the cooperative management, restoration, and enhancement of fish, wildlife, and related habitats within entire river ecosystems. For 1993, the Connecticut, Missouri, Lower Mississippi, and Yukon River ecosystems will be emphasized;

- Develop and implement plans for providing optimal fish and wildlife resource-based recreational opportunities for people within these specific river systems; and

- Establish a wide ranging public education and outreach program to involve and exchange data and information with the public concerning problems, opportunities, and resource restoration needs within and between specific river ecosystems.

In summary, I perceive a real "window of opportunity" for Americas rivers. The Service is pursuing the concept of ecosystem management on interjurisdictional rivers for the conservation of their diverse fish, aquatic, and wildlife resources and their habitats. The future of our fish and wildlife resources will be determined by the leadership, persistence, scientific curiosity, and a dynamic "risk-taking" spirit we exhibit today. We are seeking to participate, facilitate, and/or act as a catalyst for the forging of new partnerships directed at promoting the rediscovery and conservation of America's River Ecosystems. The Conservation of America's River Ecosystems--lets CARE for America's Future.

PHYSICAL CHANGES DUE TO NAVIGATION IN THE UPPER MISSISSIPPI RIVER SYSTEM

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ABSTRACT

The Mississippi, Illinois, Ohio, and Missouri Rivers are used extensively for the transport of goods and commodities, as well as for recreational activities. The Upper Mississippi River System, extending from its confluence with the Ohio River to its headwaters near St. Paul, Minnesota, is used extensively by commercial barge traffic with typical configurations of about 32.1 by about 335.5 meters (m) in plan form, with a draft of 2.74 m. A barge convoy such as this can move up and down the river at speeds from about 1.35 to 4.4 meters per second (m/sec). Movement of such a body through a river whose cross section in low-flow conditions can be as little as 275 by 3 to 4 m creates significant temporary disturbances of the river environment.

The changes in the river environment resulting from the movement of such traffic may include creation of waves and drawdown, altered velocity and pressure regimes, resuspension and lateral movement of sediment, and temporary changes in flow direction due to the return flow. Research has been initiated to determine the physical changes associated with navigation within the Illinois and Mississippi Rivers. Field data on various hydraulic and sediment resuspension characteristics have been collected and analyzed to determine functional relationships. These physical relationships will be used in the biological models to identify and determine changes in the aquatic environment due to navigation traffic. This paper discusses some of the physical changes in a large river environment due to navigation traffic. Biological effects of navigation are given in a companion paper that follows this article.

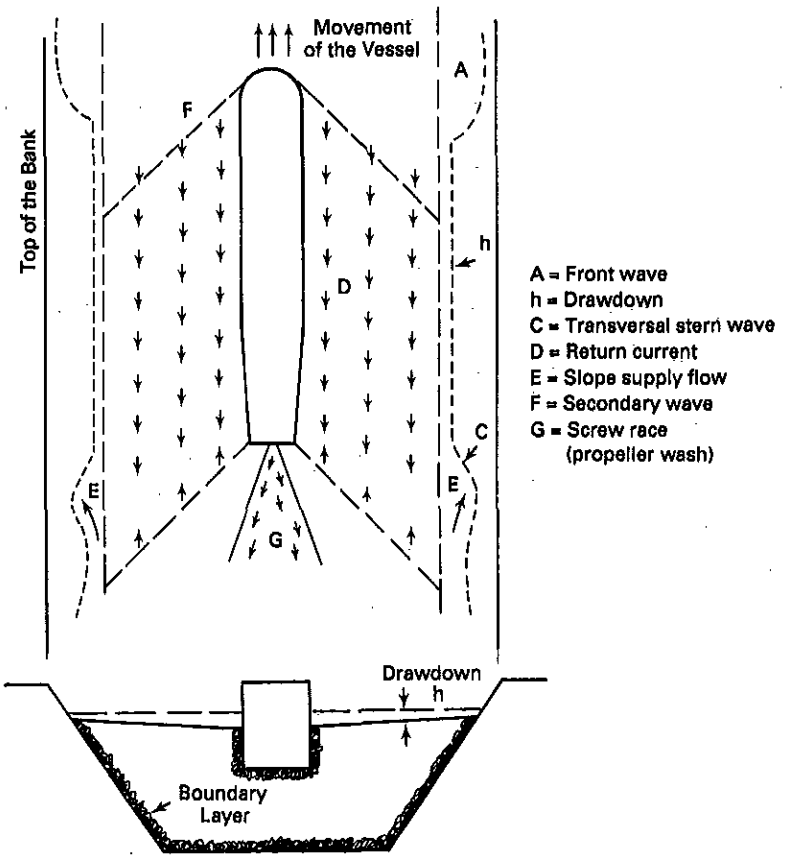

Fig. 1. Schematic Diagram showing the water motion generated by a ship (after Blaauw et al. 1984)

INTRODUCTION

Movement of barge traffic in a restricted waterway is associated with substantial physical changes within the waterway environment. These physical changes are normally temporary in space and time, but their impacts can last for a substantial amount of time, depending on the physical proximity of the various riverine habitats. Some of these changes can affect important biological habitats such as fish spawning areas, macrophyte beds, and ichthyplankton in the water. When a barge-tow configuration moves through the water, it experiences resistance. The consequence of overcoming this resistance is the development and initiation of a number of physical changes that are shown schematically in figure 1, after Blaauw et al., 1984.

If this solid body moves within stagnant surroundings, then a wave train will move with the vessel, which is shown in figure 1 as the front wave, A. With this movement of water, flow around the vessel will accelerate in the direction opposite which the vessel is moving (return current D); and to maintain the continuity, the water level will drop within the channel as shown by drawdown Δh. Slope supply flow E and transversal stern wave C more or less move with the vessel's movement. Other important physical changes include the prop wash, shown as G in figure 1. The various physical changes may or may not be noticeable in all waterways because

of variations in their physical dimensions and the speed at which the vessel is moving. The return flow D shown in figure 1 is rarely parallel to the shore, and the interaction of various physical forces will generate a complex flow pattern around the vessel and near the shores (Bhowmik and Mazumder 1990).

Current research by the Illinois State Water Survey is attempting to determine the various physical changes that are associated with navigation traffic in the Upper Mississippi River System (UMRS). This research is being conducted as part of the Environmental Management Plan of the U.S. Army Corps of Engineers and sponsored through the U.S. Fish and Wildlife Service (USFWS). This research is instrumental in the development of appropriate management alternatives for the UMRS, which includes the Illinois River. Data collection techniques and results are included in this paper to illustrate the patterns and types of hydraulic and physical changes that occur when a barge tow moves through a restricted waterway such as the Illinois River.

DATA COLLECTION

Field data for this project were collected from both the Illinois and Mississippi Rivers, using collection techniques given by Soong, Bogner, and Reichelt (1990). Velocity data were collected by utilizing two-dimensional electromagnetic current meters, such as the Interocean S4 and the Marsh-McBirney 527 and 511. All of these meters measure two horizontal components of velocity data with a collection frequency of one second. All the velocity data were collected from three to eight locations on one side of the river at one to three transects. Three to thirteen meters were utilized to collect the velocity data. All the raw velocity data were stored in field computers before being transferred to the mainframe for final analyses.

Suspended sediment data were collected by utilizing pump samplers at three to four locations and at two to three points in each vertical location. Sampling frequency was 3 minutes during a barge-tow event and 25 minutes at other times. All the suspended sediment samples, including samples for particle-size distributions, were analyzed in the laboratory. These data were subsequently used to determine changes in suspended sediment concentrations during a barge-tow event.

Wave and drawdown data were collected by utilizing a wave gage that was designed, developed, and built at the Water Survey. Other data included river characteristics, background information, barge-tow characteristics, and site characteristics. Following are some of the results.

Suspended Sediment

Point-integrated suspended sediment samples indicated that when a barge tow moves in a navigable waterway such as the Illinois River, it can resuspend sediment in the channel border areas. Increased concentrations of these resuspended sediments can last for several minutes to more than 30 to 40 minutes, depending on the traffic characteristics and the location from which samples were collected. Figure 2 shows the sediment concentration for a set of data collected on October 13, 1990, from two elevations at a single vertical location on the right side of

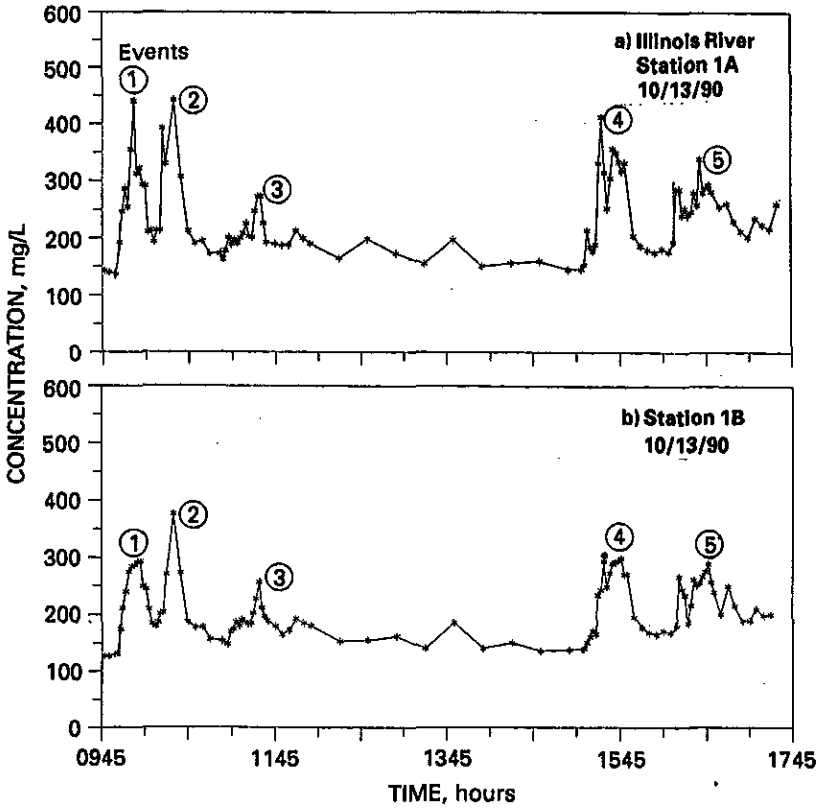

Fig. 2 Variation in suspended sediment concentrations, Illinois River near Kampsville

the Illinois River (River Mile 35), looking downstream. Station 1A was located at 0.15 m above the bed and station 1B was located 0.46 m above the bed; both stations were located 7.6 m from the shore.

On this particular day, five barges passed the test site between about 0945 to 1745 hours. This figure shows five major peaks, which correspond to each barge-tow event. Moreover, the background sediment concentration was approximately equal to 160 milligrams per liter (mg/l) at both elevations. Events 1, 2, and 4 were associated with higher increases in sediment concentrations at station 1A, which were close to 450 mg/l. However, at station 1B the maximum increases in sediment concentrations were less than at station 1A for all corresponding events. Thus, station 1A, which was closer to the bed, experienced greater increases in sediment concentration than did station 1B. This type of variability was observed for numerous other events at many other sites and locations.

Barge-tow movements that can temporarily alter the flow characteristics by changing velocities can and will resuspend some of the fine materials on the bed. Increases in resuspension are higher near the bed than farther from it. This is expected to happen because once the bed materials are resuspended, they tend to remain in suspension near the bed by virtue of vertical component of the turbulent fluctuations of velocities. The increased suspended sediment concentrations ranged from 20 to 50 minutes in duration at station 1A, and from 30 to 80 minutes at station

1B for all five events. The maximum increase in sediment concentration occurred with event 1 at both elevations. These increases were on the order of 300 percent at station 1A and 200 percent at station 1B. At the same time, the average ambient sediment concentration was about 135 mg/l in the early morning hours before any barge tow passed the site. The ambient sediment concentration near the end of the day, at about 1740 hours, was 260 mg/l at station 1A and 200 mg/l at station 1B. Increases in ambient suspended sediment concentrations were also observed on other days with comparable barge-tow traffic.

TURBULENCE AND VELOCITIES

The return flow patterns shown in figure 1 are neither steady nor constant. Disturbances created by the barge-tow events are associated with turbulent fluctuations of velocities. The magnitude and duration of turbulent fluctuations and flow velocities depend on traffic characteristics and the morphometry of the river reach. Altered velocity fluctuations due to two barge-tow events, one moving downstream and one moving upstream, are shown in figure 3.

The data were collected with a series of three current meters installed at a distance of 33.5 m from the shore in a vertical array 0.3, 1.2, and 2.4 m above the bed. Event 1 consists of 14 barges (three by five less one) with a draft of 2.74 m moving downstream at a speed of 2.77 meters per second (m/s). Event 2 consists of 12 barges (3 by 4) moving upstream at a speed of 2.19 m/s with an effective draft of 1.68 m. This figure amply illustrates what happens in the flow field when barges such as these move in the river.

As the barge tow moved downstream during event 1, the component of the return flows parallel to the shoreline started to move in the upstream direction, decreasing the ambient velocity from about 0.28 to 0.03 m/s at meter 1, (0.3 m above the bed). The duration of this disturbance was about 5 minutes. At meters 2 and 3, located 1.2 and 2.4 m above the bed, respectively, the corresponding decrease in velocities ranged from 0.34 and 0.46 m/s to 0.04 and 0.23 m/s, respectively.

Illustrations such as figure 3 are extremely important in the evaluation of physical changes associated with navigation. They show that return flows occur at all vertical elevations and that the magnitude of the net return velocities is similar at all elevations. This point is further illustrated in the same figure for event 2, in which the barge tow was moving upstream. This upstream movement of the barge tow was associated with a return flow in the opposite direction--downstream in this case. Consequently, the flow velocities increased at all three elevations from about 0.28 to 0.60 m/s at meter 1, 0.34 to 0.68 m/s at meter 2, and 0.46 to 0.68 m/s at meter 3. Again, the relative increase was similar at all elevations except near the surface, where it was somewhat smaller in magnitude.

The purpose of showing the results from two events, one moving in the downstream direction and another in the upstream direction, is to illustrate the fact that even though these two events occurred within a period of 13 to 14 minutes, the flow characteristics between the barges and the shoreline changed completely in response to the characteristics of the particular traffic, including its direction of movement.

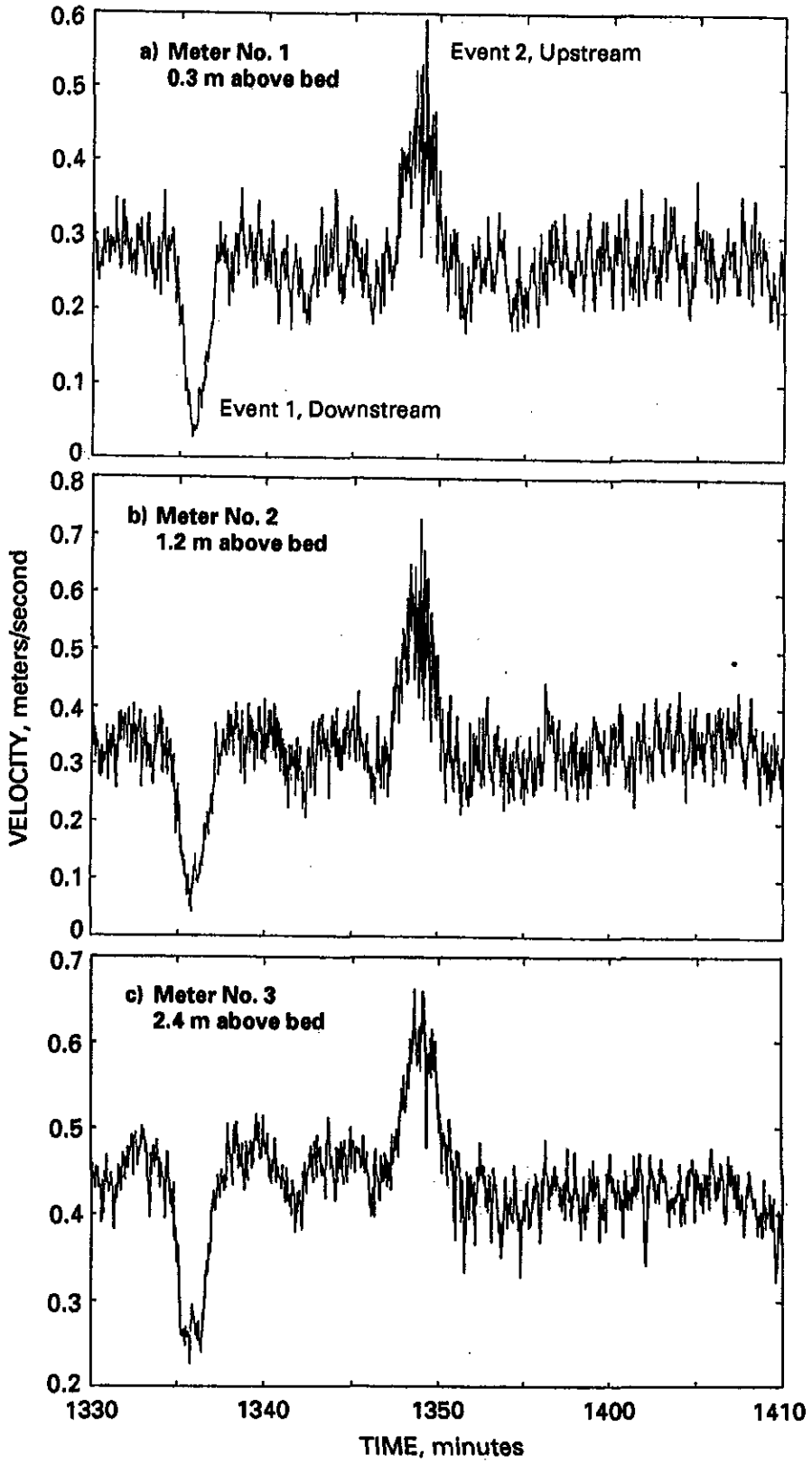

Fig. 3 Velocity changes at a single vertical due to the downstream and upstream movement of barge tows

Similar variabilities in flows were observed for many other events at this and other sites. In general, the maximum observed changes in flows occurred at a point equal to about 20 percent of the width of the river from the shore, where the magnitude of the return velocities was approximately equal to the ambient velocities. Thus, the velocities at this point were about zero for a certain period of time. After this temporary period of stagnation, the ambient velocity became strong enough to re-establish the flow patterns. Analyses of many lateral velocity distribution data have shown that the distribution of the lateral velocities follows two distinct patterns. This conceptual formulation is shown in figure 4. The lateral velocity distribution is parabolic from the shore to the 20 percent point and then is approximately linear up to the side of the barge. The distribution remains symmetrical on both sides of the river, especially in a straight reach. Based on this formulation and the field data, a new mathematical formulation has been developed and proposed for determining the return flow distribution in a straight reach of a river such as the Illinois (Bhowmik et al. 1991).

Analysis of the turbulent fluctuations of velocities (as shown in figure 3) has shown the turbulence associated with the barge tow event is normally much higher than that associated with the ambient flow in the river (Mazumder et al. 1991).

DRAWDOWN AND WAVES

As the vessel moves forward it pushes water, whose motion then accelerates beside and beneath the barge. At the same time, the propellers suck a large amount of water from beneath the vessel. As water movement accelerates, a drop in pressure results. The kinetic energy of water increases, while the potential energy decreases. The decrease in potential energy and pressure manifest themselves in a water-level depression. As the water level drops, the vessel also drops down in a process known as "squat." The lowered water level in the entire flow field is known as "drawdown." Channel constrictions, both in depth and width, greatly increase drawdown, since the flow in restricted channels is accelerated more than that in

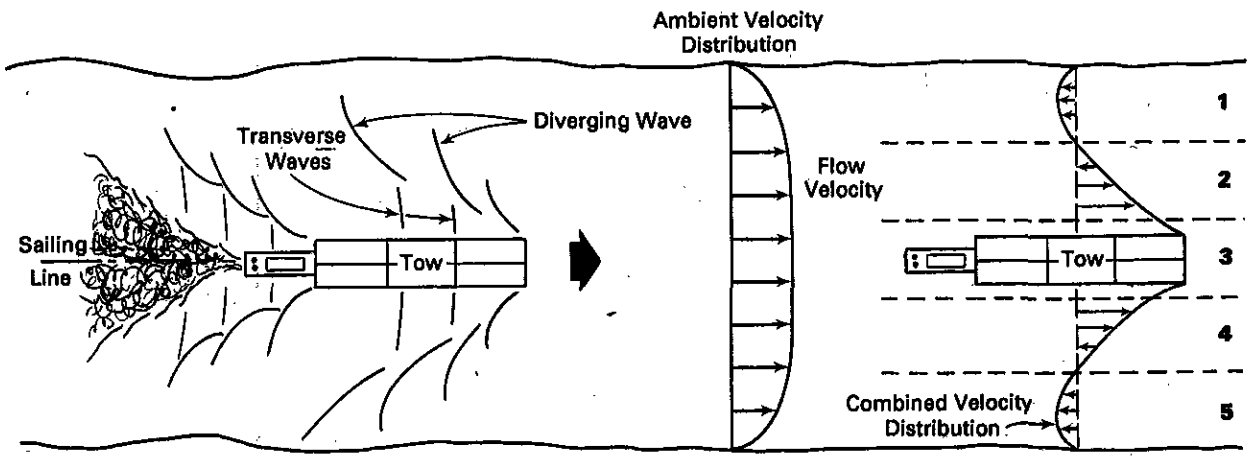

Fig. 4 Conceptual distribution of return velocity across the width of a channel due to the movement of barge tows

unrestricted channels. If the vessel moves near the shore, drawdown will be higher in the region between the vessel and the shore than it would be if the vessel moved through the mid-section of the channel. Based on a fairly small set of data, Bhowmik et al. (1981) developed a regression type of equation to determine drawdown. The data collected for the present project have shown that drawdown could vary from about 0.05 to 0.3 m, with the majority of drawdown ranging in the order of 0.1 m.

When a barge moves through water, a system of bow waves and wakes is formed at the water surface. In general, the system consists of two sets of diverging waves and one set of transverse waves. The diverging waves move forward and outward from the vessel, while the transverse waves move in the direction the vessel is moving. The transverse waves meet the diverging waves on both sides of the vessel along two sets of "cusp lines," which form angles of 19°21′ with the vessel trackline for a point disturbance moving with a constant velocity in an initially still, deep, and frictionless fluid (Sorensen 1973). Since waves are generated both at the bow and stern of a vessel, they interact with each other at some distance from the vessel. If the waves generated at the bow and stern are in-phase, they tend to reinforce each other and become higher. If the waves are out of phase, they tend to cancel each other.

In deep water, wave height generally increases with increasing velocity, except at certain points where the bow and stern waves tend to cancel each other. Wave heights then decrease with distance from the vessel as the total energy per wave is distributed over a larger area (Sorensen 1973, and Bhowmik 1976). In shallow streams, the water-particle motion generated by the waves will reach the bottom, and the wave pattern will change significantly. The important parameter in shallow-water waves is the depth Froude number, F. For F above approximately 0.4, the waves will reach the bottom. As F increases with an increase in vessel velocity or a decrease in depth, the diverging waves rotate forward and finally form a right angle with the sailing line. When F = 1, the diverging and transverse waves form a single wave, which travels at the same speed as the vessel. An equation for estimating the wave height due to the movement of barge traffic within a body of water is given by Bhowmik et al. (1981).

The wave data collected for the current project are now being analyzed. These data have shown that the maximum wave heights measured close to the shoreline vary from about 0.05 to 0.35 m, with the majority occurring within a range of 0.10 to 0.15 m.

SUMMARY

This article has briefly described how navigation traffic on the UMRS is normally associated with a set of physical changes, including sediment resuspension, return flows in the direction opposite the movement of traffic, and increased turbulence, drawdown, and waves. It has also been shown that the distribution of lateral return flows is non-uniform across the width of the channel, even though vertical velocity changes is fairly constant at a specific location. The duration of altered velocity structure can last for several minutes. Data have also illustrated that the resuspension of sediment is normally higher near the bed than near the water

surface. Elevated sediment concentrations can last from about 15 minutes to more than an hour, and the repeated movement of traffic can increase ambient suspended sediment concentrations. The average heights of the measured waves and drawdown were about 0.1 to 0.15 m.

ACKNOWLEDGMENTS

This research project was partially supported by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service through the Environmental Management Program for the UMRS. The project was administered by the USFWS Environmental Management Technical Center, Onalaska, Wisconsin, with Ken Lubinski as the project director. Many Illinois State Water Survey staff assisted in field data collection and processing, including Rodger Adams, Bill Bogner, Jim Slowikowski, Ed Delisio, and others. The author expresses his sincere thanks to all of them for their outstanding efforts in this endeavor.

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CHEMICAL AND BIOLOGICAL MONITORING OF THE UPPER ILLINOIS RIVER

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ABSTRACT

Water quality of the Illinois Waterway has improved over the last thirteen years as indicated by an improved macroinvertebrate community and improved water chemistry. For macroinvertebrates the numbers of individuals and taxa of caddisflies and mayflies have substantially increased in the lower Des Plaines and upper Illinois Rivers. The Cal-Sag Channel and the Sanitary and Ship Canal have also shown improvement shifting from 100 percent sludgeworms to a community dominated by midges and including other taxa such as flatworms, snails, sowbugs, scuds, damselflies and dragonflies. Total ammonia concentrations have significantly decreased throughout most of the basin since 1978. Dissolved oxygen levels have increased in the Cal-Sag Channel and the Sanitary and Ship Canal. Suspended solids are still elevated throughout most of the Illinois River, especially between Henry and Pekin. Elevated concentrations of phoshorus are also present in the waterway with highest levels between Lemont and the Kankakee River confluence. Illinois Waterway sediments are contaminated with numerous compounds including mercury, chromium, zinc, lead, copper, phosphorus and PCBs. Highest sediment concentrations are in the upper part of the waterway between Lemont and the Kankakee River confluence (River Mile 304-274).

INTRODUCTION

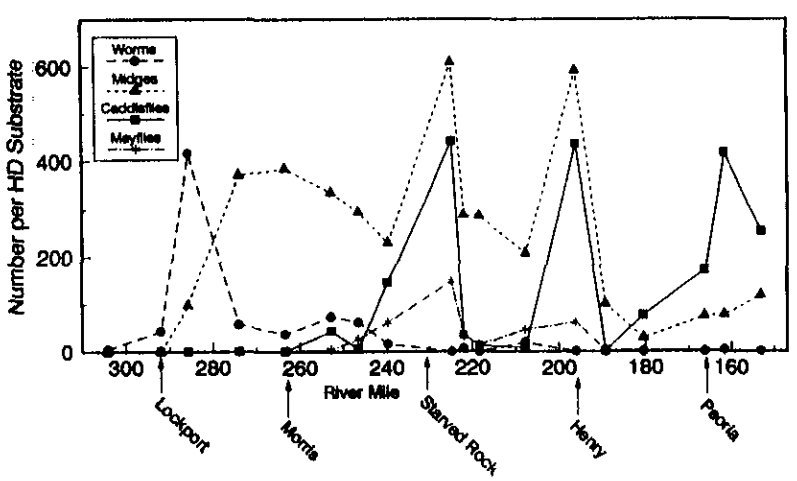
The Illinois Environmental Protection Agency conducted an intensive survey of the upper Illinois River basin from Lockport (River Mile 292.0) to Pekin (River Mile 153.0) in 1989 and 1990. Data on water quality, sediment chemistry and macroinvertebrates were collected at nineteen mainstem stations and at seven major tributary stations. Water quality samples were collected monthly from April through October, 1989 and from June through September, 1990. Sieved (62u) sediment samples were collected once at each

station in 1989. Macroinvertebrates were collected twice a year at each station between May and September using Hester-Dendy artificial substrates (four-five week exposure period) or by hand-picking (tributaries). In addition to these data, historical information from Illinois River studies conducted in 1967 and 1978 as well as thirteen (1978-1990) years of monitoring data at fourteen ambient stations within the basin were reviewed.

MACROINVERTEBRATES

Macroinvertebrate data collected on the Illinois Waterway from Lemont (R.M. 304.2) to Pekin (R.M. 153.0) in 1989 and 1990 were compared with data from 1966-1970 and 1978. Four major groups of benthic organisms usually dominated most of the samples: sludgeworms, midges, caddisflies and mayflies. In general, sludgeworms and midges are classified as tolerant to pollution, while caddisflies and mayflies are classified as intolerant to pollution. These data indicate substantial temporal improvement in the water quality of the Waterway since the late 1970's. In 1978, sludgeworms were the only organisms found in the Cal-Sag Channel and in the Sanitary and Ship Canal (Figure 1) and were the dominant organism in the Des Plaines River at Joliet (R.M. 285.7). Midges were the dominant benthic organism in the Des Plaines River about one mile upstream of the Kankakee River confluence (R.M. 274.0) and remained dominant throughout most of the Illinois River to Chillecothe (R.M. 180.4). Caddisflies and mayflies began to appear at Seneca (R.M. 252.7) and did not contribute significantly to the population until Ottawa (R.M. 239.6). Caddisflies were the dominant benthic organism only in the lower end of the river from Chillecothe (R.M. 180.4) to Pekin (R.M. 153.0). In 1990, caddisflies and

Figure 1. Macroinvertebrates in the Illinois Waterway, Lemont to Pekin, 1978.



mayflies were found in the Des Plaines River (R.M. 288.7 to 274.0), although midges still predominated (Figures 2 and 3). Caddisflies were dominant throughout most of the Illinois River, especially from Morris (R.M. 263.4) to Starved Rock (R.M. 229.6). Together, caddisflies and mayflies were dominant or codominant with midges at all Illinois River stations except at Lacon (R.M. 189.2) and Creve Coeur (R.M. 159.3) in 1990.

Figure 2. Macroinvertebrates in the Illinois Waterway, Lemont to Pekin, 1990.

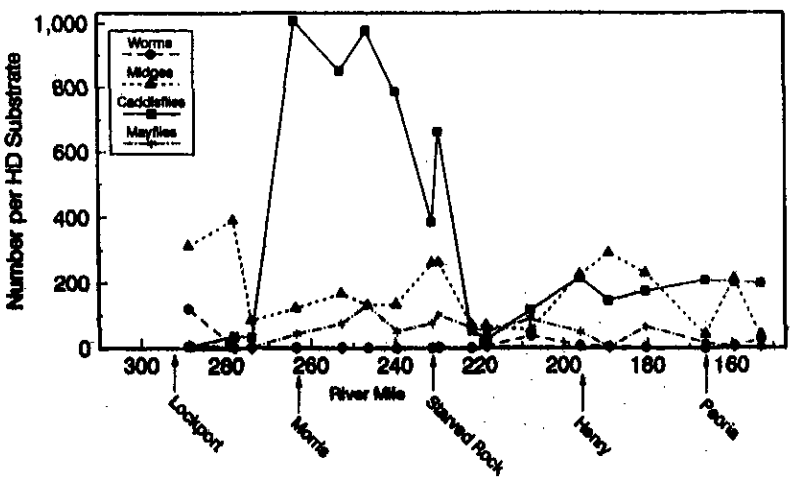
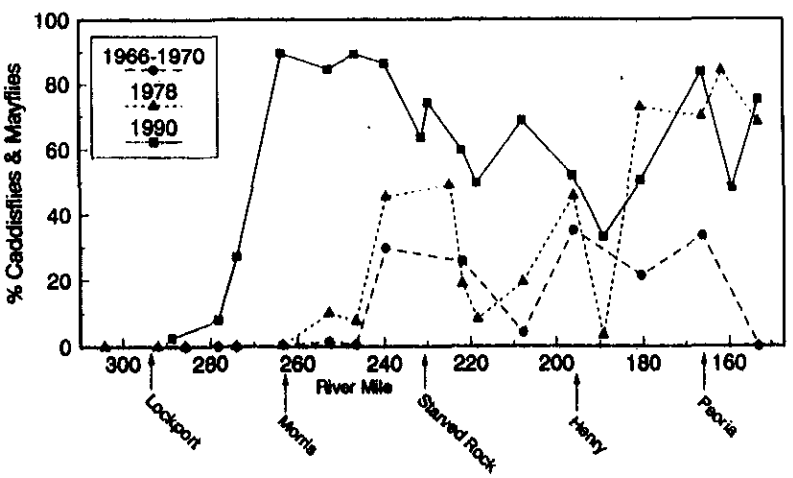


Figure 3. Caddisflies and Mayflies in the Illinois Waterway, Lemont to Pekin.



Since 1978, samples were collected on a more regular basis at six Illinois Waterway stations including the Cal-Sag Channel near Lemont, the Sanitary and Ship Canal at Lockport, the Des Plaines River above the Kankakee River confluence, and the Illinois River at Marseilles, Peoria and Pekin. The upper end of the

waterway from Lemont to Marseilles has shown considerable improvement over the last thirteen years and especially over the last three years. Numbers of individuals and taxa of caddisflies and mayflies have substantially increased in the Des Plaines River and the Illinois River at Marseilles (Figures 4 and 5). The Cal-Sag Channel and Sanitary and Ship Canal have also shown improvement. During the late 1970s and early 1980s, only sludgeworms were found and in very low numbers. In more recent sampling, midges have become dominant in the benthic community while sludgeworm numbers decreased greatly. Other macroinvertebrates were also present including snails, flatworms, leeches, sowbugs, scuds, damselflies and dragonflies. The lower end of the waterway at Peoria and Pekin has not changed much over this period. Caddisflies have been present in relatively high numbers and mayflies have been present but in low numbers since 1978.

Figure 4. Caddisflies and Mayflies in the DesPlaines River at River Mile 274.0 (G24).

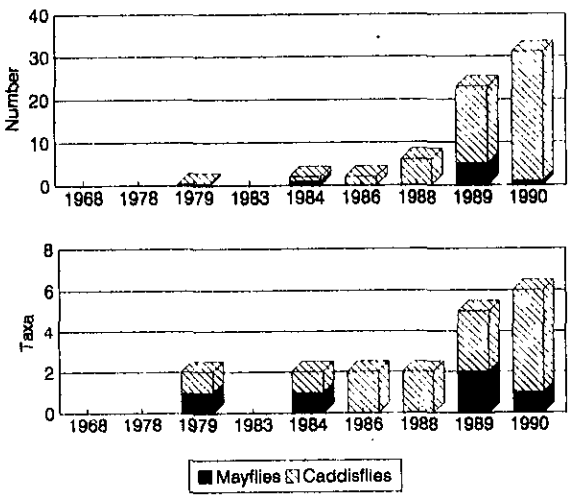
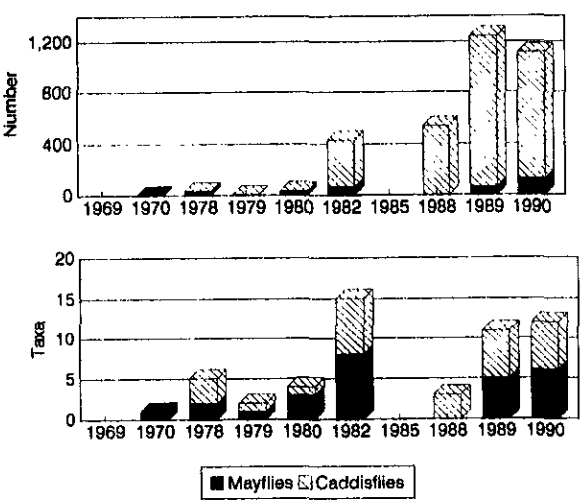


Figure 5. Caddisflies and Mayflies in the Illinois River at Marseilles (D23).



WATER QUALITY

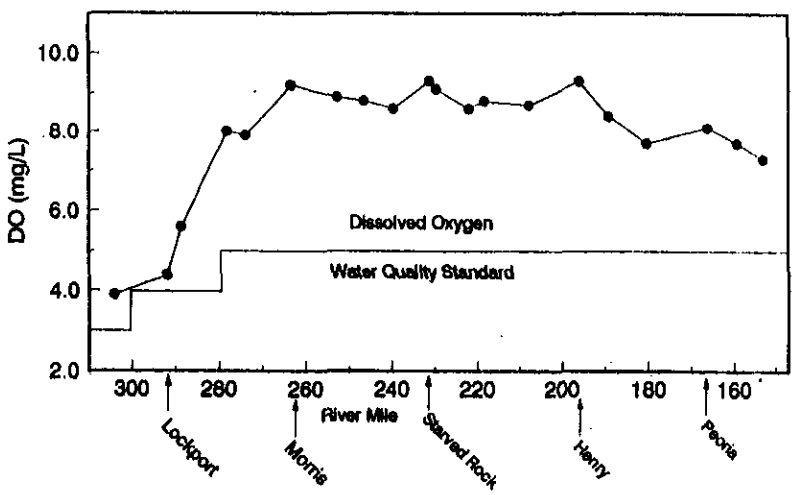
Extensive water quality analyses were performed in 1989 and 1990 for nutrients, metals, organochlorine compounds and suspended solids. Organochlorine compounds and toxic metals were rarely detected or were present at very low levels. Usually,these compounds are rarely found in water but are more common in the sediments. .

Important water quality parameters include dissolved oxygen (DO), ammonia, total suspended solids (TSS) and total phosphorus. There are state water quality standards for DO and ammonia but not for TSS and total phosphorus. Along the Illinois Waterway there are two sets of standards: Secondary Contact and Indigenous Aquatic Life

Standards and General Use Standards (35 IL Adm Code 302). Secondary Contact Standards are less stringent and apply to the Cal-Sag Channel, the Sanitary and Ship Canal and the Des Plaines River from the confluence with the Sanitary and Ship Canal (R.M. 290.1) to the I-55 bridge (R.M. 278.2). General Use Standards govern the rest of the Illinois Waterway and tributaries.

Lowest levels of dissolved oxygen in 1989 were found in the Cal-Sag Channel and gradually increased through the Sanitary and Ship Canal and the Des Plaines River and leveled off in the Illinois River until Henry (R.M. 196.0), where levels began to gradually decline (Figure 6). All mean concentrations were above minimum water quality standards. However, while the lower Des Plaines and Illinois Rivers were well above the standard, the Cal-Sag Channel and the Sanitary and Ship Canal were just barely above the standard. The Cal-Sag Channel was below the 3.0 mg/L dissolved oxygen standard once during the sampling period and the Sanitary and Ship Canal was below 4.0 mg/L on two occasions. The only violation of the General Use Standard (5.0 mg/L) was found in the Illinois River at Pekin (4.8 mg/L) in 1989.

Figure 6. Mean Dissolved Oxygen in the Illinois Waterway, Lemont to Pekin, 1989.



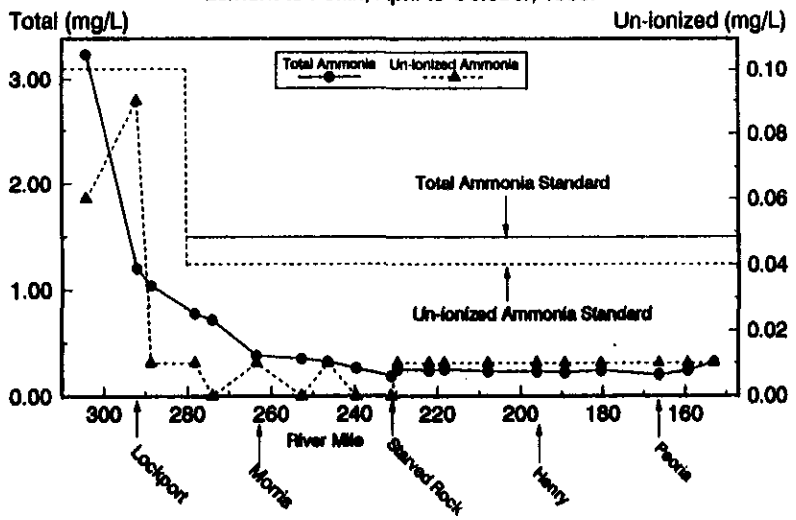
The Secondary Contact Standard for ammonia is 0.10 mg/L as un-ionized ammonia. The General Use Standard is a combination of total and un-ionized ammonia:

> Total ammonia shall not exceed 15 mg/L. If total ammonia is greater than or equal to 1.5 mg/L, then un-ionized ammonia shall not exceed 0.04 mg/L. Total ammonia concentrations less than 1.5 mg/L are lawful regardless of un-ionized ammonia concentrations (35 IL Adm Code 302).

Un-ionized ammonia is calculated using total ammonia, pH and water temperature. Un-ionized ammonia is of concern because it is the toxic component of total ammonia. In 1989, the highest levels of total ammonia were found in the Cal-Sag Channel and the highest un-ionized ammonia levels in the Sanitary and Ship Canal (Figure 7). Total ammonia declined sharply from the Cal-Sag Channel to the

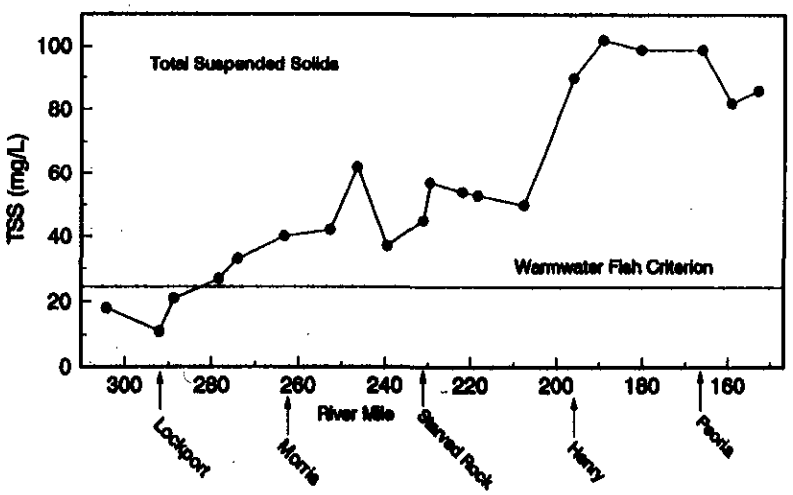
Sanitary and Ship Canal with a gradual decline through the Des Plaines River into the Illinois River. Un-ionized ammonia increased from the Cal-Sag Channel to the Sanitary and Ship Canal then declined sharply into the Des Plaines River after which it remained fairly stable through the Illinois River. All mean levels were below appropriate water quality standards. The Secondary Contact Standard of 0.10 mg/L un-ionized ammonia was exceeded once in the Cal-Sag Channel and twice in the Sanitary and Ship Canal. There were no violations of the General Use Standard.

Figure 7. Mean Ammonia in the Illinois Waterway, Lemont to Pekin, April to October, 1989.



There are no State Standards for total suspended solids (TSS) and total phosphorus. Guidelines for warmwater fish of 25 mg/L TSS and 0.1 mg/L total phosphorus are often used to assess impact (USEPA, 1976). Mean TSS levels increased spatially downstream, especially between Hennepin (R.M. 207.8) and Henry (R.M. 196.0), and remained high to Pekin (R.M. 153.0) (Figure 8). Mean TSS concentrations in 1989 exceeded the 25 mg/L guideline at all stations from the Des Plaines River at I-55 bridge to Pekin. Mean

Figure 8. Mean Total Suspended Solids in the Illinois Waterway, Lemont to Pekin, 1989.

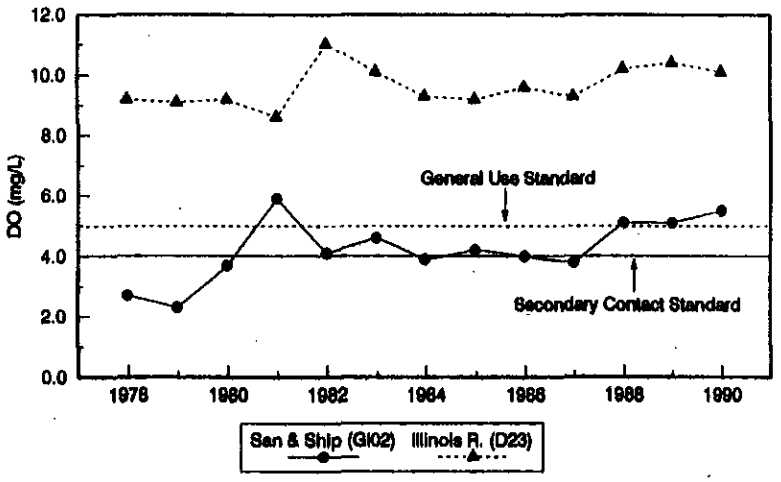


total phosphorus concentrations exceeded the 0.1 mg/L guideline throughout the waterway. Mean phosphorus levels ranged from 0.28 mg/L in the Illinois River at Lacon to 0.96 mg/L in the Cal-Sag Channel near Lemont.

Water quality data have been collected at seven Illinois Waterway stations since 1978 at the Cal-Sag Channel near Lemont, the Sanitary and Ship Canal at Lockport, and the Illinois River at Marseilles, Hennepin, Lacon, Peoria and Pekin. An eighth station on the Des Plaines River at Joliet was added in 1982. In addition, eight tributaries to the waterway have also been sampled since 1978 and include the Des Plaines, DuPage, Kankakee, Mazon, Fox, Vermilion, Little Vermilion and Big Bureau Creek.

Dissolved oxygen in the Illinois Waterway has shown improvement in the Cal-Sag Channel and the Sanitary and Ship Canal since 1978. Mean DO levels in the Sanitary and Ship Canal have increased from a low of 2.3 mg/L in 1979 to 5.5 mg/L in 1990 (Figure 9). Dissolved oxygen concentrations in the Illinois River at Marseilles have been well above the General Use Standard throughout this period (Figure 9). The other Illinois River stations show similar DO levels.

Figure 9. Mean Dissolved Oxygen in the Illinois Waterway at Lockport and Marseilles.



Total ammonia in the Illinois Waterway has declined significantly at all stations since 1978. In addition, several Waterway tributaries (Des Plaines, DuPage and Kankakee Rivers) have also shown a decline. Un-ionized ammonia has not shown a significant decline for most stations over this period. Mean total ammonia concentrations in the Sanitary and Ship Canal have decreased from 5.06 mg/L in 1978 to 1.39 mg/L in 1990 while un-ionized ammonia levels have fluctuated, primarily because both water temperature and pH have been variable showing no definite trend over this period (Figures 10). The large increase in un-ionized ammonia in the Sanitary and Ship Canal in 1989 was due to an increase in ambient pH. The mean pH in 1989 was 8.1, 0.7 units higher than any other year. Increased algal activity may be responsible for the observed

increase in pH levels. Also, the low un-ionized ammonia levels of 0.00 to 0.01 mg/L from 1982 to 1986 were due to low pH values which ranged from 6.4 to 6.9. Mean total ammonia concentrations in the Illinois River at Marseilles have decreased from 1.64 mg/L in 1978 to 0.34 mg/L in 1990 (Figure 11). Again, un-ionized ammonia has not shown this same level of decline.

Figure 10. Mean Ammonia in the Sanitary & Ship Canal at Lockport (GI02).

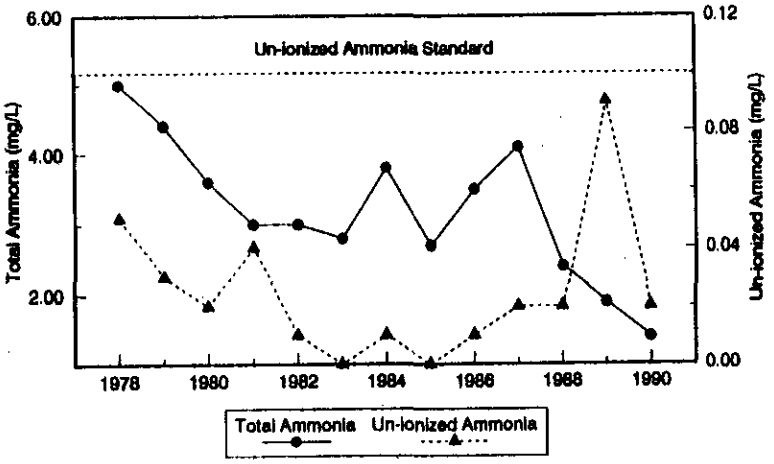
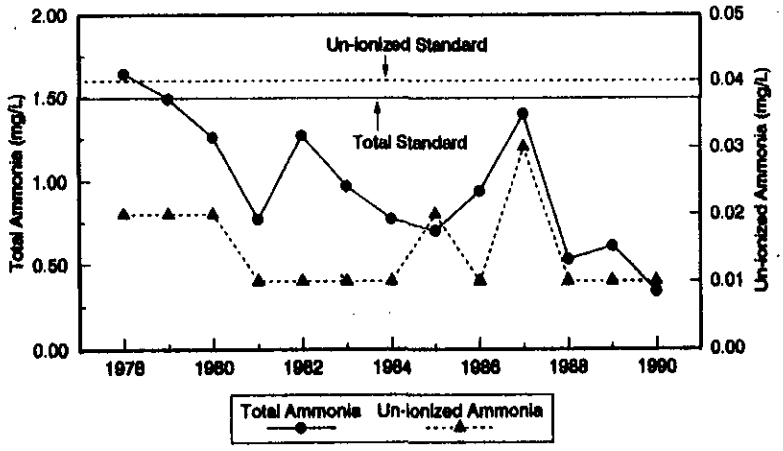


Figure 11. Mean Ammonia in the Illinois River at Marseilles (D23).



Annual mean TSS concentrations show no definite trends in the Sanitary and Ship Canal and the Illinois River at Marseilles, but total phosphorus shows a decrease since 1978.

In cooperation with the U.S. Geological Survey, a more detailed trend analysis was performed on data collected over a twelve year period (1978-1989) at six Illinois Waterway stations from Joliet to Pekin (IEPA, 1990). The Seasonal Kendall test was applied to sample

concentrations and concentrations adjusted for flow. Ammonia showed an improving trend in concentrations and in flow adjusted concentrations at all stations. Total suspended solids concentrations at Marseilles, Hennepin, Lacon and Peoria showed a declining trend, but flow adjusted concentrations showed a declining trend only at Pekin . Total phosphorus showed a declining trend at Peoria and Pekin and dissolved oxygen showed an increasing trend at Peoria.

SEDIMENTS

Sediment samples were analyzed for nutrients, metals, organochlorine compounds, chemical oxygen demand (COD) and volatile solids. Concentrations were compared with five classifications developed by Kelly and Hite (1984): nonelevated, slightly elevated, elevated, highly elevated and extreme. These classifications are not based on toxic or biological effects, but rather on deviations from background concentrations.

Highest numbers of extreme and highly elevated levels of contaminants were found in the upper part of the Illinois Waterway. The most heavily polluted sediments were found in the Des Plaines River at Joliet (R.M. 288.7) and included extreme levels of mercury, chromium, copper, lead, zinc, PCBs and phosphorus. The highest number of samples with extreme concentrations was found for mercury with nineteen, followed by zinc and chromium with ten each, lead with seven, phosphorus with four, copper with two and PCBs with one. Most contaminants generally followed a decreasing trend downstream (Figures 12, 13 and 14) except for manganese and Kjeldahl nitrogen. Manganese concentrations increased somewhat spatially downstream and Kjeldahl nitrogen concentrations fluctuated. Sediment samples have been collected four to five times at several Illinois Waterway stations during the 1980s including the Cal-Sag Channel, Sanitary and Ship Canal, Des Plaines River (R.M. 274.0) and the Illinois River at Marseilles. In general, the sediments showed variable concentrations with no overall improvement since 1982.

Figure 12. Mercury in Illinois Waterway Sediments, Lemont to Pekin, 1989.

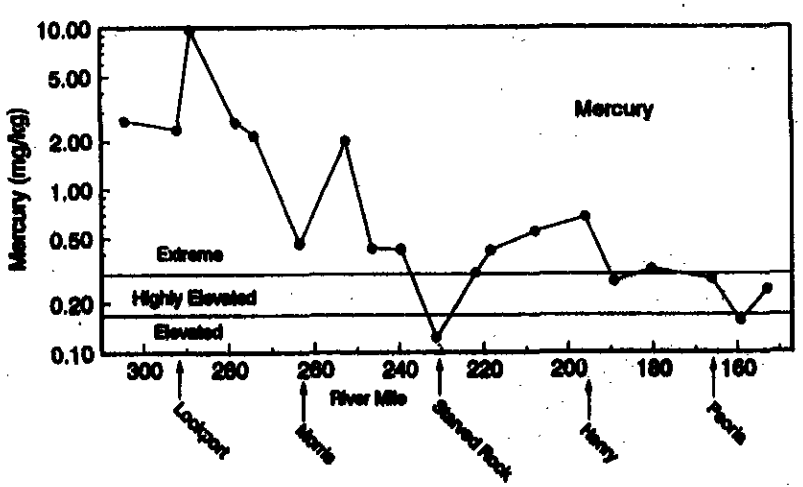


Figure 13. Zinc in Illinois Waterway Sediments, Lemont to Pekin, 1989.

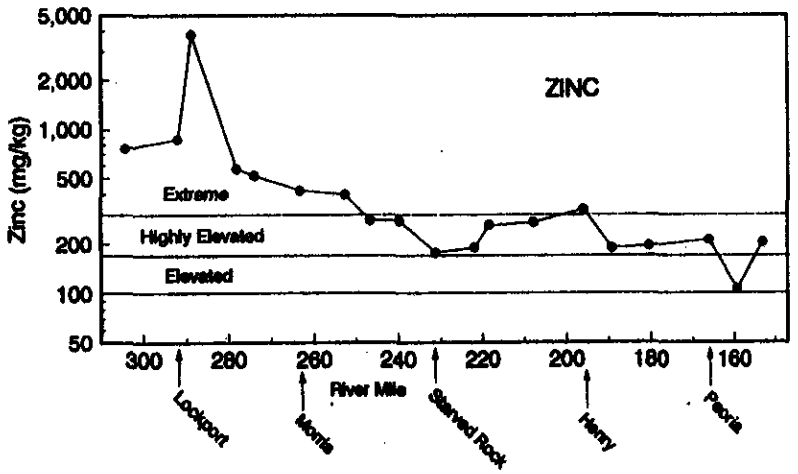
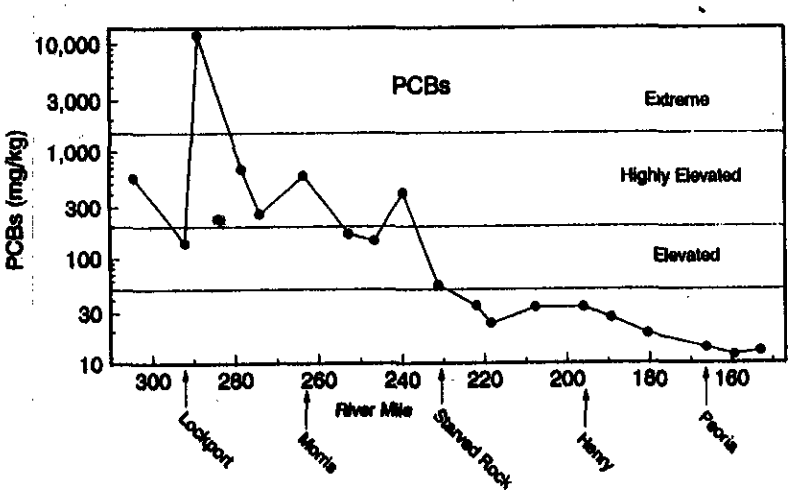


Figure 14. PCBs in Illinois Waterway Sediments, Lemont to Pekin, 1989.



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SEDIMENT AND WATER QUALITY IN THE UPPER ILLINOIS RIVER BASIN

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ABSTRACT

The U.S. Geological Survey implemented several sampling programs as part of an assessment of the water quality in the upper Illinois River basin in Illinois, Indiana, and Wisconsin. Among these were monthly sampling at eight fixed-stations, synoptic sampling programs for specific categories of constituents and specific media, and runoff-event sampling for agricultural-organic compounds. Analyses of streambed sediments for trace inorganic constituents indicated that concentrations of eight U.S. Environmental Protection Agency priority pollutants were enriched in the Chicago urban area and in streams draining the urban area, relative to rural areas; enriched in main stems, relative to tributaries; and enriched in low-order streams in areas with high population densities, relative to low-order streams in areas with lower population densities. Results from sampling for agricultural-organic compounds in water indicated that the insecticides diazinon and malathion were found in a greater percentage of the samples from urban areas than from agricultural areas, that herbicides generally were detected in greater concentrations and in a greater percentage of the samples from agricultural areas than from urban areas, and that atrazine was present in 98 percent of the samples from agricultural areas.

INTRODUCTION

In 1986, the U.S. Geological Survey (USGS) began a National Water-Quality Assessment (NAWQA) program with seven pilot studies in four river basins and three aquifers. The goals of these pilot studies were to test and refine assessment concepts and approaches and to evaluate the potential uses and costs of a full-scale national program. The goals of the national program are to (1) describe current water-quality conditions, (2) define long-term trends in water quality, and (3) determine relations of conditions and trends in water quality to natural factors and land use and waste-management activities. In 1991, the USGS began implementation of the full-scale NAWQA program, which ultimately will include 60 study units,

encompassing about 45 percent of the land area of the conterminous United States, and 60 to 70 percent of the Nation' s water use.

The upper Illinois River basin (UIRB), which drains 10,949 mi^2 (square miles) of Illinois, Indiana, and Wisconsin, was one of four river basins selected for pilot studies of the surface-water-quality element of the national program. The UIRB is composed of four principal river systems: the Fox River, which drains 2,658 mi^2; the Des Plaines River (except the Chicago Sanitary and Ship Canal), which drains 1,371 mi^2; the Kankakee River, which drains 5,165 mi^2,and the Chicago Sanitary and Ship Canal, which drains 740 mi^2 (figure 1). Land use in the basin is 75 percent agricultural, 20 percent urban, and 5 percent industrial. A detailed description of the basin is given by Mades (1987).

The study of each basin during the pilot phase of the NAWQA program consisted of 1 year of compilation, screening, and interpretation of existing data; 3 years of intensive data collection; 5 years of low-level sampling and report writing; and then the cycle is to be repeated. For the UIRB, the period of intensive data collection was from April 1987 through August 1990 and included monthly sample collection at eight fixed stations in the basin and synoptic studies of selected water-quality constituents at many sites. Samples were collected and analyzed to determine concentrations of major- and trace-inorganic constituents in streambed sediments, suspended sediments, water, and biota; organic compounds in streambed sediments, water, and biota; dissolved oxygen, nutrients, chlorophyll-a, and fecal-indicator bacteria in water. Samples were collected and field measurements performed to determine biological community structure and composition.

Purpose and Scope

This paper summarizes the data collection performed as part of an assessment of the water quality of the UIRB in Illinois, Indiana, and Wisconsin between 1986 and 1990 and summarizes results of preliminary analyses of the data that were collected for selected constituents. Presentations herein are limited to summaries of the overall program. The data, detailed description of the sampling programs, the methods used to analyze these data, and detailed results from analyses of these data are presented in other reports from this study.

SEDIMENT AND WATER QUALITY

The following sections describe the sampling programs that were conducted between 1987 and 1990 as part of the NAWQA study of the UIRB. The number of sites sampled, the media sampled, the period and frequency of sample collection, and the constituents for which analyses were conducted are described. Results from analyses of these samples are summarized for constituents for which the analyses are completed.

Three different sampling approaches were conducted during the assessment of the UIRB--fixed-station sampling, synoptic sampling, and runoff-event sampling. The following paragraphs give an overview of each of these approaches.

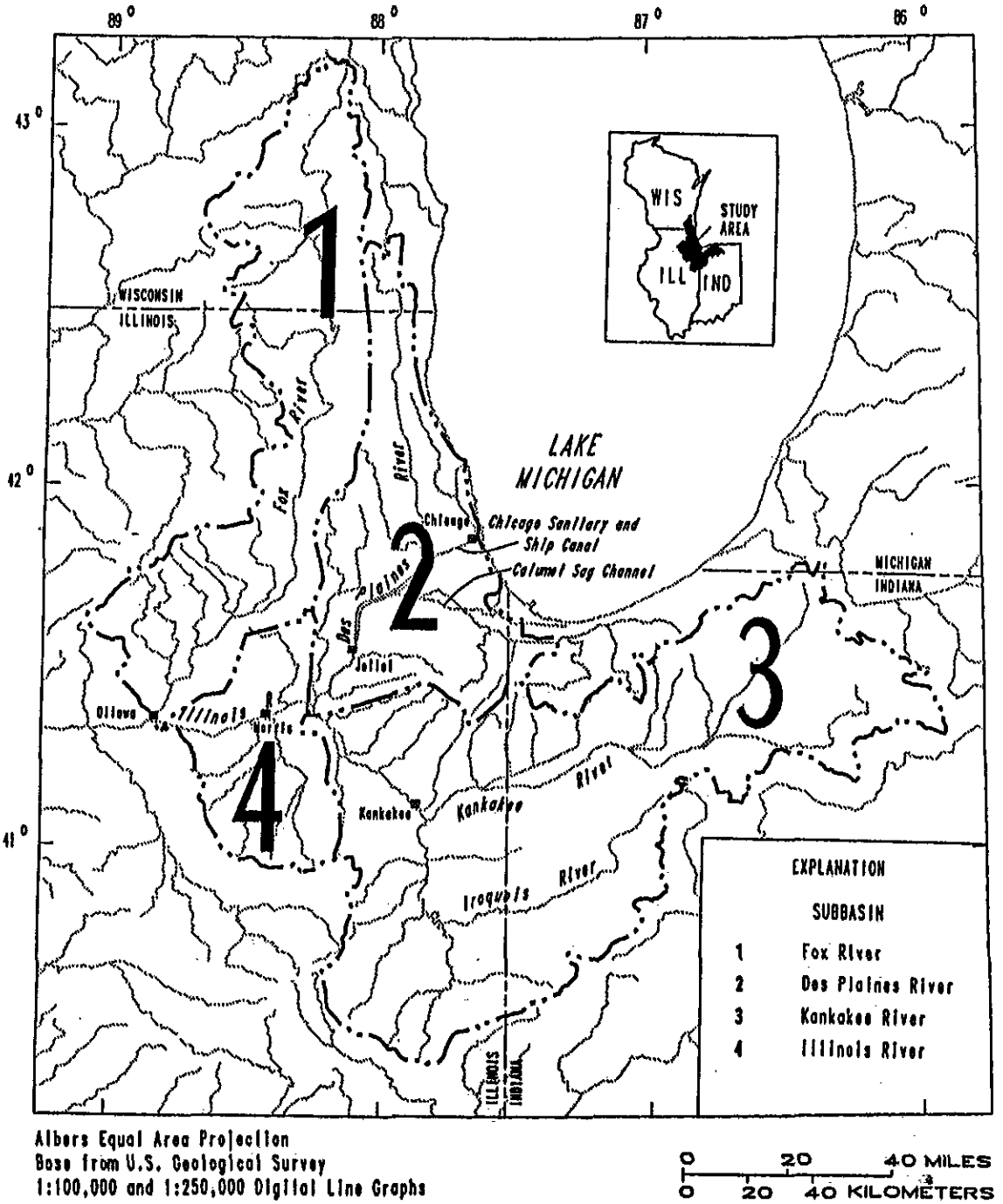

Figure 1.--Location of the upper Illinois River Basin.

Fixed-station sampling involved the USGS collecting water and suspended-sediment samples monthly at eight fixed stations between April 1987 and August 1990. The USGS continues to collect water samples monthly and suspended-sediment samples bimonthly at four of these stations. The Illinois Environmental Protection Agency (IEPA) collected water samples at approximately 6-week intervals from 32 stations in the UIRB. Water samples from all 40 of these sampling stations were analyzed by the IEPA laboratory. Periodic quality-assurance water samples were analyzed by the USGS National Water-Quality Laboratory in Denver, Colorado. Data from all 40 of these fixed stations were published in the USGS annual data reports (Fitzgerald and others, 1988; Coupe and others, 1989; Sullivan and others, 1990; and Richards and others, 1991). Samples from the fixed stations provided descriptions of the long-term temporal patterns in the concentrations and loads of constituents at a limited number of locations.

Synoptic sampling involved collecting samples at a large number of sites over a short period. Synoptic sampling targeted specific constituent groups and sampling media. Synoptic sampling provided a description of the spatial distribution of the constituents being sampled, but, apart from comparisons with results from other sampling, no information about the temporal variation of those constituents. Comparison of results from similar synoptic sampling efforts between different intensive data-collection periods of the NAWQA study of the UIRB is planned to describe temporal variation in these constituents.

Runoff-event sampling involved collecting samples for selected constituents from several sites at intervals throughout the duration of runoff from selected storm events. Additional samples were collected from the same sites during low-flow periods. Runoff-event sampling provided descriptions of temporal patterns at a finer resolution than the fixed-station sampling, but with more limited spatial coverage and a more limited sampling period.

All of the sampling conducted as part of the NAWQA study of the UIRB is summarized in table 1. This table lists different sampling done for each constituent category, including the number of sampling sites, the period and frequency of data collection, the sampling approach used, the type of media sampled, and the specific constituents or community type sampled.

Major and trace inorganic constituents

Water and suspended-sediment samples for major- and trace-inorganic constituent analysis were collected monthly by the USGS at eight fixed stations between April 1987 and August 1990. Water samples for the same constituents were collected at 6-week intervals by the IEPA at an additional 32 fixed stations. Water, streambed sediment, and biological samples were collected for major- and trace-inorganic constituents during five synoptic studies between 1988 and 1990.

Samples of fine-fraction (less than 63 micrometers) streambed-sediment for major- and trace-inorganic constituent analysis were collected at 238 randomly-selected sites on low-order streams and 135 sites spaced at regular intervals on high-order streams during the fall of 1987 (J.A. Colman, U.S. Geological Survey, written commun., 1991). Tissue samples for analyses for 21 inorganic constituents were

Table 1. **Summary of sampling conducted as part of the water-quality assessment of the upper Illinois River basin**

[BNA, base- neutral-, and acid-extractable organic compounds; bed, streambed sediment; DO, dissolved oxygen; fecal, fecal-indicator bacteria; nutr., nutrients; susp. sed., suspended sediment;VOC, volatile organic compounds]

No. of sites	Period	Sampling frequency	Sampling type	Constituent category	Media sampled
		Major- and trace-inorganic constituents			
8	April 1987 - August 1990	monthly	fixed-station	inorganic	water
8	April 1987 - August 1990	monthly	fixed-station	inorganic	susp. sed.
4	September 1990 - present	monthly	fixed-station	inorganic	water
4	September 1990 - present	bimonthly	fixed-station	inorganic	susp. sed.
373	Fall 1987	once	synoptic	inorganic	bed
16	Summer 1989	once	synoptic	inorganic	water
16	Summer 1989	once	synoptic	inorganic	biota
25	Summer 1990	once	synoptic	inorganic	bed
25	Summer 1990	once	synoptic	inorganic	biota
		Organic compounds			
2	August 1988 - March 1990	monthly	fixed-station	organic	water
31	July 1988	once	synoptic	VOC	water
21	July 1988	once	synoptic	BNA	water
16	Summer 1989	once	synoptic	organic	biota
83	August 1989	once	synoptic	organic	bed
25	Summer 1990	once	synoptic	organic	bed
25	Summer 1990	once	synoptic	organic	biota
4	Summer 1988 and Summer 1989	variable[1]	runoff-event	herbicides and insecticides	water
17	Summer 1990	variable[2]	runoff-event	herbicides	water
		Dissolved oxygen, nutrients, fecal-indicator bacteria, and general[3]			
8	April 1987 - August 1990	monthly	fixed-station	general[3]	water
4	September 1990 - present	monthly	fixed-station	general[3]	water
[4]32	Prior to 1986 to present	6-weeks	fixed-station	general[3]	water
20	August 1987	once	synoptic	nutr. and DO	water
60	July 1988 - August 1988	once[5]	synoptic	nutr., DO, and fecal	water
		Biological indicators of sediment and water quality			
12	Summer 1989	twice[6]	synoptic	community	biota
22	Summer 1990	twice[7]	synoptic	community	biota

1. Total of 25 samples collected during 4 storms and intervening low-flow periods.
2. More than 400 samples collected during 3 major storms and intervening low-flow periods.
3. Includes measurement of physical parameters, nutrients, fecal coliform and *Escherichia coli* bacteria, major ions, chemical oxygen demand, suspended solids, and 21 metals.
4. Sampled by Illinois Environmental Protection Agency.
5. Four sites were sampled hourly for a 24-hour period.
6. Fish-community samples collected at all sites; invertebrate-community samples also collected at 10 sites.
7. Fish-community samples collected at all sites; invertebrate-community samples also collected at 20 sites.

collected at 16 sites during the summer of 1989, and at 25 sites during the summer of 1990. The 25 sites that tissue samples were collected at in 1990 included 12 of the sites sampled in 1989 and 13 new sites. The 1989 tissue sampling included 9 fish-liver samples, 4 mollusk samples, 1 insect sample, 8 decapod (crayfish) samples, and 4 aquatic-plant samples. The 1990 tissue sampling included 24 fish-liver samples, 1 whole-fish sample, 6 mollusk samples, and 2 aquatic-plant samples. Samples of different organisms were collected based on what was available at the sites. Samples of several organisms were submitted from some sites to allow comparison of concentrations among organisms. Water samples were collected in 1989 and 1990 and streambed-sediment samples were collected in 1990 for analyses for major- and trace-inorganic constituents in conjunction with the biological sampling. All the sampling programs conducted for major- and trace-inorganic constituents are summarized in table 1.

The NAWQA synoptic sampling of major- and trace-inorganic constituents in fine-fraction streambed sediment significantly extended the coverage of existing data on these constituents, including the number of sites sampled (from 103 to 501 sites), the area sampled (from Illinois only to Illinois, Indiana, and Wisconsin), the stream-orders sampled (from biased strongly toward mainstems to mainstems and first- and second-order streams), and the number of constituents sampled (from 10 to 46 constituents). In addition, the NAWQA sampling sites were selected using a stratified (by stream order) random site selection to provide a nonbiased, representative sample and to allow comparison of spatial variability with sampling error using a nested analysis of variance (ANOVA) design.

Results from the synoptic sampling for major- and trace-inorganic constituents in fine-fraction streambed sediments indicated three distinctive patterns of enrichment for eight U.S. Environmental Protection Agency (USEPA) priority pollutants (antimony, cadmium, chromium, copper, lead, mercury, nickel, and zinc): enrichment of constituents in the Chicago urban area and in streams draining the urban area, relative to rural areas; enrichment of constituents in main stems, relative to tributaries; and enrichment of constituents in low-order streams in areas with high population densities, relative to low-order streams in areas with lower population densities. The within-sample ratios of these constituents to each other were variable in the Chicago area but were constant downstream. The concentrations of these constituents decreased in the river reach downstream from Chicago. Within-sample ratios of these constituents in Illinois River sediments imply that 35 to 40 percent of the fine-fraction sediments originated from the Des Plaines River whereas 60 to 65 percent originated from the Kankakee River (J.A. Colman, U.S. Geological Survey, written commun., 1991).

Preliminary analyses of trends in major- and trace-inorganic constituent concentrations in water from the 38 IEPA fixed stations indicate downward trends in concentrations of total strontium in streams in urban areas and in concentrations of total barium, boron, manganese, and upward trends in concentrations of total strontium in streams in rural areas. Downward trends in barium concentrations were observed at 11 sites in the Chicago-urban area, one site downstream on the Illinois River, and 5 sites on the Fox River. Downward trends in boron concentrations were observed at 12 sites in the Chicago-urban area and one site downstream on the Illinois River. Downward trends in manganese concentrations

were observed at 11 sites in the Chicago-urban area, 1 site downstream on the Illinois River, and 3 sites on the Fox River. Upward trends in strontium concentrations were observed at 14 rural sites in the Kankakee River, Iroquois River, upper Des Plaines River, and Fox River basins and 1 site in the Chicago-urban area; however, downward trends in strontium concentrations were observed at 5 sites in the Chicago-urban area and 1 site downstream on the Illinois River. Concentrations of most trace-inorganic constituents listed as priority pollutants were below the detection limits at most sites in the UIRB, which substantially limited trend analyses of these constituents.

Organic Compounds

Water samples for volatile organic compounds were collected approximately monthly at two of the fixed stations (Chicago Sanitary and Ship Canal at Romeoville, Illinois, and Des Plaines River at Riverside, Illinois) between August 1988 and March 1990. Water, streambed-sediment, and biological samples were collected during six synoptic studies and two runoff-event sampling for organic compound analyses between 1988 and 1990. Water samples for 52 volatile organic compounds were collected at 31 sites from July 18-22, 1988. Water samples for 54 semivolatile, base-, neutral- and acid-extractable organic compounds were collected at 21 sites during the same period. Samples for agricultural-organic compounds (herbicides and insecticides) in water were collected at two urban and two agricultural sites during runoff events and low-flow periods in 1988 and 1989, and at 17 agricultural sites (herbicides only) during runoff events and low-flow periods in 1990. The 1988, 1989, and 1990 sampling for agricultural-organic compounds emphasized runoff events, with low-flow samples collected to define background concentrations. Unsieved (less than 2 millimeter) streambed-sediment samples for organic-compound analyses were collected at 83 sites during August, 1989. Unsieved streambed-sediment samples for organic-compound analyses also were collected at 25 sites in 1990 in conjunction with sampling for tissue and fish community. Tissue samples for organic-compound analyses were collected at 16 sites during the summer of 1989 and at 25 sites during the summer of 1990; these were collected at the same sites and times as the tissue samples for major- and trace-inorganic constituents. The 1989 tissue sampling included 9 fish-muscle samples, 14 whole-fish samples, 1 mollusk sample, 10 decapod (crayfish) samples, and 1 aquatic-plant sample. The 1990 tissue sampling included 25 whole-fish samples, 4 mollusk samples, 3 decapod (crayfish) samples, and 1 aquatic-plant sample. All tissue samples were analyzed for 22 chlorinated agricultural-organic compounds; invertebrate and plant samples also were analyzed for 14 semivolatile organic compounds. All the sampling programs conducted for organic compounds are summarized in table 1.

Results from the synoptic sampling for volatile organic compounds in water indicate concentrations of trichloroethylene exceeded the USEPA maximum contaminant level (5 micrograms per liter) at one site and tetrachloroethylene exceeded the USEPA proposed maximum contaminant level (5 micrograms per liter) at one site. Results from the fixed-station sampling for volatile organic compounds in water indicated that concentrations of 1,2-dichloroethane exceeded the USEPA maximum contaminant level (5 micrograms per liter) in two samples at one site. Concentrations of all other volatile organic compounds in all samples were less than the established or proposed maximum contaminant levels. Results from the synoptic

sampling for 54 base-, neutral-, and acid-extractable compounds at 21 sites indicated that all concentrations were less than the detection limits.

Quality-assurance samples, including replicate and split samples, were collected at 15 of the 83 sites during the 1989 synoptic sampling of organic compounds in fine-fraction streambed sediment. Analysis of variance (ANOVA) results from these samples indicated that variability between samples from a site generally was equal to or greater than the variability between sites. This indicates that comparisons between sites should be limited to detection or nondetection of compounds. Results from this survey identified 16 sites where 10 or more of the 74 USEPA priority pollutants analyzed for were detected. Fourteen of these sites were in the Chicago urban area; the other two were on the Fox River.

Water samples collected in 1988 and 1989 exhibited differences in the agricultural-organic compounds detected between agricultural and urban areas. The insecticides diazinon and malathion were found in 88 percent of the samples collected in urban areas and in only 12 percent from agricultural areas. Herbicides generally were detected at greater concentrations and in a greater percentage of the samples from agricultural areas. Results from samples for agricultural-organic compounds collected in 1990 indicated that atrazine, a widely-used organic herbicide, was present in 98 percent of the samples.

Nutrients, Dissolved Oxygen, and Fecal-indicator Bacteria

Water samples for nutrients and dissolved oxygen were collected at all of the fixed stations and during synoptic studies in 1987 and 1988. Water samples for fecal-indicator bacteria *(Escherichia coli (E. Coli)* and fecal coliform) also were collected at the fixed stations and during the 1988 synoptic study. Water samples were collected at 20 sites in the Kankakee River basin from August 19-21, 1987, and at 60 sites throughout the UIRB from July 26 to August 4, 1988. Samples were collected between 5:00 a.m. and 8:00 a.m., as the dissolved oxygen concentrations were expected to be least during this period. All the sampling programs conducted for nutrients, dissolved oxygen, and fecal-indicator bacteria are summarized in table 1. The following paragraphs present results from the 1988 synoptic sampling, as this sampling provided the most complete coverage of the UIRB.

Dissolved oxygen concentrations ranged from 1.85 to 11.2 mg/L (milligrams per liter). Dissolved oxygen concentrations were lower than 5 mg/L at 20 of the 60 sites sampled. In the Kankakee River basin, 10 of the 17 sites had dissolved oxygen concentrations less than 5 mg/L, including the site with the lowest measured concentration. In contrast, dissolved oxygen concentrations at all of the sites measured in the Fox River were greater than 5 mg/L.

Total phosphorus concentrations ranged from 0.01 to 4.0 mg/L. Total phosphorus concentrations greater than 1.0 mg/L were observed at 14 sites, all of which were in the Des Plaines River basin. Concentrations in the Kankakee River basin were the least, with a median (of 18 observations) of 0.12 mg/L.

Dissolved nitrite plus nitrate (as nitrogen) concentrations ranged from 0.10 to 15.0 mg/L. All concentrations greater than the 90th percentile of all observations (8.1 mg/L) were observed in the Des Plaines and Du Page Rivers. Concentrations in the Kankakee River were the lowest in the UIRB, with a median (of 17 observations) of 0.14 mg/L.

Dissolved ammonia (as nitrogen) concentrations ranged from 0.01 to 4.20 mg/L. All concentrations greater than the 90th percentile of all observations (0.7 mg/L) were observed in the Des Plaines River basin. Concentrations in the Fox River were the lowest, with a median (of 15 observations) of 0.03 mg/L.

Counts of *Escherichia coli (E. Coli)* ranged from 8 to 130,000 col/100 mL (colonies per 100 milliliters). Thirty-four of the 60 sites had *E. Coli* counts greater than 298 col/100mL, and 26 of the 60 sites had counts greater than 576 col/100mL (298 col/100mL and 576 col/100mL are the USEPA water-quality criteria maximum *E. Coli* densities for a single sample for moderate full-body contact and infrequently used full-body contact recreation waters, respectively).

Biological Measures of Sediment and Water Quality

Fish community samples were collected at 12 sites in 1989 and at 22 sites in 1990. The sites sampled in 1990 included 9 of the sites sampled in 1989, as well as 13 new sites. Invertebrate community samples were collected at 10 sites in 1989 and at 20 sites in 1990. The sites sampled in 1990 included 8 of the sites sampled in 1989 as well as 12 additional sites. All the sites sampled for invertebrate community also were sampled for fish community. All the sites sampled for fish community also were tissue-sampling sites for organic and inorganic constituents in tissue. A quantitative assessment of the habitat also was performed at each of the community and tissue-sampling sites. Water samples were collected at each of the community and fish-sampling sites in 1989 and fine-fraction streambed-sediment samples were collected at each of the community and fish-sampling sites in 1990. All the sampling programs conducted for biological measures of sediment and water quality are summarized in table 1.

SUMMARY AND CONCLUSIONS

Several sampling programs were implemented in the UIRB by the USGS, including monthly sampling at eight fixed-stations, synoptic sampling programs for specific categories of constituents and specific media, and runoff-event sampling for agricultural-organic compounds. The inorganic-constituent data collected by this assessment have extended the existing data base to include the Indiana and Wisconsin portions of the UIRB, 36 more constituents, and first- and second-order streams. The organic-constituent data collected by this assessment extended the existing data base to include smaller stream sizes, runoff-event sampling, and concentrations of agricultural-organic compounds in urban areas. Data collected by this assessment have also provided concurrent descriptions of concentrations of organic and inorganic constituents in water, sediment, and biota, the fish and invertebrate community, and a quantitative description of the habitat.

Analyses of streambed sediments for trace inorganic constituents indicated that concentrations of eight USEPA priority pollutants were enriched in the Chicago urban area and in streams draining the urban area, relative to rural areas; enriched in main stems, relative to tributaries; and enriched in low-order streams in areas with high population densities, relative to low-order streams in areas with lower population densities. Within-sample ratios of these constituents in Illinois River sediments imply that 35 to 40 percent of the fine-fraction sediments originated from the Des Plaines River, whereas 60 to 65 percent originated from the Kankakee River. Analyses of trace-inorganic constituents in water indicated downward trends in barium, boron, and manganese concentrations and upward trends in strontium concentrations. Results from sampling for agricultural-organic compounds in water indicated that the insecticides diazinon and malathion were found in a greater percentage of the samples from urban areas than from agricultural areas, that herbicides generally were detected in greater concentrations and in a greater percentage of the samples from agricultural areas than from urban areas, and that atrazine was present in 98 percent of the samples from agricultural areas. Results from the 1988 synoptic sampling of nutrients, dissolved oxygen, and fecal-indicator bacteria indicate that concentrations of total phosphorus, dissolved nitrite plus nitrate (as nitrogen), and dissolved ammonia (as nitrogen) were greatest in the Des Plaines River and its tributaries.

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OVERVIEW OF THE ZEBRA MUSSEL INVASION: BIOLOGY, IMPACTS, AND PROJECTED SPREAD

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ABSTRACT

Since their discovery in Lake St. Clair in 1988, the European zebra mussels (*Dreissena polymorpha*) have established colonies in all of the Great Lakes and the major inland waterways (Illinois, Hudson, Allegheny, Ohio and Mississippi River drainages). Zebra mussels have a combination of characteristics which make them an especially effective invader - high fecundity, a planktonic larval stage, tolerance for a wide range of environmental conditions, and a generalist filter feeding strategy. These features, in combination with the strong attachment of adults to solid substrates, make zebra mussels a severe nuisance to humans as well as a threat to the ecology of the Great Lakes and large rivers. They have clogged water intake pipes in water treatment facilities, power plants, industries, and boats; they have fouled recreational beaches and sunk navigation buoys; they may also foul commercial fishing nets and spawning reefs of native fish. Because zebra mussels feed on planktonic organisms, they may critically impact aquatic food webs. Ecologically sound control measures which minimize damage to the environment need to be developed and assessed, and the effect of the mussels on native species must be examined.

INTRODUCTION AND BACKGROUND

The history of the Great Lakes ecosystem since the 1800's is dominated by the introduction and subsequent effects of non-indigenous species. Among these species, the alewife, lamprey, and Pacific salmon have perhaps had the most impact, and received the highest publicity. However, most of these species have remained within the Great Lakes basin, and the effect of their presence has been limited to fisheries agencies and fishermen. In marked contrast, within four years of the appearance of the zebra mussel (*Dreissena polymorpha*) in Lake St. Clair, this mollusc has affected industries, utilities, marinas, boaters, biologists and fisheries managers in the Great Lakes. These effects will soon be experienced in the major rivers and inland lakes. This paper will provide a brief outline of the biology, spread, and current status of the zebra mussel in North America, and then will discuss its projected impacts on the Illinois River basin and possible management strategies.

Zebra Mussel Biology

Zebra mussels are a freshwater bivalve native to the area near the Black Sea in Europe. The adult mussels grow up to five centimeters in length, and live three to five years. Their shells are angular, and are

usually striped with alternating bands of brown and yellow, although a wide range of patterns occur. The sexes are separate, and fertilization is external. Reproduction occurs when the water warms up in spring, although mussels living in warm-water effluents from industrial plants may reproduce during the winter. Each female sheds up to 40,000 eggs into the water, which are fertilized by sperm released synchronously by males. The eggs hatch within hours into 60µm planktonic veliger larvae resembling microscopic clams. The veligers drift passively for up to four weeks, or until they are 180-250µm, after which they settle onto hard substrates. Once a suitable location is found, the larvae extrude sticky threads called byssus with which they attach themselves to the substrate. Attached zebra mussels are difficult to displace, due to the strength of the byssal attachment, but they can voluntarily detach from the substrate and move around using their muscular foot.

Settled mussels reach maturity in the spring following their hatch. The adults are voracious filter-feeders, removing any particles between 15 µm and 450 µm from the water column (Sprung and Rose 1977). Items that are not suitable for ingestion are aggregated into a mucoid ball and ejected as pseudofeces. Zebra mussel colonies can create sizeable accumulations of humus due to the production of this pseudofecal matter.

Adult zebra mussels are eaten by diving ducks and some dabbling ducks (scaup, tufted ducks, mallards), mammals (muskrats), crayfish, and several fish species (freshwater drum, carp, yellow perch, sturgeon). Coots have been reported to consume as much as 93% of the standing crop of adult mussels in local bodies of water in Europe during the winter (Mikulski et al. 1975, cited by Stanczykowska et al. 1990). The veliger larvae are eaten by adult zebra mussels, and recent research indicates that they may also be food for gizzard shad (Ed Mills, Cornell Biological Field Station, Bridgeport, NY, personal communication). In Europe, newly-established zebra mussel populations typically decline five to ten years after their initial exponential growth phase. These population declines presumably occur due to increased predators and disease organisms, and depletion of food resources by the mussels.

Population Distribution And Expansion

Zebra mussels first began to spread from their native range in the 1700's by accidental transport on boats navigating between the Caspian Sea and western Europe. They were found in Hungary in 1794, in Britain in the 1820's, in the USSR in 1845, and in Italy as late as the 1970's (Mackie et al. 1989). They were first noted in North America in Lake St. Clair in 1988, having probably arrived in 1985 or 1986 in the ballast water of an ocean tanker (Hebert et al. 1989). Their range expansion in North America has occurred in two manners: downstream, by passive transport of the veligers or dislocated adults, and both upstream and downstream by man-mediated transport. Possible methods which enhance the spread of the mussels include adult attachment to boat hulls, veliger transport in bilgewater and bait buckets, dumping of aquaria into which mussels had been introduced, and fish stocking by state and federal agencies. By 1990 the mussels were present in all of the Great Lakes and the New York State barge canal, and by 1991 they had been found in the Hudson, Susquehana, Rideau, Ohio, Illinois, and Mississippi river drainages. They have also been found in several inland lakes: Oneida and Cayuga in New York, Muskegon Lake in Michigan, and Indian Lake in Ohio. At this point their spread throughout the North American river drainages is inevitable, as water currents will transport them freely and man will transport them inadvertently.

Mussel densities vary widely among sites. In Lake Erie, most of the available hard substrate is covered with mussels in densities up to 45,000/m^2, and densities as high as 700,000/m^2 have been noted in a power station intake canal (Griffiths et al. 1989). In contrast, most of the recent sightings in the Illinois and Mississippi rivers comprise less than half a dozen individuals at each site. Newly established populations such as in Green Bay, WI, Oneida Lake, NY , and Cayuga Lake, NY comprise individuals of a single year class, whereas older colonies in Lakes Erie, Ontario, and southern Lake Michigan consist of 2- and 3-year old mussels encrusted with 1- and <1-year old juveniles.

In lakes, the highest mussel densities are found at 3-7 meters. The mussels can tolerate water temperatures from 0°C to 34°C, although summer water temperatures above 26°C appear to reduce veliger survival (McMahon 1990). Mortality occurs at oxygen concentrations below 40-50% of air saturation. Optimum salinity is <0.5ppt, although up to 6.8ppt can be tolerated (MacNeill 1991).

Impacts

Zebra mussels are predicted to have significant impacts on both the aquatic ecosystem and on human water users. Feeding by millions of these mussels, which can each filter over a liter of water per day, threatens to deplete the population of microorganisms which are the base of the aquatic food chain. Ultimately, this depletion could reduce forage fish populations and threaten the health of the sport and commercial fisheries. The excretion of pseudofeces into the sediments may reduce benthic dissolved oxygen during decomposition. Lake trout and walleye spawning areas are at risk due to clogging of interstitial spaces by dense colonies of mussels. To date, however, none of these anticipated effects has been documented. Some changes in fish diets have been noted: freshwater drum, carp, and yellow perch have been caught with zebra mussels in their stomachs, and young yellow perch appear to benefit from the increase in macroinvertebrate populations which feed on pseudofeces (David Garton, Ohio State University, Columbus, OH, personal communication). The most obvious and immediate effect of the mussels on native species has been due to the attachment of zebra mussels onto the shells of native mussels, clams, snails, and crayfish. Crayfish can be rendered immobile and unable to shed by large numbers of mussels on their carapace. Dense settlement of zebra mussels on native clams and mussels can result in growth deformities, suffocation, or starvation due to competition for food.

Documenting the effects of zebra mussels on large lake and large river ecosystems is made difficult by the size of the ecosystems, the large natural fluctuations in many environmental variables, and the potential for long delays before effects are detectable. Thus, cause and effect may be difficult to demonstrate. For example, the water clarity in Lake Erie has increased dramatically since the arrival of the mussels, but this change may be due to natural, long-term lake cycles.

In contrast to their biological impacts, the effects of zebra mussels on man-made structures are already clearly evident. The mussel's high fecundity, rapid growth, and ability to attach strongly to any hard substrate have caused dramatic problems due to clogging water intake pipes, sinking navigation buoys, and fouling docks and boat hulls and engine cooling systems. In Lake Erie, windrows of dead and sharp, broken mussel shells over a foot deep have caused inconvenience to bare-footed beach walkers. Byssal mats which remain after the adults have died can promote corrosion on metals, due to the anaerobic conditions which are formed under the byssus. This is a particularly severe problem in industrial plants and on boat outdrives.

The most severe impacts of zebra mussels have occurred in industries and public utilities with water intakes in the Great Lakes. For example, the water treatment plant in Monroe, Michigan, suffered a 60% loss of water delivery in 1989, due to mussel infestation (LePage et al. 1989). The Detroit Edison Power Plant in Monroe manually removed 40 cubic meters (10 metric tons) of mussels from water intake structures in 1989. This cleanup took eight days and cost $25,000 (Kovalak et al. 1989) The implementation of control methods such as mechanical cleaning or chemical treatment involves considerable cost, especially when retrofitting is involved. Prophylactic chemical treatments to prevent settlement of veligers can cost up to $1,000/day (John Sapia, Bethlehem Steel, Chesterton, IN, personal communication). One-time treatments to kill settled adults can have deleterious consequences as dead mussels are suddenly released en masse into the water pipes. For example, the Burns Harbor Bethlehem Steel plant in Indiana suffered a 50% plant shutdown for two days when dead mussels clogged their small-diameter pipes which provided blast-furnace cooling water. Similar problems occurred when the Asiatic clam, *Corbicula fluminea*, invaded the Mississippi drainage from the south. Industries in Illinois such as the Granite City Steel Company on the Mississippi River near St. Louis use strainers and traps in their water systems upstream of critical components (e.g., water cooled bearings) to catch the clam. The plants also shut down periodically to clean

portions of the water systems so the Asiatic clams cannot grow to a size that would block pipes. Unlike the zebra mussel, however, the Asiatic clam does not attach to surfaces, so it is less of a problem to remove.

ZEBRA MUSSELS IN THE ILLINOIS RIVER

Zebra mussels were first seen in Chicago in late 1989, and by late 1990 they were noted in low densities (<100/m^2) at multiple industrial sites along the south coast of the lake. In 1991, monitoring at eleven sites along the Illinois and Indiana shorelines showed an exponential increase in veliger densities. The highest densities were noted at the southernmost portion of the lake, where warm, shallow waters and industrial thermal effluents may enhance the growth of the mussels. Thus, veligers can readily enter the Chicago and Calumet rivers which drain into the Chicago Sanitary and Ship Canal and thence into the Illinois River (Fig. 1).

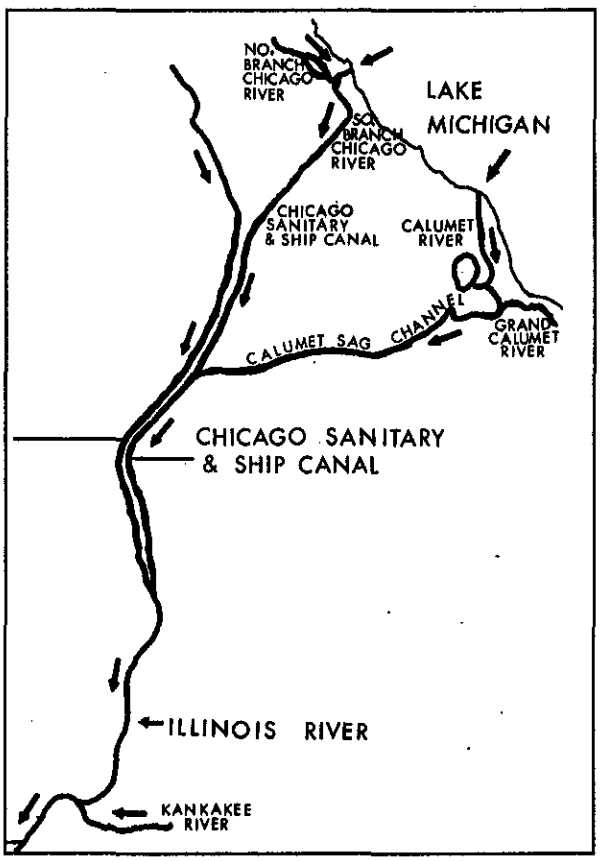

Figure 1. Map of water flow from Lake Michigan to the Illinois River: routes of zebra mussel transport.

The first confirmed sighting of a zebra mussel in the waterways connecting Lake Michigan to the Illinois River was on 19 April 1989 (Mr. Irwin Polls, Metropolitan Water Reclamation District of Greater Chicago, Chicago, IL; personal communication). A single, quarter-inch long specimen was collected in a Ponar grab sampler from the Chicago Sanitary and Ship Canal at Western Avenue. Fifteen months later (18 July 1990), another quarter-inch individual was taken from the Cal-Sag Channel at Route 83. The first confirmed sighting in the Illinois River proper (downstream of the junction of the Des Plaines and Kankakee rivers) occurred on 18 June 1991 when a commercial clammer sent a zebra mussel to the Illinois Natural History Survey Laboratory at Havana. The mussel had been found attached to a native three-ridge mussel in Bath Chute, a side channel approximately 200 miles downstream of Chicago. Additional specimens were soon being found throughout the river, some only 50 miles from the confluence with the Mississippi River

(Fig. 2). Because these mussels were at least two years old and were found in low numbers, they may have been carried downstream as adults on commercial barges or pleasure boats. If they had entered as swarms of veliger larvae, many individuals should have settled out together. Although no commercial barges enter the 7-mile-long Bath Chute, small pleasure boats do pass through this side channel.

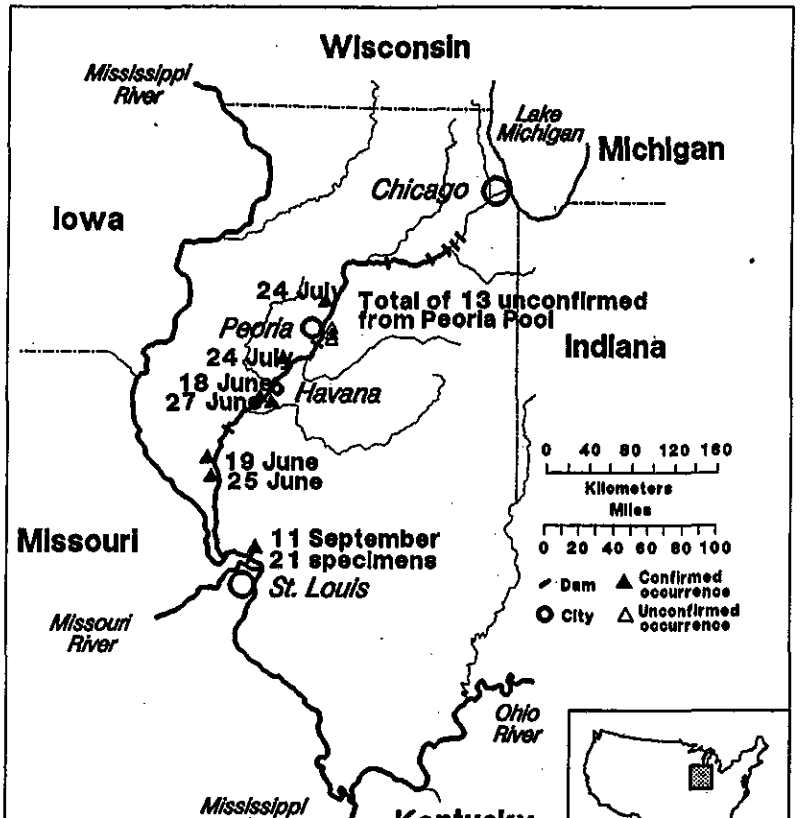

Figure 2. Zebra mussel sightings in the Illinois River as of Sept. 11, 1991.

By late September 1991, 1/8-inch mussels were found attached to special mussel sampling plates that had been placed in the Illinois River near water intake valves at L.T.V. Steel, at river mile 209 near Hennepin, IL. These numerous small individuals could only have arrived as veliger larvae, indicating that either the zebra mussel is reproducing in the Illinois River or larvae are being swept in from Lake Michigan. If reproducing populations are not already established in the Illinois River, they are likely to be by the spring of 1992.

September also brought reports of zebra mussels from pools 8, 12, 16, 18, and 26 of the Upper Mississippi River, so this small invader now occupies at least 500 miles of the Mississippi River from La Crosse, Wisconsin on the north, to St. Louis, Missouri on the south (Riffe 1991; Thomas Keevin, U. S. Army Corps of Engineers, St. Louis, MO, personal communication). A similarly rapid invasion took place in the New York Barge Canal where zebra mussels travelled over 100 miles in one year to reach Oneida Lake in 1991 (Ed Mills, personal communication).

Most, if not all of the zebra mussels problems encountered in the Great Lakes will undoubtedly also occur in the Illinois and Mississippi rivers. In particular, protection of the locks and dams on the navigable rivers from zebra mussel fouling will present unique engineering challenges. Encrustation of zebra mussels on barge hulls will increase flow resistance and lower fuel efficiency. From an ecological perspective, one of the most severe effects of the zebra mussel in the Illinois River may be on the native mussels. In 1990

the commercial harvest of mussels totaled 3.4 million pounds, worth $3,300,000 (Fritz 1991). A substantial portion of this harvest came from the Illinois River. The native mussel populations are already stressed by harvest for the cultured pearl industry, pollution, and commercial shipping which greatly increases local turbidity (Starrett 1971, Sparks and Blodgett 1983, 1988, Blodgett and Sparks 1987). Native mussels occur in dense beds that provide hard substrate - a scarce resource in sand or mud bed rivers like the Illinois and Upper Mississippi Rivers. Caddisflies attach their feeding nets and pupae to mussel shells, and snails and other invertebrates lay their eggs on them (Anderson and Vinikour 1984; Coker et al. 1921; Sephton et al. 1980; Beedham 1970; and personal observations by the authors). The native living mussel maintains itself, and the community of smaller organisms that it hosts, at the sediment-water interface, so the "guest" organisms are not buried by sediments nor scoured downstream. Small fish are attracted to the shelter from current and predators afforded by the large native mussels and the fish feed upon insects and other small invertebrates that occur among the shells (Moy and Sparks 1991). Larger predatory fish are in turn attracted by the smaller fish, so that the living native mussel bed creates an ecosystem of its own. Unfortunately, the native mussels are also the primary hard substrate available for settlement by zebra mussels. As has been seen in the Great Lakes, encrustations by zebra mussels deform and eventually kill native mussels. Zebra mussels may also compete with native species for microscopic food particles and interfere with their siphoning by overgrowing their shells. It is unlikely that the zebra mussels will provide exactly the same services to the "mussel bed ecosystem" as the native mussels, because of differences in their size and positioning behavior in the sediments.

Monitoring the Illinois River for adult and juvenile zebra mussels is important for several reasons. First, utilities and industries require an early warning of potential infestations. Retro-fitting a plant to control mussels can take up to two years, as can obtaining a permit for the use of chemical treatments. Second, research on ecological effects of the mussels will require knowledge of where they are and their local population densities. Third, the Department of Conservation will require information on mussel distribution in order to advise the public; for example, local boaters need to be alerted that the presence of the mussels may cause hull fouling and engine cooling water problems. Standard sampling techniques for zebra mussels have been described, and are being utilized by state, provincial, and federal agencies to ensure comparability of monitoring data (Marsden 1991). The Illinois Natural History Survey, in cooperation with the U.S. Fish and Wildlife Service and the Army Corps of Engineers as part of the Long Term Resource Monitoring Program, has initiated a sampling program on both the Illinois and Mississippi rivers. Both larval and adult mussels will be monitored, and information about sightings by the public will be collected.

ZEBRA MUSSEL CONTROL AND MANAGEMENT

Any discussion of zebra mussel control must begin with the realization that eradication of the mussels is not an option. To kill mussels in the aquatic ecosystem without extensive damage to native species would require a mussel-specific pathogen; while such efforts have been initiated by the U. S. Fish and Wildlife Service, the U. S. Environmental Protection Agency, and the New York State Museum, years of research are needed to find and test such pathogens. Therefore, control is currently limited to site-specific treatment.

Pest control has a long history in terrestrial systems, but is a relatively new and unknown science in aquatic systems. In order to avoid repeating the problems incurred in terrestrial pest control, an understanding of the concept of pest management is urgently needed. Management implies regulated coexistence, not indiscriminate destruction. Despite perceptions based on fear, most water-related installations can tolerate some level of mussel infestation without a detectable loss of efficiency or negative economic impact. Effective management depends upon a determination of the critical threshold of mussel infestation, below which the mussels have negligible impact. Control methods should be implemented only when this threshold is reached. The consequences of unmanaged control can include (1) the economic burden of unnecessary or ineffective treatments, such as treating for veligers even though they are absent from the water column; (2) rapid reinfestation after treatment, due to the renewed availability of substrate and food resources; (3) unintentional selection for resistant strains, leading to reduction in the efficacy of treatments; (4) loss of treatment options as resistant strains develop; (5) undesirable effects on non-target

organisms; (6) potential environmental hazards from residual chemicals or accidents during treatment; and (7) negative perceptions by the general public and environmental groups about chemical treatments.

Multiple techniques are available for controlling mussels within industrial plants, including chemical and thermal treatments, surface coatings, physical removal, and design modifications (e.g., see Mackie 1989, McMahon 1990). Development of an optimal mussel management strategy will involve consideration of all of these techniques. An open-minded interaction between biologists, engineers, and plant managers is critical to this process. Combining techniques can lead to improved solutions. For example: the effectiveness of chemical treatments to kill adult mussels is hampered by the ability of the mussels to close their shells for up to two weeks, which permits them to avoid adsorption of toxins. The efficacy of some biocides may be increased by raising the water temperature, altering the pH, or adding an anesthetic such as potassium or carbon dioxide to increase the mussels' susceptibility to the biocide (Anderson et al. 1976; Peter Howe, U. S. Environmental Protection Agency, Chicago, IL, personal communication). A good solution which has been used effectively in Europe is to install dual intake lines, so that one can be deoxygenated during the winter to kill encrusting mussels while the other line is in use.

Individual plants may have design features which will cause unique problems, but may also offer unique solutions. Each industry needs to create their own management strategy, including: monitoring for veligers, so that treatments are not implemented when veligers are not present; determination of the most vulnerable locations in the plant, such as small-diameter pipes; determination of the economic and action thresholds for zebra mussels at the most vulnerable sites; and consideration of re-design of critical areas to increase tolerance thresholds. Ultimately, zebra mussel control should be guided by consideration of environmental impacts, and economic impact to the consumer as well as the industry.

CONCLUSIONS

The rapid infestation of all of the Great Lakes by zebra mussels has made the invasion of the Illinois and Mississippi river drainages inevitable. The problems caused by the mussels in Lakes Erie and Michigan will undoubtedly also occur in the rivers: these problems include clogging of water intake pipes in water treatment facilities, power plants, industries, and boats; fouling of recreational beaches, navigation markers, and boat hulls; and potential fouling of commercial fishing nets and fish spawning reefs. The mussel's rapid population growth and intensive filter feeding may deplete planktonic organisms, and thus decrease the food available for forage and sport fish. Native mussels, clams, and crayfish are particularly vulnerable to the zebra mussels, which may settle on their shells and cause growth deformation, suffocation, or starvation. In the Illinois and Mississippi rivers, locks and dams may be vulnerable to fouling by dense colonies of mussels. Barges may lose fuel efficiency when their hulls are fouled with mussels. Public education may help to slow the spread of this invader, and will enhance understanding of the problems caused by zebra mussels. Use of responsible pest management techniques should be strongly encouraged by state and federal governments. To develop and implement creative approaches to pest management, research on the basic biology of the zebra mussel is urgently needed. In the Illinois and Mississippi rivers, monitoring is required to track the progress of the invasion, and to determine the effect of the zebra mussel on native mussels and clams, including commercially important bivalves.

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THE ILLINOIS RIVERS PROJECT

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ABSTRACT

The Illinois Rivers Project, begun in February 1990, was funded as a part of the State of Illinois Scientific Literacy Grant Initiative. The grant supported this pilot project to involve high school students in the monitoring of the waters of the lower Illinois and the Mississippi Rivers. Initially, eight schools with three teachers from each school developed a plan to study the rivers in three areas: science, social studies, and English. As a results of these investigations, students and teachers have developed a set of river study materials. Each school is hooked into an electronic mailing network called "SOILED NET" that enables it to interact with other schools and with Southern Illinois University.

During the next school year (1990-1991), 27 new river town high schools joined the project, thus allowing 35 schools to study the rivers of the state of Illinois. In January 1991, 13 schools from Minnesota, Wisconsin, and Iowa joined with schools in Illinois to form the Midwestern River Project. With a grant awarded by the Eisenhower Foundation, 24 additional Illinois schools became part of the River Project. Today, 87 schools stretching from Little Falls, Minnesota, to Cairo, Illinois, monitor and research their local river.

PROJECT OVERVIEW

The Illinois Rivers Project, funded by the Illinois State Board of Education's Scientific Literacy Grants Program, is now entering its third year. From its beginning as a pilot program involving eight schools (with 24 teachers representing science, social studies, and English) along the Mississippi and the lower Illinois

Rivers near St. Louis, the Project has expanded to 87 high schools (with 250 plus teachers) from Cairo, Illinois, at the junction of the Ohio River, to Little Falls, Minnesota, north of Minneapolis, and on every major river in Illinois. The Project's expansion includes a Midwestern network of 16 schools from Iowa, Wisconsin, and Minnesota. Schools from Missouri, Indiana, North Carolina, Montana, and the Great Lakes have recently expressed interest in joining the network.

The Illinois Rivers Project has followed a high visibility course that has gained much attention in the towns where the schools are participating. The local media find the idea of high school students patrolling the river's banks in search of trouble spots a highly desirable and thus photographic activity. The required field study in the Project, including collecting water, performing some on-site tests, and bringing samples in to complete testing is considered a valuable effort by teachers and students alike. Water quality kits that are both readily available and easy to use make this activity a relatively uncomplicated task. Nine water quality tests are run: dissolved oxygen, fecal coliform, pH, biochemical oxygen demand, temperature, total phosphorus, turbidity, nitrates, and total solids (American Public Health Association 1985).

Once the data have been collected and analyzed, the Project's telecommunication system, SOILED NET (the Southern Illinois Education Network), allows students to transmit their data as well as view all that has been collected by the other 87 schools. At the same time, the Project calls for the social studies and English classes to write about the history and the culture of their community as it relates to the river, which results in the Project's publication, *Meanderings*. *Meanderings* is a collection of scientific articles, historical research, interviews, folklore, creative writing, and illustrations. Students with varied talents and interests are provided a vehicle to display the products of their efforts. In the second year of the Project, student writings were transmitted via SOILED NET to be edited by Project staff into a finished product. Copies of this book were distributed to local and school libraries, state and regional libraries, and the Library of Congress. The students' writings in the areas of science, culture, and history became part of the written collections of both academic and local establishments. Though SOILED NET has been used primarily to transmit data obtained from the water quality testing, it is now on-line to transmit water quality data to the data bank at the Environmental Management Technical Center, a branch of the U.S. Fish and Wildlife Service, where it is analyzed by their staff to monitor the quality of Midwestern rivers. The data is then made available to the entire scientific community through the Geographic Information System (GIS). The first annual Illinois Rivers Project Student Congress was held on April 19-20, 1991 in Quincy, Illinois, allowing 200-plus students to showcase and share their experiences and efforts with their peers.

ELSAH CASE STUDY

Each school in the project retains special autonomy and its interest in developing the River Project in a unique direction. Some schools assign a minimal time, doing the recommended tests and writings, while others pursue open avenues of interest.

This article describes one of the diversities that occur as students pursue studies of real life problems.

Students of Jersey Community High School (one of the eight pilot schools) in Jerseyville, Illinois (a rural community of 7500 people), experienced first hand the many political issues and ramifications that resulted from their discovery of a highly polluted creek. Using data compiled from their water quality testing, senior government students became involved in the politics of the quaint little village of Elsah, Illinois. Testing indicated the presence of fecal coliform at levels unfit for human contact in the creek that runs through the entire length of the village before it empties into the Mississippi. Instead of merely reading about political action in a government textbook, the students themselves became activists and experienced the reality of confrontation and public reaction to environmental issues. Students in this two year study cooperated with village officials, residents, health officers and the media to explore and attempt to remedy the environmental problems and discovered what emotions could be elicited by those involved and, in some cases, the negative responses to their efforts to clean up the creek.

Location Of The Study

Elsah is a village that has retained its 19th century charm and style. Listed in the National Register of Historic Homes, all homes and businesses are subject to an ordinance that requires restoration and building to maintain the historic style of the village.

While Elsah has its own unique character and is a charming place to visit (a bed and breakfast community for nearby St. Louis), living alongside its polluted Elsah Creek presented a hazard to both its citizenry and the environment. Unfortunately, the village's sewage system is as antiquated as some of its buildings. Most of the 65 homes and businesses contribute to the pollution of the creek by either the draining or leaking of raw sewage down its entire length. Fecal coliform counts(in this case an indicator of human waste) soared to levels much higher that acceptable health standards allow. Jerseyville students chose to confront the problem directly. As a result of the action taken by these students, lessons in both environmental and political reality were experienced by 17 and 18 year-old students who had dreams to make a difference in their world.

The Project Begins

Elsah Creek was not one of Jerseyville's original six testing sites. As interest began to build in the River Project and the water testing taking place in the advanced chemistry classes, a student, who was a resident of Elsah, brought in a sample of water from Elsah Creek. She reported that the creek had an odor and she wanted the class to test the water. From that small jar of water, students at the high school became involved in an environmental issue in which they found they could have an impact on a community.

After several testing periods, it became apparent that the fecal coliform level at Elsah Creek was unacceptable. Fecal coliform is derived from the feces of humans or other warm-blooded animals. While fecal coliform bacteria by themselves are not

pathogenic, they occur naturally in the human digestive tract; their presence indicates the possibility of more dangerous and pathogenic bacteria. The students learned that fecal coliform counts higher (over 200 colonies/100 ml in water sample) can result in a greater probability that pathogenic organisms are present. A person wading or swimming in such water might swallow some pathogenic organisms, or these organisms might enter the body through the nose and ears or through a cut in the skin. Diseases and illness such as typhoid fever, hepatitis, gastroenteritis, dysentery, or ear infections can be contracted in waters with high fecal coliform counts.

Treated sewage effluent levels should not exceed 200 colonies/100 ml of water. The same level is true for swimming; but the acceptable level for partial body contact(boating) is higher at 1000 colonies/100 ml water (Mitchell 1991).

The fecal coliform results from the testing done at Elsah Creek were the following:

DATE	WEATHER	RESULT
March 6, 1990	Overcast	6000
March 27, 1990	Clear	TNTC
April 9, 1990	Overcast	5400
April 10 1990	Rainy	TNTC
June 19, 1990	Clear	TNTC
June 26, 1990	Clear	TNTC
July 3, 1990	Clear	TNTC
July 10, 1990	Overcast	TNTC
July 17, 1990	Clear	TNTC
July 27, 1990	Clear	Site 1 1000 Site 2 2250 Site 3 2100 Site A TNTC Site B TNTC Site C TNTC Site D TNTC Site E TNTC Site F TNTC Site G TNTC
Sept 8, 1990	Clear	2800
Oct 17, 1990	Overcast	600
Nov 12, 1990	Rainy	600

The Students Organize

As the water quality results began to accumulate the students became extremely concerned about the high fecal coliform counts they continued to get from Elsah Creek and they wanted to take action. What better place than a government class

for political action to be developed--and that is exactly what was done. The students were encouraged by their teacher to develop their own ideas on how to deal with the water quality of Elsah Creek. If a feasible idea emerged, plans were developed

The water testing began on March 6,1990 and the political action efforts were initiated in May,1990. The students first plan was to organize a letter writing campaign. They felt that information about the problem might bring about solutions.

The first letters they drafted were sent to state and federal senators and representatives. In these letters the students told of their River Project--what it was, what they had been doing, and how they had found the high fecal coliform counts. They basically were making their politicians aware of the environmental problem and that they were working to find a solution.

The second letter sent was to the Elsah City Council. Once again they explained about the River Project and informed the council of the alarmingly high fecal coliform data they continued to receive. The students suggested better trained personnel (eventually the Madison County Environmental Center confirmed the high results) evaluate the water quality of the creek for it potential harmful effects to nearby residents. In this case, the whole town bordered Elsah Creek. The students were amazed by the reply from the mayor. She said Elsah had been aware of the problem since the 1950s and there had been many attempts to remedy the problem. So far, she reported, every attempt had failed. This was intriguing to the students and during the school year of 1990-1991, a researched history of Elsah's sewage problem began.

A third set of letters were sent to three agencies, the Jersey County Health Department, the Illinois Department of Public Health, and the Illinois Environmental Protection Agency. Once again the students told of their involvement in the River Project and how they were consistently receiving high fecal coliform data. Their letters ended by saying they hoped steps were being taken to restore the creek and the river back to its original healthy state.

The Elsah Creek Expedition (Summer 1990)

By this time, the 1990 school year had ended. Two extremely active students in the project wanted to continue testing the water through the summer months. During this testing period the fecal coliform results remained high. At the end of July the students wanted to walk Elsah Creek and take samples at different locations to see if they would continue to get the same high readings the length of the creek, as well as to locate specific coliform sources. This became known as the "Elsah Creek Expedition."

On July 27, 1990, two teachers and the two summer students walked the length of the creek. It was a sunny, hot, humid day. The group was equipped with sterilized jars, flags for spot markers and paper and pencils. Each place where a water sample was taken, was marked with a flag and a written observation was made. The expedition took three hours and in the end only confirmed the fact that the entire creek had high fecal coliform counts. The students compiled a five page

written summary of the expedition. This included the objectives, a site synopsis, the aquatic life, a diagram of the explored area, the test results, and a project conclusion. One unexpected outcome of the expedition was a phone call to the government teacher from an outraged Elsah citizen. She claimed the creek behind her house was private property and we had been trespassing while in the creek. She wondered what we were trying to do and even went so far to say that if we walked in the creek again, she would have someone arrested.

New Students Take Up the Campaign

With the start of the 1990-1991 school year, a second group of government students were now ready to continue the political action. Research on Elsah's sewage system was the first project. The students conducted interviews of people who had been involved in previous efforts to obtain a sewage system. The mayor of Elsah, the president of the Elsah Sanitary District, an engineer from the firm hired to design a sewage system, the Director of Environmental Health for the Jersey County Health Department, and a representative from the Illinois EPA were interviewed by the students.

The students discovered that Elsah citizens were aware of their water and sewer problems. Since the 1950s, concerned citizens and the local board had been investigating various solutions to the problem. In the 1970s, the solution most feasible was to use a provision of the Clean Water Act that provided for funding of local sewer projects. An engineering firm was hired to develop a plan for the Village of Elsah. Their first plan was rejected by the Illinois EPA. At this time, the Illinois EPA informed the Sanitary District they would give them 85 percent of the money to finance an alternate system. Elsah would have to finance only 15 percent of the project. By 1989, a second plan had been approved by the Illinois EPA. After many heated public meetings concerning the financing of the sewer project, the referendum was rejected by the people in March of 1990. The alternative to the sewer project was for each individual home or business to put in their own septic system. The residents of Elsah had been sent letters from the Environmental Director of Jersey County stating they have to start the process to comply with state standards.

The mayor of Elsah once made the comment: "If only these students had been involved in their project earlier, maybe the outcome of the referendum would have been different." The students certainly felt that they would have made a difference if the timing would have been better.

Other groups of students attended meetings held in Elsah. One focused on the different types of individual sewage systems. They also attended an Elsah City Council meeting presenting a program on the River Project and answering questions by members of the council. Later council meetings were attended where they merely acted as observers. A fourth meeting was requested by the lady who said the students had been trespassing in the creek. The meeting began as a "gripe session" by the residents against the students and the River Project. By the end of the meeting, the residents had a better understanding of the project and what the students were trying to accomplish--to find a solution--not to cause trouble, as many had believed.

On a Saturday morning in October of 1990, the students went to Elsah to conduct a survey of the residents. Fifteen questions had been prepared, from "How close are you to the creek?" to "What type of sewer system do you have," to "How old is your sewer system?" Elsah was divided into sections and groups of four went door to door. They soon discovered the residents of Elsah did not want to talk to them. People would look out their windows, but not answer the door. One lady was on the phone and turned her back on the anxious young researchers. They learned some valuable lesson about the nature of people.

The students then developed a flyer to be distributed in Elsah. This flyer warned that Elsah Creek was hazardous to health and to the environment. It stated the high readings of fecal coliform the students discovered during water testing and the diseases fecal coliform and other pathogens could cause. The citizens of Elsah were asked to take the initiative and help solve the problem.

Finally a Solution Is Reached

The more the students became involved in the issues, the more they wanted to do. What a change from the first days of the project. The issue was finally brought to its final stages by a visit from the local health department representative. He asked the students, by way of their teacher, to file a complaint with the Jersey County Health Department against the citizens of Elsah. The students maintained the residents had their opportunity to remedy the problem--the referendum--and chose not to do so. Now they would have to be held accountable for the creek in their backyard. The chief piece of evidence for the successful complaint was the summer work conducted during the Elsah Expedition and the series of water quality results conducted by the students.

As a result of these students' political and scientific actions, the residents were forced to work towards a solution. The students took a helping role to seek ways to enable residents to find ways to finance the expensive sewage systems. Information on financing sewer loans and other such information were forwarded to the mayor for dissemination.

Student awareness and the ability to convince others to take action has been an unexpected but rewarding result of the project. Students have actually "seen" first hand that chemistry has application in everyday life. They then "saw" their own political involvement could make a difference. When choosing to take action on this issue these students had the opportunity to change their "I don't care attitude!" What they learned through the River Project and through the "hands on experience" of science and government working together in the classroom will, hopefully, carry over into their adult lives.

Who knows what lasting effect this will have on the students? This could inspire them to pursue politics and law, or simply to be well-versed citizens. We do know that two of the summer students are pursuing environmental careers; Jerru in engineering and Katie in environmental biology. One thing is certain, all these students for a short time, did make a difference. That is something they won't soon forget, nor will the citizens of Elsah, Illinois, the lovely, quaint, and cleaner village on the banks of the mighty Mississippi.

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POSITIVE IMPACTS OF THE *PAR-A-DICE* ON RIVERFRONT DEVELOPMENT

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Greater Peoria Riverboat Corporation

The site--62 acres (27 acres of land and 35 acres of water) located on the southeastern shore of lower Peoria Lake--was previously a landfill with scattered concrete and debris throughout, numerous mosquito beds and treacherous, entangled, massive sections of concrete bridge deck lining the shoreline.

Prior to beginning construction, the site was rid of a great amount of debris to satisfy EPA requirements, then cleared and graded for drainage. The river work permitted through the U.S. Army Corp of Engineers consists of:

- Redredging of an existing channel at United Facilities, then dredging a channel and turning basin to the *Par-A-Dice* docking facility. This dredging and future maintenance dredging will assist in the Saving Peoria Lake Program through the removal of approximately 376,000 cubic yards of silt.

- The extensive concrete removal along the shoreline is being recycled into rip-rap to be reused along the shoreline and drainage areas to aid in erosion control.

- With the development of the *Par-A-Dice* project, including two on-site hotels, we have planned and maintained landscaping and paved parking lots with "storm-water" retention and a storm sewer system, which aids in erosion control through controlled run-off.

- The creation of sheet piling sea walls, such as we have done, eliminates shoreline erosion and offers some degree of on-site flood control. This proves that a consolidated effort of proper planning and logical environmental practices can make the development of the Illinois River beneficial to all.

ECONOMIC AND TOURISM IMPACTS OF THE *PAR-A-DICE* ON THE ILLINOIS RIVER

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Par-A-Dice Riverboat Casino

The following statistics are an indication of *Par-A-Dice*'s impacts on the Peoria area:

- Anticipated payroll of nearly $17 million dollars a year.
- Expect 800,000 customers in the first twelve months.
- Projected gaming taxes of over $8 million for the first 12 months.
- Currently the *Par-A-Dice* employs over 700 staff.

The business's impacts on local tourism is tremendous. Already more than 20,000 group tickets have been sold. Many are bus groups from the Chicago area, Quad Cities, Indianapolis, southern Illinois, southern Michigan, southern Wisconsin, Milwaukee, and St. Louis. New tour companies have been and continue to be created because *Par-A-Dice* exists. Companies catering to groups of all sizes who wish limo or bus service to *Par-A-Dice.*

Local hotels have been active in putting together special packages including rooms, meals and other attractions in the area, and have actively sought new visitors because of *Par-A-Dice.* Local hotel and motel executives indicate to us they expect *Par-A-Dice* will lead to capacity or near capacity room nights. The same is true for many area restaurants, some of which have already packaged and sold lunches, dinners, and banquets in conjunction with cruises on the *Par-A-Dice.*

The best indication of the impact on local tourism and the local economy is the planned construction of a new $6.1 million Hampton Inn to be built at the *Par-A-Dice* land base in East Peoria. A second hotel is also planned, as is a new restaurant on a five-acre section near the land base.

RECREATIONAL GREENWAYS AS AN ENVIRONMENTAL MANAGEMENT STRATEGY

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ABSTRACT

Greenways are multi-purpose public corridors of open space. Unlike larger blocks of land typically thought of as "parks," greenways are relatively narrow strips of continuously connected land. Canals, riverine corridors, former railroad rights of way and or utility transmission rights of way offer this potential. Greenways expand upon the concept of the "town commons" by attempting to maintain the character of a region by connecting points of environmental and or cultural value.

INTRODUCTION

Greenways represent a hybrid variety of environmental resource. Nature resource protection, preservation and appropriate public recreational uses are generally accommodated within a relatively narrow corridor. The concept of open space defining the character of an area has its roots in urban/regional planning and landscape architectural literature and practice. As one component of an open space spectrum (i.e., public parks, forest preserves, natural areas, and so on). Greenways represent the explicit integration of social and environmental values into both urbanizing and relatively rural landscapes.

BENEFITS

As a conscious environmental management strategy or approach Greenways can:

Preserve habitat

As relatively undeveloped landscape corridors, a greenway affords habitat preservation and/or the opportunity to recreate former native landscapes. The Des Plaines River wetlands project in northern Lake County demonstrates the latter. The linear nature of a corridor affords large amounts of edge, one indicator of habitat diversity.

Provide wildlife migration corridors

Greenways afford habitat for terrestrial animals, especially in urban areas. Migrating waterfowl frequent larger riverine corridors. One proposed greenway in Florida would enable a protected bear population to use the corridor for migration to less crowded habitat.

Preserve native landscapes

In central Illinois, often the last vestiges or remnants of the original tallgrass prairie are found within railroad rights of way. Management of such rights of way as greenways can protect these remnants. Prairie remnants are known to exist along abandoned rights of way in Ford, Iroquois, Champaign and many other counties.

Mitigate urban flooding

Perhaps the most utilitarian aspect of greenways concerns urban flood mitigation. This concept may appear obvious and somewhat elementary. However, floodplain management requires recognition of a riparian corridor for floodplain management purposes. Such recognition can therefore, define a corridor's explicit or implicit function.

Offer public outdoor recreation opportunities

Public outdoor recreation opportunities within a greenway are typically non-motorized trails such as those for hiking and bicycling. Public recreation opportunities are not necessarily required nor are they a principle purpose of greenways. However, more often than not, public recreation is compatible and generally complimentary to the aforementioned purposes. In Illinois, public outdoor recreation opportunities are generally integral components of greenway development.

COSTS

The foregoing described some generally recognized social and environmental benefits associated with greenways. However, as with most investments, (individual or collective) benefits cannot accrue without incurring certain costs or undertaking risks. The following are integral components of greenway development. A few are:

Acquisition of interest

Typically a public agency assumes the responsibility for or is directed to acquire an interest in real estate for public greenway purposes. Interest can be acquired by fee ownership or less than fee, such as with an easement or lease. In Illinois the Department of Conservation typically acquires fee interest in land by purchase or gift. However, long term leases between the State and Federal governments also exist. Acquisition necessarily runs the risk of public outcry as the exercise of eminent domain is always a possibility.

Identification of Management Authority

Management assumes the day to day responsibility of enforcing applicable statutes to both maintain greenway integrity and preserve it's purpose. Public safety is also of paramount concern. Perhaps management's greatest obligation is its implicit assumption of liability to ensure resource protection, preservation of purpose and maintenance of public safety. Typically, public agencies assume this responsibility.

Amenity Development

Where deemed or agreed to be appropriate, amenity and other facility provision is another important aspect of management. Recreational development emphasizes the multi-purpose nature of many greenways. Hiking and bicycling trails are among the more compatible public uses of greenway acquired for environmental management purposes.

Project Planning

Among the costs associated with greenway development, planning accounts for articulation of purpose, definition of a specific corridor, dialogue with interest groups (pro and con) and conflict resolution. Planning necessarily involves continual iteration, accounting for the seeming ambiguity of many such efforts. However, to proceed without attempting to define a greenway's purpose or providing a reasonable rationale for its existence mitigates against the resource itself.

SUMMARY

In Illinois, recreational greenways are inherently multiple benefit landscapes. Natural, historic, scenic, cultural and outdoor recreational resources are generally intertwined in a land configuration unlike traditional blocks of land for fish and wildlife or parks.

The greenway concept is supported in part by statewide legislation (Public Act 86-466) directing the Department of Conservation to acquire and develop landscape corridors for bike path purposes. Local and regional greenway planning efforts are numerous and very ambitious. One notable regional effort involves the development of a 1,000-mile multiple-use greenway system in the six county region of northeast Illinois. The Northeastern Illinois Planning Commission and the not for profit Open Lands Project based in Chicago are spearheading this effort. This

planning involves the assistance of all regional forest preserve and local park districts. This undertaking is further supported and underwritten in part by the Department of Conservation.

Increasing societal concerns regarding quality of life issues appear to be principle motivating factors driving the greenway concept. These general concerns should continue to provide the fabric with which to weave a more environmentally diverse and human landscape pattern.

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SOIL EROSION CONTROL--THE 1990 FARM BILL

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On November 28, President George Bush signed the Food, Agriculture, Conservation and Trade Act of 1990, calling it "the most environmentally progressive farm bill ever signed."

A key part of the 1990 Farm Bill is Title XIV, the Conservation Title. This title strengthens the conservation provisions of the 1985 Farm Bill, and introduces new provisions that, taken together, will help protect and enhance the environment by reducing soil erosion on agricultural lands, protecting wetlands, improving wildlife habitat, and improving water quality.

Established in the 1985 Farm Bill, conservation compliance requires farmers to develop and carry out approved conservation plans on highly erodible cropland to remain eligible for USDA farm program benefits. To date over 94 thousand tract plans covering 5.3 million acres have been completed statewide. The Illinois River Watershed contains 1.6 million of those highly erodible acres. Currently 35 percent of the 1.6 million plan acres have the plans fully applied. Acres with applied compliance plans save an average of 9 tons of soil per acre per year.

The 1990 Farm Bill strengthens conservation compliance by extending the loss of benefits to include more programs, and by prohibiting producers who put land into new CRP contracts from bringing any newly purchased highly erodible land into production.

The Act also makes conservation compliance easier to enforce by establishing a system of graduated penalties ranging from $500 to $5,000, depending on the severity of the violation.

The swampbuster provision of the 1985 Farm Bill helps preserve the important environmental values of wetlands, by disqualifying producers who plant crops on newly converted wetlands for USDA farm program benefits.

The 1990 bill changed the triggering of swampbuster penalties from planting a commodity crop on a wetland to the point when wetlands are actually drained, dredged, filled, or altered to make the production of a crop possible.

Producers may mitigate the loss of wetlands by restoring a prior converted wetland of equivalent value. A mitigation plan must be developed by SCS and FWS. Producers must agree to protect the restored wetland via an easement for as long as the converted wetland remains in agricultural use or is not returned to its original wetland classification.

As with conservation compliance, the loss of benefits swampbuster is extended to include more programs and total loss of benefits system was replaced by a system of graduated penalties for unintentional violations.

The 1990 Farm Bill established several innovative new provisions. The Agriculture Water Quality Protection Program was established and encompasses the Environmental Conservation Acreage Reserve, the Agriculture Water Quality Protection Program, and the Environmental Easement Program. These programs expand opportunities for resource protection and enhancement.

Under the Environmental Conservation Acreage Reserve Program you will find the Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP). CRP gives producers an incentive to voluntarily convert highly erodible croplands well as environmentally sensitive land from production for a period of ten years. Producers who enroll land into CRP receive an annual rental payment as well as cost-share for establishing the permanent cover.

The 1990 Bill strengthens the CRP by broadening eligibility for the program to include some marginal pastureland, cropland that contributes to water quality degradation, and other lands.

Other lands includes, shelterbelts, windbreaks, wildlife corridors, filterstrips, newly created sod waterways and land posing an environmental or productivity threat due to salinity.

Existing CRP contracts in vegetative cover may be converted to hardwood trees, windbreaks or shelterbelts and extended to 15 years.

The Illinois River Watershed has over 714,000 acres enrolled in CRP saving an average of 20 tons of soil per acre per year. This adds up to 14.2 million tons of soil annually.

The 1990 Farm Bill provides us the opportunity to protect natural resources. Now it is up to us to work as a team to aid farmers and land managers in the application of their compliance plans, there by insuring a healthy soil resource for the future.

STREAMBANK AND HABITAT MANAGEMENT STRATEGIES ALONG ILLINOIS RIVER TRIBUTARIES

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ABSTRACT

Losses of river and stream habitat along the Illinois River are closely connected with the channel erosion resulting from channelization of tributaries. Large sections of the eroding channel undergo massive bank erosion while the stream bed is downcutting through the stream system. The long-term result has not only been the loss of stream habitat but the loss of downstream wetlands from suspended sediment and bedload deposition. The stream channel instability also increases damages to county bridges, roadways, homes, and floodplain fields.

During a four-year watershed study of Crow Creek by the Floodplain Planning Program of the Illinois Department of Conservation, scientists from the Illinois State Water Survey documented the loss of wetland habitat along the Illinois River and the contribution of increased stream channel erosion. Channelization and the loss of riparian vegetation on vertical banks have increased channel erosion so that more than 212,000 tons have eroded from 0.5 mile of stream between 1970 and 1989. All calculations are illustrated with aerial and video photography.

In the Cameron Wildlife Refuge, the Crow Creek delta was channelized to move floodwaters and sediment through the highway and railroad bridges. This results in the loss of 180 acres of surface water in the wildlife refuge during major floods during the 1970s. Losses in quality wetland habitat, waterfowl populations, and gamefish have been severe. Presently gravel and sand from upstream channel erosion has refilled the stream channel. Major floods during 1990 endangered highway travel and destroyed a county bridge. Soil bioengineering techniques stopped channel erosion during floods that destroyed highway bridges during 1990. While vegetative stream stabilization has stopped bank erosion at two sites in the

0.5-mile demonstration area, more than 30 major sites remain in this one tributary of the Illinois River.

INTRODUCTION

The loss of channel stability in tributary streams of the Illinois River is destroying the habitat of both wildlife populations and the people living nearby. Wildlife habitat losses along both the Illinois River and its tributary streams have been regarded as the inevitable consequences resulting from the economic development of the landscape for agriculture and housing--the creation of better habitat for people.

The conception of Illinois streams as better habitat for people has ranged from tree-shaded banks along a meandering mixture of deep pools and riffles to grass covered ditches crossing valleys of corn in straight lines. Both views represent extremes under present Illinois conditions. The conversion of upland prairies and wetlands sharply increased the rates of water runoff by the 1930s so that stream channels became unstable. In efforts to reduce flooding and erosion, many streams were also channelized (straightened and shortened by removing the eroding stream bends or meanders). In streams along the Illinois River, channelization increased the already rapid floodwater velocity, eroded the streambed down, and began to reform the old meanders. During this process the stream undercut the older riparian trees, filled the deep pools with sand, scoured away grasses, and eroded stream channels into floodplain rowcrop fields.

By 1991, both the constructive and destructive effects of basic land management strategies are clearly evident in tributary streams, in the Illinois River and on the "improved" watershed. For wildlife, the loss of habitat means the loss of food sources, shelter, and even safety. The loss of habitat has a similar meanings for people but economic losses are included.

The destruction of 30,000 acres of river backwater has been driven by sedimentation within one generation. Lakes which existed for 5,000 years will be filled in our lifetime. The extensive damage of such large water sources has not been correlated with major damages to the land habitat of the human population. Much of the public has been unable to relate the losses of aquatic habitat with their own property losses. One object of this watershed study was to define this correlation for the Crow Creek watershed near Henry, Illinois.

Vegetative bank stabilization is reversing the destruction of habitat for both wildlife and people. The testing and development of these bioengineering techniques was funded by the Illinois Department of Conservation and the Illinois Department of Energy and Natural Resources through the local Soil and Water Conservation Districts. The role of the local Soil and Water Conservation Districts has been expanded with training sessions on the bioengineering techniques for contractors and government personnel with the Cooperative Extension Service. Such training is necessary for expanded erosion control funding initiated by the Illinois Department of Agriculture and Conservation.

THE WATERSHED

Crow Creek is a large tributary stream of the Illinois River, entering the Peoria Pool near Henry, Illinois (figure 1). With a steep bluff watershed area of 54,000 acres, Crow Creek floodwaters have extremely high velocity (9 ft/sec) during heavy rains. Such high velocity floodwater will erode and transport large amounts of soil. Bank erosion measurements have found over 6000 tons eroded from a single bank site during floods. Since a large flood will transport about 30,000 tons of soil, severe bank erosion sites are major sediment contributors. Since the loss of stream and riparian habitat has been a major factor in the continuing erosion of tributary channels, then vegetative stream channel stabilization not only reverses habitat losses but also reserves the continuing economic losses to farmlands, roadways, and homes.

WATERSHED EROSION SOURCES

Therefore within the Crow Creek watershed, the identification and control of erosion sources with high sediment delivery rates is critical for the protection of both the Cameron National Wildlife Refuge and the entire Peoria Pool of the Illinois River. Sediment delivery to the Illinois River will depend on the severity of erosion at each landuse site, the site velocity of surface water runoff which much carry the suspended sediment, and the distance which the suspended sediment must be carried. Regardless of calculated erosion amounts, sediment is not likely to reach the river in quantity if the water velocity is slow and transport distances great. Conversely even small areas of erosion may be large sediment sources if water velocities are high and transport distance is short.

EROSION AND SEDIMENTATION DAMAGES

Sediment discharge from Crow Creek has been a severe detriment to the Cameron National Wildlife Refuge at the creek mouth. Wetland habitat and vegetation has been buried under silt. Sedimentation has filled 180 acres of surface water in Goose and Weis lakes during the last 40 years. The Crow Creek delta was 460 acres in 1939, 500 acres in 1964, 530 acres in 1970, and 640 acres in 1979. The greater increase of delta area between 1970 and 1979 indicates that sediment delivery increased during the 1970's. The U.S. Fish and Wildlife Service states the waterfowl populations on the refuge has dropped from 1,000,000 duck use days to less than 100,000 as a result of the sedimentation.

In the Peoria Pool of the Illinois River, all backwater lakes and wetlands are experiencing similar losses in wildlife habitat and recreational use of the river system. A recent sediment survey of Peoria Lake (Demissie and Bhowmik, 1985) found the rates of sedimentation for 1965-1985 were double the sedimentation rates of the previous 40 years (1903-1965).

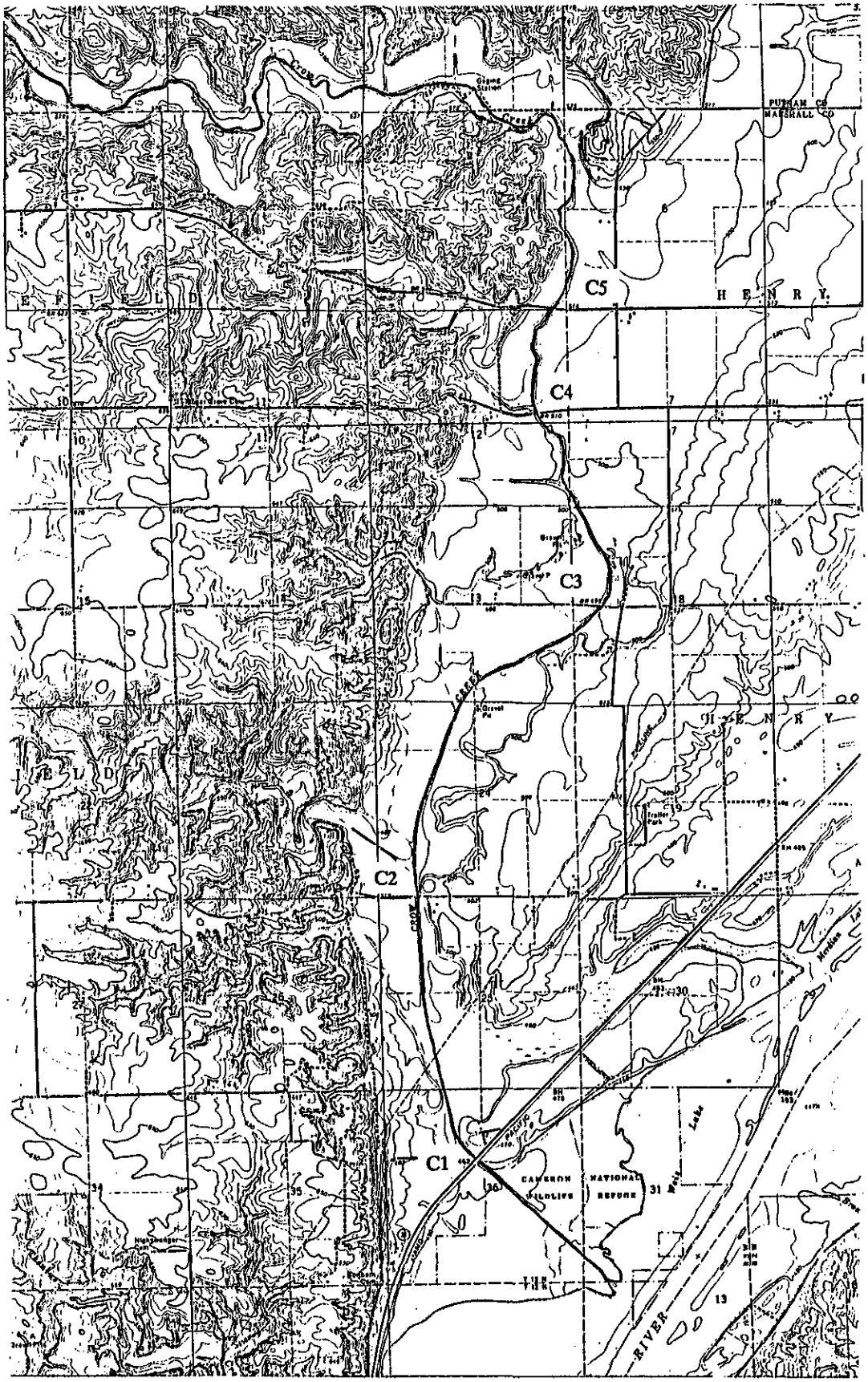

Figure 1. Channelized floodplain segment of Crow Creek.

HIGHWAY DAMAGES

In response to county concerns about the deposition of sand and debris around State Highway 29 bridge (C1 bridge in figure 1) and Rock Island railroad bridge, the U.S. Fish and Wildlife excavated a stream channel through the Crow Creek delta in 1964. The straightened channel was 0.5 mile long, 30 feet wide, and 6 feet deep. In 1969, 1970, and 1974, maximum stream flows were double the maximum floods occurring during the previous 20 years of record. The newly constructed stream channel was completely filled with sand, gravel, and debris.

Simultaneously with rapid sedimentation of wetlands along the Illinois River, massive bank erosion sites began occurring in channelized segments of Crow Creek. Aerial photographs detail the long history of channelization of Crow Creek as it flows through the floodplain to the Illinois River. The 1939 ASCS aerial photographs reveal that two miles of stream were channelized above Highway 29 in an effort to drain the wetlands and pass all stream waters through the downstream bridges (figure 1). While the railroad bridge is blamed for the loss of floodwater conveyance and sand deposition, the entire streambed has risen with the rapid accumulation of sand in the Crow Creek delta. Much of the present road maintenance is the removal of sand and debris from the highway bridge. This occurs during each major flood so that vehicles must drive through floodwaters (figure 2). The filling of bridge channels is common on streams draining the Illinois River bluffs.

On the next bridge upstream private landowners are creating levees from the sand deposition in the channel of Crow Creek. During the June 22 flood of 1990, the levees raised flood heights because floodwaters could not overflow into floodplain fields. This resulted in the loss of the county bridge (C2 in figure 1) when the high floodwaters and debris pushed the concrete spans off their piers (figure 3). The streambed at C2 is higher than the surrounding floodplain fields. During major floods, these sand levees will usually breakdown but not before severe economic damage occur.

Immediately upstream, the foundation of the next bridge (C3 in figure 1) has been eroded by channel erosion started by stream channelization. The streambed is now 5 ft. deeper than in 1939. The bottom of the first old bridge footings are 2 feet higher than the channel bed. Two more bridges have been built at this location - the latest in 1989.

At the next bridge upstream (C4 built in 1970), the county highway department is attempting to stop the erosion of bridge abutments by piling concrete slabs across the stream channel and against the abutments.

STREAM BANK EROSION

While several USDA soil conservation projects have addressed sources of rowcrop erosion in the watershed, no project has determined the severity of bank erosion nor bank erosion's contribution to sediment yields or has demonstrated methods of bank stabilization. The Illinois Department of Conservation funded a

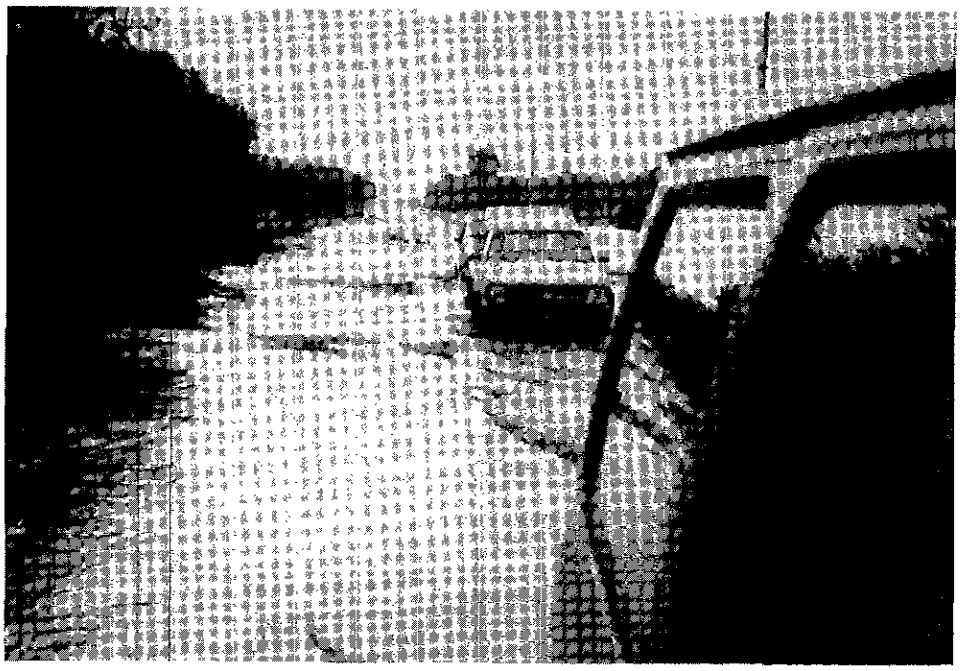

Figure 2. Floodwaters block traffic on Rte. 29 near C1 bridge.

Figure 3. C2 bridge destroyed by floodwaters.

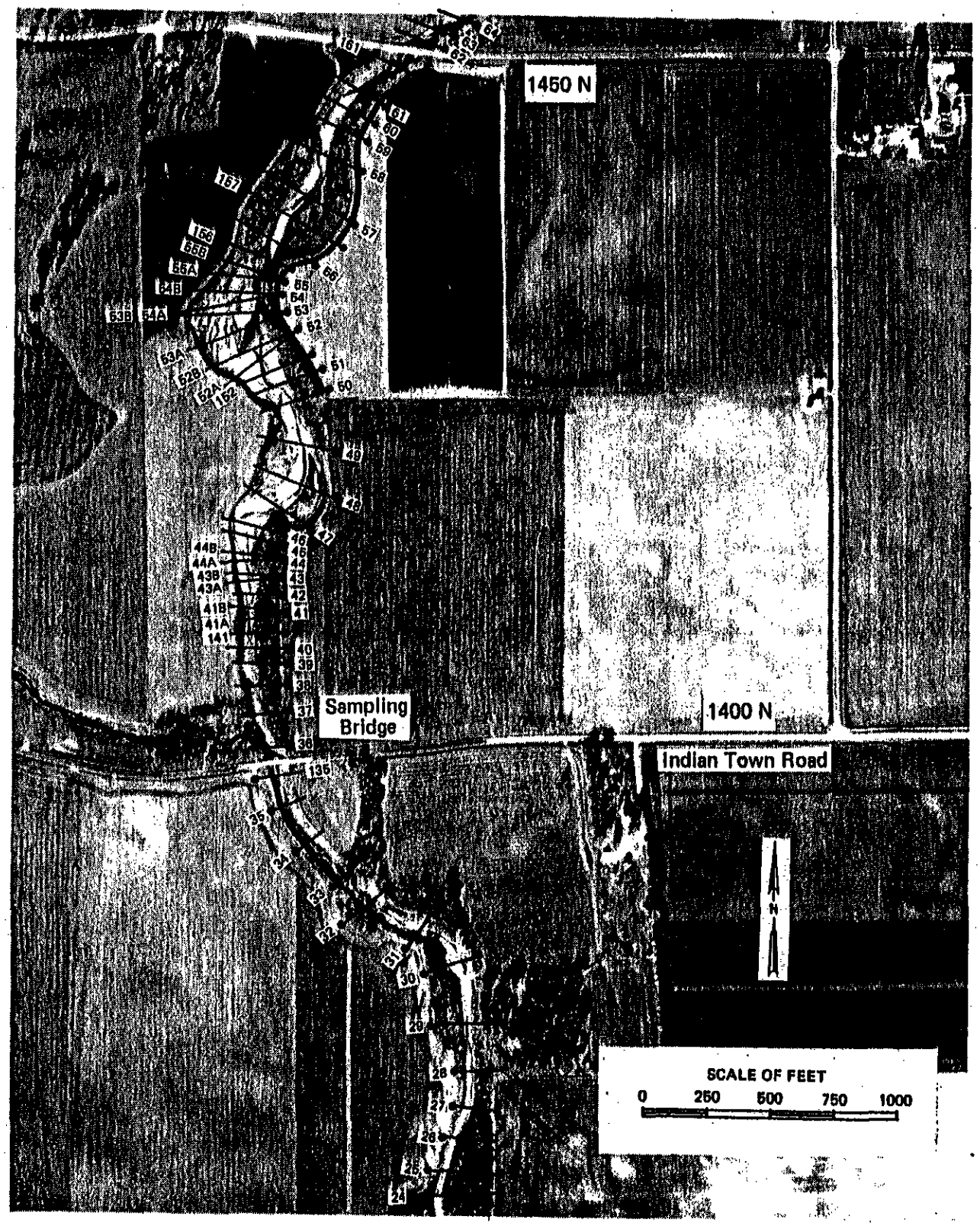

Figure 4. Stream maps of Crow Creek demonstration area. Stream bank erosion was most active between transect 40 and 53.

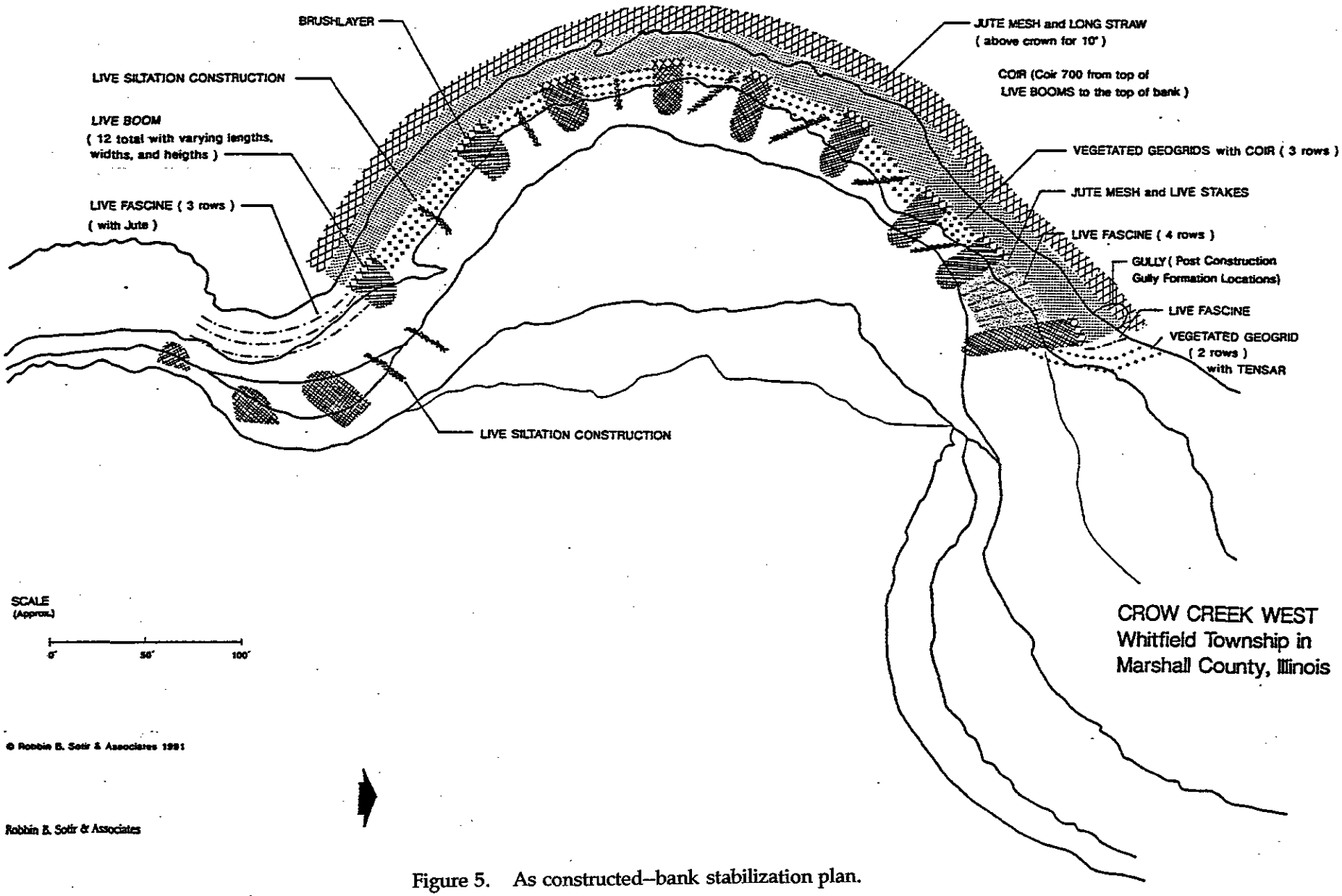

Figure 5. As constructed–bank stabilization plan.

multi-agency approach to solve these deficiencies in the watershed's soil erosion monitoring and erosion control programs. In 1987 and 1988, the Illinois State Water Survey established a system of stream channel and stream flow monitoring in a 1.5-mile segment of the stream. Bank erosion measurements determined that stream erosion was greatest between transects 40 and 47 (figure 4). The most active erosion site was chosen for the proposed vegetative stream stabilization site. The next most active segment was immediately upstream between transects 48 and 53.

Even during the relatively dry years of 1986-1989 with record droughts, bank erosion cut through two separate 30-feet wide easements at the bank stabilization site. Over 6,000 tons of soil was eroded at this one site during 1986. During 1988 and 1989, bank erosion between transects 40 and 53 equaled 12 percent of all sediment carried by Crow Creek during floods.

SOIL BIOENGINEERING PLAN FOR BANK STABILIZATION

The objective of this plan (figure 5) was vegetative bank stabilization of a highly erosive bank without additional channel stabilization methods. While grade controls should be applied wherever streambed downcutting occurs through the entire stream length, the costs and manpower required were prohibitive for this pilot project. Indeed, often the stabilization of an entire stream system would be cost prohibitive even for a major project in a state park.

BANK STABILITY

The bioengineering concept for this site has been very stable during the immediate post-construction period (to the date of this report--October 1991). A bankful flood with a stage rise of 6 feet and peak flow of 800 cfs occurred in April of 1990. The only damages were the loss of large riprap and soil from the channel end of live booms 8 and 9. These were repaired but remained at a shorter length because the channel narrows at this segment.

A very large flood (floodwaters rose 17 feet with a measured flow of 5,000 cfs) occurred on June 22--only three months after the end of construction. No bank erosion occurred at the construction site although a nearby county bridge was destroyed on Crow Creek (figure 3). By August of 1990, riparian vegetation along the restored stream banks was abundant. The vegetative growth remains lush into July of 1991 although another drought has reoccurred in central Illinois.

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THE NEED FOR A COMPREHENSIVE MANAGEMENT PLAN FOR THE ILLINOIS RIVER BASIN

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ABSTRACT

The Illinois River is the single most important river in the state of Illinois. Approximately 95 percent of the urban areas and half of the agricultural lands in the state are located within the Illinois River basin. The Illinois Waterway, which consists of the Illinois River and its tributary streams, is the only waterway that links the Great Lakes to the Mississippi River and thus the Gulf of Mexico. The Illinois Waterway is therefore an important commercial waterway.

Because of its strategic location in the state and because it is downstream of the Chicago Metropolitan Area, the Illinois River has experienced significant human influences over the years. The most significant influences have been related to commercial navigation, municipal and industrial waste discharges, and agricultural practices in the watershed. Because of the lack of a basinwide comprehensive management plan, many of the environmental and ecological problems in the Illinois River basin have not been addressed adequately over the years. The most serious and difficult to manage problem facing the Illinois River is the problem of sedimentation in the river channel and backwater lakes. Many of the backwater lakes have lost over 70 percent of their capacities to sediment accumulation and might not last too long unless appropriate rehabilitation and management techniques are applied in the near future. Problems in the Illinois River basin are not, however, limited only to sedimentation. Issues such as water quality, non-point source pollution, flooding, degradation of aquatic habitats, and water based recreation need to be addressed. It is therefore important that a comprehensive management plan that treats the river, its valley, and watershed as an integrated system and that deals with all the environmental problems, is developed for the Illinois River basin.

INTRODUCTION

The Illinois River is the single most important river in the state of Illinois, draining nearly half of the state. With the exception of 4,000 square miles in Indiana and Wisconsin, the Illinois River watershed, (totalling 28,906 square miles) is contained within the state of Illinois. Approximately 95 percent of the urban areas and half of the agricultural lands in the state are located within the Illinois River basin. Most of the significant rivers in the state including the Sangamon, LaMoine, Spoon, Mackinaw, Vermilion, Fox, Kankakee, and the DesPlaines all drain into the Illinois River. Historically the Illinois River has played a significant role in the development of the state, in terms of both commerce and transportation. It is the only waterway that links the Great Lakes to the Mississippi River and thus the Gulf of Mexico. Waterborne commerce is very important and significant in the states economy. Illinois accounts for about 15 percent of the total barge shipments on the inland and intercoastal waterway system of the United States. The Illinois Waterway alone handles about 60 percent of the total barge shipments in Illinois. Important commodities transported in the waterway include grain and grain products, petroleum, chemical products, fertilizers, coal, sand, and gravel.

Because of its strategic location in the state and because it is downstream of its Chicago Metropolitan Area, the Illinois River has experienced significant human influences and manipulations over the years. Most of the manipulations have been related primarily to commercial navigation and waste discharges without sufficient concern for the environmental integrity of the river. Present and past agricultural practices in the watershed also continue to negatively impact the Illinois River.

Because of the lack of a basinwide comprehensive management plan, many of the environmental and ecological problems in the Illinois River basin have not been addressed adequately over the years. Some of the issues in the Illinois River basins that have been raised, investigated, and debated include the following: sedimentation, erosion control, nonpoint source pollution, water quality, flooding and flood control, accidental spills of hazardous materials, commercial navigation and its environmental impacts, degradation of aquatic habitats, and water based recreation (Illinois State Water Plan Task Force, 1987).

The most serious and still unmanaged problem facing the Illinois River is the problem of sedimentation in the river channel and the backwater lakes. As a matter of fact, the sedimentation rate is higher for the most recent period than for the earlier periods indicating that the sedimentation problem is getting worse instead of getting better (Demissie and Bhowmik, 1986; Belrose et al., 1983). The most important areas of concern are the main channel and the backwater lakes that are located along the Illinois River. Many of the lakes have already lost a large part of their capacity to sediment accumulation, and still continue to do so at a very high rate. Several of the lakes in the valley have completely filled in with sediment and others will follow in the near future.

The Illinois River has been sometimes referred to as "the most studied river in the world." It is true that there have been countless studies conducted on the Illinois River and its watersheds by numerous agencies and organizations. However, there has never been a single comprehensive basinwide environmental

study conducted to develop a balanced environmental management program for the whole river basin. Most of the previous studies have been either issue specific or site specific. Generally, different segments of the river or portions of the basin have been the subject of various studies from time to time. It is high time that we see the river and its watershed as an integrated system and develop mutually compatible programs to manage, protect, and restore the river into the 21st century.

COMPONENTS OF A COMPREHENSIVE MANAGEMENT PLAN

It will be impossible to adequately discuss all aspects of a comprehensive management plan for a watershed like the Illinois River in a brief paper like this. However, it is possible to outline the major issues as initial discussing points in hopes that more detailed and inclusive documents will be prepared. Therefore, the following are some of the important issues that need to be addressed in a comprehensive management plan.

Because of the size of the river and its watershed and the number of environmental issues that need to be included in a comprehensive management plan, it will be convenient to group the issues into major categories. For the Illinois River basin, the most appropriate categories will correspond to the physical characteristics of the basin and the nature of the issues. Discussion of the issues, and management strategies would be facilitated more efficiently if the issues are grouped as follows:

- Main River Issues
- River Valley Issues
- Watershed Issues
- Institutional Issues

Main River Issues

The main river issues are those issues that can be strongly identified with the main river channel of the Illinois River. The major factor in the management of the main river channel are of course the requirements for navigation and its environmental impacts. Therefore the important issues primarily related to the main river include the following:

- River regulation for navigation
- Navigation impacts
- Sedimentation and dredging
- Water quality
- Accidental spills of hazardous materials

River Valley Issues

The river valley issues are those issues that deal primarily with the backwater lakes and floodplain of the Illinois River valley. Because of the size of the Illinois River valley and the importance of the backwater lakes there are a number of issues that are especially relevant to the Illinois River valley. These issues include the following:

- Backwater lakes
- Flooding and floodplain management
- Wetlands
- Streambank and bluff erosion
- Sedimentation
- Water quality
- Sediment quality
- Recreation

Watershed Issues

Issues that are more pertinent with respect to the large watershed outside of the main river and the valley are well organized under watershed issues. These issues include:

- Agriculture
- Watershed erosion
- Streambank and gully erosion
- Non-point source pollution
- River corridor management

Institutional Issues

A comprehensive management plan has to include guidelines on how the recommendations will be implemented. The two most important issues will be how the projects will be financed and which agencies will be responsible for implementation. Because of the number of issues and the size of potential projects, many federal, state, and local agencies will have to be involved. Therefore the mechanism for coordination and cooperation of the different agencies will be one of the most important issues that has to be dealt with in a comprehensive management plan. Implementation of most of the recommendations of a comprehensive management plan for a basin the size of the Illinois River basin will require significant financial outlay, which are unlikely to be available under existing programs. Therefore, new funding mechanisms have to be developed. These issues have to be included in a comprehensive management plan.

EROSION AND SEDIMENT MANAGEMENT STRATEGIES

Since it is not possible to discuss all the different components of a comprehensive management plan in any detail in this brief paper, only discussions of selected issues mainly pertaining to erosion and sedimentation are presented in the remaining part of the paper. More detailed discussions of the different issues and the appropriate management strategies will of course be required before an acceptable management plan is ready.

The management of erosion and sedimentation in the Illinois River watershed will remain a major environmental issue for many years to come because of the magnitude of the problem and the size of the watershed. It is widely acknowledged that erosion and sedimentation is the number one environmental problem in the Illinois River watershed. However, there is no comprehensive management plan to

deal with the problem. There have been numerous activities by various state and federal agencies to control erosion in different parts of the watershed over the years. However, these activities are not coordinated and well documented. Monitoring of erosion, sediment transport and sedimentation are scarce and intermittent making it difficult to evaluate the effect of different activities and the trend in the overall problem. The need for a coordinated and comprehensive approach to deal with the problem of erosion and sedimentation is obvious. However, at this point there is no such plan and it will require significant effort by state agencies to come up with a comprehensive plan.

A comprehensive erosion and sedimentation management plan for the Illinois River basin will consist of several management alternatives appropriate to the specific problems. Because of the size of the watershed and the different causes of erosion, many different types of erosion control measures have to be implemented. Similarly different sediment management alternatives have to be developed for different backwater lakes depending on the source of sediment and the planned use of the lake. The different management strategies will be grouped into two main categories: erosion control and sediment management; and discussed separately.

Erosion Control

For the Illinois River watershed there are three major types of erosion that contribute significant amounts of sediment to the Illinois River valley. These are: watershed erosion, streambank erosion, and bluff erosion. The relative significance of these three major sources cannot be accurately quantified based on available data. Depending on the location along the Illinois River, any one of the three sources could be the primary source of sediment to an area.

Watershed Erosion

Watershed erosion is used here to refer to erosion in the watershed primarily consisting of sheet, rill, and gully erosion in agricultural and non-agricultural areas. However, since more than 80 percent of the watershed is used for agriculture, erosion due to agricultural practices will make up the bulk of watershed erosion. Erosion from construction sites and mining operations could also contribute significant amounts of sediment.

With respect to watershed erosion it is well known that most of the erosion takes place within a small portion of the watershed defined as critical erosion areas that generate significant amounts of sediment. It is therefore important that these areas are identified throughout the watershed so that limited resources could be allocated where they can be most effective.

In Illinois most of the watershed erosion control activities are carried out by the Illinois Department of Agriculture through the Soil and Water Conservation Districts. A major initiative in Illinois to control erosion from agricultural lands in known as "T by 2000." The goal of this initiative is to reduce erosion in Illinois, to tolerable soil loss limits ("T") by the year 2000. "T" is defined as the maximum average soil loss in tons per acre per year that can be tolerated by the soil and still sustain production into the future. A summary of the soil erosion control programs

of the Department of Agriculture in the Illinois River basin was presented by Nichols (1989). Nichols determined that there were 3.8 million acres of agricultural land within the 36 Soil and Water Conservation Districts (SWCD's) that have all or the major portions of their territory within the Illinois River basin, that are eroding at rates greater than the "T" values. He estimated that this will require the implementation of conservation practices for 4.5 million acres of agricultural lands at a cost of $327 million. The full realization of the "T by 2000" program through state and federal funding will go a long way in controlling erosion and sedimentation problems in the Illinois River basin.

Streambank Erosion

It is estimated that there are 13,200 miles of streams in Illinois. Assuming uniform distribution of streams throughout the state, the Illinois River basin would be expected to have over 5,800 miles of streams. Most streams experience some form of bank erosion. In cases where vegetation has been removed from streambanks, bank erosion is excessive. Many channelization projects and river crossing structures such as bridges tend to increase the streambank erosion potential. There have been some studies that attempted to quantify what percent of a stream's sediment load originates from bank erosion. Percentages ranging from 20 to 80 have been reported by different investigators. The actual value will depend on the local conditions of a particular stream. In any case, streambank erosion is believed to be a major contributor of sediment in streams in the Illinois River basin. However, there is no statewide or basin wide program to control streambank erosion in Illinois. Realizing the significance of the problem and the fact that sedimentation problems will not be solved unless we control excessive streambank erosion in the basin, there is a need for a comprehensive streambank erosion control program. The program needs to identify major streambank erosion areas throughout the watershed and quantify the problem. There is a need to know how many miles of stream channels in the river basin are eroding at a significant rate. Along with identification of the erosion sites, the types of streambank failures and the suspected causes need to be documented. This is important because all streambank erosions are not of the same type and they are not initiated by the same cause. Once the locations, types, and causes of streambank erosion in the basin have been identified, then the appropriate bank stabilization techniques can be recommended.

Bluff Erosion

Because of its geological formation, the Illinois River valley is much larger than the present day Illinois River. The width of the Illinois River valley ranges from a mile to nearly seven miles. The edge of this large valley with relief from 100 to 300 feet is defined as the bluff area of the Illinois River valley. The slope of the bluff areas is extremely steep reaching up to 30 percent resulting in excessive erosion. There is also significant amounts of land wasting along the steep slopes. Small streams draining the bluff areas generally carry significant amounts of sediment much higher than streams in other settings. The cumulative significance of the bluff areas as sediment sources become important when one considers the total length of the Illinois River valley that is 280 miles with bluffs on both side of the valley. Even though bluff areas are expected to be one of the major sediment

sources, no significant erosion or land management studies have been conducted about them.

There is therefore a need for sediment data collection from small streams draining the bluff areas of the Illinois River valley to quantify their sediment yield. Sediment data and sediment yield equations based on ordinary streams will grossly underestimate sediment yield from bluff areas. The natural and human-induced causes of bluff erosion along the Illinois River valley need to be identified. Bluff areas are known to be fragile environments and experience high erosion rates even under natural conditions. Small perturbations such as tree clearing for the construction of buildings and roads could initiate massive land wastings in these areas.

After the identification of the major causes of erosion in bluff areas, there is a need for developing bluff erosion-control strategies including land use regulations.

Sediment Management

The major issues related to sediment management in the Illinois River valley can be grouped into three main problem areas: sedimentation in backwater lakes, sediment in the navigation channel, and sediment quality. The areas most significantly affected by sedimentation in the Illinois River valley are the backwater lakes, which on the average have lost over 70 percent of their capacity to sedimentation. Their physical characteristics and ecological and habitat values are continuously changing. If appropriate rehabilitation projects are not implemented these important habitats and recreational areas could be lost forever. It is important at least some of the lakes are maintained to provide the proper habitat diversity in the Illinois River valley.

The sedimentation problem in the navigation channel is, however, different. First of all, sedimentation in the navigation channel is not as high as that of the backwater lakes. The higher flow velocities in the navigation channel and tow traffic tend to keep the sediment moving in the channel. Major problem areas are at or downstream of the mouth of tributary streams that carry coarse sediment into the navigation channel. The second major difference between the sedimentation problem in backwater lakes and the navigation channel is the existence of a navigation channel maintenance program by the COE. The COE routinely dredges problem areas and maintains a minimum of 9 feet depth throughout the Illinois Waterway. Therefore the sedimentation problem in the navigation channel is already managed by the COE. Possible future problems are related to dredged sediment disposal techniques and sites. Sediment management techniques other than dredging should also be considered to reduce dredging requirements.

Whenever there is potential for dredging or disturbing sediment that has accumulated over the years, there is the necessity and legal requirement to evaluate the quality of the sediment. Sediment in the Illinois River valley is known to have been contaminated by various pollutants. The contamination amount varies from place to place and in time. Recent sediment from mid 1970s to the present is of better quality than sediment deposited in the 1950s and 1960s. There is therefore the

need to develop general guidelines on how to deal with contaminants associated with the sediment in the Illinois River valley.

Sedimentation in Backwater Lakes

It has been well documented that sedimentation in backwater lakes in the Illinois River valley has been excessive. Most lakes have lost over 70 percent of these storage capacity and some of them have completely filled in with sediment. It is therefore essential that appropriate management strategies are developed to manage the sediment in some of the lakes if these lakes are to be maintained as lakes and used for fishing, recreation, and wildlife habitat. Future soil erosion control measures in the watershed will not remove all the sediment that has already accumulated in the lake over the years. If appropriate sediment management are not developed and implemented all the bottomland lakes will eventually fill-in with sediment and transform to mudflats and wetlands even under the most optimistic soil erosion rates.

To save some of these lakes from extinction the following actions have to be implemented.

(1) *Identify the most important and valuable lakes in the valley.*
(2) *Conduct sedimentation survey of these lakes.*
(3) *Develop techniques to control sediment inflow from the Illinois River.*
(4) *Develop techniques to control sediment inflow from local tributaries.*
(5) *Develop appropriate sediment removal techniques.*
(6) *Develop appropriate sediment disposal techniques including the creation of islands.*
(7) *Develop shoreline management technology, especially wetland restoration, as component of an overall lake management plan.*

Sedimentation in the Main Channel

As mentioned earlier there is also sedimentation problem in the navigation channel. There problem is not as severe as those found in the backwater lakes. Several reaches generally downstream of the junction of tributary streams to the Illinois River experience sedimentation problems that reduce the depth of water in the navigation below the minimum depth of 9 feet. The Army Corps of Engineers are required to maintain the navigation channel at 9 feet depth or deeper at all times. They accomplish this by routinely dredging problem areas. Previous dredging practices did not have strict sediment disposal requirements allowing the COE to dispose dredged sediment any place outside the navigation channel. This practice might not continue forever because of its potential adverse impact on the aquatic environment. If stricter disposal regulations are enforced the COE might be interested in developing alternative techniques to reduce the amount and frequency of dredging. Manipulation of tributary stream junctions with the Illinois River might reduce the need for dredging at those sites. In any case, the management of sedimentation in the navigation channel is the responsibility of the COE and they obtain the necessary funding to dredge as much as they need. However, the

disposal of the dredged sediment does affect the whole river and should be of concern to state and local agencies. It is therefore important that safe sediment disposal techniques are developed for sediment dredged from the navigation channel.

Sediment Quality

One of the main concerns about dredging and disposal of sediment is the resuspension of contaminated sediment into the water column and its impact on the aquatic biota. Sediment in the Illinois River valley has been contaminated by various pollutants over the years. However, sediment quality analyses of sediment cores show that the quality of sediment has been improving starting in the 1970s. Therefore the top sediment layer is generally of better quality than the deeper sediment layers. Dredging operations and other forms of disturbances could resuspend contaminants from the deeper layers, which could then be transported downstream to other locations. However, the magnitude of the contamination and its variation from place to place is not well documented. There is also little information how much of the buried contaminants resuspend and move downstream during a dredging operation.

There is a need to collect sufficient sediment core data along the Illinois River valley to quantify the extent of contamination. There is also a need to conduct experiments to investigate the resuspension and transport potential of contaminated sediment in the Illinois River flow environment. Based on these studies appropriate sediment dredging and disposal techniques could be developed.

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RIVERWATCH NETWORK--A MODEL VOLUNTEER STEWARDSHIP PROGRAM FOR ILLINOIS

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ABSTRACT

Facing a deteriorating riverway, the Friends of the Fox River created a basinwide environmental education and citizen action program called "RiverWatch Network," which during 1991 involved 4,000 citizen volunteers in three stewardship programs designed to empower them with the knowledge, skills, and confidence necessary to take active and responsible steps to save their own river. Programs include: Citizen Stream Monitoring, Annual Fox Rescue, and Adopt-A-Stream 2000.

Pollution problems in the 195-mile long Fox River watershed reflect problems statewide, and the Friends believe there is an urgent need for the state to create an Illinois RiverWatch Network, coordinated by the state, to involve citizen volunteers in river and stream protection.

Illinois' 33,000 miles of rivers and streams are burdened with a wide variety of pollution sources and causes. During the past century, over half of our state's riparian habitat has been destroyed or severely degraded by agricultural and urban development, and only one-third of Illinois waterways are in good to excellent biological health.

Today, the state maintains an Ambient Water Quality Monitoring Network of only 208 stations on Illinois' rivers and streams. Lacking water quality data in all its watersheds, the state is unable to assess pollution impacts associated with nonpoint source pollution. Without monitoring data, the state is unable to identify pollution sources, measure pollution impacts, initiate remedial actions, or evaluate the effectiveness of instituted Best Management Practices.

The state needs to expand its ability to monitor environmental quality, and establish a working partnership between citizens and government to achieve Clean Water Act goals. A technical reference entitled *Citizen Stream Monitoring: A Manual For Illinois* can serve as the foundation for building this partnership.

INTRODUCTION

I'm pleased to be here today to talk with you about The Friends of the Fox River's award winning RiverWatch Network and to ask for your support for creation of a state coordinated "RiverWatch" program for the people of Illinois.

The Friends RiverWatch Network is a model environmental education and citizen action program involving citizen volunteers in three stewardship programs designed to monitor, protect, and restore the water quality and biological health of the 195-mile long Fox River system. Programs include: Citizen Stream Monitoring, Annual Fox Rescue, and Adopt-A-Stream 2000.

RiverWatch Network is the first volunteer stewardship program in Illinois addressing water quality problems and solutions on a watershed basis. The Friends believe there is an urgent need for the state of Illinois to create a similar program, coordinated by the state, to involve citizen volunteers in a variety of stewardship programs to help monitor, protect, and restore Illinois' precious rivers and streams.

In Illinois, the state maintains a network of only 208 permanent ambient water monitoring stations (Illinois Water Quality Report 1988-1989). You can imagine how many river and stream miles are unprotected. The 1987 Clean Water Act amendments require all states to submit management plans for controlling pollution, and to document the success of these plans. The problem is, how is the state going to develop a meaningful plan, if it maintains a network of only 208 permanent monitoring stations?

Lacking current water quality data for all its watersheds, the state is unable to assess the impacts associated with nonpoint source pollution. And because no "before and after" monitoring can be conducted, it is also unable to measure the effectiveness of Best Management Practices.

A citizen monitoring program can help the state with a nonpoint source management plan in two ways, because citizen volunteers can provide the state with (1) the ability to assess unknown waters, in order to write the plan, and (2) the ability to document whether its nonpoint pollution management projects are successful.

By capturing and utilizing the vast resources of citizen volunteers, the state will gain a free labor force and help save taxpayers millions of dollars in future remedial action costs while protecting our environment and an existing multi-billion dollar capital investment in Clean Water Act improvements.

Throughout our nation, there are many cost-effective models for development of a state coordinated RiverWatch program in Illinois. Additionally, the Friends RiverWatch Network represents a working model for successful implementation of an Illinois RiverWatch program.

BACKGROUND

Illinois' 33,000 miles of rivers and streams are vital ecological areas providing many benefits, influencing the lives of people who depend upon them for clean drinking water, food, recreation, and scenic beauty. They support a diversity of aquatic life, and their riparian corridors provide important habitat for wildlife, help control flooding and soil erosion, and filter pollutants from agricultural and urban runoff.

Yet, during the past century, over half of our state's riparian ecosystem has been destroyed or severely degraded by agricultural and urban development, causing flooding, sedimentation, chemical pollution, and degradation of fish and wildlife habitat (IEC Green Papers).

Today, Illinois' rivers and streams are burdened with pollution from a wide variety of sources and causes. In the spring, erosion from construction sites and farmlands turn our rivers brown, and during low flows, they run green from algae blooms caused by nutrient overloading.

Despite significant Clean Water Act improvements, only one-third of Illinois waterways are in good or excellent biological health, and with increasing urbanization and development, the quality of our state's rivers and streams continue to decline in many areas (IEC Green Papers).

Damage to aquatic habitats and water quality is compounded by channelization, construction of dams, loss of natural vegetation strips, uncontrolled erosion from construction sites and farmlands, poor stormwater management practices, industrial waste disposal, bypassing of raw sewage by sanitary districts, and groundwater contamination from landfills and underground storage tanks leaking toxicants.

In most areas of the state, new point and nonpoint sources are created before old ones are identified and remedied. For example, in the Fox River watershed, nonpoint source pollution is increasing at alarming rates as the Milwaukee and Chicago metropolitan areas expand westward into the relatively rural Fox River Valley. Poor urban planning, destructive construction practices, and increasing use of the watershed has led to the deterioration of the surface and groundwaters that feed into the Fox River.

Nonpoint source pollution comes primarily from urban and agricultural lands. Rainwater runoff from streets, parking lots, rooftops, lawns, farmlands and construction sites bring nutrients, sediments, animal wastes, pesticides, fertilizers, heavy metals, petroleum products, and salts into storm drains and streams untreated, causing nutrient overloading, excessive algae growth, toxic contamination, siltation, loss of living resources, and cloudy, smelly water.

Typical of many Illinois rivers and streams, point source water pollution remains a serious problem. Many wastewater treatment plants continue to pollute the Fox River. In 1990, the city of Waukesha bypassed 864,000 gallons of raw sewage into the Fox River, and in 1989, the village of East Dundee bypassed three months worth of community raw sewage and household chemicals. A private sewage treatment plant in Valley View is a source of daily discharges of raw sewage into Brewster Creek.

Bypassing is typically caused by electrical failures, pump failures, defective wire connections, defective float switches, and runoff events. All wastewater treatment plants should be required to build holding facilities or ponds to collect untreated sewage for later treatment.

Additionally, the U.S. Environmental Protection Agency requires industries to pre-treat their contaminated waste water, yet many do not meet pre-treatment standards, and for those that do, they still have a license to pollute--to release toxicants into the Fox River at approved levels.

In 1991, the Aurora Sanitary alone reported nine firms in a "chronic pattern of noncompliance." One of them is a manufacturer of lead acid batteries for cars and trucks.

A CALL FOR A STATE PROGRAM

The state needs to expand its ability to monitor environmental quality and those activities that affect it, and establish a working partnership between citizens and government to reclaim the quality of our waterways and protect them in the future. The job is to big and beyond the resources of state government. This is why citizen volunteers are needed to help protect Illinois' rivers and streams.

CITIZEN STREAM MONITORING: A MANUAL FOR ILLINOIS

In August 1990, a research document was published by the Illinois Department of Energy and Natural Resources entitled *Citizen Stream Monitoring: A Manual For Illinois*. It was co-authored by Brook McDonald, William Borden, and Joyce Lathrup with technical assistance from the Illinois Natural History Survey. It represents the state of the art in citizen monitoring procedures, and the foundation on which an Illinois RiverWatch Network can be built.

Citizen Stream Monitoring: A Manual For Illinois is an inexpensive, easy to understand environmental education curriculum, and provides instruction in the ecology of streams. Its purpose is to explain how to conduct a citizen stream monitoring program and to train school classrooms, citizen groups, and individuals who want to become involved.

In the schools, the program enables teachers in grades 4 to 12 to incorporate a stream monitoring activity into existing environmental studies, like a Project Wild

activity. Also, the program empowers students to become directly involved in protecting the health of their own rivers and streams. Although primarily intended for teachers, the program was developed to involve naturalists, youth groups, garden clubs, conservation organizations, waste water treatment plant operators, and landowners in a statewide stream monitoring network.

The monitoring technique is simple and the equipment is inexpensive. Participants "adopt-a-riffle" and monitor water quality using biological procedures. Using a 3/16-inch mesh net, citizens collect aquatic organisms that live in the streams substrate (benthic macroinvertebrates). After counting the organisms diversity and quantity they chart a scientifically approved Stream Assessment Form to arrive at a Water Quality Rating of either Excellent, Good, Fair, or Poor.

The manual was adapted from the Ohio Department of Natural Resource's program manual entitled *Stream Quality Monitoring: A Citizen Action Program.* Both use the biological monitoring technique pioneered by the Izaak Walton League of America twenty years ago.

The program uses biological rather than chemical monitoring procedures for two reasons: (1) biological monitoring provides a better assessment of long-term stream health, whereas chemical testing mainly gives information about water quality at the time of testing; and (2) equipment for biological monitoring is relatively low in cost, making it possible to use a tremendous amount of volunteers. It costs less than $30 to equip a class or group. Unlike the Illinois Rivers Project, which is modeled after the University of Michigan's Rouge River Program, this program is cost effective and sustainable on a statewide basis. The Rouge River model costs up to $6,000 per school to implement.

This document is the technical reference the Friends use in its RiverWatch Network Stream Monitoring Program. It represents the foundation on which a state coordinated RiverWatch program can evolve for the people of Illinois.

FRIENDS OF THE FOX RIVER

The Friends of the Fox River, founded in January 1989, is a 501(c)3 conservation organization, formed to educate and act in the interest of maintaining and restoring the water quality and biological health of the 195-mile long Fox River system. Membership in the Friends includes 496 individuals and 64 nonprofit organizations, businesses, and government units. In 1990, the Friends won a national Take Pride in America Award and Renew America's Environmental Achievement Award for our Citizen Stream Monitoring Program.

The Fox River begins about 15 miles northwest of Milwaukee and flows south for 80 miles through Wisconsin and for another 115 miles through Illinois before emptying into the Illinois River at Ottawa. The Fox River system is part of the Illinois River watershed, and its water quality problems have a major impact on the water quality and biological health of the Illinois River, and reflect what is happening to rivers and streams statewide.

Today, residents of southeastern Wisconsin and northeastern Illinois face major environmental problems involving the Fox River watershed. As the population of the watershed expands, so does pollution from both point and nonpoint sources.

In a recent bulletin, the Northeastern Illinois Planning Commission documented the problem. The commission reported that between 1970 and 1990, the number of acres of developed land increased between 45 and 65 percent, while the population only increased 4 percent. The region lost 300,000 acres of farmland to development during this time period. The commission attributes this trend to a decentralization of the metropolitan area, as people move west searching for less crime, better schools, and a better, less congested environment.

Not only has this westward shift in population greatly increased infrastructure costs in the region for all taxpayers, it has seriously degraded the water quality of the Fox River system. With more rooftops, lawns, parking lots, and roads in the Fox River watershed, pollution sources have increased, dramatically.

In the absence of state mandated land-use planning policies to coordinate local comprehensive infrastructure and development plans, large-scale developments and annexation proposals are pitting one small town against another, as each competes for the expanded tax base the developments promise, at the expense of maintaining environmental quality and the quality of life.

Facing a deteriorating riverway, the Friends organized to build a constituency for river conservation. Our RiverWatch programs are designed to instill a conservation ethic within the population and empower the watershed's 1.5 million residents with the knowledge, skills, and confidence necessary to take active and responsible steps to restore and protect their own river.

In Massachusetts, the Department of Fisheries, Wildlife, and Environmental Law Enforcement operates a Riverways Program similar to our own that has facilitated the creation and success of citizen watershed organizations in each of its major watersheds. They offer a variety of Adopt-A-Stream activities and provide technical assistance and support services to existing and emerging environmental groups. The Friends of the Fox River is the kind of organization that an Illinois RiverWatch program could facilitate in each of its major watersheds.

RIVERWATCH NETWORK--A FIRST IN ILLINOIS

To achieve our river conservation goals, the Friends created a basinwide citizen involvement program called "RiverWatch Network" that during 1991 involved 4,000 citizen volunteers in three stewardship programs: Citizen Stream Monitoring, Fox Rescue, and Adopt-A-Stream 2000.

RiverWatch programs are designed to: provide training in riverine system ecology; involve citizens in volunteer activities to monitor, protect, and restore their own river; educate the public about pollution sources and causes, and potential intervention strategies; and to develop a basinwide data base needed to document the changing condition of the riverway.

The Friends Citizen Stream Monitoring Program is the first of its kind in Wisconsin and Illinois. Today, after one year, the program involves 32 schools and eight citizen groups. Participants establish base-line data needed to document long term trends in water quality, help track and identify sources of water pollution, organize and implement restoration projects, educate the public, build local constituencies for river conservation, and develop recommendations and action plans to benefit water quality in their communities. The program is endorsed by the U.S. Environmental Protection Agency-Region V, and we are developing a Quality Control/Quality Assurance Plan with U.S. EPA assistance.

Additionally, the Friends of the Fox River have facilitated creation of Friends organizations and biological monitoring networks on two other interstate rivers (the Rock and Des Plaines), and the West Branch of the Du Page River. And because several watersheds are shared by Wisconsin and Illinois, we are facilitating development of a Wisconsin citizen monitoring program compatible with the Illinois manual through board advisor Al Stenstrup, Wisconsin Department of Natural Resources (DNR). The DNR has established a steering committee to develop a Wisconsin Water Watch program.

Fox Rescue '91, our annual Fox River cleanup day, involved about 1,500 volunteers in a demonstration of both local and regional support for maintaining a clean, safe, healthy, pollution free Fox River environment.

In Illinois, a similar clean rivers program could be modeled after Fox Rescue or the Minnesota Department of Natural Resources's Clean Rivers Project that facilitates hundreds of river cleanups statewide throughout the year.

Our emerging Adopt-A-Stream 2000 program is modeled after the adopt-a-stream programs of Maryland's Save Our Streams, a nonprofit citizens group that employs 13 staff and is funded under a contract with the Maryland Department of Natural Resources.

Adopt-A-Stream 2000 will offer citizen groups the opportunity to choose and conduct one or more of eight new stewardship activities including: Watershed Surveys, Stream Surveys, Streambank and Habitat Improvement Projects, Stream Cleanups, Wetland Watch, Storm Drain Stenciling, Construction Site Monitoring, and Monitoring the Local Planning Process. The Friends will provide local groups with activity guides and packets.

A MODEL STATE PROGRAM

Two years ago, at the Second Conference on the Management of the Illinois River System, Brook McDonald, manager of Interpretive Services for the Wheaton Park District, introduced *Citizen Stream Monitoring: A Manual For Illinois.* He also presented a slide program describing Ohio's Citizen Stream Monitoring Network.

The Ohio program was initiated in 1983 with the assistance of the Izaak Walton League of America, which facilitates citizen monitoring networks and state

coordinated programs. The Ohio program is coordinated by the Ohio Department of Natural Resource's Scenic Rivers Program. Today, the program involves about 8,000 citizen volunteers who "adopt-a-riffle" and biologically monitor the water quality of the state's ten scenic rivers, supporting the state's data base. The program is funded primarily by a state income tax checkoff and general revenues.

About half of the volunteers are teachers and their classrooms. The other half represent citizen groups, such as, 4-H Clubs, scout troops, church groups, garden clubs, conservation organizations, and landowners.

The program is first an educational, constituency building program. It is designed to educate the public about water quality issues, involve the public in river and stream restoration activities, and raise a new generation of adult decision makers able to protect our nation's scenic and water resources.

Additionally, the program generates baseline data needed to document long term trends in water quality--on rivers and streams the state cannot afford to monitor. The data is provided to the Ohio Environmental Protection Agency for use in state 305b and annual water quality reports, and the information is used to alert local communities and health departments about water quality problems and trends.

Currently, citizen interest exceeds the capacity of the program, primarily because the program is restricted to Ohio's ten state-designated scenic rivers; however, program staff are investigating expansion of the program through Ohio's Soil and Water Conservation Districts.

The Friends believe an Illinois RiverWatch Network should begin with the development of a citizen stream monitoring program modeled after the Ohio experience. Other adopt-a-stream programs could evolve on this foundation.

TOWARD DEVELOPMENT OF AN ILLINOIS RIVERWATCH NETWORK

Many state and county governments throughout our nation have recognized they cannot protect their rivers and streams without the aide of citizen volunteers. To help achieve Clean Water Act goals, they have established stewardship programs to involve citizen's in water monitoring, adopt-a-stream, and clean river programs.

In Illinois, creation of a RiverWatch program can involve: establishing a statewide steering committee to plan the program; designating the Department of Conservation to operate the program; selecting and adapting appropriate adopt-a-stream models; selecting a program coordinator and staff; establishing and training a statewide network of program facilitators utilizing Department of Conservation, Soil and Water Conservation District, and University of Illinois Cooperative Extension Service staff and facilities; obtaining grants and raising funds from the private sector to help fund a program video, adopt-a-stream signs, and publication of a technical reference and a quarterly newsletter; maintaining a statewide data base; providing data to the Illinois Environmental Protection Agency for use in state 305b and annual water quality reports; promoting the formation and

success of watershed organizations; and conducting a yearly Citizen Congress and Governor's awards program.

Critical to the success of the program will be establishing a steering committee to help with community outreach, to provide knowledge and expertise in specific program areas, and to provide program guidance and evaluation.

Using Federal Clean Water Act Grants, contributions from the private sector, general revenues or an income tax checkoff to start the program, an Illinois RiverWatch Network can help save taxpayers millions of dollars in labor and future remedial action costs, and provide the general public, the General Assembly, and the Governor and his executive agencies with a clearer understanding of how we can better protect, manage, and restore Illinois' precious rivers and streams, before we lose more.

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AN ENVIRONMENTAL AGENDA FOR WATER QUALITY

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Thank you for inviting the Sierra Club to participate in this conference. Protecting our rivers and lakes has always been a priority for the Sierra Club, and we are now joining several other environmental groups in a project to reduce the pollution of Illinois water bodies.

A goal of the Clean Water Act is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." Progress has been made; the water quality of some Illinois rivers and streams has improved since the passage of the Clean Water Act. Unfortunately, Illinois waterways continue to be contaminated by pollutants from factories, sewage plants, polluted runoff and other sources. According to the 1988-89 Illinois Water Quality Report, only 42.1 percent of rivers and 0.3 percent of our lakes provide full support for their designated uses. Obviously, there remains much to be done to improve Illinois water quality.

The National Pollutant Discharge Elimination System (NPDES) permitting program established under the Clean Water Act was designed to eliminate the discharge of pollutants to our Nation's water bodies. As implemented in Illinois, the NPDES permitting program focuses mainly on meeting numeric limits for contaminants in our waterways. Substantial loads of toxic chemicals continue to be discharged into Illinois waterways. In the 1988-89 Illinois water quality report, testing results from nearly one-third of all Illinois rivers (as measured in river miles) and lakes (in terms of acreage) indicated that there are elevated levels of toxic contaminants in either sediments, fish or water in 50 percent of the rivers and 60 percent of the lakes.

At the center of a truly effective water pollution control program is the concept of pollution prevention. Every environmental regulatory program should keep as its ultimate goal the elimination of discharges of toxic chemicals. Steps to

prevent pollution can include requiring dischargers to conduct waste audits and demonstrate that all possible steps are being taken to reduce the use and discharge of toxic chemicals before permits are issued. I believe that Illinois should require all dischargers of toxic chemicals to conduct waste audits and prepare and implement pollution prevention plans. Such planning should be completed before an NPDES permit is reissued. Only then would the NPDES program truly live up to its name, by working toward the elimination of pollutant discharges.

A further step in protecting our waterways would be a ban on the discharge of certain highly toxic chemicals. Of special concern are persistent and bioaccumulative chemicals. Because these chemicals are likely to remain in the sediments or the biota of a water system, it is essential that their discharge be eliminated. One substantial flaw in the Illinois water pollution control program is that mixing zones or Zones of Initial Dilution may be allowed for the discharge of persistent and bioaccumulative toxins. The purpose of a mixing zone is to allow attenuation of the toxicity of a discharge. It is therefore illogical to allow a mixing zone for a chemical that is likely to build up in the river or stream.

Siltation and nutrient loading are major causes of degradation of Illinois waterways. According to the 1988-89 Illinois Water Quality Report, some 190,430.8 of 247,180 total surface acres of lakes and 12,710.6 of 14,080 stream miles in the State warranted additional corrective measures in their watershed areas to reduce nonpoint source pollution. In other words, 77 percent of our total lake surface acreage and 90 percent of Illinois stream miles are adversely affected by nonpoint source pollution. The causes of nonpoint source pollution are numerous. Because agriculture has been recognized as the major source of nonpoint source pollution, my discussion of nonpoint source control will have an agricultural focus though it is equally applicable to other sources of nonpoint source pollution.

The Illinois program to reduce nonpoint source pollution of our waterways has been based upon voluntary compliance. The Illinois Environmental Protection Agency (IEPA), in coordination with organizations such as the Soil Conservation Service and the Cooperative Extension Service, have sponsored educational programs, demonstration projects or special studies of particular watersheds.

In general, there are farmers who are concerned about the environment, and will readily participate in demonstration projects or voluntary compliance programs. Others, whether through ignorance, indifference, or just because they're evil forces of darkness, will not change their way of doing business to help protect the environment unless they're forced to do so. It is unfair to the first group to rely solely on voluntary programs. The conscientious will make the commitment necessary to operate in a way that protects the environment, while their less conscientious neighbors practice "business as usual," making no investment in conservation but continuing to profit from exploiting the land.

The value of education and promoting voluntary implementation of Best Management Practices cannot be understated. Some progress has been made in reducing point source discharges of toxic pollutants into rivers and lakes, but the nonpoint source pollution problem continues largely unabated. In the 1986-87 Illinois Water Quality Report, agriculture was estimated to be the cause of 39.8

percent of river and stream degradation. This proportion was increased slightly to 40.6 percent in the 1988-89 Report. There is clearly a need to establish a statewide regulatory program to control polluted runoff.

Pollution prevention is being recognized by industry as the solution to many environmental problems. Reducing the use of toxic chemicals and improved housekeeping practices are two components to a pollution prevention plan that will reduce industrial effluents. The same concept can easily be applied to nonpoint source discharges. For agricultural nonpoint source discharges, an agricultural version of the waste audit can be performed to assess the best ways to reduce sediment loads and stream pollution. After a waste audit is conducted, the producer, with assistance from the public as well as private sectors should develop a pollution prevention plan with specifies Best Management Practices to be implemented in a coordinated way under an implementation schedule. A state program should be established to require that farmers implement these plans.

Best Management Practices for both agricultural and urban areas have been known and available for years. Those who have participated voluntarily in nonpoint source control projects have used Best Management Practices to successfully reduce their contribution to water quality degradation. Best Management Practices can be viewed as either source reduction (Integrated Pest Management or contour plowing) or end-of-pipe controls (filter strips).

Because a farm is a business, I believe that pollution prevention practices should be extended to farmers as well as industries. A successful regulatory program could expand the water quality planning program to include mandatory pollution prevention assessment and planning to ensure that Best Management Practices are implemented to protect Illinois waterways.

The Sierra Club believes the current regulatory program is not sufficient to fully protect our waterways. Illinois water pollution control rules fall short of being fully protective in a number of ways, and we believe the rules should be changed to address these problems. As the 1992 triennial review, required by the Clean Water Act, is developed, we believe that the Illinois EPA should include, in their review, revisions to address the concerns raised above. The Sierra Club and several other environmental groups have joined forces to study the Illinois water pollution control program, and we plan to be active participants in the Illinois EPA regulatory revision process.

AN ENVIRONMENTAL CHALLENGE TO ILLINOIS AGRICULTURE[1]

Clark W. Bullard, Director, Committee for River and Stream Protection

509 W. Washington St., Urbana, IL 61801

By thy rivers gently flowing,
Illinois, Illinois
O'er thy prairies verdant growing,
Illinois, Illinois
From "Illinois,"
the official state song

I am saddened that our "prairies verdant growing" have been lost. We must prevent the same thing from happening to our "rivers gently flowing." I want us to be more visionary than our forefathers, more sensitive to our grandchildren's heritage, more willing to give back to our country a small fraction of what it has given to us.

While it *is* too late to take a child for a long walk through an Illinois prairie, it is *not* too late to canoe or walk for an entire day along one of its prairie rivers.

Illinois is blessed with more than 33,000 miles of rivers and streams. But the one beautiful Illinois River has been transformed into a superhighway for barges. Its floodplain lakes fill with silt from upstream farms, but the river is not allowed to flood and scour new channels to create new floodplain lakes.

In fact, the vast majority of Illinois' rivers and streams have been transformed into barge canals or drainage ditches. In economic terms, they have been developed. In ecological terms they have been obliterated, in most cases by agriculture.

What I propose is permanently protecting the best 5 or 10% of these rivers and streams that remain. This could be accomplished by a mandatory program such as zoning.

But a better approach would be to create a voluntary program for landowners to sell or give conservation easements or conservation rights to the State. Owners of ecologically valuable riparian habitat who agree not to cultivate or develop the land could retain some rights to the land, including the rights to use it for hunting and fishing, and even the right to prohibit public access.

Such a river protection program would protect about 100 miles of river each year. It would not only improve water quality and wildlife habitat while preserving scenic areas and biodiversity, but it would also improve fishing, boating and other recreational

[1] Presented at the third biennial Governor's Conference on the Management of the Illinois River System, Peoria, October 23, 1991

opportunities. It would cost about $25 million annually, or only $2 per person per year. Possible revenue sources include surcharges on water use, or taxes on pollution and waste disposal. For example each Drainage District could be assessed a silt tax based on measurements of total suspended solids at the outlet of District. In areas without drainage districts, the County could be responsible for allocating the tax among property owners in proportion to their contribution to the problem.

Besides saving Illinois' natural heritage, the benefits would include improvements in Illinois' farm economy. Cash from the program's funding would be distributed to participating farmers. Selling conservation easements could also reduce landowner's property taxes and estate taxes, and make existing federal subsidies such as the Conservation Reserve Program more attractive.

I believe that great things could come from a partnership of farmers and environmentalists. Each group must convince its leaders that it is in our best interest to work together. By focusing on an issue that can be resolved in Springfield, we can show ourselves and the nation that environmentalists and farmers can work together to save the land we love.

This proposal is spelled out in detail in a 12 page paper that is available upon request.[2] That's the good news.

The bad news is that the proposal is more than a year old. It has been presented and discussed at meetings of the Illinois Farm Bureau's district directors and its state board of directors. They have listened politely, and have been invited to modify the proposal and rewrite it in a form acceptable to them. Instead the response from the top levels of the Farm Bureau has been a resounding silence. Then last winter a county Farm Bureau delegate took the proposal to the statewide convention of the Illinois Farm Bureau. He introduced just the first half of the proposal, simply endorsing the goal of setting aside 2% of the land area of Illinois in its natural condition along our best rivers and streams. It was defeated soundly in committee by Farm Bureau leaders from around the state.

I have found this response from the agribusiness lobby to be profoundly disappointing. Just last weekend at the statewide meeting of the Illinois Environmental Council I was expressing my frustration to a group of environmental leaders, most of whom were from urban areas around Chicago. Frankly they think I am crazy for trying to work with the agribusiness lobby to get the funding that a voluntary program would require. One of them asked me to sit still for a moment and be quiet; he wanted to tell me this parable.

> "Once there was an ancient city that had no laws against killing. And in that city there was a man whom *we* would call a serial murderer. Because he would selectively kill persons who were lazy and nonproductive, most people felt that he was actually performing a public service. The killer even felt good about himself, and for a long time nobody cared very much. But after he had killed about 95% of the population, tensions began to build. Faced with growing public opposition, the serial killer said: 'Stop me, before I kill again... pay me to stop killing.' The citizens were faced with a difficult decision. They were forced to choose between infringing on the killer's rights by passing laws to regulate killing, and paying him to stop. That is the dilemma we face today in Illinois. Agribusiness has destroyed 95% of the

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2 Bullard, C. W. reprinted June 1991. Saving the Last 2% of Illinois, Agroecology Program Paper AE91-13, College of Agriculture, University of Illinois at Urbana-Champaign.

populations of our natural ecosystems. We can either pay them to stop, or pass a law making it illegal to destroy the last few percent of our wetlands and streamside habitat."

There is a third alternative, but to me it is unthinkable: that we do nothing, and allow Illinois agribusiness to do to Illinois' rivers what it has already done to the Illinois prairie.

Please join with me to try to gain the support of the agribusiness lobby for the funding it would take to support a voluntary program of habitat preservation. We owe it to our grandchildren, and we owe it to ourselves.

REMARKS FOR THE 1991 GOVERNOR'S CONFERENCE ON MANAGEMENT OF THE ILLINOIS RIVER SYSTEM

Lt. Governor Robert Kustra

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I really enjoy coming to visit you folks, and it's not often enough that we get a chance to do it because of the incredible size of Illinois, but it does remind me--yesterday I was working on a reading program. I gathered together teachers of English from all over the state, and we sat down to choose some books that they will help me select as classics of Illinois and American literature that we're going to be recommending to young people in high school. We hope that a few of their parents and some adults will read them as well. We were picking out the books and talking about where we could go to speak about the program. Finally, after the third reference to Peoria, one of the teachers said, "What is this thing about Peoria? Three times now you've mentioned going to Peoria to advertise this program." I said I just have this thing that Peoria being a mere hour and a half (or whatever it is) from Springfield, and Springfield being the state capital, sometimes gets overlooked. I think that those of us in Springfield that go back and forth to Chicago ought to do a better job of getting into Peoria and talking to people in Peoria--and so here I am 24 hours later, folks. I did everything I could to make that possible.

Why I am I here today? Well, I'm filling in for Governor Edgar, there's no doubt about that. Am I speaking for Governor Edgar today? Not really. Not in the sense that he or his staff gave me a speech and told me what to say. I came here today because I care. I care about our state's waterways. I care about our state's environment. I care about the ecological balance of this state, and that's really what my remarks will deal with. I visit you today out of the personal interest that I am taking in this state's environment and especially its waterways. I'll level with you -- that's a selfish interest on my part because, you see, I'm a fisherman. From the time I was a little boy I spent time on waterways all across the midwest. It's difficult time for me to even talk about it because just last week my father who is no longer able to join me on those waterways handed over every last piece of fishing equipment I grew up with that was in his possession and said, "It's yours now. I just can't use it

anymore." I took that equipment, and I thought and recollected all of those days we spent on water, growing up in the midwest as I did. I thought about my father's role in educating me and making me understand as a naturalist the importance of the human race being compatible with nature and not opposed to it. If he leaves me with no other legacy than that, I will be forever proud of my relationship with my father.

I am, you could say, a conservative in the truest sense of the word. I'm interested in conserving. I'm not interested in change for any sake, and while I'm always interested in progress, I don't want that to come at any cost. It seems to me that the demands of progress in this century and part of the last century have exacted a very, very heavy toll on the Illinois landscape and its waterways. In reading this outstanding publication, *The Illinois River: Working For Our State,* I read of the French explorer in the 1600s who said that he caught a catfish that fed 22 of his guides. Now they were either awfully little guides, or they were growing catfish a lot bigger in those days than they are today. As one who has caught a lot of catfish, I don't think mine would ever feed 22 people.

I read in that same publication about the guy who stood neck-deep in water and looked down and saw his feet in the Illinois River. Well, those days are gone. I suppose it's going to be difficult bringing back those days to what they once were, but there are many improvements we can make. As a matter of fact, many improvements have already been made. There are probably folks in this room right now who deserve a lot of credit for those improvements. But certainly, there is much work to be done. The 1970 rules and regulations of the Illinois Environmental Protection Agency went a long way to help clean up the Illinois River, and certainly going back to the 1930s, the Supreme Court decision that limited the amount of water that could come down from Chicago was absolutely crucial to the great Illinois waterway. But, however many of these decisions I want to refer to, it still isn't enough. There is still more work to be done.

The sedimentation and erosion problem is a very serious one. I don't have to tell you that. You know that. But if you want to know more about it, then I suggest you read *The Illinois River: Working For Our State.* It's well cited in there. I'm particularly interested and concerned in the backwater lakes. Again, I suppose because I like to get out there as a sportsman and enjoy that water. It's important that the water stay the way it is. We've lost too much of it already in those backwaters. And why should I be concerned about that? It doesn't just have to be because Bob Kustra gets a chance to wet a line every now and then in an Illinois River or waterway. For all of us, especially all of you in the Peoria area and up and down the Illinois River, it's a great opportunity to expand the average Illinois citizen's knowledge about the river, to bring them to the river, to our towns and cities along the river, and to expand the tourism opportunities in the State of Illinois.

I live in Park Ridge, Illinois, a suburb of Chicago. For those of you who know how people recreate around Chicago, it's no secret that Michigan and Wisconsin take many of our Illinoisans for their recreational opportunity. We're never going to change all of that. But I would suggest to you that the State of Illinois has not done a good enough job over the years of focusing on great

waterways like the Illinois River as ways of enriching the recreational opportunities right here in the center of our state. Those folks who drive north who live up there in the northeastern part of Illinois should learn how to drive south and southwest. But they will only do that when we have a waterway of which we can all be proud, a waterway that can attract tourism and offers increased opportunities for those who like to recreate in that fashion. Once again, while we've made some improvements, there is a long way to go.

You met all day yesterday, and you're meeting again today. You've discussed these problems as you did last year, and that's great. But that isn't enough either. You can sit around and talk about these problems all you want--today and tomorrow and yesterday and last year--but what we have to do is grab the good old bull by the horns and make something happen. We have to move beyond the point of information gathering. We have to move beyond the point of slapping each other on the back, telling each other how terrible these problems are, how much work there is to do, and how many challenges there are to meet. We have to agree to do something about it. In my experience in government when you make difficult decisions on public policy, you don't always make all new friends. Along the way you pick up a few folks who if they are not your enemies, they're at least not your greatest supporters because you've offended them in some way.

I suspect if you're really going to implement the work that you've set about here in this conference--if you're really going to improve the Illinois River as I think it's suggested it ought to be improved here in this document--then it's not going to be all roses. There's going to be some tough sledding along the way. You're going to have to make some tough decisions. You're going to have to suggest maybe improving some farming practices. You may have to suggest some navigation changes and improvements. You may have to come up with some specific plans for dealing with the Zebra Mussel problem. You may have to come up with some model flood plain developments that aren't just suggestions but which eventually will take on the force of law or the force of rules and regulations. So what I think is absolutely critical about what we are all doing today is not just that we're all committed to the Illinois waterway, and not that we don't want to improve its management, but that we're committed to now moving beyond--to a step that involves decisions--a step that involves calling people into a room who have considerable differences of opinion and who will balk at some of the suggestions that I've just made. That's the reason I made them so vaguely: nobody can pin me down at this moment, you see. But I'm willing to get in a room with somebody and talk specifics, and I think that's where we need to go next.

Along the way we've made changes. The Illinois EPA deserves a lot of credit, as well as a lot of other folks in this room. I'm sorry I can't go through the litany of all the folks who have contributed to where we are today. I'm only suggesting to you that we should go even further. I know you agree with that.

As your Lieutenant Governor, I came over here today from what was a day of watching the Legislature. I spent ten years in the General Assembly, and the Governor expects me to keep tabs on what they're doing over there so if he needs some help I can jump in. When I heard about this, it wasn't the Governor directing me to be over here, because I'm needed over there. It was more my making a

personal decision to add my voice to your voices, to let you know that in my office there is an ear. There is a willingness to work with the varied interests that are out there. This is a great agricultural state. It is a great state of transportation arteries across it, not just waterways. All who are interested in the development, the improvement of the Illinois River waterway are going to have to sit down and talk about change, about the need to roll back existing practices that may hurt river streams and waterways. I think those kinds of things must come, and I just want to add my voice to those of you who have already called for them.

I close on this note. I don't see it much on television anymore, but I remember the anti-litter campaign conducted by one of those national organizations where that native American man turns into the camera after a few shots of littering and abuse of environment, and he has a tear rolling down his cheek. I think you've seen that at one time or another. It's one of the most popular commercials that has ever run. There's too many parts of the Illinois waterway where whether you're a native American or any kind of American a tear would roll down your cheek if you saw or if you even read about the improvements we have *not* made, about the need for further, and in some cases, more drastic action.

I would suggest to each and everyone of you today that we recommit ourselves to this task--that we recognize that the Illinois citizen, no matter from what part of the state he or she comes, must be educated on the valuable resource we have in our very midst, the heartland of Illinois, and the heartland of this nation. Peoria is the perfect city to lead this venture. With a great mayor and great leadership from your industrial community, it makes good sense that you're meeting here in this All-American City, this All-Illinois City. For all of you from up and down that river, believe me, you have my support. You have me as a working partner to improve that river.

Thank you very much, ladies and gentlemen.

CLOSING REMARKS

Roberta M. Parks, Conference Co-Chair

Peoria Area Chamber of Commerce
124 S.W. Adams, Suite 300
Peoria, Illinois, 61602-1388

I would like to reflect for a few moments on the conference and on the river. We have heard a great deal about both current and possible future management strategies for the Illinois river system. I believe that we should each be able to walk away from this two day meeting energized about our individual or corporate role in this system--and that is what will make the difference for the Illinois River.

We all have to take responsibility and we all have to realize that the river is a system; it is not just the bluffs near Starved Rock nor the Lakes in Peoria nor the mouth at Grafton. It is a complete system and we must treat it as such.

We cannot just be concerned about the problems within our *own* particular region of the river. If we do so, we will only create new and different problems for someone else, somewhere else.

When I was asked to co-chair this conference, I wondered "Why me?" I don't have any real connection to the river. I am not a scientist like many of you. My livelihood doesn't directly involve the river. I don't fish or sail or ski or use the river for other recreational purposes. So, "Why me?" I'm not sure I fully answered that question until I began to think about what I wanted to say at the close of this conference today.

I am a voracious reader, so I began to look for a quote or reference in something I had read that would express my feelings about and interest in the river. I found the reference I was looking for in a book that I used to read to my daughters when they were young. I'd like to read to you a brief passage from *Wind in the Willows* by Kenneth Grahame.

To set the stage for you, Mr. Mole has been doing his spring cleaning and cannot tolerate being confined beneath the ground any longer. He burrows out into the sunlight and wanders through a meadow, and I quote:

> He thought his happiness was complete when, as he meandered aimlessly along, suddenly he stood by the edge of a full-fed river. Never in his life had he seen a river before--this sleek, sinuous, full-bodied animal, chasing and chuckling, gripping things with a gurgle and leaving them with a laugh, to fling itself on fresh playmates that shook themselves free, and were caught and held again. All was a-shake and a-shiver--glints and gleams and sparkles, rustle and swirl, chatter and bubble. The mole was bewitched. He was entranced, fascinated.
>
> By the side of the river he trotted as one trots, when very small, by the side of a man who holds on spellbound by exciting stories; and when, tired at last, he sat on the bank, while the river still chattered on to him, a babbling procession of the best stories in the world, sent from the heart of the earth to be told at last to the insatiable sea.

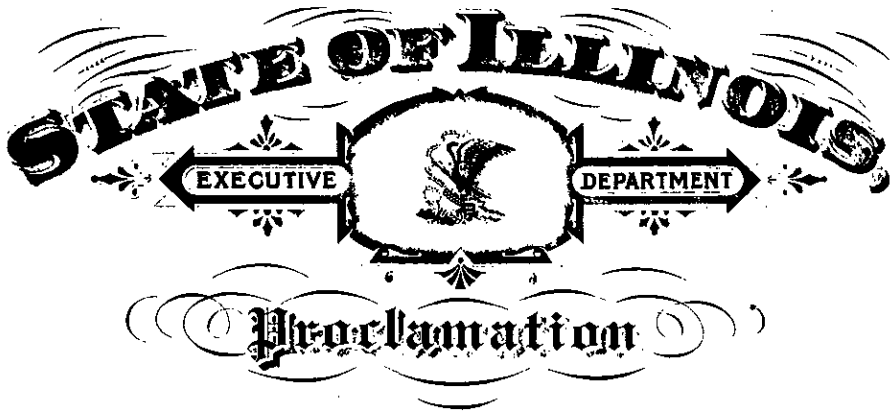
The Illinois River is important to me, as it should be to all of us, because I want my children and grandchildren as well as all of the other children in this state to have the same opportunity to experience the excitement and pleasure that Mr. Mole found when he came upon a river for the very first time.

Thanks to all of you for being a part of this conference. We hope that you have learned from your participation and that the river will benefit from that knowledge. We look forward to seeing you again in two years at the 1993 Governor's Conference on the Management of the Illinois River System.

Appendices

Appendix A

Proclamation



WHEREAS, the Illinois River System is an integral part of our state's geography, history, economy, and ecology; and

WHEREAS, the Illinois State Water Plan Task Force has identified sedimentation and erosion as the top problems our water resources are facing; and

WHEREAS, the Illinois River, its backwater lakes and wetlands, and the natural habitats they once provided are particularly affected by sedimentation; and

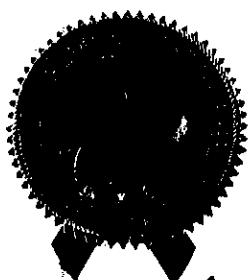
WHEREAS, the continuing degradation of the Illinois River System will severely impact our state's future economical, recreational, and environmental development; and

WHEREAS, our state should embrace an integrated approach to large-river management (viewing rivers as systems) and think and work according to a well-coordinated, efficient, and continuous management program for our river;

THEREFORE, I, Jim Edgar, Governor of the State of Illinois, call for a continuing commitment and expanded cooperation among all state, federal, and local agencies; agricultural, business, and industrial communities; and citizens and private organizations to meet these challenges and ensure the well-being of the ILLINOIS RIVER, preserving and expanding the role of the river as a vital economic, recreational, and environmental resource in our state.

In Witness Whereof, I have hereunto set my hand and caused the Great Seal of the State of Illinois to be affixed.

Done at the Capitol in the City of Springfield, this SIXTEENTH day of OCTOBER, in the Year of Our Lord one thousand nine hundred and NINETY-ONE, and of the State of Illinois the one hundred and SEVENTY-THIRD



George H Ryan
SECRETARY OF STATE

Jim Edgar
GOVERNOR

Appendix B

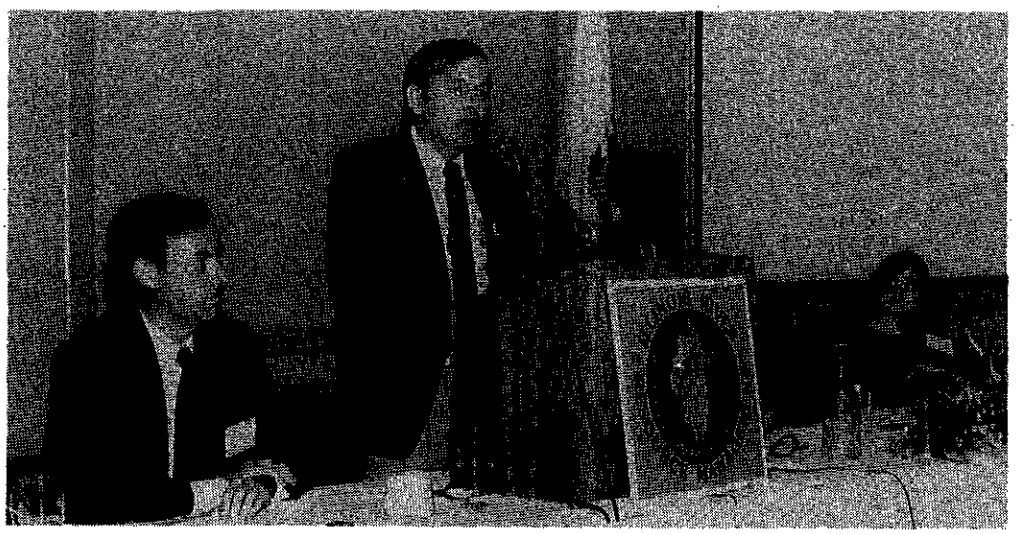
Photographs

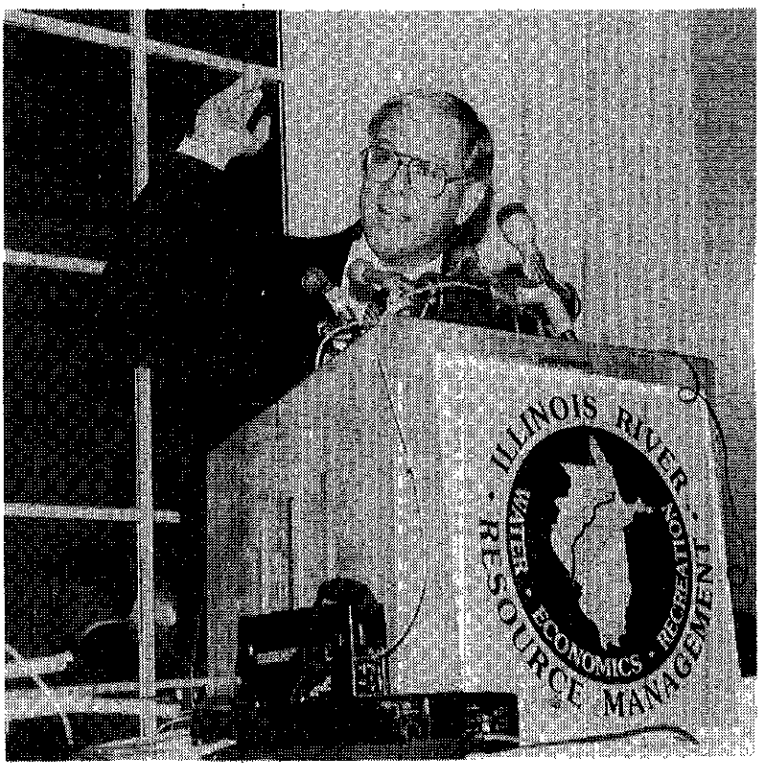
Above left: More than 250 people attended the third biennial conference on managing the Illinois River. Pictured at left are conference organizers Robert Frazee (left) and Roberta Parks. Pictured below is Peoria Mayor James Maloof, who officially welcomed guests to the conference.

Right: Lorin Nevling, Chief of the Illinois Natural History Survey, praised a new publication released by the Water Survey entitled *Illinois River: Working for Our State.*

Below: Patrick Reese (center) discussed the activities of Friends of the Fox River, one of a growing number of volunteer citizens groups dedicated to restoring and preserving Illinois' rivers. Also pictured are Clark Bullard (left) and Beth White (right).

Bottom: James Geiger (center), Chief of the Division of Fish and Wildlife, U.S. Fish and Wildlife Service, outlined new programs for restoring riverine habitat. Also pictured are (seated from left to right): Dick Semonin, Roberta Parks, Henry Holling, Lorin Nevling, and Bonnie Noble.





Left: Lieutenant Governor Bob Kustra wrapped up the conference with a promise to be a working partner to improve the Illinois River.

Below: During a post-conference tour, Don Roseboom, a scientist with the Illinois State Water Survey, described howwillow posts can be used to stabilize stream banks along tributaries to the Illinois River.

Appendix C

Poster Session Participants

Raman K. Raman, Organizer

Forest Park Foundation

Heartland Water Resources Council

Illinois Audubon Society

Illinois Department of Agriculture, Division of Natural Resources

Illinois Department of Conservation

Illinois Department of Energy & Natural Resources

Illinois Environmental Protection Agency, Division of Water Pollution Control

Illinois Natural History Survey

Illinois State Water Survey

Illinois Valley Yacht and Canoe Club

Nature Conservancy, Illinois Field Office

Northeastern Illinois Planning Commission

Pleasure Driveway and Park District of Peoria

Prairie Rivers RC&D

Soil and Water Conservation Society

University of Illinois

- Cooperative Extension Service
- Illinois-Indiana Sea Grant Program
- Water Resources Center

Tri-County Riverfront Action Forum

U.S. Army Corps of Engineers, St. Louis District

U.S. Army Corps of Engineers, Rock Island District

USDA Soil Conservation Service

Woodford County Farm Bureau

The poster exhibits were colorful and diverse. Along with maps, brochures, and buttons, were live fish, computer simulations, and a cluster of zebra mussels. Bill Mathis of Bradley University (top) broused through materials at the Sea-Grant display. Harry Hendrickson, groundwater education coordinator for the Illinois Department of Energy and Natural Resources, disoussed groundwater regulations and educational programs.

Appendix D

Newspaper Clippings

JOURNAL STAR
An employee-owned newspaper
Henry P. Slane, Chairman of the Board · John McConnell, President & Publisher
Barbara Mantz Drake, Editorial Page Editor · Jack Brimeyer, Managing Editor · Shelley Epstein, Associate Editor · Mike Bailey, Associate Editor

Just another dam study?

☐ Enlarging locks to handle more barges shouldn't come at lakes' expense

The big Illinois River conference is over and we now know that pollution, siltation, zebra mussels, pesticides, barge traffic and boaters are sucking the life right out of the Illinois River and Peoria Lake — someday to become Peoria Pond, then Peoria Puddle, then Peoria Mudflat.

So much for the old news. Ho, hum.

The new news is that the U.S. Army Corps of Engineers wants to spend $10 million to determine whether the size of the Peoria locks should be doubled at a cost of $390 million.

On the riverfront

Barge traffic on the Illinois River pumps $1 billion into the Illinois economy annually. Doubling the size of the lock will undoubtedly increase barge traffic on the river — about 18 barges a day now pass through Peoria — as commerce takes the path of least resistance. That means economic growth, which means more tax revenue, which means better schools and highways and other services.

But there are other considerations here.

When barge tows typically the size of two football fields travel the river, they displace large sections of the channel, affecting the hydraulics of the river, disturbing riverbottom sediments and accelerating shoreline erosion. Fur-

Chicago Tribune, Thursday, October 24, 1991 Section 4 9

John Husar
On the outdoors

Dreaded mussels may have benefits

Chicago Tribune

PEORIA—It didn't take those zebra mussels long to get around, after all.

When these freshwater invaders first were discovered in Michigan's Lake St. Clair in 1988, we were warned they'd soon be everywhere.

In a year, they had filled Lake Erie. By the next, they were in every other Great Lake. Billions now smother reefs, intake pipes and boat hulls off Chicago. And as predicted, they're now into the inland waters.

The Illinois River's first zebra mussel was reported June 18 by a commercial clammer. He found it attached to a clam. They've since been found at power plants all along the Illinois, Mississippi and Ohio Rivers. Scientists think they're probably in every Great Lake tributary and beyond.

"They're as far north on the Mississippi as Lacrosse, Wis., and as far south as Alton," said Ellen Marsden, whose office is zebra mussel central for the Illinois Natural History Survey.

"And that's just today's status report," she told a high-powered Governor's Conference on the Management of the Illinois River System this week. "The situation changes daily."

ST. LOUIS POST-DISPATCH THURSDAY, NOVEMBER 7, 1991

Flow Of Data From Many Students Benefits Waterways

By Bill Vogrin
Of The Associated Press

A university professor from Edwardsville is making a splash at high schools in four states with a project that's seeking ways to protect the region's beleaguered waterways.

the Illinois Rivers Project.

Already it's making waves in communities throughout Illinois by getting students and their teachers excited about protecting fragile river ecosystems and encouraging a sense of activism to protect natural resources.

teachers excited by giving them a cause to fight for," he said. "At the same time, we're developing a network of sensors up and down our rivers who are compiling valuable data about the health of the rivers."

A4—ILLINOIS AGRI-NEWS Friday, November 1, 1991

Agri-business termed 'serial killer of environment'

By STEVE KUKOLLA
Agri-News Publications

PEORIA, Ill. — Agricultural business was swamped with criticism during the 1991 Governor's Conference on the Management of the Illinois River System, with one speaker labeling farming a serial killer of the environment.

Speaking in support of a proposal that would allow the state to buy land from farmers for use as conservation areas, Bullard compared agri-business to a killer who murders all but a few remaining people, and then demands payment not to kill them.

"What I'm asking for is support for the idea of permanently protecting, as soon as possible, the best 5 percent or

the land, including hunting and fishing rights and the right to prohibit public access.

Bullard said landowner participation in the program would be totally voluntary. Prices would be negotiated to reflect the value of the rights sold and retained like selective timber harvest, limited grazing or controlling

about similar programs in other states, and was still willing to discuss the proposal, although Bullard has apparently given up on Farm Bureau.

"I don't know if the board will discuss this any further ... he (Bullard) has burned a lot of bridges here today," she said.

Bullard is convinced that IFB had no

Pekin Daily Time

Price 35¢ Serving Tazewell and Mason Counties © The Pekin Daily Times Wednesd

Water quality up, new locks proposed

By TAMARA L. ALDUS
Times staff writer

PEORIA — The Illinois River:

Traffic is up.

Water quality has improved.

And in the next decade, Donald R. Vonnahme sees a lot being done to the river, from modernizing the waterway to restoring destroyed habitat and preserving what's left.

new locks. It should be completed in five years.

Traffic on the river is up from 1.7 million tons a year in 1935 to 46 million tons a year in 1990, Vonnahme said. It continues to grow, he said.

"The Illinois River system has fallen victim to a variety of destructive and wasteful environmental management practices that has threatened its

Station, the two-inch creature is causing panic.

The mussel, originally from Europe, can decrease the plankton needed for the food chain, can clog spawning grounds, suffocate native clams, deplete oxygen and hinder operation of water and power plants by clogging access to the river.

"We're not going to get rid of zebra

Peoria, Illinois

JOURNAL STAR

WEDNESDAY, Oct. 23, 199

SERVING CENTRAL ILLINOIS SINCE 1855 *** AN EMPLOYEE-OWNED NEWSPAPER

New navigation lock considered for Peoria

☐ Corps of Engineers says new lock would benefit barge traffic

By MARNIE MEAD OBERLE
of the Journal Star

canal at Marseilles Lock, said Col. John R. Brown, commander at the Rock Island District of the U.S. Army Corps of Engineers.

The current lock at Peoria is about 600 feet. Increasing the

lion.

Both men were in Peoria Tuesday to participate in the 1991 Governor's Conference on the Management of the Illinois River System.

Illinois has 2,000 miles of

system is very, very important," he said.

The lock at LaGrange south of Beardstown poses the longest delay for barge traffic in the state and ranks in the top 20 nationwide, Brown said. Peoria

Peoria lock
Opened: 1938
Cost: $3.4 million
Lock size: 600 feet
Operated by: U.S. Army Corps of Engineers.

Monday, October 28 1991 Page 3 FarmWeek

'Evil' farmers blamed for river's woes

By Ray Shipman

An environmentalist panel last week called for mandatory registration of farming practices as a solution for the Illinois River's problems with one panelist comparing farmers to serial killers and another calling some farmers "evil forces of darkness."

Clark Bullard, University of Illinois professor and Committee for River and Stream Protection director, made the serial killer comparison.

Using a parable, he compared farmers' alleged killing of environmental habitats with actions of a serial killer in a town that continued his actions as long as he killed unarmed citizens. As the population dwindled, the killer was asked to stop. He agreed to do so if he were paid.

The townspeople then were faced with killing him to stop the killing or paying him.

The public either "indulges on the serial killer's rights by taking away his freedom) or pays him to stop. That's exactly what's happening with agribusiness," Bullard told about 200 participants at the Governor's Illinois River management conference in Peoria.

Previous speakers had said the river's water quality had improved substantially - although more work was needed, especially with sedimentation - and farmers' conservation plans and such programs as the Conservation Reserve Program have controlled soil losses and added wildlife habitat.

Scientists and government agency officials addressed a lengthy list of factors, in addition to agriculture, that impact the river. Those ranged from the number and size of river barges to increased water flow from urban areas to stream channelization projects several decades ago. No farmers were on the conference program.

However, environmentalists focused on agriculture and proposed several ideas ... most needing state funding.

A statewide watchdog group of citizens and schoolchildren could help collect data and learn about river pollution problems, said Patrick Reese, president of Friends of the Fox River Inc. Data collection and river monitoring programs could be expanded from high school students to fourth through sixth graders, Reese said. The data could be added to state agency information.

The Friends' goal is to expand its current river watch program from 70 classes to 270 schools. The group will discuss its plan with the governor and heads of the Illinois Department of Conservation and the Environmental Protection Agency.

Mary Ross of the Sierra Club's Illinois Chapter said the state should require farmers to develop and implement pollution-prevention plans. Siltation is the river's major problem and "agriculture is probably the major source in both," Ross said.

Some farmers are concerned and try to stop erosion, but others pollute either because they're ignorant or "evil forces of darkness," Ross said.

The U of I's Bullard proposed a voluntary state program of landowners selling conservation easements on river and stream banks. The program would cost the state $25 million annually over 10 to 20 years, he said. He suggested money could be raised by water sale taxes, pollutant taxes, or by taxing water drainage districts, holding "farmers responsible for whatever (silt) comes out of their drainage district."

Ironically, Bullard said he was in a minority of environmentalists who want to work with farmers and the agribusiness lobby to get funding for his proposal, but he criticized Illinois Farm Bureau for its "resounding silence" after his meeting nearly two years ago with some IFB directors and staff.

Nancy Erickson of IFB's governmental affairs division countered Bullard's version, reading from an IFB letter to Bullard that the organization was intrigued but had questions about his proposal and looked forward to the next discussion. Bullard had asked IFB staff to research other states' conservation easement programs for him, which the staff did. "We thought we were moving in a good direction," Erickson said.

Bullard responded that he would like to continue discussion with IFB and any other ag groups about his idea.

A Cass County Farm Bureau member pointed out to participants that the conference was scheduled in the middle of harvest and agriculture speakers weren't on the program. "If agriculture is going to be a major topic, then people hosting the meeting should make sure agriculture is represented," said P. John Taylor, Virginia, a member of the 1988 national policy wetlands forum.

Conference highlights

In other sessions from the Governor's Illinois River management conference it was reported:

- The U.S. Geological Survey learned by tracing elements in sediment that are unique to the Chicago urban area that, 40 percent of Illinois River sediment originated in the Des Plaines River according to Arthur Schmidt, supervisory hydrologist with the national water-quality assessment program.

Schmidt said water samples from two urban sites on the Des Plaines River and two agricultural sites from the Kankakee River showed insecticides present in 88 percent of the urban samples and 12 percent of the agricultural samples. Samples were taken in 1988 and 1989.

Samples from agricultural areas along the Kankakee and Iroquois rivers in 1990 were analyzed for atrazine. Atrazine at at least one microgram per liter was detected in 98 percent of the samples. In half the samples, the levels exceeded the proposed Environmental Protection Agency limit of three micrograms per liter. Most of the samples were collected during storm runoff periods.

- Illinois Environmental Protection Agency (IEPA) surveys of the upper Illinois River show substantial improvement in water quality from 1978 to 1990, although that quality is still the poorest in the river basin, said Howard Essig, IEPA aquatic biologist. Quality in the lower parts of the river haven't changed much over the same period. However, sediment is still a problem.

- Products shipped riverwide on the Illinois River are expected to increase to 55 million tons by 1995, which would continue to make it No. 4 nationally for the most tonnage, according to Paul Soyke, chief of the U.S. Army Corps of Engineers' Rock Island District economic and social analysis planning division.

Illinois River use saves $326 million annually in transportation costs, a 40 to 70 percent savings for most commodities. For example, it costs $14,000 to transport a barge of grain from Peoria to New Orleans by river, but would cost $28,000 to send the same load by rail. Last year, river use saved more than $80 million in corn transportation costs.

Soyke said locks at Peoria and La Grange are expected to reach capacity in the next 10 years and studies indicate new locks are needed. "The consumer pays as a result of delayed tows as the river gets more congested," he said.

Kustra adds his voice for river improvement

By Ray Shipman

Lt. Gov. Bob Kustra warned changes needed to improve the Illinois River "won't all be easy" and proceeded to list farming practices among the items need ing improvement.

Kustra urged participants at last week's Governor's Illinois River management conference to stop talking about the river's problems and start discussing specifics. "You have to grab the bull by the horns and make something happen," he said.

Along with farming practices, Kustra's list included navigation changes and development of model flood plains. Such changes may "eventually take on the force of law," he said.

Asked about the possibility of state funds for river projects, Kustra said that would be difficult to do next year, but not all decisions hinge on dollars and cents.

Kustra said the farming community may need some education about the relationship of the river to land along it.

"Sedimentation and the erosion problem is a very serious one," Kustra said. He mentioned particular concern for backwater lakes along the river.

The lieutenant governor let it be known his interest in the Illinois River was more than just that of a state official. He's personally interested because he enjoys fishing and spoke fondly of fishing trips he took as a child with his father.

He compared the situation to a filter commercial in which an Indian cried. "For too many parts of Illinois' waterways ... a tear would roll down your cheek if you saw or even read about the improvements not made."

Kustra told conference participants they had an ear and a willing partner in the lieutenant governor's office. "All those interested in improving the waterway have to sit down and discuss changes," he said. "I want to add my voice to those of you already calling for it."

B2 JOURNAL STAR, Peoria, Thursday, O

River needs more work, Kustra says

☐ Lieutenant governor tells those attending river conference that the next step is action

By MARNIE MEAD OBERLE
of the Journal Star

Illinois' rivers are cleaner now than in the past, but there's still a lot more work to do, Lt. Gov. Robert Kustra told the 1991 Governor's Conference on the Management of the Illinois River System.

Kustra, the keynote speaker for the final day of the conference at Hotel Pere Marquette, didn't commit to any specific

Appendix E

Conference Program

Tuesday, October 22

9:15-9:30 Call to Order
"Progress with the Management of the Illinois River System"
Robert Frazee, *Conference Co-Chair*
University of Illinois, Cooperative Extension Service

Welcome
Mayor James Maloof
City of Peoria

James Christopher
Peoria County Board

Session I: PERSPECTIVES ON THE OVERALL MANAGEMENT OF THE ILLINOIS RIVER

9:30-10:30 **Richard Semonin,** *Moderator*
Illinois Department of Energy and Natural Resources, State Water Survey

"Perspectives on the Future Management of the Illinois River System"
Donald R. Vonnahme
Illinois Department of Transportation, Division of Water Resources

"St. Louis District Corps of Engineers: Employing Sustainable Development on the Illinois River—A Natural Resource Perspective"
James D. Craig
U.S. Army Corps of Engineers, St. Louis District

"North Central Division Perspective of the Management of the Illinois River"
John D. Brown
U.S. Army Corps of Engineers, Rock Island District

Session II: RIVER-BASED RESOURCES

10:45-11:55 **Lorin Nevling,** *Moderator*
Illinois Department of Energy and Natural Resources, State Natural History Survey

"Freshwater Mussels of the Illinois River: Past, Present, and Future"
Kevin S. Cummings
Illinois Department of Energy and Natural Resources, State Natural History Survey

"Illinois River Fisheries and Wildlife Resources"
Michael W. Conlin
Illinois Department of Conservation, Division of Fisheries

"Economic Impacts of Barge Transportation"
Paul Soyke
U.S. Army Corps of Engineers, Rock Island District

"Tourism Resources Along the Illinois River"
Martin R. Botkin
Western Illinois University

Noon-1:30 pm Luncheon
Robert Frazee, *Moderator*
University of Illinois, Cooperative Extension Service

Invocation
Bonnie Noble
Heartland Water Resources Center

Featured Speaker
James G. Geiger
Chief, Division of Fish and Wildlife Management, U.S. Fish and Wildlife Service

Session III: ENVIRONMENTAL CONCERNS

1:45-3:15 **Steve Havera,** *Moderator*
Illinois Natural History Survey

"Physical and Biological Impacts of Navigation"
Nani G. Bhowmik
Illinois Department of Energy and Natural Resources, State Water Survey
Kenneth S. Lubinski
U.S. Fish and Wildlife Service

"Chemical and Biological Monitoring of the Upper Illinois River"
Howard W. Essig
Illinois Environmental Protection Agency

"Sediment and Water Quality in the Upper Illinois River"
Arthur R. Schmidt
U.S. Geological Survey

"Overview of the Zebra Mussel Invasion: Biology, Impacts, and Projected Spread"
J. Ellen Marsden
Illinois Department of Energy and Natural Resources, State Natural History Survey

Session IV: COMMUNITY IMPACT

3:30-4:30 **Roberta M. Parks,** *Moderator*
Peoria Area Chamber of Commerce

"The Illinois Rivers Project: Using High School Students to Monitor Illinois Rivers"
Robert Williams
Southern Illinois University, Edwardsville

"Positive Impacts of the Par-A-Dice on Riverfront Development"
Dave Schielein
Contractor

"Economic and Tourism Impacts of the Par-A-Dice on the Illinois River"
Carole Halicki
Par-A-Dice

5:30-8:00 River Cruise and Dinner
Aboard the *Spirit of Peoria,* at the Boatworks

Wednesday, October 23

Session V: MANAGEMENT STRATEGIES

8:00-10:15

William P. White, *Moderator*
Illinois Department of Conservation, Division of Planning

"Recreational Greenways as an Environmental Management Strategy"
Rick Pietruszka
Illinois Department of Conservation, Division of Planning

"Soil Erosion Control—The 1990 Farm Bill"
Thomas J. Krapf
U.S. Department of Agriculture, Soil Conservation Service

"Streambank and Habitat Management Strategies Along Illinois River Tributaries"
Donald P. Roseboom
Illinois Department of Energy and Natural Resources, State Water Survey

"Illinois River Projects and the Environmental Management Program"
Barry Drazkowski
U.S. Fish and Wildlife Service

"Need for a Comprehensive Management Plan for the Illinois River Basin"
Misganaw Demissie
Illinois Department of Energy and Natural Resources, State Water Survey

Session VI: RIVER ISSUES AND INITIATIVES

10:30-12:00

Richard Mollahan, *Moderator*
Illinois Environmental Protection Agency

"Getting to the Urban Waterfront: Where Do We Start?"
Beth White
Friends of the Chicago River

"Riverwatch Network—A Model Volunteer Monitoring Program for Illinois"
Patrick Reese
Friends of the Fox River

"Environmental Agenda for Clean Water"
Mary A. Ross
Sierra Club, Illinois Chapter

"Environmental and Economic Significance of Wetlands"
Deanna Glosser
Audubon Council of Illinois

"Environmental Challenge to Illinois Agriculture"
Clark W. Bullard
Committee for River and Stream Protection

Noon-1:30 pm

Luncheon
Henry Holling, *Moderator*
Caterpillar Inc.

Invocation
Bonnie Noble
Heartland Water Resources Council of Central Illinois

Closing Remarks
Roberta M. Parks, *Conference Co-Chair*
Peoria Area Chamber of Commerce

2:00-4:30

Tour of Richland Creek Streambank Stabilization Demonstration Area

Appendix F

Participants

Agee, Steve
Student, East Peoria High School

Aldus, Tamara
Pekin Times

Alexander, Sue & Bill
Heartland Water Resources Council

Armstrong, Scott
Student, Bradley University

Austin, Lee
Environmental Science & Engineering, Inc.; Heartland Water Resources Council

Austin, Tom
USDA, Agriculture Stabilization & Conservation Service

Awong-Taylor, Judy
Environmental Science & Engineering, Inc.

Bachman, Richard
Woodford County Farm Bureau

Baietto, Mike
Peoria Park District

Bair, Dina
WHOI Channel 19

Baker, Richard
U.S. Army Corps of Engineers

Baldwin, Jim
Caterpillar Inc.; Heartland Water Resources Council

Baldwin, Lou
Illinois River Valley Association

Bauman, Bill
Illinois Institute of Technology

Beckman, Bill
East Peoria High School

Beer, Carol
Heartland Water Resources Council

Beers, Hettie
Peoria Park District

Bell, Peter
Environmental Science & Engineering, Inc.

Beltremacchi, Peter
Illinois Institute of Technology

Bender, Dave
Lt. Governor Kustra's Office

Benjamin, Orrin
WMBD Channel 31

Beno, Michael
Peoria Park District

Bersin, Stan
Daily & Assoc. Engineers Inc.; Heartland Water Resources Council

Bevenour, Don
East Peoria High School

Bhowmik, Nani
Illinois State Water Survey

Bialeschki, Jacob
Woodruff High School

Bjorklund, Richard
Bradley University

Blanchard, Stephen
U.S. Geological Survey

Blye, Charles & Mrs.
Tri-County Riverfront Action Forum; Heartland Water Resources Council

Bogner, Bill
Illinois State Water Survey

Botkin, Martin
Western Illinois University

Bowersox, Dan
Illinois State Water Survey

Boyle, John
Tri-County Regional Planning Commission

Britton, Edward
U.S. Fish & Wildlife Service

Brown, David
Peoria County Board; Heartland Water Resources Council

Brown, John
U.S. Army Corps of Engineers

Bruce, Darlene
Peoria League of Women Voters

Brummitt, Jenni
East Peoria High School

Bruyn, Rodger
Bureau County Farm Bureau

Bullard, Clark
Committee for River and Stream Protection

Burhans, Bob
Clark Engineers MW, Inc.

Burkett, Dale
Illinois Department of Conservation

Burns, Steve
Central Illinois Light Company; Heartland Water Resources Council

Butts, Thomas
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Byrd, Angie
Washington High School

Chadwick, Theresa
USDA, Soil Conservation Service

Christianson, Carl
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Cima, John
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Clark, Gary
IDOT, Division of Water Resources

Coffey, Jill
Illinois Valley Central

Colten, Craig
Illinois State Museum

Compton, Buddy
Orguls Co.

Condit, Don & Amanda
Illinois River Soil Conservation Task Force; Heartland Water Resources Council

Conlin, Michael
Illinois Department of Conservation

Copeland, Tracy
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Corso, Angela
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Cox, Michael
U.S. Army Corps of Engineers

Craig, James
U.S. Army Corps of Engineers

Crow, Jo
Metamora Grade School

Crumby, Angie
East Peoria High School

Cummings, Kevin
Illinois Department of Energy & Natural Resources

Czapar, George
University of Illinois, Cooperative Extension Service

De Vos, Alois
U.S. Army Corp of Engineers

Demissie, Misganaw
Illinois Department of Energy & Natural Resources

Dimmick, Mike
WEEK Channel 25

Dobbelaire, Charles & JoAnn
East Peoria City Council; Heartland Water Resources Council

Donels, Bill
Illinois Department of Conservation

Drazkowski, Barry
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Duckman, Howard
U.S. Environmental Protection Agency

Dugan, Jim
WCBU-FM90

Dutt, Owen
U.S. Army Corps of Engineers

Dunne, Erin
East Peoria High School

Edwards, Tom
Sierra Club

Ehnle, Kurt
Soil & Water Conservation District; Heartland Water Resources Council

Ehresman, Jack
Peoria Journal Star/Outdoor Life

Eichelkraut, Richard
Izaak Walton League Illinois; Heartland Water Resources Council

Eicken, Gary
Assoc. of Illinois Soil & Water Conservation Districts

Ellis, Monica
U.S. Army Corps of Engineers

Erickson, Nancy
Illinois Farm Bureau

Essig, Howard
Illinois Environmental Protection Agency

Fehr, Doug
Peoria County Farm Bureau; Heartland Water Resources Council

Forbeck, Gerald
Bureau County Soil & Water Conservation District

Fournier, Ron
U.S. Army Corps of Engineers

Frazee, Bob
University of Illinois, Cooperative Extension Service; Heartland Water Resources Council

Fuller, Jack
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Georgi, Michelle
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Girard, Tanner G.
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Gittinger, Jack
LZT Associates

Glosser, Deanna
Audubon Council of Illinois

Goettel, Robin
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Goff, Jerry
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Grimm Erica
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Groth, Eric
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Par-A-Dice

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Havera, Stephen
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Herrison, Dominique
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Hooker, John
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Howard, Timothy
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Hubbert, Jon & Mrs.
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Huggins, Jack & Carol
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Hullinger, David
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Husar, John
Chicago Tribune

Ingram, Owen
Environmental Consultant

Kammueller, Jim
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Keefer, Laura
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Kern, Ron
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Koch, Bill & Mrs.
Varna, Illinois

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Krapf, Tom
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Kubillus, Sandy
Friends of the DesPlaines River

Kukolla, Steve
Illinois Agri-News

Kustra, Robert
Lieutenant Governor of Illinois

LaHue, Beverly
Peoria Park District

Lambie, Pete
Woodford County Board

Langewisch, Edwin
Medina Township Trustee

Lant, Christopher
Southern Illinois University, Dept. of Geography

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Marsden, J. Ellen
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Mayer, Christine
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Meadows, Jim
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Miller, Michael
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Miller, Tom
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Mock, Dean
Willow Knolls Residents Assn.

Mollahan, Rick
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Monzingo, Rich
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Morse, Wally
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Nelson, Michael
Gustavus Adolphus College

Nelson, Richard
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Pinkerton, Bob
Southwestern Illinois Planning

Pocock, John
Prairie Farmer Magazine

Price, Sandra
Peoria Area Chamber of Commerce

Oberle, Marnie Mead
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Ristau, Scott
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Robinson, Jean Ann
Canal Corridor Association

Rone, Gil
NRDC

Roseboom, Donald
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Sierra Club, Illinois Chapter

Rudolphi, Stephanie
Illinois Valley Central

Runyon, Darwin
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Sleeth, Shad
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Schanzle, Robert
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Schatz, Pat
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Schielein, Dave
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Schneider, Nick
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Schroering, Susan
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Scott, Virginia
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Semonin, Richard
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Shackleford, Dana
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Shipman, Kay
Farm Week

Shults, Steven
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Simmons, John
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Simpson, Doug
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Siwicke, George Ann
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Attorney, Peoria, Illinois

Smith, Jeff
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Smith, Jill
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Socha, Dawn
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Representative Tom Walsh's Office

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Hey and Associates

VanWinkle, Steve
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Variakojis, John
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Associated Press

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Vonachen Industrial Supplies, Inc.

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Warner, Kathy
Sierra Club

Webber, Warren
The Detweiller Trust

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White, Bill
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